

GUIDELINES FOR ADMINISTERING OIL AND GAS ACTIVITY ON STATE FOREST LANDS



FORESTRY

4th Edition

Revised 2016

The objective of this document is to establish and communicate a set of “guidelines” and Best Management Practices (BMPs) that provide consistent, reasonable and appropriate direction for managing oil and gas activity on State Forest lands in accordance with the Bureau’s mission.

*Commonwealth of
Pennsylvania*

*Department of
Conservation and
Natural Resources*

Bureau of Forestry

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1. Purpose

The Department of Conservation and Natural Resources (DCNR), Bureau of Forestry (BOF or Bureau) manages Pennsylvania's 2.2 million-acre state forest system for a variety of resources, uses and values including scenic beauty, recreational opportunities, timber, plant and animal habitats and minerals.

The Bureau of Forestry's mission statement clearly identifies the ***environmentally sound utilization of mineral resources***, which includes oil and gas, as a key component of state forest management. Oil and gas management decisions must be based on the *mission* and work toward ensuring the long-term health, viability, and productivity of the Commonwealth's forests and to conserve native wild plants.

Mission

The mission of the Bureau of Forestry is to ensure the long-term health, viability and productivity of the Commonwealth's forests and to conserve native wild plants.

The Bureau of Forestry will accomplish this mission by:

Managing state forests under sound ecosystem management, to retain their wild character and maintain biological diversity while providing pure water, opportunities for low-density recreation, habitats for forest plants and animals, sustained yields of quality timber, and environmentally sound utilization of mineral resources.

Decisions, both policy and on-the-ground, are guided by many sources of information including: laws and regulations; public input; the [State Forest Resource Management Plan](#) (SFRMP); gas leases and contracts; and guidelines and procedures. Examples of legislation or regulations that influence decisions include:

- ***Act 18 (Conservation and Natural Resources Act)***: This Act created the Department of Conservation and Natural Resources in 1995 and authorizes the department to arrange and execute contracts or leases in the name of the Commonwealth for the mining or removal of any valuable minerals that may be found in state forests.
- ***State Forest Rules and Regulations***: Lawful rules and regulations provided under Act 18 for "land which is owned or leased by the Commonwealth and which is administered by the Bureau of Forestry."
- ***Applicable Department of Environmental Protection statutes and regulations***, including but not limited to: Chapter 78 (Oil and Gas Wells), Chapter 102 (Erosion and Sedimentation Control), Chapter 105 (Dam Safety and Waterway Management)

The Commonwealth owns the subsurface rights for most of the 2.2 million acres within the state forest system; but approximately 15% of these rights are privately owned. These "severed" lands present a unique challenge to land managers as management of the surface lands may, at any point in time, be affected by the rights of the subsurface owner to reasonably develop their property.

The Bureau authorizes the development of oil and gas resources and/or storage of natural gas on state forest land through lease agreements. The contracts contain strong environmental provisions meant to protect the Commonwealth's interests while ensuring the conservation and management of other state forest resources, uses, and values. The primary focus of Commonwealth lessees is the production of methane or natural gas; however the formations being developed are also capable of producing natural gas liquids (i.e. propane, butane etc.) and oil depending on the extent of thermal maturation of the subsurface geology. The production of natural gas liquids is common in southwest Pennsylvania while the majority of oil production has occurred in the northwest portion of the state.

The purpose of this document is to establish and communicate a set of "guidelines" and Best Management Practices (BMPs) to Bureau staff, oil and gas operators and the public. The administration of oil and gas development is complicated by a myriad of existing ownership rights, the quantity and various vintages of existing lease agreements, the number of private operators involved and rapid advancements in oil and gas technologies. This document provides consistent, reasonable and appropriate direction for managing oil and gas activity on state forest lands in accordance with the Bureau's mission.

2. Key Principles

According to the Bureau of Forestry's *State Forest Resource Management Plan*, "Subsurface geologic resources and unique geologic features on state forest land are managed to provide long-term benefit to the citizens of the commonwealth while adhering to the principles of ecosystem management." When administering the activity, whether through the *Lease* or other agreement with a private owner, several key principles should guide management decisions:

Management of Privately Held Subsurface Rights:

The Bureau of Forestry will promote forest sustainability by managing the social and ecological impacts of oil and gas development according to lease agreements and rights afforded to private owners of subsurface oil and gas interests.

In situations where subsurface rights are owned by private interests, the Bureau of Forestry will strive to apply the principles and guidelines contained in this document by: 1) fostering a close working relationship with the private owners and operators; and 2) educating them about sound ecosystem management principles.

It is paramount that Bureau staff recognize and understand the rights of private subsurface owners while considering the *mission statement* of the Bureau of Forestry. Staff should strive to make decisions which are reasonable and in the best interest of the resource and the citizens of the Commonwealth.

The Bureau will make a reasonable attempt to secure a *Surface Use Agreement* with private subsurface interests to better manage the use of the surface during development activity so that the management goals of the Bureau may be achieved as often as possible.

Key Principles

- The Bureau of Forestry is responsible for managing and conserving the resources, uses and values of state forest lands. Multiple activities occurring in close proximity to one another may present conflicts. The Bureau strives to balance potential conflicts to ensure the long-term viability of those resources for the Commonwealth.
- The safety of workers and the general public is a very important consideration of management decisions.
- The *Lease* is a binding contract and the Bureau of Forestry is obligated to enforce the *Lease* provisions on behalf of the Commonwealth. Bureau of Forestry staff should have a detailed understanding of the applicable leases in order to successfully manage oil and gas activities on state forest lands in accordance with the Bureau's mission. Historic leases are referred to as "legacy leases."
- These guidelines provide standards and direction to aid Bureau staff in the management of oil and gas activities on state forest lands. Staff should consider the existing and future resources, uses, and values in play; recognize the associated balances and trade-offs; and exercise professional judgement to make decisions which are consistent with the Bureau's mission and protect the Commonwealth's interests now and in the future.
- The Pennsylvania Department of Environmental Resources (DEP) has jurisdictional and regulatory authority for oil and gas activities within the Commonwealth including the enforcement of Oil and Gas Wells (Chapters 78), Erosion and Sedimentation Control (Chapter 102) and Dam Safety and Waterway Management (Chapter 105).
- Bureau staff, operators, jurisdictional authorities and regulators should communicate and work cooperatively to establish constructive relationships that provide consistent, reasonable and environmentally- sound development of oil and gas resources.
- Planning is an important component of state forest management. The Bureau and operators should work together to review and discuss work plans relating to oil and gas development, production, and transmission prior to the initiation of the activity (for leased and private ownership). Planning is a mutually-beneficial tool that promotes efficiency and cost effectiveness while minimizing adverse impacts to state forest resources, uses and values.
- Bureau of Forestry staff will utilize adaptive resource management to monitor oil and gas activities on state forest lands. This approach includes the documentation of impacts – both beneficial and adverse. The knowledge and experience gained from these efforts will promote continued understanding and improvement of the guidelines, best management practices and the Bureau's ability to manage oil and gas activity. Staff should inspect and monitor active operations on a weekly basis. More frequent inspections should occur as activity and weather conditions dictate. Site inspections are considered a very high priority for all oil and gas management personnel.
- The siting of roads, pipelines, impoundments, compressor stations, well pads and associated oil and gas infrastructure should consider existing disturbances such as road networks, rights-of-way corridors or abandoned mine lands in order to minimize forest conversion and impacts to state forest lands. But it is equally important to consider aesthetics, recreational experiences, and the wild character of the forests when making these decisions.



Figure 1-1. View of the Pine Creek Valley- This valley is renowned for its recreational opportunities and experiences. Early planning efforts recognized this exceptional resource and restricted oil and gas activities within the valley.

3. Bureau of Forestry Gas Management Team

The Bureau of Forestry Gas Management Team (GMT) facilitates the management of gas exploration, development, production and transportation across State Forest lands. This team includes the majority of state forest districts and central office program staff. The management of the gas program includes all oil, gas and mineral (OGM) activity on state forest land. This includes leases issued by the Commonwealth, private ownership subject to a surface use agreement, and severed rights.

The team will be responsible for all day-to-day management of the gas program including:

- liaison to the operator's field staff and operations staff
- seismic surveys
- oil and gas infrastructure planning and siting
- freshwater acquisition and transportation
- wastewater treatment, storage, transportation and disposal
- invasive plant monitoring and management
- site reclamation and restoration
- monitoring of oil and gas activities
- community contact
- other tasks that accompany oil and gas management

GMT meetings will occur regularly and include training in oil and gas issues, problem solving, sharing lessons learned, and discussing issues regarding the activities in the various districts. The Minerals Division will be the lead in planning and facilitating these meetings.

The following sections and divisions within the Department are assigned positions within the GMT and have duties that directly relate to the management of oil and gas activity on state forest land:

Headquarters:

Includes the following offices, divisions, and sections which can be reached at: (717)-787-2703

Deputy Secretary's Office

Bureau of State Parks

Director's Office

Division of Resource Planning & Information

Division of Operations and Recreation

Division of Forest Fire Protection

Division of Conservation Science & Ecological Resources

Rural & Community Forestry Section

Communications Section

Silviculture Section

Minerals Division

State Forest Districts**D2 - Buchanan State Forest:**

(717) 485-3148

D4 - Forbes State Forest:

(724) 238-1200

D6 - Gallitzin State Forest:

(814) 472-1862

D8 – Clear Creek State Forest:

(814) 226-1901

D9 - Moshannon State Forest:

(814) 765-0821

D10 - Sproul State Forest:

(570) 923-6011

D11 – Gifford Pinchot State Forest:

(570) 945-7133

D12 – Tiadaghton State Forest:

(570) 753-5409

D13 - Elk State Forest:

(814) 486-3353

D14 – Cornplanter State Forest:

(814) 723-0262

D15 - Susquehannock State Forest:

(814) 274-3600

D16 - Tioga State Forest:

(570) 724-2868

D19 – Delaware State Forest:

(570) 895-4000

D20 - Loyalsock State Forest:

(570) 946-4049

Additional contact information is available upon request. Please contact a state forest district or the central office.

4. Recreation and Public Safety



Figure 4-1. Public recreation, such as primitive backpacking, is a primary use of state forest lands.

Public lands comprise 30% of the 17 million acres of forestland in Pennsylvania. State forest land alone encompasses nearly 2.2 million acres. The Commonwealth's citizens have a rich and long-standing outdoor heritage which is intrinsic to these public lands.

State forests provide unique opportunities for outdoor recreation due to their large, contiguous land area. Generations of Pennsylvanians have been drawn to the wild, undeveloped character of the state forests and millions more are attracted annually. Public recreation is one of the primary uses of the state forest system and it continues to grow. The Bureau encourages low-density dispersed recreation and strives to promote and enhance these types of activities. State forest visitors should be assured of a high quality outdoor experience. Recreational opportunities on state forest lands are focused on compatibility with the forest ecosystem or forms of recreation not represented by other land uses.

Today there are many state forest users whose activities and views sometimes conflict. Some visitors prefer more traditional forms of recreation, such as scenic driving sight-seeing, hiking, hunting, fishing, horse-back riding, and cross-country skiing; while others utilize the same area for less traditional recreational activities, such as riding ATVs, snowmobiles, mountain bikes, hang gliders, and dog sleds. The Bureau of Forestry will follow ecosystem and multiple-resource management practices for all gas-related activities to minimize conflicts and adverse impacts to these diverse recreation activities.

Oil and gas development is a highly industrialized activity which starkly contrasts with the expectations and experiences of state forest users. Gas development activities dramatically increase the potential for adverse impacts and conflict through: increased traffic volumes; elevated noise levels; and adverse aesthetic impacts. These potential impacts are dependent upon a visitor's location, activity and anticipated recreational experience within the state forest.

New leases and rights-of-way will be prohibited on designated state forest wild and natural areas. Rights-of-Way expansions will be considered on an individual basis and only when the activity will not harm the feature for which the area was designated and is justified as the alternative that will result in the least overall ecological damage to state forest lands. The Bureau has designated 60 state forest natural areas and 18 state forest wild areas which account for 11% of state forest lands. Other areas excluded from surface activity include State Parks where the Commonwealth owns the subsurface rights.

State forests provide unique opportunities for dispersed, low-density outdoor recreation that can be obtained only through large blocks of forest. Natural gas activities are incompatible with the user's anticipated recreational experiences within primitive and semi-primitive non-motorized zones as identified through the Recreation Opportunity Spectrum (ROS) inventory and planning tool. Planning efforts should strive to maintain the integrity and extent of existing primitive and semi-primitive non-motorized zones.

Recent lease offerings delineated areas within the tract that restrict gas development activity. Designated *Non-Development Areas* preclude surface disturbance or development of any nature. *Areas of Special Consideration* require additional coordination and pre-planning of all exploration and development activities with the Forest District Manager to prevent unnecessary impacts to a specific use or resource. Aesthetic values, recreational uses and amenities, and primitive and semi-primitive non-motorized ROS zones were among the resources, uses and values considered when these areas were delineated.

Aesthetic buffers are established to avoid or minimize potential impacts to recreational resources, uses or values, and all waivers will be considered on a case-by-case basis. In some instances, placing infrastructure in buffer zones along roads results in less surface disturbance and overall reduced environmental impact. Operators are expected to fully consider aesthetic and wild character impacts in their waiver proposals. ([See Setbacks](#))

Organized Tours of State Forest Lands

Shale gas drilling activity has generated significant interest from a variety of stakeholders, organizations, educational institutions, government agencies and other groups for organized tours of state forest lands. These tours, conducted by both the Bureau and the operators, offer valuable opportunities to demonstrate how natural gas activity is conducted and managed on public lands. [State Forest Rules and Regulations](#) regarding group activities apply. It is the Bureau's policy to take a coordinated approach with public outreach tours and prior permission is required. The Bureau will contact operators for tours on their leases and it is expected that the operators will contact the Bureau for tours they plan to conduct. All tour participants shall be provided with and required to wear personal protective equipment including hard hats, protective eye wear and appropriate footwear. Fire retardant (FR) outerwear must be worn on all well pads where live gas is present. The Communications Section will be the primary contact.

Public Safety

The intensity and industrial nature of gas development has created new challenges regarding public access and safety. Historically, there were very few areas within the forest where public access was restricted. Shale gas development is a new and unique activity on state forest land which tends to increase the curiosity of some visitors. Active gas development areas (i.e., well pads, impoundments, wastewater treatment sites and critical infrastructure) can be hazardous and are unsuitable for public access. The safety of the public and gas operators is paramount. As such, public access may be restricted in areas by posting signage, gating and/or fencing to provide for public safety and protection. The posting of a restricted area should be approved by the Forest District Manager. The public should respect restricted areas and abide by the posted conditions.

The use of explosives to assist in the excavation of bedrock is sometimes necessary during construction activities. The PA DEP is responsible for regulating the storage, handling and use of explosives in the commonwealth. Blasting conducted within Pennsylvania regulatory limits will not damage state forest land. Public access may be temporarily limited during these activities. The use of explosives for any construction activities should be discussed with the Forest

District Manager during the planning and approval process. District personnel should be provided notice two weeks in advance of planned blasting activities in an effort to avoid impacts to planned stakeholder activities.

Access Roads

Roads constructed by the operator for accessing well pad sites are considered administrative roads and they may be used for official company business only. Although public vehicular access is restricted, non-vehicular public access is permitted so long as the road is not coincident to a restricted area. Gas operators or subcontractors which are not engaged in official company business will be considered members of the general public. Individuals violating restricted access areas may be cited as set forth in the [State Forest Rules and Regulations](#).

Speed Limits

Posted speed limits should always be observed. The speed limit for un-posted state forest roads is 25 miles per hour. Posting more restrictive speed limits on public use roads must be approved by and coordinated through the Forest District Manager. Speeding is unsafe, potentially deadly, and displays negligence and disregard towards others that rely on these same roads as a means to access state forests.

Fencing

Fencing may be warranted for facilities associated with natural gas production due to security regulations or public safety concerns. Operators should consider potential aesthetic impacts to state forest land and minimize the use of fencing to the greatest extent possible. Fencing options should be consistent with the level of security required. Operators should proactively discuss fencing requirements and options with the Forest District Manager prior to installation. For example, Forest District Managers may prefer the use of woven wire over chain link in certain situations. Vegetative screening may be required in areas where aesthetics are a primary consideration. Proper signage should also be considered as a potential alternative to fencing.

Note:

All state forest land is open to the public except for active restricted areas; therefore, checkpoints should foster an environment focused on safety rather than security. Safety personnel or other employees that may interact with members of the public should be courteous and cordial.



Figure 4-2. Example of a typical safety checkpoint station.

Safety Check Points The safety and security of onsite gas operations and infrastructure are the responsibility of the operator. Numerous companies utilize private security firms to oversee active operations within areas typically posted as “restricted”. Safety personnel are typically posted 24 hours a day at safety check points (i.e., guard shacks, gates) to the entrances of active drilling operations. The installation of safety check points requires written authorization from the Forest District Manager and operators are strongly encouraged to consult with this individual regarding suitable siting locations. The Bureau prefers that these check points are placed as close to well pads as possible. The use of security

cameras by operators is permissible. Cameras should only be placed to monitor infrastructure within areas posted and restricted from public access. Electronic traffic control equipment may be used at the discretion of the Forest District Manager. Operators must provide written notice at least two weeks prior to its intended use.

Signage

Signage is necessary to inform the public, provide direction and maintain public safety. State forest signage should be minimized, well planned, consistent and discreet in order to blend with the landscape and perpetuate expectations of wild character. To aid in this endeavour, the Bureau developed an internal document to guide and standardize the use of signage. Most of the signage used in state forests are created by hand. The primary sign shop is located at Penn Nursery and several satellite shops are embedded within the districts. Several new signs have been developed to facilitate state forest administration where gas development is occurring. These signs are available through the sign shop. Only Bureau approved signage should be utilized on state forest lands.

Reporting Law Enforcement Incidents

Bureau of Forestry law enforcement personnel have the authority to conduct criminal investigations on state forest lands. It is imperative that the Forest District Manager is apprised of any incidents in a timely manner. Safety personnel should focus on the safety and security of lease operations and associated equipment.

Gas operators, safety personnel or other employees may:

- Request identification from any individual wanting access to a restricted area
- Request that an individual without proper authorization exit a restricted area
- Provide a description of the individual and/or vehicle to the appropriate Forest District Manager who will assign a DCNR Ranger to pursue an investigation as necessary

Note:

Actions which exceed an individual's authority could result in criminal or civil charges being filed against the employee, contractor and/or the gas company.

Gas operators, safety personnel or other employees should not:

- Enforce laws and/or state forest regulations on state forest lands
- Investigate unlawful activities on state forest lands
- Perform patrols or traffic stops
- Approach a member of the public or the Bureau without proper cause
- Hold anyone against his/her will
- Block the exit of anyone that decides to comply with the request to leave
- Acquire or attempt to acquire identification information through vehicle registrations or permits or leases administered by the Bureau (i.e. camp lease, fuelwood, etc.)

Safety Zones and Wildlife

Hunting is permitted on state forest land surrounding active drilling sites, however; hunters must observe Pennsylvania Game Commission safety zone regulations which prohibit hunting within 150 yards of an occupied residence, camp, industrial or commercial building. Operators or associated personnel should secure their food and garbage such that it does not attract animals to their site.

The following should be considered with respect to recreation and public safety:

- A. The safety of the public and gas operators is paramount. Temporary closures of roads or trails should be considered where conflict is inevitable and no reasonable compromise exists.
- B. Public access to dangerous surface structures or equipment (primarily during active drilling and completion operations) should be restricted. Operators are responsible for onsite security. Posting, gating, and/or fencing to provide for public safety and protection should be coordinated and approved by the Forest District Manager. The operator should post a copy of [State Forest Rules and Regulations](#) at the entrance to operations (i.e. well pad).
- C. Consider the full extent of recreational activities and the seasons in which they occur when planning natural gas exploration or development.
- D. Avoid areas of concentrated recreational activity and developed recreational sites when locating natural gas related infrastructure
- E. Preserve the integrity and current extent of semi-primitive non-motorized and primitive ROS zones
- F. Coordinate the timing of oil and gas activities with the operator to avoid public conflict and to minimize potential damage to state forest roads. Forest District Managers should consider suspending activities requiring heavy trucking during:
 - Periods of heavy public use
 - Weather conditions that make the roads impassable
 - Traditionally wet periods when road damage is most probable
 - Spring frost breakup

Trucking should be closely monitored during high-use and wet periods if it is not possible to suspend activities.

- G. Protect the integrity and connectivity of existing trail systems. Provide temporary trail re-routes when gas activity adversely impacts the recreational experience or substantial conflict exists. Original trail segments



Figure 4-3. Hunting is an important recreational use of state forest lands.

can be re-opened once the conflict no longer exists. Necessary new connector segments will be planned, permitted and constructed at the operator's expense under the direction of the Forest District Manager.

- H. Co-locate recreational trails within rights-of-way corridors only where appropriate. Gas operators are encouraged to utilize existing disturbances, such as road networks, when siting infrastructure, however some activities may not be suitable within newly widened corridors.
- I. Maintain or improve aesthetics and recreational use of trails when gas infrastructure parallels or intersects a trail corridor. Stage materials and equipment out of sight from the trail. Consider alternative construction techniques that maintain aesthetic character when intersecting a trail. Minimize the removal of vegetation and replant as appropriate. Utilize trail assurance markings per established guidelines.
- J. For reasons of safety, the Forest District Manager should temporarily remove joint-use roads used by the operator from the snowmobile trail system during periods of heavy use. If the roads are not removed from the joint-use system, plowing will be prohibited unless the operator has the specific written permission from the Forest District Manager. Relocating snowmobile trail segments onto rights-of-way corridors allows both activities to occur with minimal impact to the other user.
- K. In situations where state forest resources or public-use facilities are impacted; gas operators will provide necessary security, safety, and signage measures (as approved by the Bureau) during operations at no cost to the Bureau. The gas operator must notify the Bureau in writing when work is expected to begin in the area and the anticipated operational period. The operator will provide notices of temporary closures to the Bureau who will notify the umbrella user groups, other impacted lessees, rights-of-way interests and local media.
- L. Security cameras should only be placed to monitor infrastructure within areas posted and restricted from public access.
- M. Permanent exterior lighting should not be used on operator infrastructure. When exterior lights are needed, use downward-directed fixtures, advanced lighting technologies, and on/off switches or motion detectors that activate light only when needed.
- N. Oil and gas operators should provide a minimum of 10 days' notice to the Forest District Manager when flaring activities are anticipated. This is exceptionally important in proximity to designated dark sky areas around Cherry Springs State Park. The Forest District Manager should encourage the operator to modify the flaring activity when it directly conflicts with special events planned on the state forest or state park lands or periods of high fire danger. Whenever feasible, the operator should secure functional pipeline rights-of-ways prior to gas production so that unnecessary flaring is avoided.
- O. During the following holidays and high visitor use periods there should be no heavy hauling (i.e., rig moves, water trucking, sand trucking, etc.) blasting or seismic activity or seismic activity, to protect public safety and prevent large scale recreational impacts. The district should provide gas operators with a list of high conflict dates on an annual basis to aid in the planning and scheduling of activities.

Holidays:

- Memorial Day weekend
- Fourth of July holiday or weekend
- Labor Day weekend

Hunting & Fishing Seasons:

- Opening weekend of trout season
- Opening weekend of youth spring gobbler season
- Opening weekend of spring gobbler season
- Opening weekend of the early muzzleloader
- Regular bear season
- A portion of regular firearms deer season

Note:

The Bureau will consider minor truck traffic on state forest roads between the hours of 2200 and 0400 hours, only for daily or essential needs (e.g., cuttings removal, drinking water delivery, sanitation, cement) during periods of heavy hauling restrictions.

Other Activities: The Forest District Manager may determine that restrictions on hauling and seismic restrictions are necessary to protect public safety during the following activities:

- Special activities and events on state forest land or adjacent state park
- Morning hours of spring turkey
- Opening day of deer archery season
- Opening day of youth/special use hunting
- Opening day of general small game

P. Operators must abide by the [State Forest Rules and Regulations](#).

5. Ecosystem Management and Resource Sustainability

The Bureau of Forestry holds itself to a high standard of land management excellence and balances ecological, social and economic considerations on state forest lands. This often complex practice is referred to as ecosystem management. Ecosystem management is a key principle of the Bureau of Forestry's mission which ensures that forests retain their wild character and maintain biological diversity while providing pure water, opportunities for low density recreation, habitats for forest plants and animals, sustainable yields of quality timber and environmentally sound utilization of mineral resources.

Responsible oil and gas development assumes a shared responsibility to ensure that state forest resources and ecosystems are sustained. This chapter outlines several practices and methods the Bureau employs to balance our resources and energy extraction. There is no "one size fits all" approach, but rather the Bureau works case-by-case with operators and consultants to determine the best possible course of action to address all concerns. The Bureau recognizes the variability of subsurface ownership but applies the same review process and considerations for each one, providing consistency. The application of management is often unique and depends on specific resources and values involved.

Practices

On state forest lands, oil and gas exploration and development is conducted in a manner that minimizes impacts to water, soil, flora, and fauna resources while being compatible with other uses of state forest land such as timber management, watershed protection and recreational activities. As with other development on state forest lands, the Bureau uses the general approach of avoidance, minimization, mitigation, and monitoring to manage any undesirable effects of natural gas development.

Strategies provided in this section should be considered when negotiating gas activities on state forest lands. Where sensitive areas or existing infrastructure are found (including wetlands, habitat, or other district-identified important areas such as deer fences), avoidance will always be the first option to be considered. However, the Bureau understands that avoidance will not always be possible or the best option. When all avoidance options have been evaluated and rejected, the Bureau and operators will work together to identify minimization techniques. In cases where avoidance and minimization still do not eliminate all impacts to resources or values, the Bureau and operators will work to identify ways to mitigate these impacts. These efforts will be monitored by Bureau staff to further inform and refine our management practices, and it is suggested that companies monitor the effectiveness of these practices as well. In certain specific situations the operator may be required to monitor, such as for the presence of invasive plants.

In order to effectively conduct ecosystem management for responsible oil and gas extraction, the Bureau prefers to evaluate plans at a landscape-level scale to better understand cumulative impacts. This entails review of an entire tract-level development plan. Oil and gas ownership boundaries on state forest lands are divided into tracts, and ownership of each tract is taken into consideration. By managing at a tract-level, the Bureau and operators will focus on landscape-level planning rather than a piecemeal approach, such as a well-pad-by-well-pad basis. Through early planning, the Bureau obtains a landscape-level perspective, facilitating the placement and location of infrastructure that avoids sensitive areas. Comprehensive site plans may be dynamic, but they afford the opportunity to consider potential impacts from a landscape perspective.

The following materials can aid the Bureau of Forestry when reviewing landscape-level plans:

- Original conceptual development plans (includes pads, roads, pipelines, compression needs, laterals, and pad infrastructure and placement when possible)
- Water sourcing, storage, handling and disposal plan
- Erosion and sedimentation plans for all facilities as they become available
- Completed ecological surveys
- Permit applications
- Geological or seismic data

A. Avoidance

Operators are expected to utilize early planning to avoid impacting important resources on state forest lands. Below are some commonly used strategies that may help avoid impacts to surface resources.

Existing Disturbed Areas:

Operators and the Bureau may consider maximizing the use of existing disturbed areas, such as road networks or rights-of-way corridors, for the placement of oil and gas development and associated infrastructure in order to minimize disturbance on state forest lands. For example, in cases where public safety, recreation, aesthetics, and ecological resources are not affected, pipelines may be considered for placement along or within existing roads or right-of-way corridors, thereby minimizing additional land conversion. By working with the Bureau, operators will be able to identify suitable sites of existing areas of disturbance for development.

Non-Development Sites or Exclusion Areas:

The Bureau can provide maps to the operator that delineate known areas of ecological, forest management, recreational importance or other sensitive or important areas on leased or severed rights tracts. These maps of non-development sites, or exclusion areas, can provide a starting point for the known important resources in an area. As further review of the information and site takes place, additional surveys may be requested and other important areas may be identified. It is expected that surface disturbances will be prohibited or strictly limited in these areas. Surface disturbances associated with oil and gas development will be prohibited within all state forest wild and natural areas and state parks where fee-simple mineral rights exist. Waivers will not be considered for such instances.

Note:

Requests to encroach upon the identified setbacks may be considered on a case-by-case basis. The Bureau considers granting waivers when the waiver provides greater protection for environmental or social values and is determined to be in the best interest of the Commonwealth. Waiver applications for these instances must be submitted in writing and will require State Forester (or their designee) approval. Please see the Gas Program Waiver Requests section for more information.

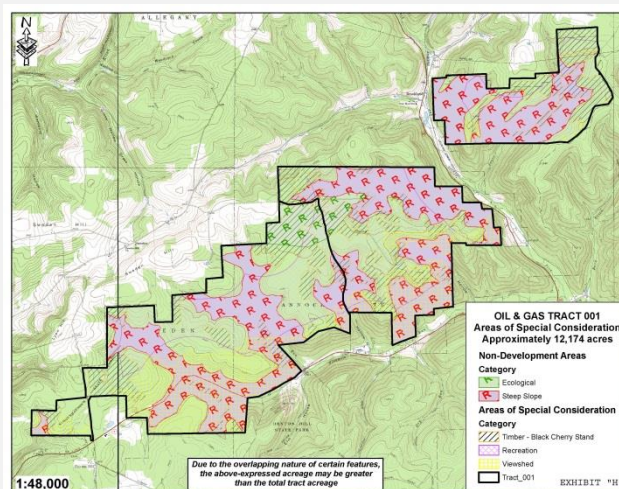


Figure 5-1. Lease tract map illustrating non-development areas and areas of special consideration.

B. Minimization

When it is not possible to avoid impacts to sensitive or important resources, activity on state forest lands goes through a review process to identify and minimize impacts. Bureau of Forestry staff will work to minimize potential adverse impacts to resources and values by applying appropriate setbacks or incorporating techniques such as timing restrictions or reducing ROW widths. The Bureau reviews oil and gas development in a consistent manner, while recognizing ownerships and lease requirements. The Bureau's goal for the ecosystem management process is that each tract will be managed in the most appropriate manner, utilizing the best techniques. Bureau staff and operators should work together to incorporate new guidance into legacy lease requirements whenever possible.

Setbacks:

In order to protect unique resources, important features and experiences, the Bureau of Forestry has developed a list of standardized setbacks for use when siting activities on state forest, including oil and gas development. The different ownerships of state forest land tracts (leased and severed lands) have different contractual agreements and provisions, including setbacks, which direct development. Standardized setbacks provide consistency across the different varieties of mineral tract ownership on state forest lands, and in cases where contractual agreements or provisions differ from setbacks listed below, the Bureau will work with the operator to determine the most appropriate course of action.

These setbacks represent the minimum distance from land disturbance that the Bureau has deemed is appropriate for each feature or situation. The Bureau and operators should weigh all resources and values involved in a situation and make decisions based on the best available information.

1. 500 feet from leased camp site buildings and state forest-owned buildings.
2. 200 feet from any stream, wetland, vernal pool, spring seep, other wet areas or any other body of water
3. 300 feet from a wetland, vernal pool, spring seep or other wet areas with threatened and endangered species and species of special concern
4. 300 feet from any Exceptional Value (EV) or High Quality (HQ) stream or body of water (as defined by Pennsylvania's Environmental Quality Board (EQB))
5. 300 feet of any trail or road
6. 300 feet of the state forest land boundary line
7. 600 feet of the boundary line of state park lands, designated state forest wild and natural areas, designated picnic areas, and designated state forest camping areas



Figure 5-2. Impacts to important resources, including wetlands, are avoided using established setbacks.

Note:

It is important to begin thinking about long-term restoration goals early in the planning process. Often, these goals aid or influence decisions regarding the placement of natural gas related infrastructure upon the landscape. Additional guidance is provided under [Site Rehabilitation](#).

8. Any requirements or guidance requested by another jurisdictional agency (DCNR, PGC, PFBC, USFWS, DEP, ACOE, PHMC) for species or resources of concern, areas of historical importance or otherwise required by regulation
9. Any additional setback restrictions based on local features important in a state forest district (e.g., steep slopes, high recreation areas, viewshed, fire tower, vista, or other significant conditions).

C. Mitigation

Despite the Bureau's and operators' best efforts to avoid and minimize, it may not be possible or fully adequate in all situations to prevent impacts to resources, uses and values. After disturbance activities conclude, mitigation will be necessary to alleviate adverse effects of development. Mitigation opportunities include but are not limited to: reforestation, ecological restoration, species habitat enhancement, or removal of pre-existing populations of invasive species.

State wide, certain provisions exist regarding well site restoration and site stabilization. Operators are required to restore the area disturbed in siting, drilling, completing and producing a well per the Oil and Gas Act. Site restoration includes implementation of erosion and sedimentation control measures and the removal of all drilling supplies and equipment not needed for production. DEP's erosion and sedimentation control regulations define stabilization as the proper placing, grading and covering of soil, rock or earth to ensure their resistance to erosion. Stabilization is categorized as permanent or temporary. Permanent stabilization is achieved when the disturbed areas have been revegetated to a minimum uniform 70% perennial vegetative cover or a permanent best management practice has been employed to minimize accelerated erosion and sedimentation. However, revegetation of disturbed areas is considered the only acceptable practice to achieve permanent stabilization on state forest lands.

Please note that the Bureau makes a distinction between state-required erosion and sedimentation well site restoration activities ("stabilization" or "revegetation") and "reclamation" or "restoration." While site stabilization is necessary or mandated by law, it is not equivalent to mitigation of adverse impacts, nor reclamation or restoration of forest ecosystems. Mitigation is an action that takes place in addition to site stabilization, in order to compensate for a resource, use or value that has been impacted or lost when avoidance is not possible. Restoration, as defined by the Bureau, is the return of a disturbed site to its original functioning ecosystem state prior to disturbance, and often cannot be accomplished until after the site is no longer in use. However site reclamation projects—that reduce the overall size of the disturbed area by using native forbs, shrubs, and trees to begin to rebuild organic topsoil, improve native plant diversity, and encourage site use by native insects and early successional wildlife—are often the first step towards restoration.

D. Monitoring

The Bureau has established a monitoring program to track activities, detect changes and monitor impacts that may be occurring on state forest land in conjunction with oil and gas activity. The program is focused on evaluating changes in plant and animal communities, infrastructure, and water resources, as well as changes in social and



Figure 5-3. Monitoring is essential to detect the changes, both beneficial and adverse, associated with oil and gas development.

recreational values. Updates to the Bureau of Forestry *Shale Gas Monitoring Report* will summarize and communicate any changes to state forest land and facilitate adaptive management strategies that address these findings. These updates can be found on the Bureau of Forestry [website](#).

Implementing Ecosystem Management and Resource Sustainability

The Bureau's gas management approach of avoidance, minimization, mitigation and monitoring strives to promote environmentally-sound gas exploration that maintains contiguous forests, conserves wetlands, protects threatened and endangered plants and animals, upholds water quality, maintains the forest's wild character, and provides high quality recreation.

The following sections were developed to specifically address the overarching goal of ecosystem management and resource sustainability in consideration of the different facets of oil and gas development and production on state forest lands. Each section identifies and prescribes practices consistent with goals and objectives described in this document and in the *State Forest Resource Management Plan*.

A. Seismic Surveys

Seismic data facilitates the successful exploration and development of oil and natural gas reservoirs in Pennsylvania by providing an opportunity to view the underlying geology of an area prior to a well being drilled. Seismic data is produced when an energy wave travels through the subsurface and the variation in the rock properties of each formation causes a portion of this energy wave to be reflected back to the surface. A device on the surface called a geophone records the amount of time it takes for each energy wave to be reflected back to the surface. By processing the data recorded on each geophone, an image can be created of the subsurface underlying a given area.

Energy waves can be produced in a variety of ways. On land, the most commonly used sources to generate energy waves are small explosive charges buried within a previously drilled borehole, or from a heavy truck-mounted vibrating plate (commonly called vibroseis). Each seismic survey may employ one or both types of energy sources depending on the survey parameters and the land features within the survey.

Explosive charges require the drilling of a borehole tens of feet deep in which the charge is placed. The drilling of boreholes is typically conducted by either a small track mounted drill, or a helicopter delivered heli-portable drill. This flexibility allows for the use of explosive charges to be used in a wide variety of applications, whereas vibroseis typically requires the use of a pre-existing road network due to the size of the equipment. The use of explosive charges in most seismic surveys is undetectable at the surface.

Seismic data is typically acquired in two-dimensional (2-D) or three-dimensional (3-D) form as indicated by the image produced of the subsurface:

2-D surveys: Require an energy source that is in line with the receiver to produce a vertical profile of the subsurface. 2-D surveys consist of one or more seismic lines acquired individually. Each line will produce an image in a single vertical plane.

3-D surveys: Require a multitude of geophones that collect the reflection signals from points outside the plane of the energy source to produce a “cube-like” profile of the subsurface. Multiple receiver lines collecting data simultaneously are required to produce a three dimensional image. 3-D surveys are more complex, labor intensive; and more land-base is required.



Figure 5A-1. Track mounted drill buggy completing a seismic borehole.

The following is the Bureau process to review seismic survey requests on state forest land:

1. Company submits their application to the Bureau:
If interested in acquiring seismic data on state forest lands, the seismic operator or an appropriate contractor must notify the Bureau of the proposed project either through the applicable State Forest District Office or through the Minerals Division. Following the Bureau's notification, the seismic operator must submit the following:
 - Location (i.e., boundaries of project)
 - Acres affected
 - Narrative and justification for project
 - Proposed methodology of acquisition
2. Bureau performs preliminary review of project and decides if its justification is warranted.
3. If the project is accepted, the operator will submit an operational seismic survey plan to the Bureau. The operational plan will include:
 - Map depicting the preliminary location of source and receiver points
 - Standard operating procedures for working in and around sensitive areas
 - Communication protocol for notifying field crews of exclusion areas
 - Descriptive methodology to be used for placing shot holes and receivers
4. Bureau reviews the operational plan and identifies exclusion areas and the basis for their designation. Exclusion areas may include:
 - Wetlands, streams, vernal pools, spring seeps
 - Invasive plant populations
 - Known or potential habitat for threatened and endangered species
 - Recreational resources and aesthetically sensitive areas
 - Other sensitive areas identified by the state forest district
5. The Bureau will provide the seismic operator with the following information prior to the initiation of any field work:
 - Geospatial data of any known exclusion areas delineated as polygons
 - A list of suspected sensitive resources and their anticipated location
 - A list of operational restrictions and/or avoidance measures pertaining to each exclusion area
6. Agreement:
The Seismic Agreement will clearly define the number and extent of exclusion areas, buffer areas, and operational restrictions. These items will be emphasized and reiterated to the company prior to the commencement of any activity.
7. Pre-Activity Meeting:
The company will meet with the Bureau prior to commencing construction/seismic activity. The Bureau will discuss the terms and conditions of the seismic agreement with the operator, contractor, and employees that will be engaged in the fieldwork.

Note:

The contractor should enlist the services of a qualified professional to walk all planned shot lines (ahead of the seismic field crews) and locate suspected sensitive resources. If these resources are encountered, they will be delineated in the field, mapped and added to the list of exclusion areas.

8. Monitoring and Inspection:

Bureau will monitor and inspect seismic activity throughout the survey to ensure compliance with the standards of the agreement and other agreed upon best management practices. Deficiencies must be brought to the seismic operator's attention as soon as possible in order to limit environmental impact and conflicts with other state forest users.

9. Post-Survey Inspection:

Following the seismic survey, Bureau staff will conduct a post-survey inspection of the area to ensure that all areas disturbed have been properly reclaimed and all equipment has been removed. The Bureau will also continue to monitor the area of the survey for the propagation of any invasive species in order to determine control and treatment of any invasive populations found.

The following should be considered to protect forest growth with seismic surveys:

- The use of mulching machines to clear vegetation or to lay cables should be avoided. The Bureau may consider the use of this equipment on state forest under limited certain circumstances. Written requests and justification of need should be submitted to the Forest District Manager. If approved for use, guidance on "no mulch" buffers and other operational restrictions will be provided.
- The tying back of vegetation should be used in favor of cutting. Vegetation should be cut or removed only when no other alternative is feasible.
- The seismic operator should use its best efforts and practices in maneuvering equipment in such a manner as to prevent damage to forest growth not intended to be removed.

The following should be considered for seismic survey equipment:

- Wireless receivers aid in avoiding conflicts with state forest users and should be utilized whenever possible
- The use of all-terrain vehicles should be avoided. Equipment should instead be placed by personnel on foot. If it is absolutely necessary for the seismic operator to utilize all-terrain vehicles, prior written authorization must be granted by the Forest District Manager
- The use of existing roads, motorized trails and clearing should be used to the greatest extent possible during the placement of equipment
- When wire receivers are used, caution should be taken when cables are strung across trails and roads. Cables should be secured tightly to the ground with anchors so that hazards are not created to hikers, bikers and horseback riders

The following should be considered regarding the use of drill buggies:

- Avoid all sensitive and wet areas
- Use rubber tracks in lieu of metal whenever possible
- Utilize portable GPS units with the capability of displaying exclusion areas

- Avoid travelling along non-motorized trails when moving between source points
- Avoid drilling holes within the running surface of trails and roads

The following should be considered to protect exclusion areas:

- Exclusion areas containing sensitive resources should be clearly delineated in the field and seismic crews should be fully aware of operational restrictions and/or avoidance measures. In some cases it may be necessary for the operator to have environmental consultants direct field staff and ensure that sensitive features will be avoided
- Seismic activity should adhere to requested setbacks and established buffers ([hyperlink to setbacks](#))
Note: Vibroseis trucks and helicopters (with portable drills) minimize surface disturbance and may be preferred in sensitive ecological areas. However, these techniques may cause temporary adverse impacts to local aesthetics and recreational experiences

The following time restrictions should be considered with seismic surveys:

- Operations should be planned and scheduled appropriately to avoid unnecessary conflict including:
 - High visitor use periods (i.e., hunting seasons, special events and holiday weekends). Please see the [Recreation Section](#) for timing restrictions.
 - Critical wildlife mating or nesting seasons.
 - Wet periods when impacts to infrastructure, soils, water and vegetation are likely
 - Periods of high/extreme wildfire danger

The following should be considered for invasive species prevention with seismic surveys:

- All equipment utilized during the survey should be cleaned prior to entering state forest lands to ensure the removal of any invasive species that may be present. Equipment should be cleaned in a manner consistent with the [U.S. Department of Interior's Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species](#).

B. Well Pad Sites

There are many aspects to planning well pad development on state forest lands. These considerations include: understanding the pad placement within the landscape and tract; siting and constructing the pad appropriately given the resources in the area; efficiently organizing infrastructure on the pad; signage and spill safety. Operators should work cooperatively with the Bureau to minimize impacts to state forest resources, uses, and values.

Well Pad Placement

Existing landscape conditions and characteristics associated with potential pad locations should be evaluated and documented prior to construction, to provide baseline data and facilitate restoration. Limiting forest fragmentation, avoiding sensitive areas and decreasing aesthetic impacts are some characteristics that are considered.

The following principles should be considered with well pad placement:

- Where fragmentation is the primary concern, well pads should be co-located with existing disturbances to reduce additional impacts to core forested areas where applicable.
- In aesthetically sensitive areas, locations should be selected that provide for vegetative and topographic screening. Consider supplemental plantings of conifers to establish or enhance vegetative screening or leaving a buffer.
- Well pads should be designed to fit within the landscape and minimize excessive cut and fill construction practices. In many cases, it may be appropriate to design well sites in an irregular shape (i.e., non-rectangular).
- The operators should limit fragmentation and aesthetic impacts by minimizing pad and infrastructure development within the tract, while maximizing the efficiency of the gas extraction. For example, increasing the number of wells per pad or horizontal bore distance may result in fewer pads and less fragmentation and aesthetic impacts. The Bureau recognizes that economic, technological, and geologic constraints may influence the size and number of pads.



Figure 5B-1. Example of a recently constructed well pad.



Figure 5B-2. During active development, the well pad is completely utilized by necessary ancillary infrastructure.

The operator has agreed to drill wells as reasonably prudent as possible; however, not all leases have disturbance thresholds. Some leases limit the number of well pad locations or acres disturbed within a lease tract. Other leases hold operators to a maximum number of well pad locations, or total disturbance of a predefined acreage, whichever occurs first (see tract lease for specific limitations). If an operator wishes to deviate from the well pad numbers or acreage, a waiver and State Forester approval will be required in accordance with the lease. In legacy lease areas or areas without a lease, Bureau staff will work with the

Note:

When determining the placement of a pad within a landscape, it is important to consider occasions where goals of limiting fragmentation and aesthetic impacts may contradict.

operators in planning and identifying opportunities to limit conversion and fragmentation to state forest lands.

Well Pad Construction

Well pads are constructed to accommodate all components of drilling and completion which determines their size. A typical shale gas well pad can be several acres in size and can host many individual wells. Pads are constructed to be solid, relatively level and soil compacted in order to adequately support the weight and maneuverability needs of modern drill rigs and the facilities needed for completion and production. During the hydraulic fracturing (i.e., fracing) and completion process, nearly every square inch of the pad is occupied. Pipeline rights-of-way and access roads are not considered part of the well pad.

Traditional well pad construction may include:

- Removing and stockpiling the topsoil
- Developing a suitable sub-base using one of the following methods:
 - amending the upper subsoil with a stabilizing medium (e.g., portland cement, lime, fly ash) and then lining with geotextile
 - lining the subsoil with geotextile and covering with several thousand tons of larger diameter stone
- Top-coating the base with smaller diameter stone and compacting to extreme tolerances, assuring a consistently flat surface allowing the rig to “walk” or “skid” from one well to the next



Figure 5B-3. Lining of a graded and compacted well pad site with geotextile. Stone will be added to this surface and compacted to provide a stable base for well development.

The Bureau encourages reduction of stone volume used for well pad construction.

The use of large volumes of stone can present challenges. Removal of material will increase truck traffic and it also will create more intensive reclamation. Other techniques are available that limit the amount of stone used for well pad construction, such as timber mats, composite mats (rig mats), or cellular confinement systems.

Cellular confinement systems, also known as geocells, are widely used for load distribution, base stabilization and strength, surface stabilization, and erosion control. Geocells enhance load-bearing capacity while reducing the amount of aggregate material required. This can simultaneously reduce the usage of haul equipment, which in turn reduces fuel usage, pollution and the carbon footprint, and minimize on-site disruption from dust, erosion and runoff. As a composite system, cellular confinement strengthens the aggregate fill, thereby enabling the use of poorly graded inferior material (local native soils, quarry waste, recycled materials, etc.) The perforations in the cells can reduce post construction storm water by increasing permeability.

Any topsoil (i.e., O and A horizons) removed during pad construction should be stored on site and segregated from subsurface materials to avoid mixing during construction, storage and partial restoration. Topsoil stockpiles should be vegetated with a native seed mix to minimize erosion and maximize reclamation potential. In addition, topsoil should not be stored under plastic because it greatly reduces the viability of the seedbank in the soil. Rocks, stumps, tops or slash should be pushed to the edge of the opening and used for wildlife habitat enhancement, when feasible. In those instances where vegetative debris cannot be incorporated, guidance will be provided on other beneficial uses (e.g., chipping, stockpiling).

Well pads are considered impermeable, and as such, may require post construction stormwater controls. During the planning stages the Bureau encourages operators to be creative in design of storm water controls. This reduces the need for large scale clearing of vegetation and requires less long term maintenance. For this reason, large scale infiltration basins such as those used in other types of residential or commercial development are not preferred. The Bureau prefers techniques such as infiltration berms which can be constructed adjacent to the pad.

During the development phase, equipment such as the drill rig, drill pipe and casing, containers for rock cutting and trailers to house personnel are on location. Drilling mud and other materials removed from the bore hole are captured in a series of steel tanks referred to as a closed-loop system that facilitates the recycling of drilling fluids and the separation of rock cuttings. Cuttings are disposed of at DEP-approved landfills.

Once the well is drilled and casing is set the drill rig is disassembled and other equipment needed for drilling is removed from the site and the pad is prepped for well completion (hydraulic fracturing and flow back). During completion operations the majority of the well pad surface is occupied with equipment which ultimately influences the size of the pad needed.

Facility Organization on Pad Sites

Well pads are sized to accommodate all components of drilling and completion. Certain infrastructure will be required on the well pad for the life of the well (i.e., production phase), and site plans should distinguish these areas from those that are only needed during the short term (i.e., development phase). Areas needed for the development phase of the well pad should be rehabilitated once they are not necessary and those utilized for the production phase will be rehabilitated once the well is no longer economical to maintain. This is also a [Marcellus Shale Coalition Recommended Practice](#).

Production infrastructure on the well pad should be clustered and centralized to the maximum extent possible without jeopardizing the safety of operators, Bureau personnel or the public. Each pad should also have the maximum number of well bores possible without endangering safety or reliability.

Spill Safety

Operators should strive to eliminate all spills on state forest land. However, operators should develop and employ techniques and strategies to minimize, contain and mitigate spills if they occur. Consider the following guidance during planning stages:

- Use closed loop systems and tanks with secondary containment for collecting wastewater

- Wherever possible, store chemicals and liquids inside storage trailers. If feasible, the storage facility should employ secondary containment controls and should be underlain with impervious geotextile
- Product and hazard labels should be legible at all times and replaced as necessary
- Install concrete sump collection boxes down slope of all secondary containment controls to facilitate containment and pumping of spills

Please see [Medical Emergencies and Pollution Events](#) for more information.

Signage

The use of signage on state forest lands is generally minimized to ensure consistency with its undeveloped character. However, signs are necessary for operators to convey information to personnel, Bureau employees, regulatory authorities, and emergency responders during the development and production phases of shale gas. The following guidelines are intended to minimize aesthetic impacts and ensure consistency in accordance with regulations:

PA Chapter 78 and Act 9

On January 26, 2013, Act 9 amended Pennsylvania's [Chapter 78 regulations](#) to include emergency response planning at unconventional well sites. The new regulations require the installation of specific emergency response signage at the entrances to well sites (i.e., well pads). The regulations further prescribe specific sign composition and color schemes based on administrative versus public roads. Bureau of Forestry access roads are administrative roads constructed and maintained primarily for the purpose of fire protection, administration, and utilization of state lands and/or facilities. These roads are open to the public to provide access to the state forest for outdoor recreation opportunities and can be closed by the Bureau at any time, thus are not considered "public highways."

As set forth in the regulations, the signs must be installed at the "entrance" to the well pad, being the intersection of the access road and the nearest road with an address range. Emergency response signage should be installed as close as possible to pad locations. A name and address range should be established for access roads when: 1) the pad is not visible from a designated road, and 2) the road provides access to multiple pads and is un-named. The Bureau will work cooperatively with operators and the proper authorities to ensure that names and addresses are assigned as efficiently as possible. Signage for newly named roads should be consistent with Bureau road sign standards, as well as those prescribed in the amended [Chapter 78 regulations](#). These solutions will be beneficial to emergency responders and will minimize sign pollution in the state forest.



Figures 5B-4 and 5B-5. Examples of Act 9 signage

Information Boards

Operators often require additional space to post other required permits or to relay important information to employees and the public about safety hazards, requirements and general information about the pad and surrounding area. An information board may be installed to accommodate such needs at the discretion of the Forest District Manager. The construction, material and color scheme for informational boards should be consistent with Bureau sign standards and shall not exceed a width of four feet and a height of eight feet.



Figure 5B-6. Example of an information board

C. Freshwater Acquisition

The water intensive nature of the shale gas development requires extensive advanced planning. A conceptual site plan that includes water acquisition, transportation, storage and disposal should be submitted to the Bureau for review and approval before the initiation of construction activities on state forest lands. The Pennsylvania Department of Environmental Protection (DEP) and corresponding interstate River Basin Commissions have jurisdictional oversight of surface water resources and associated water withdrawal requests.

The development of a single shale gas well requires approximately four million gallons of water for the completion process (i.e., hydraulic fracturing). This quantity of water must be readily available to the well site throughout this process. Centralized fresh water storage facilities and temporary pipelines for transporting water may be preferred over the traditional method of housing multiple storage tanks on the well pad and filling them via truck depending on the situation. Centralized freshwater facilities reduce high volumes of truck traffic and decrease total acreage disturbance.

Note:

The Bureau of Forestry was established in 1895, in part, to acquire forest lands and protect headwaters and streams. This remains part of the Bureau's mission today.

Water Acquisition

Water needed for shale gas development is acquired through:

- Surface water withdrawals
- Groundwater well withdrawals, although not preferred

When reviewing requests for water acquisition, the Bureau takes into consideration potential impacts to watersheds, headwater streams, wetlands and adjacent ecological resources.

The following should be considered when determining water sources for shale gas development:

- The terms for surface and groundwater withdrawals on fee simple state forest lands are set forth in the lease agreement.
- The terms for surface and groundwater withdrawals on severed state forest lands are customarily contained in a surface use agreement.
- Surface water withdrawals, utilizing temporary freshwater pipelines, are preferred over trucking water to the site or ground water withdrawals.
 - Surface water withdrawals are readily monitored, provide high yields, and can be controlled during low flow conditions.
 - Trucking water is expensive, increases traffic volumes, may necessitate road improvements, induces potential conflict with state forest visitors and requires additional land disturbances when stored on well pads in frac tanks.
- Groundwater wells are strongly discouraged on state forest land due to the inherent uncertainty that exists regarding potential impacts to other resources. All groundwater well requests will be subject to a multi-discipline review process. The review includes determining the hydrologic and hydrogeologic characteristics of the area (both surface and groundwater), assessing the potential for ecological impacts

due to the resulting cone of depression and local water table lowering, and assessing the suitability of a proposed location based on its proximity to recreation, roadways, riparian areas, etc.

- Siting ground water wells in close proximity to headwater streams should be avoided. These streams support multiple ecological roles, are highly sensitive to changes in land use or flow and are often intimately connected to springs and wetlands.
- Excessive groundwater pumping in headwater watersheds may result in adverse impacts to wetlands and stream quantity, quality and ecological and aquatic community structure and function.

Water Transportation

Whenever feasible, freshwater should be moved from centralized storage facilities to the well pads via pipeline, significantly reducing heavy hauling, minimizing vehicular conflicts and decreasing air and dust pollution. These pipelines may incorporate above-ground or buried water pipeline networks, or a combination of the two. Above-ground pipelines should be placed in a manner to reduce aesthetic impacts, vegetation damage and the potential for vandalism. Below ground pipelines should be co-located with existing pipelines, buried within the ditchline or vegetated berm or trenched and buried beneath the running surface of the road in order to minimize earth disturbance and forest conversion.

Water Storage

There are several options for water storage, depending on the specific needs of the project:

- **Earthen Impoundments**: non-portable, open pit that may involve significant construction operations; typically 5-14 acres in size and can serve many well pads, thereby reducing the overall disturbance. Constructed dam breasts over 15 feet high require DEP permitting.
- **PortaDams**: semi-portable, above-ground impoundment consisting of heavy duty liners on a steel framework; perimeter can be surrounded with frac tanks for screening and additional storage capacity
- **Above-ground Storage Tanks**: semi-portable, bolt together, cylindrical tanks that are often set on concrete pads
- **Frac Tanks**: portable, fixed-axle tanks which can be transported by tractor; capacity is generally 500 barrels (21,000 gallons)



Figure 5C-1. Freshwater impoundment with safety fencing.

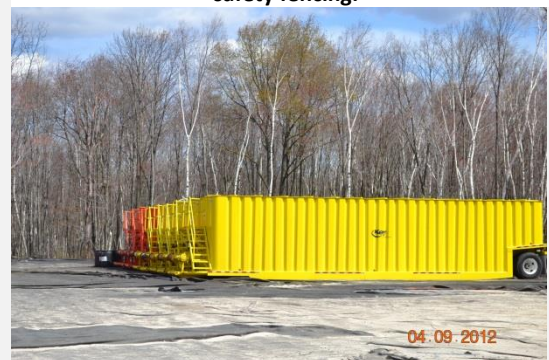


Figure 5C-2. Portable fixed-axle frac tanks on a well pad.

The following should be considered when determining water storage needs:

- Place freshwater storage facilities within existing non-forested openings, reducing new landscape disturbances.
- Utilize impoundment liners of sufficient thickness to minimize potential leaks. Thicker liners are more resistant to tears during construction and pumping.
- Use a manifold/dry-hydrant system to alleviate the need for the “loose hose” method of filling/emptying. This system should also contain the appropriate metering scheme for water accounting.
- Prevent stored fresh water from becoming septic by installing aeration systems.
- Install sufficient exclusionary fencing to keep wildlife from falling into the impoundments. Incorporate deterrents when the fences alone are not consistently successful.
- Facilitate animal movement by lifting sections of above ground pipelines or mounding topsoil.
- Install jute matting along the top, inside edge of an impoundment to enable amphibians and small mammals to exit the slippery plastic-lined impoundments.
- Freshwater impoundments must maintain adequate freeboard. The discharge of surplus water is regulated by DEP. Further information and requirements can be found at <http://www.pacode.com/secure/data/025/chapter78/chap78toc.html>.

D. Wastewater Treatment, Storage, Transportation, and Disposal



Figure 5D-1. Above ground steel storage tanks with secondary containment measures

Unconventional gas wells require several million gallons of water for hydraulic fracturing operations. After hydraulic fracturing is complete, approximately 10 to 30 percent of this water returns to the surface during initial flowback. Variability in the volume of recovered flowback is dependent on geologic conditions and the completion techniques utilized. Additionally, most wells will continue to produce water, found in the pores of the rock formation, for the life of the well. This is often referred to as produced water. Flowback and produced water, collectively referred to as wastewater, contain dissolved salts, metals and chemicals as well as fragments of rocks and minerals which must be properly disposed of or treated before reuse in subsequent completion operations.

In 2011, the PA Department of Environmental Protection asked natural gas drilling operators to voluntarily stop disposing wastewater at municipal and commercial treatment plants because of the high concentrations of bromides and other dissolved solids being discharged into rivers and streams used for public drinking water sources. Operators currently strive to recycle 100% of their wastewater through minimal treatment, blending with fresh water for future well completions and other practices. The Bureau supports the recycling of wastewater and reducing the overall amount of freshwater consumed for shale gas operations.

Permitting:

DEP's OG-071 authorization allows the treatment of waste streams from a well site under certain conditions. This authorization is also required when modular, open air tanks will be used to store wastewater. All wastewater storage on state forest lands must be closed and self-contained. While OG-71 authorization does not require landowner notification, prudent and responsible operators are highly encouraged to notify and communicate all OG-071 authorization activities with the Forest District Manager.

In accordance with the DEP policy known as the "100% rule", operators may transport the total volume of wastewater generated from one well site directly to another well site, or multiple well sites, where it must be completely reused. Wastewater treatment may occur at the site where it is generated or the site(s) where it will be reused.

Centralized storage, centralized treatment and multiple transfers of oil and gas waste streams are administered through the DEP Waste Management Program under the WMGR-123 permit. The WMGR-123 permit provides the operators

with additional flexibility to treat and store flowback wastewater, requires landowner consent and bonding, and entails a thorough review of the proposed facility

The following guidance should be considered when managing wastewater:

1. Storage of wastewater in lined, open pits or modular, open air tanks is not permitted on state forest land.
2. Wastewater storage must utilize closed and self-contained tanks. Tanks should accommodate anticipated wastewater volumes and employ adequate secondary containment measures.
3. All wastewater infrastructure, such as valves, tanks, and piping, should be tested frequently for connectivity and seal integrity. Frequent inspections should be performed to ensure the continued integrity of the operation during blending operations.
4. All wastewater operations and infrastructure should utilize adequate secondary containment measures. This containment should be frequently inspected.
5. In addition to mandatory reporting to DEP, all spills should be reported to the Bureau, promptly per the [Medical Emergency and Pollution Incidents](#) guidelines.

Potential Future Operations

Centralized wastewater treatment and storage operations are neither covered under the provisions of DCNR's oil and gas lease nor inherent in the rights afforded to subsurface owners. These operations require additional justification, review, and agreements with oil and gas operators, including those operating on both leased lands and lands with severed rights.

While the Bureau generally is not in favor of additional infrastructure on the state forest, in certain situations, providing options for alternative methods and flexibility to handle oil and gas wastewater may be in the best interest of the Commonwealth.

The Bureau of Forestry has developed an approach for considering centralized wastewater treatment and storage system proposals on state forest land. Operators are required to submit a detailed proposal justifying their project and providing information such as: system and equipment specifications, safety protocols, chemical storage, spill prevention and response protocols, transportation analyses, and the reasons the project would be in the best interest of the Commonwealth (please refer to [Appendix: Criteria for Wastewater Treatment Storage System Proposals](#)). After Bureau review and approval, the provisions for managing the wastewater facilities and activities on state forest land are customarily contained in a *Surface Use Agreement* between the operator and the Bureau. This *Surface Use Agreement* would apply strictly to the project area hosting the wastewater activity.

The Bureau will consider all proposals; however, the Bureau does not support large-scale, for-profit wastewater projects on state forest lands. Wastewater operations should be considered temporary in nature and should be operational only so long as it serves oil and gas operations on state forest land. Proposals for storing, treating, or transporting wastewater associated with a non-Commonwealth issued oil and gas lease operation will need to present a clear benefit to the Commonwealth.

The use of fresh water, and the reuse and treatment of flowback waters, are subject to continuously changing technology. This information represents current best management practices and will be revised as necessary to

accommodate changes in technology and advances in best management practices which perpetuates environmental quality and minimizes impacts to state forest land.

E. Roads

An efficient, sustainable, and environmentally sound road system is critical to the administration and management of Pennsylvania's state forest system. Roads provide necessary administrative access as well as recreational opportunities for the general public. State forest roads are typical of most rural road systems—they are generally narrow, gravel, uncongested, and rather inconspicuous within the landscape. Many of these roads were constructed by the Civilian Conservation Corp during the height of the Great Depression or converted from abandoned railroad grades once used to remove timber. State forest roads are minimized to the extent that they satisfy operational needs while maintaining the primitive, scenic and undeveloped character of state forest land.

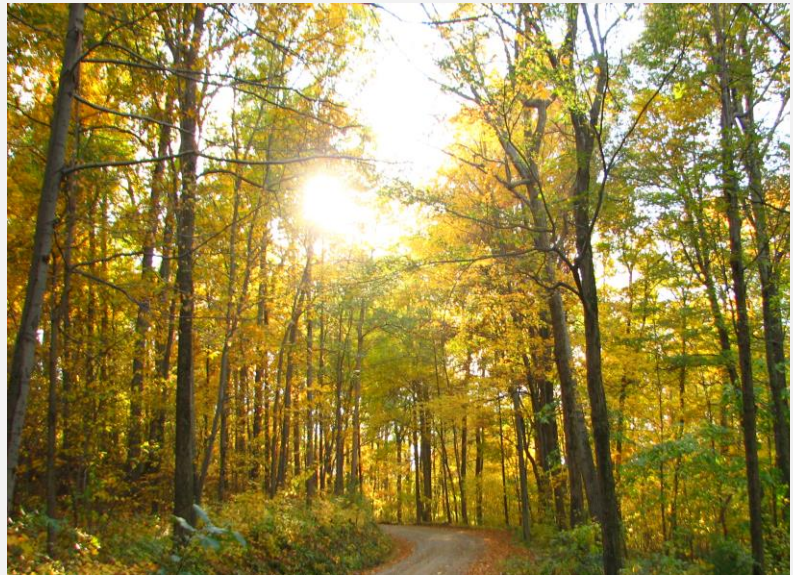


Figure 5E-1. Traditional narrow, winding state forest road with canopy connectivity.

State forest roads are not public roads in the sense of other federal, state, or municipal roads. Rather, they are considered administrative roads that are open to public travel unless gated or posted closed. These roads are shared-use in the sense that they may be utilized by the public for multiple recreational experiences such as mountain biking, hiking, horseback riding and scenic driving. Many of these roads are also considered “*joint-use*” wherein they are open for travel by licensed motor vehicles and are also managed as part of the snowmobile trail system during the winter riding season. The Bureau does not perform winter maintenance activities on these roadways such as plowing snow or the application of anti-skid materials and melting agents.

State forest roads are not public roads in the sense of other federal, state, or municipal roads. Rather, they are considered administrative roads that are open to public travel unless gated or posted closed. These roads are shared-use in the sense that they may be utilized by the public for multiple recreational experiences such as mountain biking, hiking, horseback riding and scenic driving. Many of these roads are also considered “*joint-use*” wherein they are open for travel by licensed motor vehicles and are also managed as part of the snowmobile trail system during the winter riding season. The Bureau does not perform winter maintenance activities on these roadways such as plowing snow or the application of anti-skid materials and melting agents.

Shale gas development is a highly industrialized activity that requires intensive heavy truck traffic on state forest roads. Although temporary in nature, the volume and frequency of truck traffic is a stark contrast to the public's intrinsic expectations and experiences of state forest lands. In addition, roads may require modification and widening to accommodate the scale and weight of the activity. Heavy truck traffic increases social and environmental concerns related to noise, dust, access limitations, public safety, user experience, and also increases operational concerns associated with road conditions, maintenance and rehabilitation.

The sound environmental utilization of mineral resources is part of the Bureau's mission—but the activity must be consistent with the other resources, uses and values for which state forest land is managed.

The following principles should be considered regarding the use, construction, modification, maintenance and rehabilitation of state forest roads:

- Public safety is always the first priority. Hazardous and unsafe conditions will not be created or sustained.
- Consideration must be given to all users of state forest roads. Restrictions may be necessary and warranted to promote public safety. State forest roads must accommodate the safe passage of two-wheel drive vehicles as weather conditions permit.
- Construction, modification and maintenance practices, techniques and materials must be compatible with the Bureau's specifications. Consistency is expected within and between state forest districts.
- Nonstandard construction or maintenance practices, overbuilt roads, or the use of substandard materials will dramatically affect future maintenance activities and cost.
- Environmentally sound maintenance techniques should be utilized on state forest land.

Planning/Siting

An adequate road network is necessary to facilitate the responsible development of natural gas resources. Access needs should be planned at a landscape level and alternatives should be investigated. Sustainable road use should accommodate the development needs of the operator in a manner that is consistent with the expectations and needs of the Bureau of Forestry. Lessees and subsurface owners have the right of ingress, egress and regress to their subsurface estates which includes the right to construct new roads as necessary. New road construction is costly and burdensome. The Bureau discourages this practice and favors the responsible use of existing state forest road in these instances. If new construction is unavoidable, proper road location is the most important consideration in reducing impacts to the forest recreational users and ecosystem functions. Private use of state forest roads is considered a privilege and the activity is administered through a road use agreement which prescribes annual rental fees and substantial bonding requirements.

Many state forest roads were built upon old tram roads and trails that follow streams. The current existence of a road may not mean it is properly located. Operators should work with districts and identify problem areas that may need to be mitigated prior to construction activities. A need may exist to relocate the road to a more desirable location. The operator should also work with DEP to account for the improved condition as a water credit toward the new road.

The following principles should be considered with road planning and siting:

- Maintain connectivity between important habitats such as wetlands and avoid the fragmentation of large blocks of core forest
- Co-locate with existing disturbances and keep corridors as narrow as possible. Maintain connectivity of mid and overstory tree canopies over the corridor.
- Avoid long linear segments. Bends in roads reduce aesthetic and wildlife impacts and help to maintain reduced vehicle speeds.
- Road corridors should accommodate other uses and needs. Pipeline placement should be considered and incorporated into road modification or construction plans. Place pipelines in the road shoulders to reduce conversion and fragmentation impacts. Both gathering lines and distribution lines have been successfully installed in road shoulders with appropriate consideration.

- Identify unsustainable road segments or problem areas during landscape level planning and seek long term solutions which are consistent with Bureau protocols and expectations. Consider rerouting such segments, rehabilitating the old road and returning it to its natural state.
- Seasonal timing of construction activities is important to reduce E&S concerns. Operators should avoid construction activities during spring thaw or during periods of heavy rain when soils are saturated and increased erosion risk is a potential.
- Minimize the amount of drainage area intercepted for surface water/storm water drainage through proper road siting



Figure 5E-2. Examples of distribution pipelines placed within the road shoulders to reduce clearing width and fragmentation effects.

Road Use Agreements

The commercial use of state forest roads is prohibited without first obtaining a *Road Use Agreement* per [State Forest Rules and Regulations](#). A *Road Use Agreement* is required for all lessees and private subsurface owners using state forest roads. Road Use Agreements identify the criteria, bonding and rentals required for the use, modification and maintenance of the given road. Lessees do not incur annual rental fees or additional performance bonding beyond that mandated in the lease. Operators are responsible for all upgrades, maintenance needs and damages incurred for the roads they utilize. Agreements for roads that are accessed across forest district boundaries must include all affected forest districts.

Current and Conflicting Uses:

Shared Use Roads

State forest roads are shared-use roads that accommodate vehicular access and numerous recreational activities. The safety of all users is a paramount concern. Road uses should be identified and managed for in the planning stages of development and use to avoid potential negative effects. The Bureau [restricts heavy hauling and seismic surveys](#) during periods of high recreational activity including holidays and hunting and fishing seasons.

Aesthetics, anticipated user experiences and the wild character of the forest are important values to consider when planning for operational needs. [Setbacks](#) from recreational features, including roads and trails, have been

established to maintain and perpetuate these values. Planning efforts must consider all resources, uses and values in play as part of the decision making process and strive to achieve a balanced solution amongst these competing interests. Additional information on avoiding conflicts can be found in the [recreation and public safety](#) and ecosystem management and resource sustainability sections of this document.

Joint-Use Roads and the State Forest Snowmobile Trail System

State forest roads constitute a significant portion of the snowmobile trail system. State forest roads that are open to motor vehicles and snowmobiles at the same time are called joint-use roads. The Bureau's snowmobile trail system opens the day after the last day of Pennsylvania's regular or extended rifle deer season and closes by April 1 each year.

Advance planning should strive to identify potential user conflicts with joint-use road impacts, such as snow plowing, and develop sustainable long term solutions. Alternative trail segments should be developed when joint-use roads are impacted, with an emphasis on maintaining the integrity of the trail loop system. The operator will assume all responsibility and expense incurred for planning, permitting, and constructing these alternative trail segments, which should be operational prior to plowing or closing any joint-use roads. The objective should be to maintain the integrity of the system and promote public safety while minimizing conflict.



Figure 5E-3. Snowmobiles utilizing a public use road as a joint use snowmobile trail.

Traffic Control and Road Closures

Traffic control may be necessary for safety concerns such as narrow roads with steep embankments, sharp turns that limit turning ability of large trailers or temporary road closures. Creating a temporary one way flow pattern may be permissible for short periods where heavy hauling creates a safety concern. Safety checkpoints, or automated traffic control devices may also be utilized with the Forest District Manager's approval. Operators must provide written notice prior to the intended use and districts should post the information on the advisories tab of their respective website. *See also the [Recreation and Public Safety](#) chapter of this document.*

Road Modification and New Road Construction:

Construction & Modification Practices

The Bureau of Forestry has a cooperative partnership with the Penn State University Center for Dirt and Gravel Road Studies (<http://www.dirtandgravel.psu.edu/>) to identify and apply best practices for dirt and gravel roads. The Center has developed technical bulletins and the Environmentally Sound Maintenance Practices course to address common construction and maintenance issues with dirt and gravel roads. The Bureau has been implementing these practices on its roads whenever improvements are needed. New construction by operators should be consistent with these practices to the greatest extent possible.

Modification versus Construction

The differences between road modification and construction have significant ramifications regarding permitting and regulations. Modification or maintenance is defined as disturbance activities which occur between the top of the cut slope and the toe of the fill slope of a pre-existing roadway. Any disturbance activity occurring beyond this area is considered new construction. Construction activities must develop approved erosion and sedimentation plans that address post construction stormwater management (PCSM). All previous disturbances, including historical log skid roads and tractor paths can be considered as pre-existing impervious area. Only new disturbance outside of the existing disturbance needs to encompass water calculations for PCSM features. As such, it is imperative that the extent of pre-existing roadways are well documented prior to the initiation of any disturbance activities for plan and permit purposes.

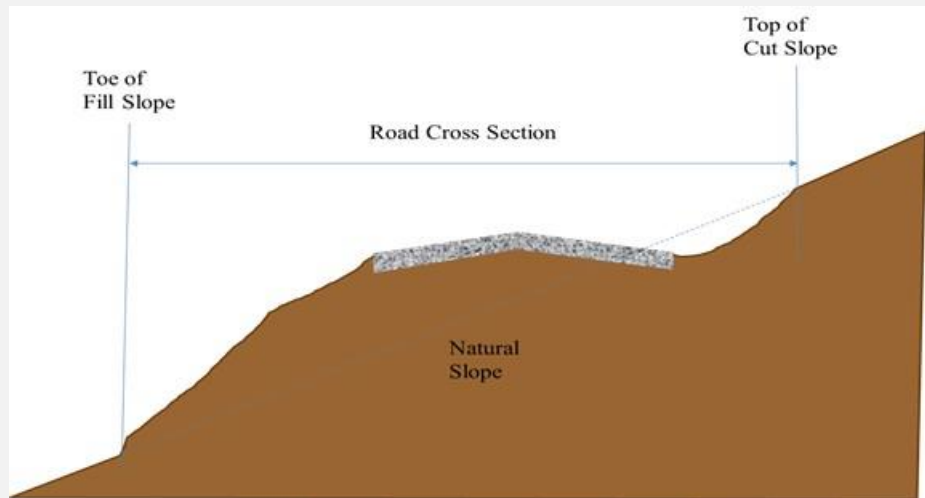


Figure 5E-4. Illustration depicting the limits of pre-existing disturbance within a road profile.

Width

Any new access road or modification of a road outside of the existing cut and fill profile is considered new construction. Typical state forest road running surfaces range from 12-16 feet in width. This width lowers maintenance costs, promotes tree canopy connectivity, reduces environmental impacts and maintains the wild character while permitting safe vehicle passage. The large trucks and equipment trailers that are utilized for well pad construction, drilling and completion operations may require a wider road width to accommodate safe travel. Road running widths should not exceed the maximum 16 foot running surface. If needed, pull offs coupled with staggered or staged traffic patterns, drivable ditches or temporary one way traffic patterns may be used. Tree clearing should be minimized during any road construction or modification to the greatest extent feasible and utilized as a Best Management Practice (BMP) for DEP storm water management.

Material

The materials used to construct new roads will vary depending on geographic location, geology, topography and commercial availability of aggregates. Some state forest districts lack sources of quality surface aggregate, while others have abundant commercial sources of crushed limestone and/or sandstone. Operators should strive to utilize *the most appropriate and highest quality* materials available. The Forest District Manager can advise operators on the location and availability of the most optimal materials available locally.

Road Base

The road base is arguably one of the most important components to the road itself. Without an adequate base the road is prone to repeated failure. All drainage and structural support issues should be addressed at the base level. The base itself should be sufficient to hold the anticipated traffic weight. Prior to the placement of surface running aggregate, the base should be crowned or cross-sloped to the same desired surface profile. 4-minus stone is the preferred road base material. This aggregate is adequate for heavy loads and is easily manipulated to achieve the desired road crown.

Soil stabilization:

Soil stabilization techniques (e.g., cement modified soil) may be utilized for road base construction or full depth reclamation (FDR). However, these techniques are not explicitly approved for all roads and the Bureau will review each proposal on an individual basis. These techniques should not be seen as stop-gap measures for repairing improperly constructed, maintained, or damaged roads. The soil stabilized layer also cannot be used as the final running surface of the road. There should be a suitable running surface such as 2A or DSA placed over the modified road base to a depth of 8 to 12 inches. Exposed soil cement (i.e. plowed free of aggregate) during freeze thaw cycles is easily broken down and can cause sedimentation issues.

It is important that all drainage features for the road are functioning properly prior to initiating soil stabilization, and that there is enough surface material covering drainage pipes to allow heavy machinery to cross.

If soil stabilization techniques are used for road base construction or FDR, road widths must not be wider than the post construction or reclamation widths approved on the ESCGP-2 permit. An operator wishing to utilize soil stabilization techniques for road construction should submit a written request to the appropriate forest district and division of operations and recreation including the following information:

- A soil analysis for the proposed area
- The composition and ratio of stabilization additives proposed (e.g., lime, fly ash, Portland cement, chemical additives)
- A description of the existing road profile and predicted road profile post-construction
- A succinct description of the process being proposed, including but not limited to what equipment will be used; how, when, and what amount of materials will be added; and curing time for the project area before traffic may utilize the road

Road Surface

The preferred running surface aggregate on public use roads is Driving Surface Aggregate (DSA). DSA is a specific driving surface aggregate that does not contain clay and silt particles and is designed to bind together mechanically. The lack of clay and silt particles reduces the likelihood of pumping or rutting during wet periods and generates less dust during dry periods. If DSA is not locally available, 2A (also known as 2A modified) can provide satisfactory performance if it is processed and placed correctly. 2RC aggregate often includes significantly higher percentages of clay and silt, which is not the most suitable material. 2A can be substituted for DSA on public use roads during heavy hauling operations. However, DSA should be applied as the final running surface aggregate when the well drilling and completion operations are complete. 2A is adequate as the final running surface aggregate for gated administrative roads not open to the public or where anticipated future traffic levels are very low.

Road Drainage

When possible, horizontal sheet flow to a natural vegetative filter strip (forest) is the preferred drainage and infiltration method when establishing new roads or managing surface drainage on existing roads. This is accomplished by eliminating drainage ditches that are parallel to the road surface on flat or slight slopes. The water is instead infiltrated immediately rather than being concentrated and moved off site. On steep side cut roads, or roads with sustained grade where obtaining sheet flow is not practical or possible, a ditch or ditches constructed parallel to the roadbed are essential for proper drainage.

Stormwater Management

Recent changes in the ESCGP-2 permitting requirements for PCSM practices are creating new and unanticipated impacts for dirt and gravel roads that are inconsistent with desired forest conditions. Infiltration basins and bio-retention ponds are not acceptable stormwater controls for state forest roads. Structural systems create wider corridors and reduce sheetflow that is important for adjacent forest ecological processes. They also collect water and can easily become a sink to important amphibians or invertebrates. Structural systems are also very costly to maintain and reduce the wild character of the forest. All available non-structural BMPs should be considered for credits in equations and the project should be broken down into drainage segments that allow for adequate volume and rate reductions.



Figure 5E-5. Example of undesirable post construction stormwater structures for a road improved for gas activities.

The following principles should be considered regarding stormwater management:

- Avoid the use of structural PCSM devices, particularly those that concentrate or hold water
- Utilize all water credits with tree retention as a primary focus
- Calculate a water budget for the site to create realistic expectations for infiltration, evaporation and transpiration
- When calculating PCSM needs, break down projects into the smallest drainages achievable to reduce the volume of water being managed
- Incorporate numerous dispersed infiltration techniques
- Follow contours to reduce cut and fill slopes and overall corridor width to aid in water management.
- When crossing contours at 90 degree angles the road should follow the highest ground possible to improve the ability to shed water from the road surface quickly and reduce erosion risk
- Avoid concentrating water in ditches and conveying it to another location wherever possible

- Shallow, vegetated and parabolic shaped ditches are the first preference for ditch protection for slopes less than 5 percent
 - Avoid the use of rip-rap armouring as it is difficult to maintain, can be unsightly and may cause safety issues for motorists leaving the running surface
- Consider pull-offs when designing the road system that incorporate underground tanks that contain stormwater and release it slowly over time. The surface of the pull offs can also be designed as a permeable surface that further reduces runoff from the site.
- Raise cross pipes to ground level and utilize grade breaks to shed water from the road surface

Head and Tail Walls

Head and tail walls act as a retaining wall that supports the road edge at drainage cross pipe locations. These structures prevent road material sediment from washing or collapsing into the watercourse. As such, all cross pipes should have a headwall and tail wall installed.

The following principles should be considered regarding head and tail walls:

- Use natural materials that blend with the landscape
- Dry stack stone is the preferred method of building head and tail walls as it is easily repaired and replaced. Palletted stone can be easily purchased and installed.
- Pre-cast concrete may be acceptable option depending on the application and resemblance to natural materials. This option may hamper future replacement of cross pipes.
- Plastic material should not be used as it is fragile and easily damaged



Figure 5E-6. Palletted stone for drystacking head and tail walls.

Stream Crossings

Proper planning and construction of stream crossings are imperative to maintain stream habitat conditions and ecosystem function. Stream crossings should be avoided when possible and minimized when necessary. Structures such as culvert pipes, tiles or box culverts can significantly disturb the stream bed, disrupt continuity of streambed aggregate and become perched (outlet above the streambed), creating a physical barrier to the movement of aquatic organisms.

The following principles should be considered regarding stream crossings:

- The use of open bottomed structures such as arches, bottomless pipes or bridges that avoid streambed disturbance is preferred
 - When a culvert is necessitated, use a single squash pipe less than 36 inches in diameter. At least 20% of the pipe's height should be embedded into the streambed so it can fill in with natural substrate material. The pipe should be oversized to account for the 20% volume loss that is embedded and should also be wider than the bank full width.
- Structures should span the entire bank full width of the stream and allow for aquatic and terrestrial passage
- Structures should be placed at a 90 degree angle to the stream channel
- Structures should only cross streams where a uniform bank exists. Braided stream channels and bends in the stream should be avoided
- Keep structures as narrow as possible to minimize disturbance, sun exposure, effects of thermal pollution and the potential for invasive plant establishment.
- Use native material placed in a natural manner when protecting streambanks from scour.

The exposed façade of bridges or arches on public use roads should be comprised of, or made to resemble, natural materials to blend with the surrounding landscape. Visible steel superstructure components are acceptable for use on gated administrative roads provided they are temporary in nature. DEP defines temporary as 1 year or less under GP-8 permitting; however, on state forest land temporary is defined as being less than 5 years in duration. Structures intended to be in place for a longer time period should employ natural materials as outlined above. Steel substructure is acceptable for use in all bridges or arches. Steel guiderails are considered acceptable if they are constructed of self-weathering steel.

Road Maintenance:

The Bureau is responsible for the expense of road materials and maintenance on its own roads. Maintenance activities are performed at the district level by a staff of skilled employees. Roads and drainage features are regularly assessed and rehabilitated to maintain a proper crown or cross slope and minimize environmental impacts. The Bureau works closely with the Pennsylvania State University's Center for Dirt and Gravel Road Studies to develop and implement best practices for road construction and maintenance. These environmentally sound practices and techniques maximize the efficiency of operations while minimizing costs. Technical bulletins have been established and can be found at <http://www.dirtandgravel.psu.edu/>.

Operator maintenance responsibilities

Operators utilizing state forest roads for commercial purposes are responsible for road maintenance and stormwater control devices. *Road Use Agreements* should outline maintenance responsibilities and expectations on an annual basis. Inspections should be conducted on a regular basis and after each storm event by the operator and district staff to determine maintenance needs and response. Potholing and rutting that affect the ability of the road surface to shed water are priorities that require immediate mitigation per the discretion of the Forest District Manager.

Winter Maintenance

The Bureau does not perform winter maintenance on its roads. Exceptions to this rule are permitted when public safety is a concern. Plowing snow, or applying anti-skid, or snow melting materials to state forest roads without prior authorization is prohibited per [State Forest Rules and Regulations](#). Permission for plowing joint-use roads requires a *Letter of Authorization* or *Road Use Agreement*. Snow plows should be equipped with plow shoes set high enough that the cutting edge does not scrape or remove any aggregate from the road surface. If anti-skid is to be applied it should be comprised of crushed stone or gravel only. Examples of appropriate anti-skids are as follows: Type 2; Type 3; 6S or AS4 materials as outlined in Penn DOT form 408 and LTAP technical sheet #167. Suppliers of these materials can be found in Penn DOT Bulletin 14.

Dust suppression:

Comprehensive dust control programs are typically not utilized by the Bureau because of a lack of traffic volume. With the significant increase in traffic produced by shale gas extraction, dust has begun to affect traditional users and has created environmental and safety concerns. Dust suppressants themselves may create environmental impacts and often times increase maintenance issues and costs.

The following principles should be considered regarding dust control on state forest roads:

- Reduce speeds on state forest roads to minimize dust. [State Forest Rules and Regulations](#) prohibit speeds in excess of 25mph.
- Avoid convoys and stagger truck traffic to allow dust to settle when visibility and safety are concerns
- Apply only untreated fresh water as a dust suppressant
 - Potable water can retain chemicals that injure plant and aquatic life
 - Non-potable water effectively suppresses dust, but may require multiple applications daily during dry periods
- Do not apply brine or other produced fluids to state forest roads
- Manage shade appropriately within high impact and ecologically sensitive areas. Maintaining shade on the road surface will result in less dust, decrease aggregate replacement needs, and reduce large canopy breaks in interior forests.
- Apply a running surface with minimal fine clay particles such as DSA

Chemical Dust Suppressants:

The use of chemical dust suppressants should only be considered if the previously identified measures are unable to provide effective dust control. The benefits of chemical dust suppressants usually do not outweigh potential maintenance and ecological concerns associated with their use. Mineral and synthetic oil based products may show potential however more testing and observation is needed before the Bureau adopts the use of these products. The use of asphalt cutbacks (i.e., petroleum emulsions), chlorides (e.g., magnesium chloride, sodium chloride, calcium chloride), soy oils, paraffin dissolved in mineral oil, and produced fluids from well drilling and completion operations will not be permitted by the Bureau.

Any request to use chemical dust suppressants on state forest land should adhere to the following process:

1. The request should be submitted to the state forest district. The district will determine if all other alternatives have been exhausted and the project has merit.
2. The state forest district then submits an electronic Dust Suppressant Notification Form to the Recreation Section at least three days prior to the chemical application.
3. The Bureau will review the request and provide written authorization for use.
4. Beneficial and adverse impacts will be documented by the Bureau and influence future decision making.

Rehabilitation:

All state forest roads shall be restored to equal or better profile and condition than existed previously (i.e., pre-gas). The Forest District Manager will determine what restoration or rehabilitation efforts are required and if the restoration results are acceptable. Roads that are no longer used for well drilling operations should be returned to a 12-16 foot running width. Reducing the impervious area will reduce the extent of required PCSM structures for which the operator is responsible for maintaining. It is vital that final restoration is compatible and consistent with the Bureau's maintenance practices and expectations.

F. Pipelines

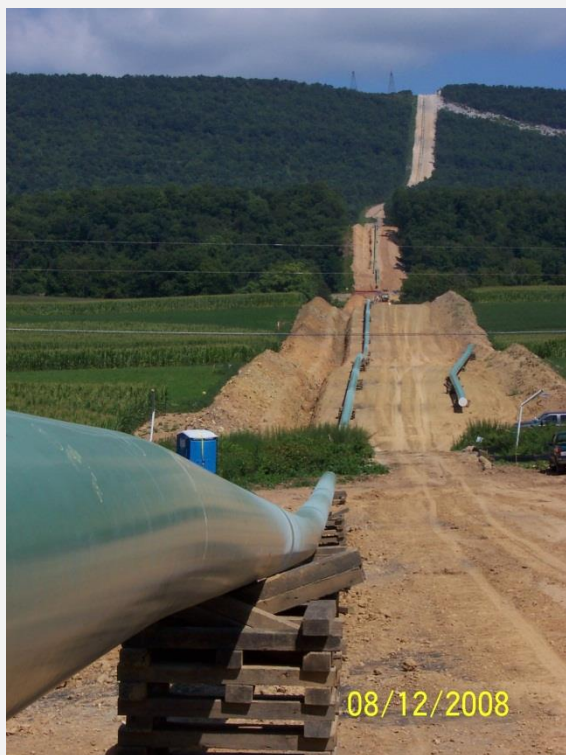


Figure 5F-1. Transmission pipeline under construction.

The development of oil and gas resources requires the construction of pipelines and compressors for delivering the product to market. Moving produced gas from the well to the marketplace requires significant planning, engineering and infrastructure development. Gathering pipelines move natural gas from multiple well pads to transmission pipelines. Transmission pipelines receive large volumes of gas from multiple gathering lines and transport it to a distribution center or storage field. Transmission pipelines are regulated. The Federal Energy Regulatory Commission (FERC) maintains oversight of interstate lines and those tied to storage fields; and the Pennsylvania Public Utility Commission (PUC) is responsible for intrastate transmission lines. Distribution pipelines move gas from the transmission system directly to the customer.

Existing pipeline infrastructure and capacity is inadequate for current and anticipated gas production needs. Operators generally prefer flexibility in designing, constructing and controlling their own pipeline gathering systems rather than relying on independent pipelines. However, independent pipelines accommodate the needs of multiple operators, reduce the need for additional rights-of-ways, decrease costs and minimize unnecessary impacts. Well planned rights-of-way

corridors are necessary for the efficient transportation of natural gas resources and minimization of adverse impacts.

The impacts associated with rights-of-way corridors may be far reaching if not managed properly. Pipeline corridors cause forest conversion, disrupt landscape connectivity, encourage the establishment of invasive plant species, fragment core forest blocks and alter the existing habitats of many plant and animal communities. In addition, the corridors can promote unauthorized vehicular access and negatively impact important social values such as aesthetics, wild character and recreational use.

However, rights-of-way corridors can be managed to provide multiple benefits. The vegetation along the linear openings can be feathered to promote vertical and structural diversity and early successional habitat for a wide variety of plants and animals. Construction debris such as rock and tree tops can be utilized within the corridor to enhance structural habitat for a wide variety of small mammals and reptiles. Thoughtful design, construction and timing techniques can minimize impacts to wild character and promote opportunities for healthful outdoor recreation on pipeline rights-of-way.

Pipeline Siting

Strategic and tactical pipeline planning should occur early in the oil and gas development process. A strategic landscape approach is required to consider, evaluate and plan potential routes for rights-of-way corridors. Landscape planning considers land management techniques and site specific values and needs that promote and balance social, economic

and environmental objectives amongst competing land uses. The location of rights-of-way should accommodate operational needs while maximizing pipeline efficiency, be compatible with current land use, employ avoidance or minimization techniques as appropriate and avoid duplication of infrastructure. The objective of strategic planning is to assure the pipeline is located in the most appropriate place, and with the least amount of conversion, within the landscape.

Tactical planning efforts must also extend to pipeline construction and infrastructure placement within the corridor. Items to consider include: safety; temporary workspace and permanent rights-of-way widths; pipeline materials and capacity; pipe spacing and placement within the corridor; burial depth in relation to surface use and supportable loads; integrity protection; future maintenance; waterbody crossings and operator needs. The objective of tactical planning is to assure the pipeline is sited appropriately within the corridor and in a manner that is consistent with the existing resources, uses and values.

The following principles should be considered when planning and siting rights-of-way corridors on state forest lands:

- Identify areas that are incompatible with rights-of-way development and preclude development
- Identify areas that don't preclude development, but require additional consideration due to significant ecological, cultural or recreational resources.
- Establish a clear need for the rights-of-way and investigate alternative routes. The location of the preferred route should be justified.
- Work within the constraints of existing corridors to maximize pipeline capacity. "Lift and lay" replacement of pipelines that increase capacity are preferred over the addition of a new line.
- Employ long term planning and consider infrastructure capacity that accommodates current and future needs
- Avoid the creation of new corridors when opportunities exist for incorporating rights-of-way into existing disturbances
- Minimize fragmentation by co-locating infrastructure with existing disturbances such as roads and other rights-of-way corridors
- Minimize permanent and temporary rights-of-way widths and maximize infrastructure capacity within the corridor to the extent that workability and safety are not jeopardized
- Consider alternative construction techniques that minimize the construction footprint (i.e. trenchers). Utilize roads or adjacent rights-of-way for temporary workspace.
- Consider burying pipelines within the road footprint when maintenance needs and safety can be maintained
- Encourage companies with adjacent rights-of-way interests to work cooperatively in the use, management and siting of infrastructure
- Encourage proposals that accommodate the needs of multiple operators and avoid duplication of infrastructure on the landscape
- Bury pipelines deep enough to accommodate anticipated surface activities
- Apply setbacks where forest connectivity, recreation and aesthetics are the primary values. Work within topographical constraints to minimize aesthetic impacts and 'hide' infrastructure. Use 'dog-legs' to break up the visual effects of long linear corridors.
- Coordinate the timing of pipeline installation and construction activities to avoid conflict with recreation during periods of heavy use. Consider restricting operator activity during high conflict dates or develop alternatives as applicable.

- Consider opportunities for enhancement of existing recreation and co-locate low impact recreational trails within rights-of-way corridors where appropriate
- Minimize probable conflict with the unauthorized use of rights-of-way corridors by off road vehicles
- Consider appropriate signage measures.

Pipeline Materials

Attention should be given to the type of materials used when constructing the pipeline. Material selection is an up-front activity that considers operational needs, cost, availability, flexibility, performance and benefits afforded with each material. Available pipeline materials include steel, flexible steel and High Density Polyethylene (HDPE).

High Density Polyethylene (HDPE) is corrosion resistant and has many decades of successful use in low pressure oil and gas service. Because of its low friction characteristics, HDPE has a higher flow rate than steel pipe of comparable diameters. HDPE does not require cathodic protection to maintain the integrity of the pipeline. However, HDPE is pressure and temperature limited. HDPE is commonly used to transport water and low pressure gas.

Flexible steel, spoolable composite or bonded reinforced thermoplastic pipe consists of two layers of HDPE pipe sandwiched around a reinforcing steel layer. It is a ductile product with an average bending radius of three to five feet. Flexible steel is corrosion resistant, does not require cathodic protection, provides superior flow characteristics, accommodates high pressures and is produced in long lengths which minimizes the number of connections and welds. The pipe can be installed above or below grade and requires less equipment to do so thereby reducing the operational footprint. It is well suited for trenchless installation, such as directional boring, and can be sleeved through existing pipes for rehabilitation purposes. While flexible steel pipe offers numerous benefits, currently capacity is limited to pipe diameters ranging from two to eight inches. Flexible steel pipe is commonly used to transport water and high pressure gas.

Given the limited pressure tolerance of HDPE and size restrictions of flexible steel, the vast majority of natural gas transmission lines are made of high strength steel. Steel, when not otherwise protected, can corrode resulting in a loss of pressure-carrying capacity. These pipelines must be properly coated and have cathodic protection systems to maintain integrity. The use of cathodic protection systems requires additional spacing between co-located pipelines within the rights-of-way corridors resulting in an increased operational footprint.

The following principles should be considered regarding pipeline materials:

- Consider pipeline materials that promote the minimization of necessary safety offsets (i.e. flexible steel versus steel)
- Consider pipeline materials with coatings that are consistent with the re-establishment of vegetative habitat, tolerant of woody roots and maintain pipeline integrity

Pipeline Stream Crossings

Stream habitat is abundant across DCNR lands and provides habitat for an entire community of organisms. This includes, but is not limited to, invertebrates, reptiles, amphibians, and fish. Riparian areas are critical to stream health as they provide stream bank stability, shade for the stream, filter capabilities of runoff, food input to stream ecosystem

(foliage and terrestrial insect input), nesting habitat for songbirds, food for wildlife (mast/berries), and a visual screen. Care must be taken when considering a stream crossing to minimize impacts to the aquatic community. The following practices will help ensure aquatic ecological integrity.

The following principles should be considered to minimize disturbance during stream crossings:

- Crossings should be perpendicular to the stream
- Stream crossings should focus on straight sections of the stream
- Narrower stream sections are preferred over wide stream sections for crossing
- The number of stream crossings should be minimized

The following principles should be considered during construction of stream crossings:

- Minimize ROW width within the riparian corridor
- Install trench plugs on both sides of the stream
- Bury the pipeline at a sufficient depth to prevent erosion from impacting the pipe
- Screen pump intakes to minimize fish mortality
- Trap and transfer fish that are isolated during the dewatering process
- Place sediment filter bags at least 100 feet away from the stream if possible to allow sediment to settle out before water returns to the stream
- Avoid impacts to spring and fall breeding organisms in cold water streams by constructing between June 15th and Sept 30th
- Minimize potential erosion and sedimentation issue by avoiding disturbance within 50 feet of the stream until construction of the crossing is imminent.

Note:

BMP Avoidance Measures Based on Aquatic Resources Present:

Resource Avoidance Period

Naturally Reproducing Wild Trout Streams October 1- December 31

Class A Wild Trout Streams October 1-April 1

Stocked Trout Streams March 1- June 15

The following principles should be considered regarding restoration of stream crossings:

- Stabilize stream banks and restore the streambed within 24 hours of construction activities and before returning flow
- Use biodegradable material for erosion control to reduce risk of wildlife entrapment
- Revegetate the disturbed areas 100 feet on either side of the stream as soon as possible
- Revegetate the 50 foot riparian area on either side of the stream with vegetation similar to adjacent undisturbed lands. No trees should grow within 15 feet of the pipeline
- Limit vegetation maintenance in the riparian area to the greatest extent possible. A 10 foot native herbaceous corridor may be managed over the pipeline
- Retain stumps in the temporary work space in riparian areas to promote sprouting. Native trees should be replanted if this is not possible.
- Install slope breakers across the ROW on slopes greater than 5 percent

- Utilize Anti-degradation Best Available Combination of Technologies (ABACT) referenced in Chapter 17 of DEP Erosion and Sediment Pollution Control Manual

Vegetation Management and Corridor Rehabilitation

The Bureau of Forestry prefers and supports an Integrated Vegetation Management (IVM) approach to vegetation management within rights-of-way. IVM promotes a sustainable, low-growing vegetation community that provides quality wildlife habitat while remaining compatible with corridor use. In this scenario, only undesirable vegetation with the potential to interfere with pipeline integrity is treated using a combination of chemical, cultural, biological, mechanical or manual techniques. IVM separates the corridor into two distinct management zones (Figure 5F-2). A low-growing herbaceous community is encouraged within the pipe zone. Herbaceous vegetation will not obscure visual inspection of the pipeline and the roots systems are shallow enough to avoid contact with the pipe and potentially jeopardize integrity. The border zone functions as a transition between the high canopy of the existing forest and the herbaceous vegetation in the pipe zone. Shrub species are encouraged in the border zone to feather or soften the hard edge of the corridor. The application of IVM dramatically enhances wildlife habitat by providing a diversified food source and increased escape cover. IVM has a proven track record of maintaining transmission reliability, reducing long-term vegetation maintenance costs, improving aesthetics, and minimizing the establishment of invasive plant species.

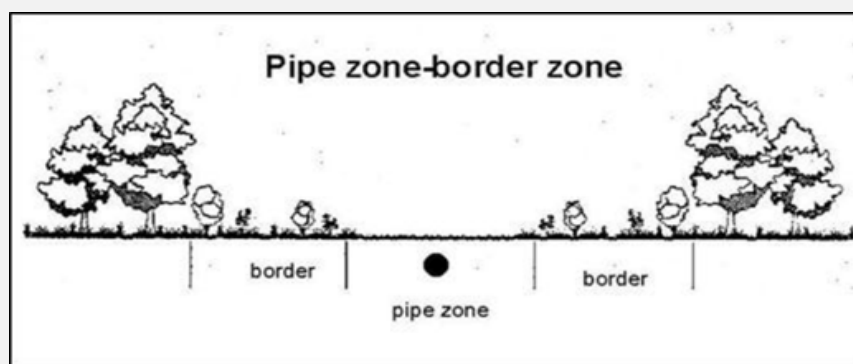


Figure 5F-2. Illustration of pipe zone-border zone.

The following principles should be considered for vegetation management and corridor rehabilitation on state forest lands:

- Maintain the pipe zone in an herbaceous state using native plant species. Mowing may be required every 3-5 years.
- Plant a variety of native shrubs, grasses and forbs in border zone to create vertical and structural diversity. Supplemental plantings can be incorporated within the border zone of existing rights-of-way.
- Feather vegetation in the border zone by leaving vertical structure between the pipeline and the undisturbed forest
- Retain stumps in temporary workspaces to promote re-sprouting of vegetation. Supplement with native plantings as necessary.
- Treat vegetation when it threatens pipeline integrity or encroaches on the pipe zone
- Minimize rights-of-way widths within riparian areas and retain stumps and vegetative cover. Supplement with plantings of native grasses, forbs, shrubs and trees. Plan waterbody crossing proactively and consider directional drilling or boring techniques when appropriate.

- Incorporate downed woody debris within the corridor and along above-ground temporary pipelines to facilitate wildlife crossings
- Improve habitat for threatened and endangered species near confirmed locations. Activities could include rock piling, shrub planting or establishing crossings with escape cover.
- Maintain soil productivity during construction and rip the soil to mitigate compaction where feasible

Rights-of-Way Requests

Lessees or subsurface owners have the right to construct pipelines to transport oil and gas produced on state forest land. These rights are specific to the lands described in the lease agreement or recorded reservation. To construct a pipeline on state forest lands for which they do not hold such rights, the owners/lessees must obtain a *License for Right-of-Way*. The Bureau has developed a [formal process](#) to administer such requests. Central office, in cooperation with the affected state forest district, will administer right-of-way requests that meet any of the following thresholds:

1. The project is under the jurisdiction of Federal Energy Regulatory Commission (FERC) or the Pennsylvania Utilities Commission (PUC)
2. The disturbance footprint is equal to or greater than 25 acres
3. Projects that cross Bureau management boundaries (i.e. forest districts)
4. Other right-of-way requests as determined by the Forest District Manager or central office staff

The local state forest district will administer all other right-of-way requests.

G. Compressor Stations

Compressor stations are commonly used in association with gas production and pipelines. Compression is needed to maintain transportation of natural gas between two points due to declining reservoir pressure, differential pressures in pipeline systems, and/or friction loss resulting from topography, fluids, or pipeline materials. Compressor stations utilize turbines, motors, or engines powered by electricity, diesel fuel or natural gas to reduce the volume of gas and increase pressure to move it from one location to another.



Figure 5G-1. Newly constructed compressor station.

During production, compressors regulate the pressure of gas to facilitate production. Additional compression may be necessary depending on the length of the gathering line, to increase pressure as the gas enters larger transmission lines.

The specific needs of each development area dictates the design, configuration, and specifications of each compressor station. Numerous compressor engines are often required at a site to generate the desired level of compression which may change over time. These sites may also include gas related infrastructure such as separators which capture

undesirable particle or liquids which may condense

out of the gas stream as it flows through the pipeline. This function maintains integrity and extends the life of the pipeline system. Compressors are generally housed within a structure and under roof. Pipelines, fans, the volume and pressure of gas, and other ancillary infrastructure may contribute to the noise level of compressor stations.

There are two strategies for locating the compression necessary for successful gas production:

Distributed:

The compressors are co-located on the established well pad and service all the producing wells within that pad. Compressors are smaller, generate less horsepower and are more numerous than those associated with centralized compression. The configuration is dynamic and compression is moved and adjusted as necessary.

Centralized:

The compression is strategically located within the development field to service gas produced from multiple well pads and dozens of individual wells. Centralized compression often requires multiple large units which produce considerable horsepower. These facilities typically require the development of an additional pad site to accommodate the necessary infrastructure.

Because of the size of the land base, state forests provide a unique opportunity for dispersed low-density outdoor recreation that cannot be obtained from small forest areas or from private ownership. The undeveloped wild character of state forests offers peace, solitude and a feeling of remoteness for many users. Compressor stations are industrial in nature, employ artificial lighting, and produce continuous noise—all of which can dramatically affect a user's recreational experience and generate conflict. Most sources of potential noise conflicts on state forest land are temporary in nature; however, compressor stations produce continuous noise and have the potential to impact nearby residents, the recreating public, wildlife, and wild character. Thus, compressor stations are considered predominately incompatible with state forest resources, uses and values. Alternatives that avoid siting on state forest lands should be pursued where possible. The Bureau's objective is to maintain and perpetuate a visitor's anticipated recreational experience on state forest lands.

When no suitable alternatives exist and a compressor station must be sited on state forest lands, consider the following:

- Compressor stations are inconsistent with primitive and semi-primitive non-motorized Recreational Opportunity Spectrum (ROS) classes and will not be located in these zones
- The operating noise level of the compressor station should not exceed a L_{dn} of 55 db(A) at any distance greater than 300 feet from the compressor building
- Setback distances from ecological, recreational or other important resources should be upheld
- Siting location within the landscape, topography, vegetation and prevailing wind direction is attenuation that can dramatically influence noise. Siting considerations include the following:
 - Employ landscape level planning when siting compressor stations and other infrastructure to minimize potential impacts to state forest resources, uses and values
 - Co-locate compressors with other infrastructure or roads to decrease conversion and fragmentation in core forest areas. Increase setback distances when recreational resources or social concerns exist.
 - Use “dog-legged” access roads to reduce sound propagation and aesthetic impacts
 - The safety and security of both personnel and infrastructure are primary concerns for operators
- Vegetative screening should be promoted or developed around compressor stations to minimize aesthetic and noise impacts. Studies have shown that vegetation may reduce noise levels by 3 – 8 dB (A).
 - Utilize existing vegetation and enhance with a diversity of conifer and shrub species to create vertical stratification that reduces visual and noise impacts
 - Vegetative screenings should be located as close as practical to the noise source. Wider and denser plantings that block the line of sight are preferred.
- Cluster with existing infrastructure and development, limiting the size of the footprint to what is necessary
- Recommended colors for the facades of all buildings include forest green, brown, gray, black or natural stain
- Permanent outdoor lighting of compressor stations should be avoided and security cameras should only monitor infrastructure within areas posted and restricted from public access
- Field observations suggest that electric compressors may generate less noise than those powered by other means. These compressors require three-phase electrical power, which may not be readily available. Bringing electric power to the site may require additional rights-of-way and be cost prohibitive.

Operators are strongly encouraged to quantify the existing ambient noise level at the proposed location during “leaf off” conditions before construction of the compressor station. A minimum of 24 consecutive hours is recommended to quantify the existing ambient noise level of the location.

H. Native Planting and Seeding

A portion of the Bureau of Forestry's mission is to ensure the long-term health, viability, and productivity of the Commonwealth's forests and to conserve native wild plants. As the jurisdictional authority over plants in the Commonwealth (i.e., the Wild Plant Program) we encourage the use of native plant species for rehabilitation projects on state forest land. Native species provide enhanced wildlife habitat and forage, increase the biodiversity value of disturbed sites, and improve ecosystem integrity across landscapes. Native species are particularly important in areas that support populations of species of concern, contain wetlands or have a pristine character.

Supplemental planting, reclamation, and restoration are common practices on state forest lands after timber harvesting, right-of-way creation and gas development activities. Native plant species are preferred but at times non-native plant species may also be utilized. Seed mixes including non-native plants should be carefully chosen to ensure that these species are eventually replaced or succeeded by the preferred native plant species and have no known potential to become invasive.

For specific guidance on planting and seeding with native species, and for lists of species prohibited on state forest lands, refer to the [Appendix: Planting and Seeding](#)

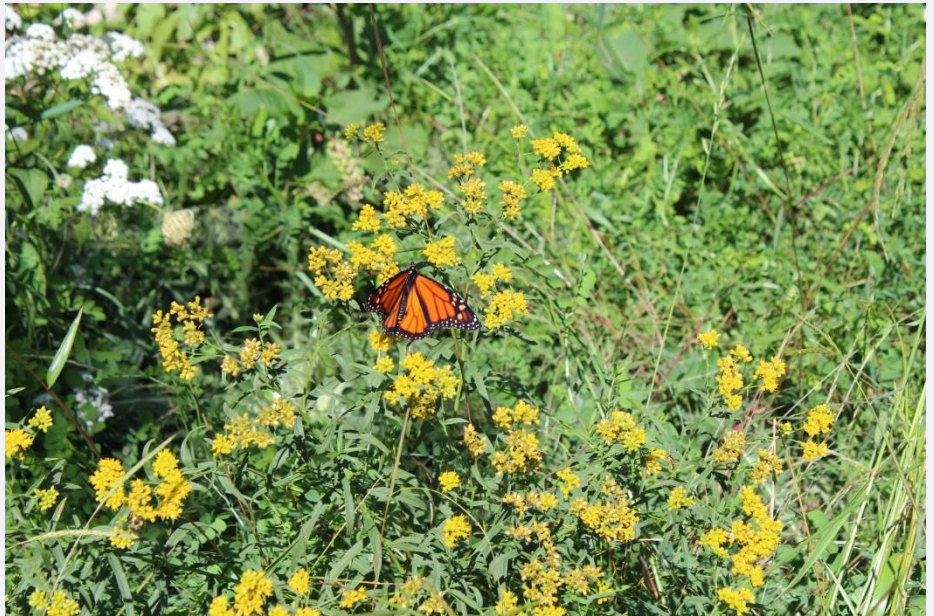


Figure 5H-1. Native plant species support a wide diversity of fauna.

The following should be considered when planting on state forest lands:

- Native grass, legume and wildflower mixes for cover and stabilization should be used within all disturbed construction areas unless otherwise noted by the Forest District Manager
- The seed mix used should provide for immediate stabilization and reduce the chance of invasive plant species establishment. A cover crop must always be planted with a native grass and/or herbaceous seed mix (e.g., oats or barley for spring plantings, wheat or cereal rye for fall plantings).
- A cover crop must always be planted with a native grass and/or herbaceous seed mix (e.g., oats or barley for spring plantings, wheat or cereal rye for fall plantings)
- Native wildflower species can be added to native warm season grass seed mixes to increase diversity and attract native pollinator species
- Native species seed mixes should be planted from late April through May to assure successful establishment. When there is a need to plant outside this recommended window, utilize an annual cover crop to stabilize soils and overseed with a native seed mix the following spring.

- Native warm season grasses, legumes, and wildflowers do not need an addition of fertilizer or lime to be used when planting, except in cases of extreme lack of topsoil (i.e. mine spoil piles), in which case only fertilizer should be used
- After seeding, all seed mix tags should be collected from the seed bags and provided to Bureau of Forestry staff to be included in the permanent tract file
- Species with rare, threatened, or endangered status (see the [PA Natural Heritage Program \(PNHP\) website](#)) should not be planted unless approved by the Wild Plant Program as part of a Species Recovery Plan
- Native plant (including tree and shrub) species with no state or federal-listing status may be planted. Pennsylvania-originated growing stock or seeds and PA Ecotypes of certain grass species should be used whenever feasible. Care should be taken to plant native species within their natural geographic range.
- Justification and stringent monitoring will be required for use of non-native planting stock or seed including cultivars and hybrids on state forest land. Please refer to the Non-native Assessment Document.
- Conifers can be used as a visual or acoustic screen to reduce edge effect into the forest and provide cover for wildlife
- Planning is essential when ordering seedlings. For instance, Penn Nursery requires an advance notice before seedlings will be available.

I. Non-Native Invasive Plants



Figure 5I-1. The establishment of non-native invasive plants, such as reed canary grass, can cause significant environmental and economic impacts to state forest lands.

Non-native, invasive plants are one of the largest threats to natural ecosystems in Pennsylvania. These plants grow quickly and aggressively, displacing or outcompeting native plants. Invasive plants are usually introduced into a region far from their native habitat. In the new location, there may not be any natural enemies, pests, or diseases to keep the invasive plant population under control in Pennsylvania. Invasive plants can severely degrade forests, wetland and riparian habitats and reduce ecosystem function.

Bureau of Forestry vegetation monitoring has shown that invasive plant species are colonizing disturbed areas around natural gas infrastructure on state forest lands. Construction activities associated with oil and gas development (e.g., well pads, pipelines, roads) create new disturbances and pathways which provide opportunities for non-native, invasive plants to establish and spread. Invasive plant seeds can be moved by equipment, vehicles and the use of infested soil and fill material.

Please refer to [Appendix: Non-native Invasive Plant Management](#) for specific best management practices regarding non-native invasive plant management.

Prevention

The phrase “an ounce of prevention is worth a pound of cure” is the epitome of non-native invasive plant species management. It is more efficient to prevent the plants from becoming established than treat them once established. Methods that aid in prevention include:

- Utilizing previously impacted areas and applying construction methods that reduce disturbance, limiting the acreage available for colonization by invasive plants
- [Cleaning equipment appropriately](#) prior to moving it to a new site reduces the likelihood of seeds or other plant parts being inadvertently carried into previously uncontaminated areas
- Utilizing weed-free material (i.e., seed, soil, gravel, mulch)
- Pre-treating pre-existing populations prior to disturbance reduces potential spread during and after construction

Detection

On-going early detection following disturbance can identify new occurrences when they are easier to manage and will facilitate the implementation of rapid control measures that increases the effectiveness of treatment while reducing costs. Identification of new populations early in the development phase promotes the effectiveness of a comprehensive management control plan. A pre-construction inventory is recommended to determine if invasive plants are already present; however this is not currently required for development on state forest lands. Initial surveillance for invasive plants should take place while surveying for infrastructure placement.



Figure 5I-2. Japanese knotweed establishing along the edge of a well pad.

Following construction, routine botanical monitoring for invasive plants is essential to minimize control costs and increase effectiveness of treatments. Initially, this monitoring will detect species that have established as a result of being brought in on equipment or in fill material. However, as the construction phase ends and the production phase proceeds, invasive plant monitoring will detect plants that were brought to the site by wildlife, namely birds, and have colonized the unreclaimed edges of the infrastructure.

Control

The operator should implement management and control measures for all new infestations discovered. The Bureau of Forestry is responsible for providing specific treatment and control prescriptions for any invasive plant populations that are to be treated on state forest lands. Management and control should be species specific and may require continuous treatments to be effective. In some situations, it may be best to wait another growing season to assess the extent of spread before implementing management techniques.

State forest lands are certified by the Forest Stewardship Council (FSC). The use of any chemical or herbicide must adhere to the standards of FSC, and be tracked and reported. All management plans should be coordinated and approved by the Bureau.

Please refer to [Appendix C: Non-native Invasive Plant Management](#) for the complete guidelines.

J. Site Rehabilitation

Oil and gas development and associated drilling activities disturb and fragment state forest land. The Bureau's goal is to reduce the impact of fragmentation on forest habitat by restoring sites to their full ecological function prior to disturbance, or reclaiming sites to a state that is consistent and advantageous for state forest purposes. With effective site rehabilitation planning and implementation, suitable habitat can be created for many species of plants and wildlife during interim reclamation and final restoration of gas-related sites.

Site rehabilitation should be considered a process with many phases, such as: stabilization for erosion and sedimentation control; interim reclamation; habitat enhancement; reforestation; and/or full complete forest restoration. Whatever form rehabilitation projects take, the objective is to stabilize the site following disturbance and re-establish ecosystem function. The Bureau of Forestry, in contrast to current DEP regulations, does not consider stabilization for erosion and sedimentation control to be the final step in site rehabilitation.



Figure 5J-1. Recently rehabilitated pipeline corridor. Shrub plantings are protected from herbivory by fencing.

Explanation of Terms

The terms revegetation, reclamation, restoration and rehabilitation are often used interchangeably but have different meanings to the Bureau of Forestry. The definitions become important when determining final goals for a site and for clarification of expected outcomes. The word restoration is used throughout this document, but often in the short term, interim reclamation is taking place in the field, with final restoration to be completed in the future. The terms are clarified below. A full ecological restoration project often involves all steps defined below.

Rehabilitation: Rehabilitation refers to the overarching act of mitigating some type of land-use change or disturbance, which may involve tree cutting, vegetation removal, soil disturbance, and/or loss of ecosystem function. Rehabilitation is a sliding scale, with required stabilization at the “low” end and complete ecological restoration at the “high” end. Rehabilitation projects often seek to stabilize soils, increase plant and wildlife diversity and/or improve ecosystem functions. Additional considerations for planning all types of rehabilitation projects are given in [Appendix D](#).

Passive rehabilitation: Passive rehabilitation is an activity where the degradation causes are identified and removed and the area recovers without further assistance to a more desirable condition. This activity is often appropriate for communities that have only been slightly impaired. This often involves opportunistic forb, shrub and tree species colonizing the site without human aid.

Active rehabilitation: Active rehabilitation in highly disturbed communities or degraded sites includes the application of management techniques such as soil stabilization, grass establishment, invasive plant control and

shrub or tree planting. These applications are undertaken with a desired final landscape in mind. All forms of rehabilitation that involve site preparation, soil remediation, or stabilization and planting are active rehabilitation projects.

Revegetation: Revegetation refers to planting grasses and legumes over a disturbed site or bare soils. This is the site stabilization required by DEP regulations to protect exposed soils at the site from accelerated erosion and sedimentation. The Bureau of Forestry considers this only the starting point for expected site rehabilitation. The Bureau's Planting and Seeding Guidelines ([Appendix B](#)) provide additional considerations for revegetation projects.

Reclamation: Reclamation reduces the overall size of the disturbed area by using native forbs, shrubs, and trees to begin to rebuild organic topsoil, improve native plant diversity, and encourage site use by native insects and early successional wildlife. Reclamation projects often seek to re-establish the original form of the vegetation community at the site and begin the process of rebuilding full ecological function. Aside from ecological reclamation, disturbed sites could also be used for other state forest purposes, such as trailheads. Additional considerations specific to reclamation projects are given in Appendix F.

Interim Reclamation: Interim reclamation refers to minimizing the original disturbance footprint by rehabilitating all portions of the site not needed for immediate production operations, while also maintaining safety and space for safe operation of active portions of the site. For example, interim reclamation is possible when temporary workspace for a right-of-way is no longer needed, or when the size of a pad can be reduced to only that which is necessary for operation and maintenance.

Final Reclamation: Final reclamation refers to the practice of reclaiming a majority or the entire disturbed site by removing infrastructure, fencing and aggregate material; spreading topsoil and re-contouring the site; and planting native grasses, shrubs and trees. Final reclamation is, in essence, the beginning of restoration. At this point, the site can proceed through natural processes toward the final restoration of all ecosystem functions that existed prior to the initial disturbance.

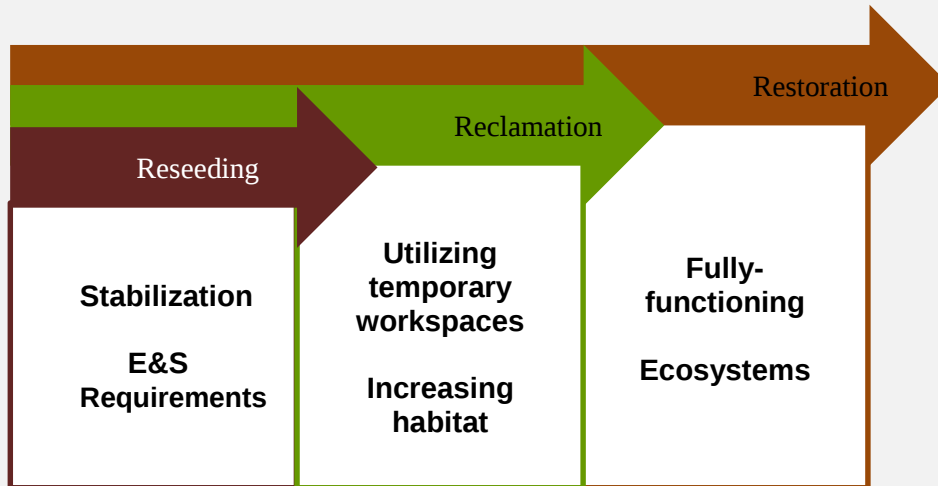


Figure 5J-2. Reclamation often includes the re-establishment of a tree and shrub community.

Restoration: The Bureau of Forestry defines restoration as the return of a disturbed site to the functioning ecosystem state prior to disturbance. Ideally, this functioning state would be the same as what existed at the site prior to disturbance; however, depending on ecological conditions, this may not always be possible. In these cases, the Bureau may seek to provide similar ecosystem functions towards a completely restored state. This type of rehabilitation accelerates the recovery of an ecosystem's health and sustainability, and provides the appropriate pathways for ecosystem functions to become self-sustaining. Merely recreating the landscape without ecosystem functions does not constitute restoration. Additional considerations for restoration projects are provided in [Appendix D](#).

Rehabilitation Timeline

Rehabilitation actions at a site often rely on natural processes to fully achieve project goals. The concepts of the stages of site reclamation are fully appreciated when considered in the context of time. Often these natural processes happen slowly, resulting in the following timeline for rehabilitation activities:



Years Following Disturbance

1 year	Revegetation – Site stabilization, to meet DEP E&S requirements
5-10 years	Reclamation <i>Interim reclamation</i> – Temporary workspaces seeded with native grasses and wildflowers and trees and shrubs planted at edges. <i>Final reclamation</i> – Ecosystem function has been returned to the entire site; but the site has not reverted to the pre-disturbance state (i.e, conifer plantation, wildlife habitat opening)
10-30 years	
30-100 years	Restoration – Pre-disturbance ecosystem functions have become self-sustaining

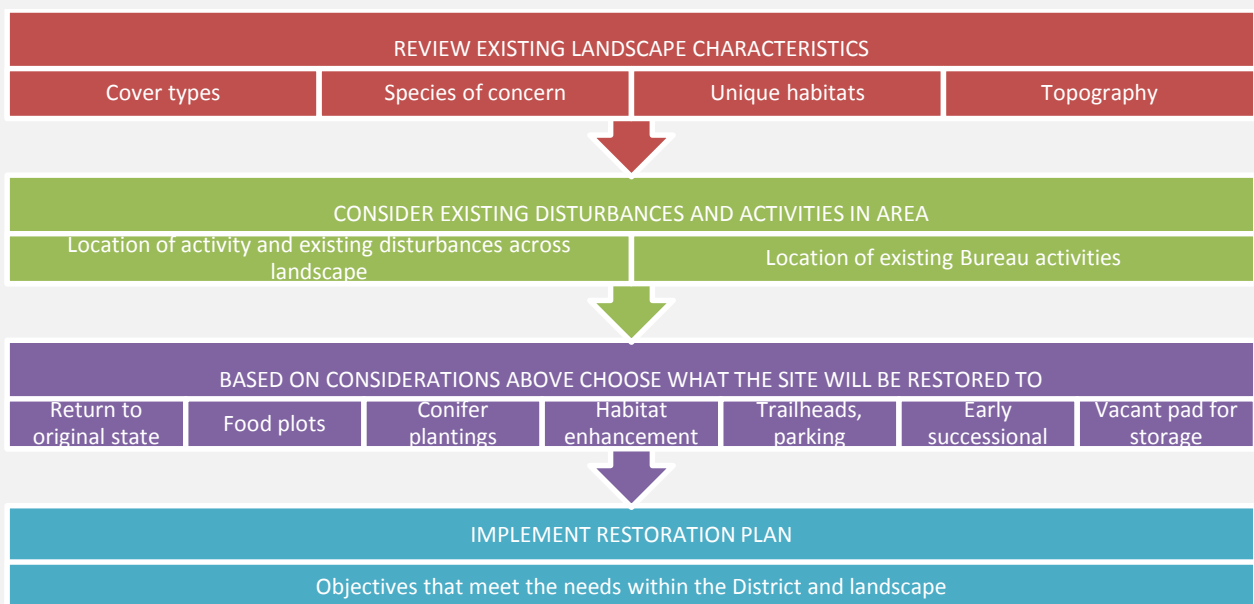
Rehabilitation Planning

Long term rehabilitation goals should be developed early in the site planning process. Goals are the ideal states and conditions that site rehabilitation attempts to achieve. Objectives are specific actions undertaken to achieve the goal. Objectives for site restoration should be formulated based on an assessment of the site's quality, soil function, community type, natural features and plant and wildlife species present. Landscape-scale assessments and the site's surrounding habitat and natural community types should also be considered. The Bureau will identify rehabilitation goals and objectives for the entire development area and communicate those to the operator early in the planning process. Written goals and objectives provide the foundation for rehabilitation activities and clearly identify the Bureau's expectations for site reclamation and/or restoration to operators.

Starting points for developing goals and objectives for the site or tract:

Establish a baseline inventory of existing conditions including: soil quality; water quality; plants and wildlife using the site; and any other information that may be pertinent for reclamation and restoration. This information is especially important if the site is different or unique from the surrounding landscape.

Consider the extent of potential impacts to each site and identify conditions that will need to be improved following disturbance activities. Soil compaction, erosion and sedimentation and vegetation removal will adversely impact the site at varying scales. The level of rehabilitation should be commensurate with the degree of impact to the site.

When developing goals and objectives for the site or tract, consider these points:

Opportunities for habitat enhancement should be utilized whenever possible throughout the interim reclamation and final restoration continuum. Examples of habitat enhancement include:

- Incorporating brush and rock piles at forest, stream and wetland edges near the site to enhance wildlife habitat
- Using native warm season grasses, legumes and wildflowers to create grassland habitat and provide food sources for native pollinators
- Feathering the edges of the site by gradually blending the opening to the adjacent forest. This can be done by adding several rows of shrubs between the site and the forested cover or by leaving stumps cut low to the ground in the temporary workspace to re-sprout.
- Creating nesting opportunities for raptors and other birds using artificial nest structures such as platforms
- Planting at least two types of trees on site to provide soil stability, species diversity and opportunities for early-successional wildlife
- Leaving/placing down woody debris benefits reptiles and amphibians by providing refugia

Interim Reclamation Planning



Figure 5J-3. Ripping compacted soils is critical to successful rehabilitation and long term restoration.

After well completion and stimulation activities have concluded a significant portion of the well pad may no longer be necessary. Interim reclamation can begin with the transition into the production phase. It is important that the Bureau and operators communicate full site rehabilitation plans at the interim reclamation stage to facilitate cooperation towards achieving long term rehabilitation goals.

Materials used to surface the well pad should be removed in all areas no longer needed for production. In many cases, is it imperative that planning where the stone pad paving material will be taken as reclamation commences is done when the infrastructure is constructed. Following removal of pad surface material, the subsoil should be ripped at least 8 inches (deeper ripping is preferred). Efforts should be made to recreate the original contours of the site that existed pre-disturbance. Following ripping of subsoils, topsoil should be re-spread over areas to be reclaimed. Stockpiled topsoil should be redistributed and graded with minimal compaction or “dumping” techniques as recommended by the [Appalachian Restoration and Reclamation Initiative](#) (ARRI). It is essential that the final grade leaves the soil loose and rough, creating an optimal rooting medium for seed and planted vegetation. Vegetation should be monitored to ensure that it is successful and free of invasive plant species.

Final Restoration Planning

Final restoration will begin when the production phase ceases for a well or it is no longer economical to maintain. At this point in time the well shall be plugged and all remaining infrastructure and site improvements can be removed. The determination that a site is reaching or has reached final restoration will be made by the Bureau of Forestry. Sites will then be evaluated for success at meeting restoration objectives and routinely monitored to ensure long term goals are met.

Please refer to [Appendix F: Site Rehabilitation](#) for the complete guidelin

6. The Review and Approval Process

The Bureau extensively reviews all gas activities and infrastructure proposed by the operator. Projects are first evaluated from a landscape or tract level perspective. To facilitate this portion, the Bureau should be provided with the operator's unconstrained conceptual site plan as early in the development process as possible. The Bureau will evaluate the tract level plan and identify known areas of concern or potential conflicts. Staff will then coordinate with the operator to develop an infrastructure layout that satisfies the needs of both parties and serves as the framework for future tract development.

The second portion of the review focuses on the siting of individual infrastructure components. These comprehensive reviews are performed by the state forest district in consultation with central office program areas. The objectives of this review include: minimizing potential adverse impacts; balancing competing and sometimes conflicting state forest resources, uses and values; confirming that well sites are geologically sound and in compliance with lease terms; and assuring the efficient extraction of gas resources. The process for the review of individual infrastructure components is outlined and described below.

Review and Approval Process

A. Submissions:

At a minimum, the operator should submit the following to the Bureau for review:

- Map delineating the planned activity in hardcopy along with ESRI ArcGIS compatible shape files or feature classes
- Narrative of the project, including the type of activity being performed, timing and areas impacted
- Any available correspondence or documentation related to PNDI, PHMC or ecological surveys
- Waiver requests and justifications as applicable

B. Desktop Review:

A desktop review is performed by the state forest district prior to a field visit with the operator. The district will function as the lead during the desktop review and will consult and collaborate with central office program staff. This review determines if the planned gas activity is in conflict with recognized state forest resources, uses, values and operations. The review includes:

- Non-development areas as specified by lease
- Areas of special concern as specified by lease
- [Required setbacks](#)
- Potential sensitive resources as identified through aerial imagery
- PNDI review of rare, threatened and endangered plants, animals, communities and invertebrates
- Water course designation (e.g. HQ, EV, WTS)
- Wetlands and other water resources
- Known cultural resources as identified by PHMC

- Recreational trails, trailheads, high-use areas and ROS zones
- Viewsheds, vistas and aesthetics
- Landscape plans (review landscape narrative and inventory info)
- Timber harvest plans
- Soil surveys
- Well spacing and technical compliance with the lease

The desktop review will define areas requiring additional investigation in the field.

Note:

Projects involving water withdrawal requests will be reviewed by central office staff and forwarded to the Bureau of Topographic and Geologic Survey for sustainability review.

C. Field Review:

Following the desktop review, a field review may be necessary to discuss location details with the operator and to investigate and substantiate those resources which may be impacted by the activity. The field review is comprised of the items below and will be performed by district staff with assistance from applicable central office program areas, as necessary.

Based on the outcome of the desktop review, the presence of the following resources will be assessed in the field review:

- Wetlands, vernal pools and spring seeps
- Cultural resources
- Ecologically sensitive habitat or potential habitat for rare, threatened and endangered species
- Current or potential timber value
- Other unique or ecologically significant features
- Recreational and aesthetic resources

Note:

Field reviews should be conducted during the appropriate time of year for the target species or resource.

A single field review should be sufficient at evaluating sites, although there are instances when multiple field visits are necessary

Operators should not submit permit applications until the field review and all necessary surveys have been completed. This practice improves efficiency and eliminates the need to modify permits due to unanticipated survey results.

D. Final Approval:

Minerals Division staff will confirm that all approvals, permits and review requirements have been satisfied for the proposed activity and provide final approval. Final approval letters will be issued for all proposed infrastructure. Commencement of construction and installation of proposed infrastructure is authorized upon receipt of final approval from the Minerals Division.

7. Gas Program Waiver Requests

The Bureau conducts a comprehensive review of all oil and gas activities and infrastructure proposals prior to issuing approval. Any deviation from terms specified in leases or other agreements requires an approved waiver. Waivers are granted when the proposed deviation affords greater resource protection, resolves conflict between competing uses and values, minimizes overall impact to the forest and is considered to be in the best interest of the Commonwealth. Each waiver will be reviewed on a case-by-case basis. The State Forester has final approval authority for all waiver requests. The waiver process provides a useful approach for discussing and updating the guidelines and ensuring that activities on state forest land conserve multiple resources, uses and values.

Waiver of Lease Drilling Restrictions Process

A. Waiver Request Submission

The operator can submit a request to deviate from conditions specified in leases or agreements.

Waivers requests should be submitted in writing to the Forest District Manager and include:

- Identification of the specific condition for which a waiver is sought
- Description of the proposed deviation and resulting minimization of forest impact
- Justification of the need to deviate from the identified condition
- Identification of alternatives considered and investigated
- Any necessary mapping including GIS data where applicable

B. Bureau Review

The district will review the waiver request to determine:

- If it reduces impacts to the state forest resources, uses and values
- If it is in the best interest of the Commonwealth
- If it is consistent with local management objectives. Suggested modifications should be provided to the operator.

The Minerals Division will review the waiver for completeness and circulate amongst central office program areas. Comments will be collected and documented, and there will be an attempt to resolve outstanding concerns.

C. State Forester Review

Requests that do not reduce impacts to the state forest resources, uses and values, and are not in the best interest of the Commonwealth will be denied. The State Forester (or his/her designee) will review the waiver request and provide an approval or denial. The operator will be provided with written notification of the waiver decision. Some waivers

Note:

Surface disturbance activities associated with oil and gas activities will not be waived within state forest wild areas, natural areas, and state parks where the Commonwealth owns the subsurface rights.

may be conditionally approved and subject to additional provisions. In the case of a denial, if the operator intends to move forward with the request, the dispute resolution process would be used.

8. Routine Field Inspections

It is critical that each state forest district consistently inspect all active construction sites. Early detection of issues may significantly reduce potential effects and facilitate management of any problems while they are easier to control. An effective field inspection will evaluate site access and safety, proper permit and information posting, infrastructure and environmental impacts and any site protections in place.

The following guidance will be followed when conducting routine field inspections:

- A. Forest District Managers should conduct weekly (if possible) inspections during any active construction unless problems or weather conditions dictate otherwise. Inspection of the final site restoration is imperative. Site inspections are considered a very high priority for the district.
- B. The Bureau of Forestry should maintain a cooperative relationship with the DEP's Office of Oil and Gas Management. State forest district offices should coordinate field inspection activities with DEP-Regional Offices, when feasible.
- C. A current emergency contact list should be maintained by the district and the operator.
- D. Forest District Managers should become familiar with and follow *DEP Oil and Gas Management Program's Safety Standard Operating Procedures* when inspecting active oil and gas operations. Forest District Managers have the authority to perform site inspections unannounced.
- E. The Forest District Manager should also incorporate video or photo documentation of any problems, to aid in describing the issue to operators, Minerals Division staff and DEP. Routine inspections may be coordinated with the operator's staff as a courtesy.

Note:

State forest district staff is not responsible for enforcing DEP regulations, state or federal laws governing the impacts to the environment. Staff should observe, document and report any activity which results in pollution or damage to the environment to the proper authority.

The following "Field Inspection Form for Oil and Gas Operations" is to be used for conducting field inspections. A separate form should be established and maintained for each facility (i.e., well pad, new road segment construction, water impoundment, compressor station, staging area and pipeline project). A copy of all field notes should be attached and the files kept in perpetuity until the lease tract is surrendered to the Commonwealth.

Commonwealth of Pennsylvania											
Department of Conservation and Natural Resources: Bureau of Forestry											
Field Inspection Form for Oil and Gas Operations (Page 1 of 2)											
Operator Name					Tract Number						
Facility ID		Latitude			Longitude						
District		County			Township						
Inspect each item listed below. Mark "v" if satisfactory. Mark "X" if unsatisfactory and explain on the back of this form. Mark "-" if not inspected that visit. Mark "NA" if activities completed and site restoration approved.											
Date earth disturbance or construction activities began:					Inspected by (initials)						
					<table border="1"> <tr> <td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </table>						
					Dates Inspected						
Access and Safety	1. Public-use roads safe for public travel										
	2. Access roads good, passable condition										
	3. Gates appropriately opened or closed										
	4. Dangerous equipment posted/fenced										
	5. Dangerous chemicals/waste posted/fenced										
	6. Dangerous areas posted/fenced										
	7. Other potential safety hazards										
Permits and Information	8. DEP Well Permit/Well ID posted on site										
	9. ESCGP Permit posted on site										
	10. E & S Control Plan posted on site										
	11. PPC Plan posted on site										
	12. Consumptive Water Use Permit posted										
	13. MSDS Sheets available on site										
	14. Emergency contact info posted										
Environmental Control	15. Other										
	16. Public-use road drainage / E & S conditions										
	17. Access road drainage / E & S conditions										
	18. Well-pad conditions										
	19. Water storage conditions tanks/ponds										
	20. Pipeline ROW conditions										
	21. Logging and/or skidding operations										
	22. Water conditions (streams)										
	23. Other E & S problems										
	24. Noticeable wildlife habitat impacts										
	25. Noticeable vegetative/forest impacts										
Property Protection	26. Noticeable invasive plant infestation										
	27. Indication of leak or spill (pad, road, etc.)										
	28. Other environmental impacts										
	29. Damage to infrastructure										
	30. Sanitation of site(s)										
	31. Other damages or problems										

Commonwealth of Pennsylvania Department of Conservation and Natural Resources: Bureau of Forestry Field Inspection Form for Oil and Gas Operations (Page 2 of 2)		
Date	Item Number	Provide explanation:
		a. Description of unsatisfactory conditions and corrective action taken (from p.1)
		b. Work completed and site restoration satisfactory
		c. Survey for non-native invasive plants conducted and actions needed
Signature - Inspecting Forester _____		
Signature - Supervisor _____		

9. Documentation and Right-To-Know Law

Bureau of Forestry staff should maintain accurate records and documentation of internal and external communications for all phases of oil and gas development on state forest lands. The public may request and obtain copies of public records that are maintained by the Bureau of Forestry through either an informal request or a formal request pursuant to the Pennsylvania Right-to-Know Law.

File maintenance protocols

A permanent file with legible copies of all documents and records will be maintained for every phase of oil and gas development on State Forest lands (typically on a tract basis) and include:

1. Copies of correspondence, as maintained according to the Department's Document Retention Policy.
2. Copies of documents showing proof of ownership/title to the oil and gas.
3. A copy of the fully-executed Oil and Gas Lease or Surface Use Agreement.
4. Plans submitted by operators:
 - Seismic Survey/ Seismic Survey Agreements
 - Pipelines
 - Roads
 - Well pad development plan
 - Erosion and sedimentation (E&S) plan
 - Water sourcing and waste handling plan
 - Site restoration plan
 - Material Safety Data Sheets (MSDS) for all chemicals stored and used on state forest lands
5. Other maps or drawings.
6. Pennsylvania Natural Diversity Inventory (PNDI) report(s).
7. Current contact information for routine and emergency situations should be maintained by the district at all times.

The above-referenced documents may be maintained in the Bureau's file; however, public disclosure of these records is controlled by the Pennsylvania Right-to-Know Law.

Pennsylvania Right-to-Know Law

The Department is committed to making public records easily accessible. Public records relating to oil and gas activities on State Forest lands may be obtained:

- Informally - by following the [DCNR Procedure for Informal Requests for Records](#)
- Formally - by following the [DCNR Policy for Responding to Right-To-Know Law Requests](#)

A requester may incur fees for both the informal and formal requests for public records, as stated in those policies.

Confidential Proprietary Information

Lessees or operators routinely provide plans and other documents to the Bureau of Forestry to facilitate the administration of oil and gas development on state forest lands. Lessees or operators also consider these items to be confidential and proprietary and expect the Bureau to not share the provided information without the lessee or operator's express permission. Information, records, and data that are provided to the Bureau by a lessee or operator will be treated as confidential and proprietary when stamped as "confidential" by the lessee or operator. However, marking documents as "confidential" does not guarantee that such items will not have to be released to the public. Whether information, records or data is public information is not a decision made by the Bureau, but is made by the Commonwealth's Office of Open Records and is governed by that office's interpretation and application of the Pennsylvania Right-to-Know Law. It will always be the lessee or operator's responsibility to establish the confidential and propriety nature of the stamped documents when the Bureau receives a request for the confidential information.

Any questions regarding the Right-to-Know Law should be directed to the Office of Chief Counsel.

10. Medical Emergencies and Pollution Events

It is anticipated that oil and gas operators will strive to maintain the highest level of safety and environmental standards while operating on state forest lands. However, the Bureau must be prepared to respond to medical emergencies and pollution incidents that may occur. Bureau staff will function primarily in a supporting role for the operator, emergency response personnel, or agencies with jurisdictional authority.

Management of Medical Emergencies

In the event that district staff is called out to a medical emergency at a construction site, it is imperative that staff have immediate access to local emergency contact lists to quickly summon necessary assistance. Each district should have an up-to-date Emergency Action Plan and make sure all staff is intimately familiar with it. Training should also be provided to district staff for handling emergency situations as well as accessing the emergency contact database. A copy of the district Emergency Action Plan should be kept in all vehicles for quick reference for Bureau staff.

The operator will assume the lead role in medical emergencies at the drill sites, construction sites and facility sites. DEP and OSHA require operators to have emergency plans on site and provide their employees with training for emergency situations. In the instance that Bureau staff is present during a medical emergency, emergency phone contacts should be offered to operator personnel to summon the necessary help.

The district should take the lead in directing the emergency flight to the nearest safe landing zone and coordinating an emergency route to the site. Numerous landing zones have been identified in the districts and the locations should be part of the district Emergency Action Plan. Do not attempt to access the well site in the event of a major fire or other hazardous situation. Assessments should be conducted a safe distance from the incident. Gas well fires are unpredictable and may flare. Operators and first responders should be the primary leads in these incidents. Bureau staff should provide support as necessary.

Operators should provide and maintain an emergency contact phone list with the Bureau. This would be used in the event that an operator or contractor personnel is found injured or in danger on state forest land or a pollution incident is discovered by Bureau personnel.

Management of Pollution Events

Pollution incidents may vary in nature and severity, but are generally defined by the Bureau as the unintended release of hazardous, regulated, or other substances with the potential to cause negative environmental effects. Examples of such substances are diesel fuel and other petroleum products, hydraulic fracturing fluid prepared prior to well injection (frac fluid), chemical additives for preparing frac fluid, flowback water recovered from the drilling process, other brine waters used during drilling operations, and drill cuttings. Pollution incidents may occur at a pad site or at some ancillary feature related to gas development, such as a compressor station, meter site, roadway, or pipeline.

Inadvertent returns are also considered pollution incidents by the Bureau. An inadvertent return is the unintentional discharge of drilling mud (primarily water and bentonite) during horizontal direction drilling, which is often employed to underdrill a stream or wetland for pipeline crossings.

Major failures of erosion and sedimentation control measures, which pollute or imminently threaten to pollute a water body, also are considered pollution incidents by the Bureau.

Bureau staff and operators should be alert at all times for pollution incidents. The public has an expectation that pollution incidents be identified, documented, and managed appropriately, in order to safeguard public health and the environment. If a pollution incident is discovered, the first concern should be for the safety of all involved and the public. Appropriate notifications should proceed as described in the sections below. The Bureau's decisions regarding pollution incidents will be made by a team of central office and district staff, in coordination with operators and DEP. DEP is the jurisdictional agency for response and remediation of pollution incidents. In its role as the land manager, the Bureau will coordinate with DEP to provide input such that the management responsibilities of the Bureau and values of its stakeholders may be reflected in DEP's response. Guidelines for the Bureau's documentation and management of pollution incidents are provided in the sections below.

Operator Roles and Responsibilities

It is expected that operators promptly report pollution incidents to the Bureau regardless of whether the pollution incident is due to the actions of the operator, its subcontractors, or other entities. The Bureau expects that operators report all pollution incidents they observe without immediate concern for who is the responsible party. To report a pollution incident, operators should first notify DEP and, if appropriate, emergency response personnel. These notifications should be performed in compliance with the DEP policy for addressing spills and releases at oil and gas well sites (Document Number: 550-5000-001) (a.k.a., the DEP Spill Policy). Second operators should call the Bureau's Notification Hotline (855-378-6629). The Bureau requests that this notification occur within two hours after the pollution incident is detected or discovered. The Bureau should be notified of pollution incidents regardless of the volume of pollution spilled or released to the ground. The Notification Hotline should also be used to report inadvertent returns and major failures of erosion and sedimentation control measures.

Site characterization or remediation activities planned by the operator (or its designated subcontractor) should be coordinated with the applicable DEP office and the Bureau. Although DEP will direct the site characterization and remediation activities as the jurisdictional agency, the Bureau may provide input to the process to ensure that state forest resources and values are considered as these activities occur.

At the time of notification of the pollution incident, the responsible operator also will be asked to provide a description of any interim remedial actions that are planned, initiated, or completed. The responsible operator should then follow the remediation requirements of the DEP Spill Policy. With respect to the DEP's Land Recycling Program regulations (a.k.a. Act 2 regulations) it is the Bureau's expectation that the residential statewide health standard (assuming a used aquifer with total dissolved solids less than 2500 mg/L) be applied to state forest lands. State forest lands generally do not meet the Act 2 definition of "non-residential" lands and should be afforded the highest possible level of protection. In the event that a statewide health standard has not been established for a particular polluting substance, then the background standard under Act 2 may be used for that particular substance. Use of an alternative process or site-specific standard for remediation should only occur in accordance with the DEP's Spill Policy. Provision of notices and reports related to remediation

should occur as described in the DEP Spill Policy. The Bureau expects that operators provide copies of such notices and reports at the same time the information is submitted to DEP.

Areas impacted by a pollution incident should be restored in a timely manner. DEP's Spill Policy requires areas affected by a pollution incident, which are not on a well pad, be restored and revegetated as soon as possible during the growing season. The policy further provides that a restored site should be capable of supporting the same vegetation community that was present before the pollution incident.

Bureau of Forestry Staff Roles and Responsibilities

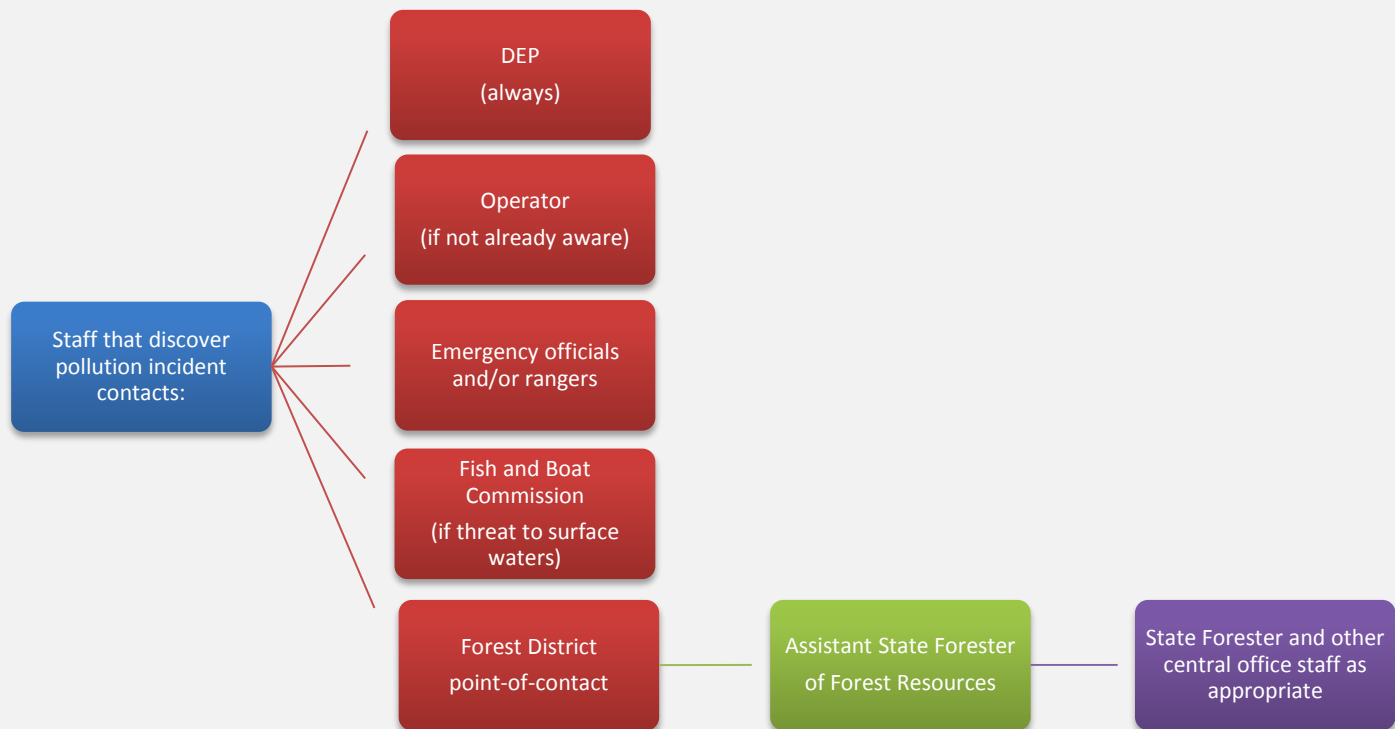
Notification

Bureau staff should be alert at all times for unintentional spills, substance releases, inadvertent returns, and failures of erosion and sediment control measures (i.e., pollution incidents). If a pollution incident is discovered by Bureau staff, their first concern should be for their safety and the safety of others. Bureau staff should not act as first responders for pollution incidents. If in doubt as to the safety of a site, Bureau staff should make the notification calls described below and remain at a safe distance from the site. If a pollution incident causes an imminent safety threat, Bureau staff should not enter the incident area until given proper clearance by authorized public safety or DEP personnel.

Upon discovering a pollution incident, Bureau staff should promptly notify emergency response officials and/or rangers (if public safety is a concern) and DEP. If the operator is not already aware of the pollution incident, Bureau staff should immediately notify the operator as well. If there is an imminent threat to waters of the Commonwealth, Bureau staff also should notify the PA Fish and Boat Commission. Contact information for these entities will be kept in all Bureau vehicles that operate within gas development areas.

In addition, Bureau staff discovering a pollution incident should notify a district point-of-contact. The district point-of-contact will relay the information to the Assistant State Forester of Forest Resources, who will inform other Bureau staff, as appropriate. A list of district points-of-contact for pollution incidents will be maintained by the Minerals Division and distributed to district staff, the Gas Monitoring Team and DEP. The district point-of-contact should mobilize appropriate district staff to assist DEP or emergency response personnel. This may include the temporary closure of trails or roads in the vicinity of the pollution incident.

The following flow chart illustrates the Bureau's notification process:



Initial Documentation

The following procedures should be adhered to by Bureau staff to document a pollution incident after the above notification calls are placed. If a pollution incident causes an imminent safety threat, Bureau staff should not enter the incident area until given proper clearance by authorized public safety or DEP personnel. If the pollution incident is minimal and not a threat to the environment (e.g., a small spill that is entirely controlled by secondary containment), a site visit may not be necessary. However, if the pollution incident poses a threat to the environment, a site visit will be necessary for proper documentation.

1. If no imminent safety danger exists, access the site and confirm a pollution incident has occurred.
2. Photo-document the pollution incident, including evidence of the incident and any interim remedial measures being taken.
3. Use the "Pollution Incident Documentation Form" to document the incident. See Appendix #.
4. Obtain contact information for all other entities involved at the site, such as the operator, subcontractors, DEP, or other agencies.
5. Coordinate with the operator and/or DEP to obtain copies of any sampling plans and/or remedial plans related to the pollution incident. If DEP has issued a Notice of Violation or completed an Inspection Report, request that a copy be sent to the Bureau.
6. If warranted, make plans to return to the site for documentation of remedial measures.

Pollution Incident Management

In response to a pollution incident, central office staff and district staff may need to make a number of critical decisions regarding the documentation and management of the incident. The Bureau may have responsibilities for traffic control on roads and trails, posting of warning signs, and public notification. In addition, the Bureau may engage staff in the incident's management to assist or complement DEP's or operator's efforts. The Bureau may help to coordinate meetings with the operator to discuss the pollution incident as well as the progress of remediation.

The section below lists a number of potential issues that the Bureau may address regarding a pollution incident. Below each issue, a list of important considerations is provided. This list of issues and considerations is not definitive or final, but rather it is meant to provide guidance for the decision-making process. Each pollution incident is unique, such that additional issues and considerations may be relevant in a given situation.

1. Coordination with DEP

- A. DEP is the jurisdictional agency for pollution incidents, and all recommendations or concerns regarding site characterization or remediation should flow through DEP.
- B. Some pollution incidents may be minor and pose no threat to human health or the environment. In such cases, the Bureau may not be involved except to document occurrence of the incident and notify DEP.
- C. Some pollution incidents may affect values or stakeholders specific to state forest land. For example, a release to a stream may occur adjacent to a popular hiking trail, or soil contamination may occur in proximity to an active campsite. In these instances, the Bureau may request that DEP alter the sampling plan or remedial plan to better address these state forest values.
- D. The gas forester should endeavor to maintain close contact with the DEP inspector involved in the pollution incident, so that the gas forester can relay information related to the incident back to other Bureau staff.
- E. In the long-term, coordination with DEP will depend on the extent and duration of environmental sampling and remedial measures. For major pollution incidents that require extensive remediation and follow-up sampling, the Bureau may continue coordination with DEP until the situation is resolved.

2. Press Releases and Public Notice

- A. Any public notifications or statements to the press should be conducted by the communications or press staff.

- B. Even in cases where DEP has determined that no adverse effects exist or are expected, the Bureau may consider a public notification to alleviate public concern.
- C. Bureau staff should post notification signs only in coordination with DEP and after receiving approval from central office.
- D. If questioned in the field by the public or press, Bureau staff may describe what they are doing (e.g., photo-documenting the incident) but should not attempt to describe the remedial investigation or actions that DEP is overseeing. Sampling results require appropriate quality assurance and analysis prior to public disclosure. Questions regarding these efforts should be directed to DEP and/or the Bureau's communications or press staff.

3. Sampling by Bureau Staff

- A. For the immediate incident response, involvement of Bureau staff in environmental sampling will depend on whether DEP requests assistance. Bureau staff, in coordination with DEP, may collect environmental samples in a joint or supplemental manner.
- B. In the long-term, Bureau staff may be involved to examine potential long-term effects of the pollution incident. This may include follow-up soil sampling, water sampling, and/or assessment of vegetation and wildlife habitat. Potentially, such long-term assessment will occur beyond the scope of the DEP investigation, as the Bureau has a responsibility to ensure the long-term health and productivity of state forest lands.

Incident Tracking and Record Management

Completed *Pollution Event Documentation Forms* will be filed in the district offices and with the Minerals Division. Any *Notices of Violation* or *Inspection Reports* obtained from DEP, as well as any reports on sampling or remediation, will be filed along with the *Pollution Event Documentation Forms*.

At present, a record of pollution incidents is being tracked in a spreadsheet by the Minerals Division. The tracking spreadsheet includes the following information:

- Date and time of the incident
- Tract, county, and forest district of the incident
- Operator responsible for the incident
- Incident details, such as substance released, volume, and reason for pollution
- Date and time that remediation was completed
- Other pertinent comments or notes

In the future, the location and other information about pollution events will be entered into the Oil and Gas Infrastructure Tracking (OGIT) system.

POLLUTION EVENT DOCUMENTATION FORM			
Name:		Date & Time:	
GENERAL INFORMATION:			
Date and Time of Incident (or when first discovered/reported):			
Infrastructure or Activity involved			
☐	gas drilling or well pad site	☐	other (please describe in box below)
☐	gas pipeline / pipeline installation		
☐	timbering (ex. fuel spill from truck)		
☐	vehicular accident (ex. fuel spill)		
District Name:		Tract No. (if applicable):	
Operator or Contractor Responsible (if known):			
County:		Township:	
Nearest Road/Intersection Name:			
GPS Coordinates:			
***TAKE PHOTOGRAPHS TO DOCUMENT INCIDENT.			
SPILL DETAILS:			
Type of substance:			
Volume spilled (gallons or barrels):			
Duration of spill (time frame, instantaneous, ongoing):			
POTENTIAL TRANSPORT AND RECEPTORS:			
Fate or transport of substance (overland flow, infiltration):			
Nearby drinking water sources (name, distance, direction):			
Nearby campsite leases (name, distance, direction):			
Nearby wetlands or streams (name, distance, direction):			
Nearby wildlife habitat (type, distance, direction):			
CLEANUP:			
Has any cleanup been performed already, describe if so:			
Is any cleanup presently planned, describe if so:			
BRIEF DESCRIPTION OF INCIDENT: <i>(how it occurred, critical dates/times, additional details)</i>			

SKETCH OF INCIDENT: (include features such as location of release, pad boundary, remedial measures, ditches, roads, streams)

SAMPLING:

Sample Location	GPS Coordinates	Bottles Collected and ID		
Sample Location	GPS Coordinates	Temp (C)	pH	Spec. Cond (uS)

NOTIFICATIONS or OTHER AGENCIES ONSITE:

Make note of the entities you have contacted and people at the site.

	Date	Time	Individual Contacted/Onsite
☐ 911 (only if an absolute emergency)			
☐ DCNR Ranger			
☐ District Point-of-Contact (see contact list)			
☐ DEP General Emergency Line: 800-541-2050			
☐ DEP Regional Office Emergency Line (#s below)			
Williamsport: 570-327-3636, Meadville: 800-373-3398, Pittsburgh: 412-442-4000,			
Wilkes-Barre: 570-826-2511, Harrisburg: 877-333-1904, Norristown: 484-250-5900			
☐ Responsible Operator/Contractor (if known)			
☐ PA F&BC: 855-347-4545 (if threat to surface water)			
☐ Others (list names)			

Appendix

Appendix A: Criteria for Wastewater Treatment Storage System Proposals

Operators should submit proposals for wastewater treatment, storage, and transportation projects to the Bureau of Forestry as early as possible to facilitate efficient review. The timeline for decision-making could be weeks to months depending on the complexity of the project.

Operators should submit proposals containing the following information:

1. General description of the facility(s), including:
 - a. Justification and need
 - b. Alternatives considered and why this proposal is in the best interest of the Commonwealth
 - c. Environmental benefits of proposed project
 - d. Relationship of this proposal to adjacent/nearby operations (both state forest land and other land, and other operators); opportunities for coordination with other adjacent COP lessees
 - e. Permits required by DEP
 - f. Duration of operation
 - g. Contractor(s) and relationships if operated by third party
2. Maps and GIS data
 - a. Location of treatment facility(s)
 - b. Location of storage facility(s)
 - c. Location/route (i.e., schematic drawing) of wastewater pipelines
 - d. Location of all existing and planned oil and gas infrastructure on the tract
 - e. Submit to DCNR per spatial data protocol
3. Detailed description of treatment/storage/transportation systems including:
 - a. Description of treatment methodology
 - b. Equipment/infrastructure required
 - c. Capacity (volumes of water; treated, untreated, stored, etc.)
 - d. Chemicals needed and plans for storage, containment, and transportation
 - e. Tank specifications (capacity, construction material, containment, recommended maintenance schedule)
 - f. Pipe and pipeline specifications (above-ground, below-ground, diameter, length, metering, auto shut-off, leak detection, pipe material and construction specifications)
 - g. Energy needs (electric, gas, diesel, etc.)
 - h. Permits required
4. Detailed description of operations
 - a. Duration of operations

- b. Wells/pads servicing; source(s) of wastewater
 - c. Detailed, tract-level transportation plans
 - i. Freshwater, untreated wastewater, treated wastewater
 - ii. Detailed trucking analysis, included
 - 1. Anticipated decreases or increases in amount of trucking
 - 2. Duration
 - 3. Routes
 - 4. Timing, frequency, and size of trucks
 - 5. Seasonal variation
 - 6. Impacts to nearby communities
 - 7. Consideration of high public use periods such as fishing and hunting seasons and holidays
 - 8. Consideration for Joint Use Roads with snowmobile traffic
 - iii. Wastewater pipeline routes
 - d. Description of periodic (daily, weekly, etc) monitoring and inspection of equipment
 - e. Overall site containment and spill prevention and clean-up measures
 - f. Plan/methods to communicate status of operations to BOF (start-up, shut-down, flow/treatment of water, etc)
 - g. Approximate number of personnel needed to operate on daily basis
 - h. Plan for disposal of waste generated, including solids management, filter cakes, etc.
 - i. Emergency response plan
 - j. Plans/need for future expansion
 - k. Site restoration plans
 - l. Method of cleaning/emptying pipes – if by pigging, where will pig launchers be placed, size needed, etc.
 - m. Security of the site and provisions for public safety
5. Detailed description of site construction requirements and materials
- a. Area of earth disturbance, including description of the current land use/conditions
 - b. Pad construction (aggregate used, concrete, etc.)
 - c. Access road
 - d. Erosion and sedimentation control measures
 - e. Lighting requirements for night operations
6. Analysis of potential impacts to state forest resources and values, including avoidance or mitigation measures
- a. Area of forest cleared
 - b. Plant communities
 - c. Animal communities
 - d. Water resources including nearby surface waters, groundwater and aquatic resources
 - e. Geologic considerations
 - f. Air quality

- g. Noise levels
- h. Recreation facilities and uses (public use roads, trails, picnic areas, vistas, etc.)
- i. Aesthetics
- j. Archeologic resources
- k. Invasive species

Appendix B: Planting and Seeding

Bureau of Forestry Planting and Seeding Guidelines 2016

1. Key Principles

Supplemental planting on State Forest lands is a common practice for activities such as re-vegetating a log landing after harvest, erosion and sedimentation control, forage and cover habitat in wildlife openings, and reclamation and restoration in gas development areas. The Bureau of Forestry utilizes native species in supplemental plantings whenever possible; however, there are occasions when native species do not fully support the purpose of the planting and non-native species may be justified. This document provides guidance on how best to plant native grasses, forbs, shrubs and trees on state forest lands, as well as information regarding non-native species that can be planted with caution on state forest lands. This document also provides information on general seed mixes recommended by the Ecological Services Section and alterations for specific need. Any non-native species planted on state forest lands are to be monitored following planting and is subject to review as per the “Assessment and Justification for the Use of Non-Native Plantings” process.

The Bureau of Forestry has researched many species being considered for planting on state forest lands and have determined that the species fit into three categories:

1. **Invasive:** Deemed invasive. Do not plant.
2. **Potentially Invasive:** Avoid planting, except in special situations (after Ecological Services consultation).
3. **Non-invasive:** Native species deemed non-aggressive and non-native species found not to be invasive.

These categories are discussed in greater detail in Sections 2 (herbaceous species) and Section 3 (tree and shrubs), including recommended species and seed mixes.

1. Invasive: Deemed Invasive: Do Not Plant

Any plant classified as a **noxious weed** by the PA of Agriculture is barred for use on State Forest lands. It is illegal to cultivate, sell, transport, or plant any species classified as a noxious weed in PA.

Plants on [DCNR Invasive Plant List](#) are prohibited from use on State Forest lands, according to principles set forth in the [State Forest Resource Management Plan](#) and the Bureau of Forestry’s Invasive Plant Strategy. Some of these species may have been planted on State Forest lands in the past. However, current standards do not allow the use of these plants on State Forest lands. This includes species on DCNR’s ‘Invasive Plant Watch List.’

2. Potentially Invasive: Avoid planting except in special circumstances or situations

Some species may have invasive potential, depending on conditions, or as noted by other states. In addition, some non-native species do not provide quality wildlife habitat/forage and may not be compatible with planted tree seedlings during reforestation activities. There may be special circumstances or situations that require the use of these species, such as unique erosion control needs or limited availability of native seed. The species mentioned in this category **should be avoided** whenever possible in favor of more acceptable native alternatives. Consultation with Ecological Services is required prior to the use of these species, and monitoring may be required following planting. New Bureau of Forestry policies also require research into the ecological benefits or impacts of the use of non-native species. Please reference the “Assessment and Justification for the Use of Non-Native Plantings” document for further information.

Non-invasive: Native and non-native species recommended for use on State Forest lands.

There are many species to choose for seed mixes and planting on State Forest lands, both native and not native to Pennsylvania. For the species listed in this document, there is little to no evidence to suggest that any of these non-native species will have invasive tendencies, or the listed native species will have aggressive tendencies. These are the species recommended for use on State Forest lands. Other species native to Pennsylvania may be used at the District’s discretion; however, other non-native species should be discussed with Ecological Services prior to their use.

Non-native Plantings Monitoring

Non-native plant species listed under category 2 (potentially invasive) WILL require monitoring. Category 3 (non-invasive) species may require monitoring after consultation with Ecological Services. This monitoring should take place once within 5 years of planting and should be completed by district staff, with help from Ecological Services. If requested, Ecological Services will be available to assist with plant identification. Species in Category 1 (invasive) should not be planted. If they have been planted in the past, treatment and/or removal is recommended.

2. Planting Guidance for Grasses and Herbaceous Plants

The sowing of grass seed mixes is a long-standing practice used on state forest lands to stabilize soils following disturbance. While the Bureau has traditionally used grass seed mixes to retire log landings and timber sale haul roads, there has been an increased use of native grasses for permanent herbaceous openings for wildlife and for reclamation practices in areas surrounding energy and right-of-way development. Combining native wildflowers and forbs to native warm season grass seed mixes increase the ecological value of restoration practices, attracting pollinators and other insects which then builds a more diverse food web and provides additional food sources for wildlife. Plantings of native warm season grasses allow for natural succession, which over time will limit the establishment of invasive plant species.

When undertaking a seeding project please consider the following:

Pre-planning:

- Anticipate ordering seed 6 months in advance to ensure seed availability. The best time to purchase native seed is in fall to be sure the supplier has enough in stock for spring plantings. Be sure to specify **PLS (pure live seed)** when ordering native seed. PLS factors in germination rates to ensure the amount of seed of an individual species is used to achieve adequate cover.
- State-listed or PA Species of Concern may not be planted unless a species recovery plan has been developed and local genetic stock is available. If a district is interested in planting state-listed species, please consult with Ecological Services.
- Seeding rates listed below may be changed when a higher density is desired for erosion control or other purposes.
- When choosing species for a seed mix, attempt to use species representative of the area and consider the management objectives (wildlife opening, road corridor, log landing revegetation, recreational use) for the site. Any mix should have both warm-season and cool-season growing species. Plan ahead for long-term maintenance of the species selected.

Soil and Site Preparation:

- In activities that cause excessive soil compaction, such as log landings or gas development, the **topsoil and subsoil should be segregated and piled** before disturbance and returned to original contour with as little compaction as possible before seeding. Ripping the soil sublayer prior to spreading topsoil is recommended to lessen compaction and increase infiltration.
- **Lime and fertilizer are not generally recommended for native seed mixes.** If lime and fertilizer are used, be sure to **reduce the nitrogen content** (first number in the N-P-K ratio), as this will promote weedy plants or invasives and can potentially kill or inhibit the germination of native seed.
- Seed may be lightly worked into the soil using a rake or bedsprings, but disking will likely bury the seeds too deep and may not be successful. Disking should only be conducted prior to spreading seed.
- If the site to be planted with native warm season grasses is currently occupied by cool season turf grasses, an herbicide application is recommended in the fall prior to spring planting.

Disking should follow once the turf grass has been killed to allow the new seed to have contact with mineral soil.

Planting:

- Use straw, **not hay**, to reduce the potential for introduction of weed seed. Hay should only be used if the cost or availability of straw is prohibitive. Invasive seed can also be introduced from contaminated fill material or seeders. Be sure seeding equipment is clean and free of any seed used previously whether on or off State Forest lands.
- Temporary cover crops should be added to all mixes to improve soil stabilization and increase the chance of establishment. Cover crops can be applied before the desired mix if waiting for the optimum time to plant native seed. When using in combination with another mix, they should be applied at a rate of 1 bushel (~30lbs) per acre. If used alone on a site, they should be applied at 2 bushels (~60lbs) per acre.
 - Spring oats (*Avena fatua*) if seeding prior to August 15th
 - Winter rye (*Secale cereale*) if seeding after August 15th
 - **Annual rye (*Lolium multiflorum*) may be used instead of oats or winter rye
- Observations of warm season grass plantings suggest **April through mid-May is the optimum time for planting and establishing native species** in the first growing season. Fall seeding may be successful (late October through late April), but make sure the seed will not lie wet in winter. If initial reseeding must take place in mid-summer, plant a cover crop of Oats for stabilization and plant native grasses the following April.
- For spring plantings, some native warm season grasses and native wildflowers will germinate the first year with most germinating the second year. For late fall/early winter plantings, native warm season grasses and wildflowers could experience dormancy conditions, but many can germinate well the first full growing season after planting.
- Broadcast and hand spreading of native seed equally across the site is acceptable. However, also consider planting single species from the mix in strips across an herbaceous opening to establish varying vertical structure. Another option is to spread some of the warm season grass seed in “patches” to create openings for wildlife between tufts of grass. Some seed, like that of little bluestem, that is “fluffier” can clog a seeder and should be spread separately from the rest of the mix.

Ecological Considerations:

- The use of synthetic matting is prohibited on state forest lands. If matting is to be used for erosion and sedimentation control, it should be made of biodegradable, Jute material. Synthetic matting is made of a stiff, microfilament netting that may entangle and cause injury or mortality to wildlife.
- When the objective is long-term restoration, rather than temporary cover, it may be important that stock is from local genetic material. Seed companies may provide the genetic origin or offer species collected from different stock. When available, select PA Ecotypes.
- For wildlife habitat, it is important to provide varied structure with good interspersed bare ground, beneath a shaded canopy which allows small mammals and birds to move freely at

ground level, search for seeds, insects and roosting cover. In other cases, on steep slopes or poorer sites, higher rates may be necessary to achieve desired conditions.

- During the first and second year of growth, native warm season grasses typically invest more initial resources in root growth rather than vegetative growth during the first growing season. This enhanced root growth improves soil retention to alleviate erosion and sedimentation issues; however, this enhanced root growth cannot always be confirmed by the quantity of aboveground, green vegetative growth.

Maintenance to Sustain Native Herbaceous and Grass Plantings or Permanent Herbaceous Openings:

- Typically, mowing of native grasses should take place for the first time on the 3rd year following initial planting and then on a 3-5 year cycle as needed. The ideal time to cut native grasses is very early spring (March or April), after snow melt. Mowing can also take place following the first frosts in November, but native grasses are ideal winter shelter for small mammals so this is only encouraged if Spring mowing is not feasible.
- In the second and subsequent growing seasons, the site should be checked for problematic weeds or invasive plants and spot treated.
- These grasses should be cut back to 8" in height by a brush-hog or similar piece of equipment. **Cutting lower than 4" may harm the development of the native grass seedlings.**
- Prescribed fire provides the best maintenance of warm season grass openings; however, in areas such as rights-of-way, this may not be practical.
- Disking could also be considered to break-up and create more space between grass clumps, break up root mats, and to provide better habitat for wildlife. This treatment should be conducted from November 1st to April 1st. It is likely that disking may only be necessary every 5-10 years.
- For more information on sustaining openings, see the Permanent Herbaceous Openings and the Maintaining ROWs for Wildlife documents.

Grasses and Herbaceous Species Lists:

1. Invasive: Deemed Invasive: Do Not Plant

A number of grasses and forbs are considered invasive by DCNR. Plants on [DCNR Invasive Plant List](#) are prohibited from use on State Forest lands, according to principles set forth in the [State Forest Resource Management Plan](#). Please carefully review this list prior to making seeding or planting selections.

2. Potentially Invasive: Avoid planting except in special circumstances or situations

The use of the species listed below should be limited in most circumstances. This list was created through examining neighboring states' invasive plant lists, communications with foresters, specialists and resource managers, and research on species behavior. Native and non-native alternatives to these species are provided within Category 3. This list is revised periodically based on field observations and literature review.

Cool Season Grasses

Kentucky bluegrass	<i>Poa pratensis</i>	Creeping red fescue	<i>Festuca rubra</i>
Non-native bluegrasses	<i>Poa species</i>	Redtop grass	<i>Agrostis gigantea</i>
Orchard grass	<i>Dactylis glomerata</i>		

Legumes

Yellow sweet-clover	<i>Melilotus officinalis</i>	White sweet-clover	<i>Melilotus alba</i>
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3. Non-invasive: Recommended native and non-native grasses and herbaceous species.

There are many species to choose for seed mixes and planting on State Forest lands, both native and not native to Pennsylvania. For these species below, there is little to no evidence to suggest any of these non-native species will have invasive tendencies, or that any of these native species will have aggressive tendencies. Other native grasses, legumes, and wildflowers not included on this list may also be used if conditions are appropriate.

Native Warm Season Grasses

Big Bluestem	<i>Andropogon gerardii</i>	Switchgrass	<i>Panicum virgatum</i>
Indiangrass	<i>Sorghastrum nutans</i>	Purpletop	<i>Tridens flavus</i>
Deertongue grass	<i>Dicanthelium clandestinum</i>	Little bluestem	<i>Schizachyrium scoparium</i>

Native Cool Season Grasses

Virginia wildrye*	<i>Elymus virginicus</i>	Autumn bentgrass	<i>Agrostis perennans</i>
Canada wildrye*	<i>Elymus canadensis</i>	Povertygrass	<i>Danthonia compressa</i>
Riverbank wildrye*	<i>Elymus riparius</i>	Povertygrass	<i>Danthonia spicata</i>

Native Legumes

Partridge pea	<i>Chamaechrista fasciculata</i>	Showy tick-trefoil	<i>Desmodium canadense</i>
Senna	<i>Senna herbecarpa</i>		

Native Wildflowers

Black-eyed susan	<i>Rudbeckia hirta</i>	Tall white beardtongue	<i>Penstemon digitalis</i>
Cardinal flower	<i>Lobelia cardinalis</i>	Ox-eye sunflower	<i>Heliopsis helianthoides</i>
Common milkweed	<i>Asclepias syriaca</i>	Goldenrods	<i>Solidago spp.</i>
Butterfly milkweed	<i>Asclepias tuberosa</i>	Asters	<i>Symphotrichum spp.</i>
Evening primrose	<i>Oenothera biennis</i>	Hoary mountain-mint	<i>Pycnanthemum incanum</i>
Ironweed	<i>Veronica altissima</i>	Narrowleaf mountain-mint	<i>Pycnanthemum tenuifolium</i>
Wild bergamot	<i>Monarda fistulosa</i>		

Native Species for Riparian or Wetland Habitats

Fox sedge	<i>Carex vulpinoidea</i>	Pennsylvania sedge	<i>Carex pensylvanica</i>
Woolgrass	<i>Scirpus cyperinus</i>	Bluejoint grass	<i>Calamagrostis canadensis</i>
Soft rush	<i>Juncus effusus</i>	Blue lobelia	<i>Lobelia siphilitica</i>
Joe-pye weed	<i>Eupatorium purpureum</i>		

Non-native grasses and forbs

Perennial ryegrass	<i>Lolium perenne</i>	Oats	<i>Avena fatua</i>
Timothy	<i>Phleum pratense</i>	Millet	<i>Millium spp.</i>
Winter wheat	<i>Triticum aestivum</i>	Hard fescue	<i>Festuca trachyphylla</i>
Cereal rye	<i>Secale cereale</i>	Alfalfa	<i>Medicago stavia</i>
Buckwheat	<i>Fagopyrum esculentum</i>	Barley	<i>Hordeum vulgare</i>

Non-native legumes

White clover	<i>Trifolium repens</i>	Birds foot trefoil	<i>Lotus corniculatus</i>
Red clover	<i>Trifolium pratense</i>	Flat pea	<i>Lathyrus sylvestris</i>
Alsike white clover	<i>Trifolium hybridum</i>	Crimson clover	<i>Trifolium incarnatum</i>

* The seed awns of the wildryes (*Elymus* spp.) have been shown in certain circumstances to become ingested or attached to a dog's fur or paws, penetrating the skin and leading to the potential for grass awn migration disease. Ecological Services is researching potential native cool season grass alternatives to replace these species. Use these species with caution in areas that may be utilized by hunters.

BOF General Native Seed Mix

Cover Crop: 30 lbs/ac Oats (*Avena fatua*)

3 lb PLS Big bluestem (*Andropogon gerardii*)

3 lb PLS Little bluestem (*Schizachyrium scoparium*)

2 lb PLS Indiangrass (*Sorghastrum nutans*)

2 lb PLS Switchgrass (*Panicum virgatum*)

2 lb PLS Deertongue (*Dicanthelium clandestinum*)

4 lb PLS Virginia wildrye (*Elymus virginicus*)

3 lb Partridge pea (*Chamaecrista fasciculata*)

0.5 lb Showy tick-trefoil (*Desmodium canadense*)

Total: 19.5 lbs/acre

Listed below are some additions or alterations to the native seed mix for unique situations or management goals.

To attract pollinators, consider adding a combination of these native wildflowers...

0.5-2 lb Showy tick-trefoil (*Desmodium canadense*)

0.5-1 lb Tall white beardtongue (*Penstemon digitalis*)

0.5-2 lb Grey goldenrod (*Solidago nemoralis*)

0.5-2 lb Common milkweed (*Asclepias syriaca*)

0.5-2 lb Wild bergamot (*Monarda fistulosa*)

0.5-1 lb Black-eyed susan (*Rudbeckia hirta*)

0.5-1 lb Ox-eye sunflower (*Heliopsis helianthoides*)

0.5-2 lb Butterfly milkweed (*Asclepias tuberosa*)

0.5-1 lb New England aster (*Symphyotrichum novae-angliae*)

0.5-1 lb Mountain-mints (*Pycnanthemum incanum* or *P. tenuifolium*)

Typically, 0.5 lbs per acre are sufficient when added to the above Native mix. If the expressed goals of the site is to attract pollinators, consider adding more seed per acre. The best

wildflower plantings include enough species to have at least one species blooming during all three growing seasons.

A simplified version of this mix to attract game species...

3 lb PLS Switchgrass (*Panicum virgatum*)
 1 lb PLS Big bluestem (*Andropogon gerardii*)
 1 lb PLS Indiangrass (*Sorghastrum nutans*)
 1 lb PLS Little bluestem (*Schizachyrium scoparium*)
 2 lb PLS Deer tongue (*Dicanthelium clandestinum*)
 2 lb PLS Perennial ryegrass (*Lolium perenne*)
 0.5 lb Canada goldenrod (*Solidago canadensis*)
 4 lb Partridge pea (*Chamaecrista fasciculata*)
 30 lb Cover Crop Oats (*Avena fatua*)
 Total: 12 lbs/acre

BOF General Native/Non-native Seed Mix

Areas with slopes less than 15%

2 lb Timothy (*Phleum pretense*)
 6 lb Perennial ryegrass (*Lolium perenne*)
 6 lb PLS Virginia wildrye (*Elymus virginiana*)
 2 lb PLS Little bluestem (*Schizachyrium scoparius*)
 2 lb PLS Big bluestem (*Andropogon gerardii*)
 6 lb White clover (*Trifolium repens*)
 4 lb Partridge pea (*Chamaecrista fasciculata*)
 0.5 lb Black-eyed susan (*Rudbeckia hirta*)

TOTAL: 28.5 lb/acre

Areas with slopes greater than 15%

6 lb Timothy (*Phleum pretense*)
 4 lb Perennial ryegrass (*Lolium perenne*)
 4 lb PLS Virginia wildrye (*Elymus virginiana*)
 3 lb PLS Little bluestem (*Schizachyrium scoparium*)
 3 lb PLS Big bluestem (*Andropogon gerardii*)
 3 lb PLS Indiangrass (*Sorghastrum nutans*)
 6 lb White clover (*Trifolium repens*)
 4 lb PLS Deertongue (*Dicanthelium clandestinum*)
 2 lb Partridge pea (*Chamaecrista fasciculata*)
 0.5 lb Black-eyed susan (*Rudbeckia hirta*)

TOTAL: 35.5 lb/ac

All attempts should be made to use all native seed mixes at sites on state forest lands. At sites with many acres that need planted, in areas with severely steep slopes, or for projects where funds available

for purchasing seed may be limited, this mix of native and non-native species may be more applicable. All additions discussed on the previous page can also be applied to this seed mix.

In shaded sites, reduce the mix to...

- 3 lb PLSVirginia wildrye (*Elymus virginicus*)
- 3 lb PLSCanada wildrye (*Elymus canadensis*)
- 5 lbAutumn bentgrass (*Agrostis perennans*)
- 2 lb PLSDeer tongue (*Dicanthelium clandestinum*)
- 30 lbCover Crop

Total: 43 lb/acre

This is a short-lived perennial mix that will allow for natural herbaceous and woody succession following timber sale retirement.

To simply control erosion and sedimentation reduce the mix to...

- 10 lb PLSDeertongue (*Dicanthelium clandestinum*) or Switchgrass (*Panicum virgatum*)
- 5 lb PLSVirginia wildrye (*Elymus virginicus*)
- 5 lb Autumn bentgrass (*Agrostis perennans*)
- 2 lb Partridge pea (*Chamaecrista fasciculata*)
- 30 lbCover Crop

Total: 52 lb/acre

Comparison Chart: Warm Season vs. Cool Season Grasses (Source: NRCS)

Use this comparison chart when creating a unique seed mix to help decide which grass type best fits the desired goals or outcomes of the planting. Generally, cool season grasses prefer growing when temperatures are between 65 and 80 degrees and warm season grasses prefer temperatures between 80 and 95 degrees. Differences between the two types are described below.

Topic	Warm Season Grasses	Cool Season Grasses
Erosion Control and Water Quality	Provide long-term benefits for erosion control and sediment trapping. Provide nutrient uptake during the summer when cool-season grasses are dormant.	Provide short-term and long-term benefits for erosion control and sediment trapping. Provide nutrient uptake earlier in spring and later in the fall than warm season grasses.
Wildlife Habitat	Excellent nesting and feeding habitat. Bunchgrasses provide openings for feeding, maintaining overhead protection from predators. Remain standing for good winter protection. Diverse - supporting a balanced mix of native plant species and insect populations.	Due to earlier "green-up," provide a better source of food (green foliage and insects) in early spring than warm season grasses. Mat down more rapidly than warm season grasses as they age, degrading nesting quality, feeding, and overhead protection.
Establishment	Seed may be more expensive and less readily available than cool-season grasses. Usually do not need much lime or fertilizer. Tolerates poor soil conditions (drought, nutrient- poor and/or low pH) better than cool-season grasses. Seeds are slow to germinate and seedlings usually need 2 to 3 years to establish. However, root structures are forming and providing erosion control even when not noticeably green aboveground.	Relatively inexpensive, readily available seeds. Have higher nutrient requirements than warm season grasses. Less tolerant of poor soil conditions. May need fertilizer maintenance. Seedlings are usually well established 1 to 2 years after planting. Rapid seedling growth results in less weed competition during establishment. Can be seeded in spring or late summer. Can also be seeded with cool season legumes. More susceptible to drought.
Maintenance	Maintained by using prescribed burning or, mowing to 6 inches tall. Grasses are long-lived and usually do not need reseeding. Selective herbicides may be used for weed control.	Maintained by mowing on 2- to 3-year rotation, and by overseeding with legumes every 3 to 4 years. As stands mature, grasses may thin out and need to be reseeded. Selective herbicides may be used for weed control.

3. Planting Guidance for Shrubs and Trees

There are occasions when planting seedlings is the most efficient method of ensuring that the next forest contains a desired species or to help forests recover after negative forest health impacts. For example, eastern white pine is commonly planted in areas without mature pines to produce seed.

Supplemental planting is the planting of species already present in the stand, but at less than desirable levels. This artificial regeneration supplements the regeneration present, and should target relatively open areas. A wide spacing is normal for supplemental planting (10-15 ft. spacing). Underplanting, a form of supplemental planting, is simply planting shade tolerant seedlings under an existing canopy. This can be done for the same reasons as enrichment planting, or to add understory species to the existing stand.

Enrichment planting is done in stands to establish desirable tree species, often after timber harvests. This can be done to increase diversity and wildlife value to the stand. Planting trees and shrubs along riparian areas can also be considered enrichment planting.

Reforestation planting is done to establish forest cover over an area previously forested, but not currently forested. This is done in areas where natural regeneration is lacking.

One of the keys to successful planting is matching the seedling species with existing site characteristics. A soil test may be appropriate to identify growing conditions. Some species, such as white pine, can grow almost anywhere there is adequate light. Site preparation is another step required for successful regeneration.

Additional Notes

In addition to the above restrictions on specific species/genera, the following planting guidelines are to be followed on State Forest lands:

- **The planting of non-native species in State Forest Wild and Natural Areas may be permitted under limited circumstances after receiving approval via a State Forest Environmental Review (SFER).**
- Native tree species with no special status may be planted. Pennsylvania stock is preferred and cultivars should be avoided. Use Penn Nursery as the primary supplier of seedling stock when possible or a suitable alternative that uses regional genetic stock.
- Former plantations of exotic species (Norway spruce, red pine, etc.) may be replaced to the same species. Conversion of plantations to more natural, native stands is encouraged unless there is special historical significance to the plantation (e.g. CCC plantation of historical significance).

- Newly planted seedlings need protection from deer browse damage in many forest districts. Consider fencing entire planting areas with woven-wire fencing or protecting individual trees with tree tubes.

Tree and Shrub Species Lists:

1. Invasive: Deemed Invasive: Do Not Plant

A number of trees and shrubs are considered invasive by DCNR. Plants on [DCNR Invasive Plant List](#) are prohibited from use on State Forest lands, according to principles set forth in the [State Forest Resource Management Plan](#). Please carefully review this list prior to making seeding or planting selections.

2. Potentially Invasive: Avoid planting except in special circumstances or situations

The use of the species listed below should be limited in most circumstances. This list was created through examining neighboring states' invasive plant lists, communications with foresters, specialists and resource managers, and research on species behavior. Native and non-native alternatives to these species are provided within Category 3. This list is revised periodically based on field observations and literature review.

Deciduous Trees and Shrubs

Sawtooth oak	<i>Quercus acutissima</i>
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3. Non-invasive: Recommended native and non-native tree and shrub species.

Conifer and shrubs may provide cover, food, or structure for various wildlife species. Soft mast producing trees and shrubs provide food for many birds and small mammals. Hard mast producing trees and shrubs provide food for mammals and some birds. Hard mast can also be stored for consumption later. The following species may be used in openings, ROWs, early successional habitats, where underrepresented in the forest, or other suitable places on State Forest lands. This list is not all inclusive, many other PA native species can be considered.

Conifers

White pine	<i>Pinus strobus</i>	Red spruce	<i>Picea rubens</i>
Virginia pine	<i>Pinus virginiana</i> (south of route I-80)	Red pine	<i>Pinus resinosa</i> (north of route I-80)
White spruce	<i>Picea glauca</i>	Pitch pine	<i>Pinus rigida</i>
Black spruce	<i>Picea mariana</i> (wet areas)		

Non-native Conifers

Norway spruce**	<i>Picea abies</i>
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Soft-mast Producing Trees/Shrubs

Serviceberry	<i>Amelanchier arborea</i>	Washington hawthorn	<i>Crataegus phaenopyrum</i>
Smooth serviceberry	<i>Amelanchier laevis</i>	Sweet crabapple	<i>Malus coronaria</i>
Staghorn sumac	<i>Rhus typhina</i>	Low serviceberry	<i>Amelanchier stolonifera</i>
American mtn-ash	<i>Sorbus americana</i>	Cockspur hawthorn	<i>Crataegus crus-galli</i>
Large-seed hawthorn	<i>Crataegus macrosperma</i>	White hawthorn	<i>Crataegus punctata</i>
Frosted hawthorn	<i>Crataegus pruinosa</i>		

Hard-mast Producing Trees

Dwarf chinquapin oak	<i>Quercus prinoides</i>	Red oak	<i>Quercus rubra</i>
Scrub oak	<i>Quercus ilicifolia</i>	Allegheny chinquapin	<i>Castanea pumila</i>
Black locust	<i>Robinia psuedoacacia</i> (south of route I-80)		

Non-native Hard-mast Producing Trees

Chinese chestnut	<i>Castanea mollissima</i>	American chestnut hybrids	<i>Castanea dentata x mollissima</i>
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Blackberry / Raspberry Species

Common blackberry	<i>Rubus allegheniensis</i>	Black raspberry	<i>Rubus occidentalis</i>
Smooth blackberry	<i>Rubus canadensis</i>	Red raspberry	<i>Rubus idaeus</i>

Shrubs

Arrow wood viburnum	<i>Viburnum dentatum</i>	Graystem dogwood	<i>Cornus racemosa</i>
Nannyberry viburnum	<i>Viburnum lentago</i>	Silky dogwood	<i>Cornus amomum</i>
Buttonbush	<i>Cephalanthus occidentalis</i>	Elderberry	<i>Sambucus canadensis</i>
Alder	<i>Alnus spp.</i>	Native chokeberries	<i>Aronia spp.</i>
American hazelnut	<i>Corylus americana</i>	Ninebark	<i>Physocarpus opulifolius</i>

****If Norway spruce is used to replace eastern hemlock, plant another native conifer (for example, white pine, red spruce, or white spruce) to increase opportunities for wildlife. A mixture of species will be required to compensate for the loss of eastern hemlock.**

Riparian Areas

Streams impacted by management activities and the riparian areas may be planted for canopy coverage or habitat enhancement. Forested riparian areas provide filter capabilities, stream bank stabilization, stream shading, additions of organic material to the stream, and shelter and food for wildlife.

Please consult the riparian tree and shrub list below. When planning riparian habitat planting projects, please partner with Ecological Services biologists to develop structure and composition specifications to meet habitat goals. Different riparian species may require different habitat and proper planning will help ensure suitable habitat is created.

Species recommended for stream crossing can include the following list, but be sure to use species native to the geographic region of interest.

Trees

Bigtooth aspen	<i>Populus grandidentata</i>	Black gum	<i>Nyssa sylvatica</i>
Quaking aspen	<i>Populus tremuloides</i>	Eastern hemlock	<i>Tsuga canadensis</i>
Pin oak	<i>Quercus palustris</i>	Red maple	<i>Acer rubrum</i>
Black willow	<i>Salix nigra</i>	Yellow birch	<i>Betula alleghaniensis</i>
Black cherry	<i>Prunus serotina</i>	American sycamore	<i>Platanus occidentalis</i>
Tulip poplar	<i>Liriodendron tulipifera</i>	Black spruce	<i>Picea mariana</i>
Eastern white pine	<i>Pinus strobus</i>	Silver maple	<i>Acer saccharinum</i>
Red spruce	<i>Picea rubens</i>	Black willow	<i>Salix nigra</i>

Small Trees

Flowering dogwood	<i>Cornus florida</i>	Serviceberry	<i>Amelanchier arborea</i>
Staghorn sumac	<i>Rhus typhina</i>	Smooth serviceberry	<i>Amelanchier laevis</i>
Smooth sumac	<i>Rhus glabra</i>	Low serviceberry	<i>Amelanchier stolonifera</i>
Winged sumac	<i>Rhus aromatica</i>	Redbud	<i>Cercis canadensis</i>

Shrubs

Alder	<i>Alnus spp.</i>	Winterberry holly	<i>Ilex verticillata</i>
Chokeberry	<i>Aronia melanocarpa</i>	Silky dogwood	<i>Cornus amomum</i>
Buttonbush	<i>Cephalanthus occidentalis</i>	Elderberry	<i>Sambucus canadensis</i>
Choke cherry	<i>Prunus virginiana</i>	Highbush blueberry	<i>Vaccinium corymbosum</i>
Gray dogwood	<i>Cornus racemosa</i>	Arrow-wood viburnum	<i>Viburnum dentatum</i>
Blackhaw	<i>Viburnum prunifolium</i>	Inkberry	<i>Ilex glabra</i>
Witch hazel	<i>Hamamelis virginiana</i>	Red-osier dogwood	<i>Cornus sericea</i>
Ninebark	<i>Physocarpus opulifolius</i>		

Wildlife Use of Native Shrub and Tree Species

Species	Wildlife Species
Shrubs	
Arrowwood viburnum (<i>Viburnum dentatum</i>)	Fruit eaten by songbirds
Northern bayberry (<i>Myrica pensylvanica</i>)	Fruit and seeds eaten by songbirds. Provides habitat for ground-dwelling wildlife.
Sweet crabapple (<i>Malus coronaria</i>)	Fruit eaten by birds, deer, small mammals.
Dogwoods	Bluebird, Cardinal, Cedar waxwing, rabbit, ruffed grouse, wild turkey, wood thrush.
Gray dogwood (<i>Cornus racemosa</i>)	Fruit eaten by pheasant, turkey, grouse.
Red osier dogwood (<i>Cornus sericea</i>)	Fruit eaten by songbirds, grouse, quail, turkey. Twigs browsed by deer and turkey.
Silky dogwood (<i>Cornus amomum</i>)	Sometimes browsed by rabbits and deer.
Elderberry (<i>Sambucus americana</i>)	Fruit eaten by many birds including bluebird, brown thrasher, cardinal, indigo bunting, rose-breasted grosbeak, pheasant and dove. Recommended for rabbit, quail and turkey.
American hazelnut (<i>Corylus americana</i>)	Nuts eaten by squirrel, deer, jays, grouse, and pheasant. Recommended by quail and turkey.
Nannyberry (<i>Viburnum lentago</i>)	Fruit eaten by songbirds. Recommended for turkey.
Hawthorn (<i>Crataegus</i> spp.)	Fox sparrow, gray fox, raccoon, ruffed grouse.
Alder (<i>Alnus</i> spp.)	Beaver, goldfinch, ruffed grouse
Pines/Softwoods	
Eastern white pine (<i>Pinus strobus</i>)	Roosting trees for birds. Seeds eaten by a wide variety of birds, squirrels, and mice. Recommended for turkey.
Pine (<i>Pinus</i> spp.)	Beaver, black-capped chickadee, brown creeper, gray squirrel, mourning dove, porcupine, and nuthatches.
Non-mast producing Species	
Bigtooth aspen (<i>Populus grandidentata</i>)	Twigs and barks eaten by deer and beavers. Buds and catkins eaten by ruffed grouse. Recommended for porcupine.
Soft Mast Producing Species	
Serviceberry (<i>Amelanchier arborea</i>)	Fruits eaten by bluebird, cardinal, cedar waxwing, grey catbird, scarlet tanager, and veery. Recommended for turkey, beaver, and deer.
Hard Mast Producing Species	
Oaks (<i>Quercus</i> spp.)	Black bear, blue jay, raccoon, ruffed grouse, white-tailed deer, turkey, wood duck

Adapted from :

MacGowan, B.J. "Designing hardwood tree plantings for wildlife." USFS FNR-213. North Central Research Station, USDA Forest Service & Department of Forestry and Natural Resources, Purdue University.

Forest Stewardship #5: Wildlife. Penn State Extension publication.

Species Considerations for Conifer Planting

Species	Wildlife Habitat Characteristics	Present Distribution	Site Requirements	Shade Tolerance/Growth
Red Spruce (<i>Picea rubens</i>)	Lacking lower limb structure & thermal characteristics of hemlock. Northern flying squirrel feeds on the fruiting body of the mycorrhizae.	Northern PA, and higher elevations in northern Appalachian mountains.	Higher elevation, good moisture regime. Grows well on poor sites, acidic and shallow soils.	Tolerant- Very Tolerant. Long-lived (350-400 years), slow growing.
Norway Spruce (<i>Picea abies</i>) **Non-native**	Retains lower limbs.	Throughout PA.	Tolerant of wide range of moisture regime and pH.	Very shade tolerant.
White Spruce (<i>Picea glauca</i>)	Retains lower limbs.	Northern PA	Tolerant of wide range of moisture regime and pH.	Intermediate shade tolerance. Long lived (250-300 years)
Black Spruce (<i>Picea mariana</i>)	Small dbh at maturity, retains lower limbs, shallow rooting.	Northern PA	Moisture regime important, prefers peat, and wet organic soils. Common in swamps or bogs.	Tolerant. 200 year lifespan typical.
White Pine (<i>Pinus strobus</i>)	Gets large, provides thermal cover, retains more lower limbs than red pine	Throughout PA	Tolerant of wide range of moisture regime and pH in northern North America.	Intermediate shade tolerance. Long lived.
Red Pine (<i>Pinus resinosa</i>)	Medium to large tree. Does not retain lower limbs	Northern PA	Tolerant of xeric sites, does well on sandy soils	Very intolerant, fast growth
Pitch Pine (<i>Pinus rigida</i>)	Medium sized tree	Mainly southern and eastern PA	Acidic soil, tolerant of fire	Intolerant
Virginia Pine (<i>Pinus virginiana</i>)	Relatively short	Southern PA	Grows well on xeric, nutrient poor sites	Intolerant

Appendix C: Invasive Plant Management

Preventing the Spread of Invasive Plant Species

The phrase “an ounce of prevention is worth a pound of cure” is the epitome of invasive plant management. It is more efficient and cost-effective to prevent invasive plants from becoming established than to control them once established. As might be expected, smaller or novel infestations of invasive plants are much easier to eradicate than well-established, larger populations. A number of prevention techniques can be utilized to limit the spread and establishment of invasive plants within gas development areas.

1. **Clean all vehicles and construction or mowing equipment thoroughly.** Prior to bringing equipment onto any state forest land, the operator is encouraged to clean equipment in an appropriate manner to remove all plant material, including rhizomes and seeds that might be carried on tires and the equipment undercarriage, which will help prevent the spread of invasive plants onto adjacent lands (please refer to [Equipment Inspection and Cleaning Manual](#), and [Vehicle Cleaning Technology for Controlling the Spread of Noxious Weeds and Invasive Species](#)). If specialized cleaning equipment is not available at a staging site, consider nearby commercial car washes with high-pressure sprayers for cleaning smaller vehicles and equipment.
2. **Whenever possible, utilize on-site mulch materials (such as mulching trees marked for removal).** While not always feasible, this practice would ensure that no contaminated mulch could be brought into the site. Invasive plants present at the edges of mulching or compost facilities could compromise and contaminate the material. Similarly, beds of dump trucks that are not properly cleaned could introduce invasive material into otherwise invasive-free mulch.
3. **Examine sources of fill and quarry material.** Instances of new populations of invasive plants following construction of gas infrastructure on state forest lands have been frequently traced back to populations growing within or at the edges of quarries. Invasive seeds and vegetative material can be collected and transported along with rock for road or pad building and become established following construction. It is recommended that operators or their botanical consultant inspect quarries prior to making large material purchases for multiple infrastructure projects.
4. **Move equipment from uninvaded areas to areas of high invasion.** The operator is highly encouraged to plan work according to invasive plant presence and avoid entering an un-infested area after working in a heavily infested area (including bringing equipment in from other states or geographic areas). If this is not logistically possible, the operator should seriously consider cleaning equipment between entries. District personnel may assist

contractor or operator in planning construction activities in relation to invasive plant locations when they are aware of their presence in particular areas.

5. **Clean seeding equipment prior to use.** Contamination can sometimes occur through the use of contaminated seed spreaders, not necessarily from the seed stock itself. Be sure that seeding equipment is clean and free of any seed used prior to these activities
6. **Use straw, not hay, following seeding.** Mulching with straw rather than hay is recommended to reduce the possibility of introducing invasive plant species propagules.
7. **Consider more aggressive native species or seed at higher rates in areas of known infestations.** Some native species, such as autumn bentgrass (*Agrostis perrenans*), deer tongue grass (*Dichanthelium clandestinum*), and switchgrass (*Panicum virgatum*) can grow aggressively and could have the potential to outcompete some invasive plants, in particular Japanese stiltgrass and reed canary grass. Seeding at higher than recommended rates of these species is necessary to achieve this result. Specific guidance in this type of seeding should be undertaken through cooperation with forest district staff and the Ecological Services section.
8. **Conduct a pre-construction survey to establish the presence or absence of invasive plants at the site prior to earth disturbance.** Knowledge of where invasive plants exist prior to construction allows for better implementation of the prevention measures discussed above. New disturbance and exposed soil often allows for the rapid spread of many invasive plants. Similarly, small infestations of invasive plants may be easier to control or eradicate when treated prior to construction.

A pre-construction survey is recommended to determine if invasive plants are already present on-site; however this is not a requirement for development on state forest lands.

The goals of a pre-construction survey are to: (1) locate established invasive plant populations that threaten the project, (2) determine appropriate prevention methods, (3) predict invasive plant control needs, and (4) assess potential responsibility for management of invasive plants and populations within a given site.

The protocol described in the “Inventory and Monitoring of Invasive Plant Species” section can serve as an example of a potential pre-construction survey protocol. Other protocols for pre-construction surveys are acceptable, but should include collecting all data described within that protocol.

Early Detection Rapid Response Protocols

Early Detection and Rapid Response (EDRR) survey and treatment protocols maximize both sampling efficiency and discovery opportunities for new invasive plant species occurrences across state forest lands.

New forest clearing or disturbance due to gas development can provide ideal habitat and growing conditions for invasive plant species. Tracking all novel populations and treating them promptly is essential to slowing the spread of invasive plants on State Forest lands. The focus of this strategy is on high priority species that are either new or uncommon to a particular district; or are currently found outside state forest lands but have the potential to colonize within a district. In addition to tracking these species, this strategy also allows for the immediate (based on seasonality) treatment of these populations when found. One main assumption of EDRR is that new occurrences, when found, are relatively small and if immediately treated, could be eradicated with minimal effort, time, and cost. The EDRR protocol provides a brief (less than 5 minutes) reporting procedure that is carried out by trained staff. Since these populations are tracked over time, the effectiveness of treatments is also evaluated.

Prior to implementation of this [protocol](#), a list of 11 high priority invasive plant species was developed and applied to all districts currently utilized for gas development in northern Pennsylvania (Moshannon, Sproul, Tiadaghton, Elk, Susquehannock, Tioga, and Loysock state forests). The [list](#) is re-evaluated annually based on the latest survey data.

Inventory and Monitoring of Invasive Plant Species

Tracking the establishment and spread of invasive plant species and detecting new populations across a leased tract, right-of-way, or at the landscape level is essential to effective prioritization planning and control of these species.

The Bureau of Forestry requires invasive plant monitoring and control following earth disturbance for the construction of gas infrastructure on state forest lands. Operators subject to a state forest Lease, Surface Use Agreement, or Right-of-Way Agreement are subject to monitoring and treatment requirements set forth by their Agreements.

As of 2015, new provisions have been put in place for new state forest Leases or Surface Use Agreements, as well as for new Right of Way Agreements. These provisions can be found at the end of this Appendix.

Prior Leases or Agreements are subject to invasive plant provisions established at the time of those particular agreements; however, the Bureau encourages operators to consider the use of more current invasive plant species control techniques and prioritization protocols.

The following are required inventory protocols for invasive plant monitoring activities:

1. During the first growing season after reseeding of the disturbed site, monitoring for invasive plant species during the growing season from May through September by a qualified botanist shall commence.
2. Target plants for monitoring are those classified as invasive, including those on [DCNR's Invasive Plant List](#) and Watch List or as specified by the Bureau of Forestry. The operator should consider

conducting inventories twice during the growing season to capture species that are conspicuous at different times during the growing season.

3. Monitoring data should be collected from the entire disturbed area plus a 100-foot buffer area, in grid cells no greater than 150' x 150' in size. The established grid should be digitized into a GIS layer, have unique labels, and be printed on maps that will be used for field data collection.
4. Standard information including date, surveyor name, and grid cell number should always be recorded prior to beginning the actual survey. During the field study, the center of each grid cell should be located using GPS, and an inventory created by noting the presence of any invasive plant species or the complete absence of any invasive plant species within the specified grid cell. For each invasive plant species occurrence, the cover class within each grid cell should be recorded as the following:

Trace = less than 1% cover
Low = between 1 and 5% cover
Moderate = between 5 and 25% cover
High = between 25 and 100% cover

Cover may be estimated as a percent of the ground covered by a particular species. All trace and low occurrence locations should be located by GPS to aid in relocation and treatment.

In addition, the average growth stage should be recorded as the following for each invasive plant species in each grid cell:

Seedling
Bolt
Bud
Flower
Seed set
Mature

5. The operator is responsible for providing the written report of the inventory findings, along with all associated data and GIS shapefiles to the Forest District Manager within thirty (30) days of survey completion. The Bureau of Forestry will assess the findings of the report and provide a treatment plan with all treatment requirement details for all prioritized invasive plant species to the operator and their botanical consultant.

Prioritization of Invasive Plant Threats

Landscape-level Management

Managing infestations of invasive plants requires diligence and effective planning, as well as an understanding of the plants-both where they currently occur and how they are spreading across a landscape. Each invasive plant species recognized by the Bureau of Forestry has different modes of spread and preferred habitat, and as such, each infestation and situation can be unique and require an individualized treatment strategy. The Bureau of Forestry is committed to managing invasive plant species across all state forest lands, which requires adaptive management and landscape-level prioritization based on efficiency, availability of resources, and perceived threat to ecosystem health. At the landscape level, rarely is it as simple as adopting a strategy of eradicating all known invasive plant populations. There are many different methods available to land managers to prioritize invasive species management across their state forest district. Many of these methods require an understanding of the current levels of infestations across a given landscape. It is recommended that prior to developing a prioritization strategy, thorough invasive plant surveys are conducted and the data is compiled spatially. The goals of the Bureau of Forestry's invasive plant management program are to: 1) control and eradicate novel and high threat invasive plant species populations, and 2) limit the spread of additional invasive plant species that threaten forest and wetland ecosystems or forest management activities.

The Bureau of Forestry is committed to a standard approach when coordinating invasive plant species surveys and treatments with operators and lessees. While managing invasive plants requires varying strategies across different landscapes, the basics of the decision-making process are similar in all forest districts. These strategies aid land managers in effectively eradicating novel invasive plant species and populations and containing the spread of existing invasive plant populations in each state forest district.

Most landscape level strategies used by the Bureau for establishing invasive plant treatment priorities consider (but are not limited to) the following factors:

- 1. Threats to forest ecosystems** – As forest managers, the Bureau's primary role is to promote the health of forest ecosystems and native plant species. Some invasive plants pose a greater threat than others to forest health by easily out-competing native herbaceous plant species for nutrients and growing space, as well as inhibiting desired tree regeneration in forest stands. Threats to state-listed species populations or Wild Plant Sanctuaries are also considered.
- 2. Density and scale of infestation** – Small or newly established populations of any invasive are easier to treat than dense, large-scale infestations. Treating these small populations provides a higher probability of success and limits the spread of species across a landscape, confining species to "core" areas of infestation.
- 3. Novelty of species on the landscape** – Species that are new to a particular landscape are often given a higher priority than established invasive plant species. As with small populations, the probability of eradicating a particular species on a given landscape is higher with novel populations. This is often accomplished on state forest lands using Early Detection and Rapid Response strategies.

4. Areas targeted for forest management – Forest managers treat well-established invasive plants in areas that are targeted for forest management activities such as timber harvesting and habitat restoration or recreational activities like trails and parking lots. This helps control the spread of established populations into newly disturbed areas or areas with high visitation by the public.

5. Resources available for treatment – After ecological and management decisions are made using the points described above, forest managers consider the amount of time, manpower, and funds that are available for invasive plant management and allocate their resources accordingly.

Treatment Strategy

The same decision-making process is used when considering how best to treat species found during a post-construction invasive plant report submitted by a lessee or agreement holder. After review of post-construction invasive plant monitoring reports and internal discussions concerning prioritization based on the five factors listed above, populations that are selected by the Bureau for treatment by the lessee or agreement holder often can be categorized in one of three ways: (1) high priority species that are new or novel to a particular region or species that the Bureau of Forestry recognizes as posing the highest threat to all native species and ecosystems (i.e. Japanese angelica tree, common reed), (2) additional invasive plant species that are known to specifically threaten forest or wetland ecosystems (i.e. Japanese barberry, honeysuckle species), and (3) species or populations that threaten existing or proposed forest management activities in the immediate vicinity of the occurrence.

Highest-threat Invasive Plant Species

The Bureau of Forestry has established the following eleven invasive plant species listed below as the highest priority targets for immediate treatment and control. These were chosen due to their ability to severely threaten all ecosystems in Pennsylvania and because they are currently found in mostly low levels in northern Pennsylvania, raising the probability of successful control and eradication. **When found, these species are to be subject to required treatment regardless of size of the population.**

Please note that this list may change as new invasive plant species are discovered in Pennsylvania. At this time, this list applies to all districts currently utilized for gas development in northern Pennsylvania (Moshannon, Sproul, Tiadaghton, Elk, Susquehannock, Tioga, and Loyalsock state forests). These species are also subject to the Bureau's Early Detection and Rapid Response Protocols, ensuring timely and aggressive treatment of any new populations identified during monitoring activities. As of 2015, the highest threat species are:

Tree-of-heaven (<i>Ailanthus altissima</i>)	Mile-a-minute (<i>Persicaria perfoliata</i>)
Japanese angelica tree (<i>Aralia elata</i>)	Common reed (<i>Phragmites australis</i> ssp. <i>australis</i>)
Poison hemlock (<i>Conium maculatum</i>)	Japanese & Giant knotweed (<i>Polygonum cuspidatum</i> & <i>P. sachalinensis</i>)
Glossy buckthorn (<i>Frangula alnus</i>)	Black swallow-wort (<i>Cynanchum louiseae</i>)
Goatsrue (<i>Galega officinalis</i>)	Pale swallow-wort (<i>Cynanchum rossicum</i>)

**And any other invasive plants classified as PA Noxious Weeds by the PA Department of Agriculture

Species Threatening Forest and Wetland Ecosystems

While the Bureau of Forestry does maintain a list of the invasive plant species with the highest priority for treatment and eradication, they are not the only invasive plant species that threaten forest or wetland ecosystems. Additional invasive plant species, such as multiflora rose (*Rosa multiflora*), purple loosestrife (*Lythrum salicaria*), Japanese barberry (*Berberis thunbergii*), garlic mustard (*Allaria petiolata*), and reed canary grass (*Phalaris arundinatum*) can easily out-compete native herbaceous plant species for nutrients and growing space, as well as inhibit desired tree regeneration in forest stands. Many known invasive plant species fit into this category and are actively managed by foresters across the state forest districts. When found in small populations, many of these species can be easily eradicated.

Species Threatening Forest Management Activities

Well-established invasive plants in areas that are targeted for forest management activities such as timber harvesting or habitat improvement are often priorities for treatment. This limits opportunities for existing invasive plant populations to encroach upon newly altered or enhanced forest habitat. Similarly, areas with high visitation by the public, such as trails or parking lots, are also priority treatment areas regardless of species. This limits the chance of high forest use to be an effective vector for the spread of established invasive plant species. Each state forest district also has unique ecological features including wetlands, spring seeps, or old growth forests that are given high priority for protection on the landscape planning level regardless of the invasive plant species that threaten these areas.

Control of Invasive Plant Species

The Bureau of Forestry has adopted an Integrated Pest Management approach to controlling and eradicating invasive plant species. This strategy allows for the combined use of a number of control measures, including: mowing, prescribed fire, hand-pulling, biocontrols, silvicultural techniques, and chemical treatments. All treatments require diligence, patience, and a commitment to follow-up to assess success and conduct future treatments. Rarely is a one-time only treatment an effective means to eradicate established populations of invasive plant species.

1. **Mechanical treatment.** The hand-pulling and digging of small populations of invasive plants (typically only a few plants) and removing the roots can be an effective means of control when a population is in its early growth stages. At times, mowing can also be effective if timed appropriately. The appropriate timing of mechanical treatments is critical to the success of this strategy. If plants are cut, dug, or removed after seed has set, the treatment will likely be unsuccessful. Similarly, if all root material is not removed, this treatment will also likely fail.
2. **Biocontrols.** Competing plants, predatory insects and fungi, and plant diseases co-evolve with plants within their native range. However, invasive plants, which often originate from other continents, rarely have any pests or effective competitors when they are introduced in

North America. Biocontrols are species (often insects) that are found in an invasive plant's country of origin and are carefully researched before being released into the wild.

Biocontrols significantly damage invasive plants and allow native plant species to better compete with invasive plants for growing space. The advantage of biocontrols is that they effectively target an invasive plant species and in time, can spread on their own to new populations in surrounding areas.

3. **Silvicultural techniques.** Often following initial control, silvicultural techniques—such as tree and shrub planting, warm season grass seeding, or prescribed fire—can be used to control invasive plants or exclude them from previously treated areas. Some trees, shrubs, and native grasses can grow quickly and aggressively if planted correctly, and shade out potential habitat for invasive plant species. Prescribed fire can also maintain habitat conditions that benefit some native species, helping areas resist invasion by non-native invasive plants. In some cases, prescribed fire can benefit certain invasive plant species; care must be taken when using prescribed fire to control invasive plants.
4. **Chemical treatment.** Herbicides are often used for the effective treatment and control of invasive plant species. The type of chemical, mode of application, and timing of application can vary greatly based on the species and size of infestation. Some herbicides are prohibited for use on state forest lands. Any chemical treatments should be done following consultation with the District manager and Ecological Services.

The ecology and growth habits of each invasive plant species are different; therefore it is imperative that the appropriate control measures are in place for each species and individual population. The incorrect control technique or the appropriate control technique during the wrong time of the growing season often results in an inadvertent increase in the population. Consultation with District managers and Ecological Services is required prior to any invasive plant control or eradication taking place on state forest land.

Reporting Invasive Plant Monitoring and Treatment

1. For projects in which invasive plant species treatment and eradication is taking place using treatment protocols provided by the Bureau of Forestry, the operator should also report on the number of treated/eradicated populations by species and the relative success of the treatments.
2. The operator is responsible for providing the written report of the inventory findings, along with all associated data and GIS shapefiles to the Forest District Manager within thirty (30) days of survey completion. The Bureau of Forestry will assess the findings of the report and provide a

treatment plan with all treatment requirement details for all prioritized invasive plant species to the operator and their botanical consultant.

3. All other requirements involving invasive plant species control and reporting on monitoring activities is included in the Invasive Plant Species Provisions at the end of this Appendix.

State Forest Invasive Plant Provisions

The Invasive Plant Provisions for State Forest land Leases or Surface Use Agreements are as follows:

**COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES**

**COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES**

**INVASIVE PLANT and REVEGETATION PROVISIONS
FOR MINERAL LEASES AND SURFACE USE AGREEMENTS
ON STATE FOREST LANDS**

Last updated January 2016

Definitions and Specifications:

These provisions apply to any disturbance or construction activities that occur pursuant to a DCNR Lease (Lease) or Surface Use Agreement (SUA) for mineral extraction.

The **disturbed area** is defined as the greater footprint of the following, plus an additional 100 feet:

1. Limits of vegetation clearing
2. Entire width and length of DCNR-issued rights-of-way (with the additional 100' buffer on all sides)
3. Soil disturbances
4. Gated access roads utilized by the lessee
5. Any road modified or improved and used exclusively by the lessee

Invasive plants include all species and watch list species identified within the most recent version of [DCNR's Invasive Plant List](#). This document is dynamic and updated on a regular basis. Plant species on [DCNR's Invasive Plant List](#) are prohibited for use in stabilization and restoration activities on state forest lands.

Monitoring encompasses the actions of inventorying, surveying, documenting, and reporting.

Prioritized species are invasive plant species that are considered a significant ecological and economic threat to a specific habitat and/or geographic location by the Bureau of Forestry.

A population of prioritized species will be considered **eradicated** when it is absent for three consecutive growing seasons following implementation and completion of the written control prescription and desirable vegetation has become established.

A. Invasive Plant Provisions:

1. Post Disturbance Monitoring

- 1.1 The Lessee or SUA holder shall monitor for all incidences of **invasive plants** found within the entire **disturbed area**, to the satisfaction of the Bureau of Forestry, upon completion of the disturbance activity and successful soil stabilization pursuant to 25 Pa Chapter 102.
- 1.2 **Monitoring** inventories shall be conducted June through September at 1 year, 3 years, 5 years, 7 years, 9 years, and 12 years following successful initial soil stabilization.
- 1.3 The Lessee or SUA holder and its botanical consultant shall meet with Bureau of Forestry staff prior to initiation of the first post-disturbance monitoring inventory. At this time, the Bureau of Forestry will provide the Lessee or SUA holder with standardized invasive plant inventory and reporting protocols that must be followed.
- 1.4. The Lessee or SUA holder shall document the presence of **invasive plants** and provide a report, including all associated data and GIS shapefiles, to the Bureau of Forestry within 30 business days of the completion of the monitoring inventory.
- 1.5 The Bureau of Forestry reserves the right to use all data and reports submitted by the Lessee, SUA holder, or its designee.
- 1.6 Bureau of Forestry personnel may inventory the **disturbed area** at any time for **invasive plants**. If invasive plants are discovered, the Bureau of Forestry will provide written notification of their existence to the Lessee or SUA holder within 10 business days of the detection.
- 1.7 If new earth disturbance (greater than 5,000 square feet) occurs on a previously disturbed, stabilized, or restored site, that area shall revert back to required post-disturbance monitoring (years 1, 3, 5, 7, 9, and 12) and invasive plant eradication requirements.

2. Treatment and Eradication of Invasive Plant Species

- 2.1 After an invasive plant population is reported by the Lessee, SUA holder, or by Bureau of Forestry personnel, the Bureau of Forestry will determine if it is considered a **prioritized species**.
- 2.2 The Bureau of Forestry will develop a written required treatment prescription for each **prioritized species** population and will provide the prescription to the Lessee or SUA holder. Each **prioritized species** population subject to required treatment shall be treated at least once annually until **eradicated**.
- 2.3 The Lessee or SUA holder shall be responsible for implementing the written prescription and **eradicating** all populations of **prioritized species** identified within the **disturbed area** for the term of the Lease or SUA.

- a. The Lessee or SUA holder may be released from this responsibility when the **disturbed area** has been restored to the satisfaction of the Bureau of Forestry.
 - b. Reseeding to stabilize soil and prevent erosion and sedimentation is not considered restoration by the Bureau of Forestry.
- 2.4 The Lessee or SUA holder is responsible for complying with all local, state, and/or federal laws and regulations regarding the use of herbicides.
 - a. Only herbicides identified in the written prescription may be used on state forest lands.
 - b. All herbicide applications on state forest land will be tracked and legible application log sheets will be provided to the Bureau of Forestry within 10 business days of treatment.
- 2.5 The Lessee or SUA holder will provide the Bureau of Forestry with written notification of the anticipated treatment location and start date a minimum of 10 business days prior to treatment.

B.Planting and Seeding Provisions

- 1. All soil stabilization and site rehabilitation activities on state forest lands shall conform to the most recent version of the Bureau of Forestry's *Planting and Seeding Guidelines*. This document is dynamic and expected to change over time when necessary in order to carry out the Bureau of Forestry's adaptive management practices.
- 2. The Bureau of Forestry may provide other written instructions for planting or seeding requirements.
- 3. The Lessee or SUA holder shall submit a soil stabilization plan to the Forest District Manager for approval, prior to any soil disturbance activities, which identifies the species and materials (including mulch, soil amendments, or other erosion control materials) planned for erosion control.
- 4. All site rehabilitation activities on state forest lands shall conform to the site-specific, long-term restoration plan and prescription developed by the Bureau of Forestry.
- 5. The Lessee or SUA holder shall provide the Forest District Manager with all seed mix tags, identifying the species composition and seeding rates utilized, within seven (7) business days of final seeding.
- 6. The Lessee or SUA holder shall ensure that tree and shrub plantings sustain a seventy percent (70%) survival rate for two (2) growing seasons following planting.
 - a) If the Forest District Manager determines its necessary, replacement seedlings shall be planted between April and June of the third growing season.

Planting outside of this window or at other times during the life of this agreement shall be at the discretion of the Forest District Manager.

The Invasive Plant Provisions for State Forest land Right-of-Way Agreements are as follows:

**COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES**

**INVASIVE PLANT and REVEGETATION PROVISIONS
FOR RIGHT-OF-WAY AGREEMENTS
ON STATE FOREST LANDS**

Last updated January 2016

Definitions and Specifications:

These provisions apply to any earth disturbance area or activities associated with a License for Right-of-Way (Agreement) on State Forest Land.

The **disturbed area** is defined as the greater footprint of the following, plus an additional 100 feet:

1. Limits of vegetation clearing
2. Entire width and length of DCNR-issued rights-of-way (with the additional 100' buffer on all sides)
3. Soil disturbances, plus an additional 100 feet perpendicular on either side of the right-of-way whenever the right-of-way corridor directly borders/parallels or bisects the following features as defined by the Department:
 - a. An area subjected to a designated silvicultural treatment (as identified by the Forest District Manager) within 7 years prior to right-of-way disturbance.
 - b. A state forest road of any kind.
 - c. A water feature of any kind.

Invasive plants include all species and watch list species identified within the most recent version of [DCNR's Invasive Plant List](#). This document is dynamic and updated on a regular basis. Plant species on [DCNR's Invasive Plant List](#) are prohibited for use in stabilization and restoration activities on state forest lands.

Monitoring encompasses the actions of inventorying, surveying, documenting, and reporting.

Prioritized species are invasive plant species that are considered a significant ecological and economic threat to a specific habitat and/or geographic location by the Bureau of Forestry.

A population of prioritized species will be considered **eradicated** when it is absent for three consecutive growing seasons following implementation and completion of the written control prescription and desirable vegetation has become established.

A. Invasive Plant Provisions:

1. Post-Disturbance Monitoring

- 1.1 The Licensee shall monitor for all incidences of **invasive plants** found within the entire **disturbed area**, to the satisfaction of the Bureau of Forestry, upon completion of the disturbance activity and successful soil stabilization pursuant to 25 Pa Chapter 102.
- 1.2 **Monitoring** inventories shall be conducted June through September at 1 year, 3 years, 5 years, 7 years, 9 years, and 12 years following successful initial soil stabilization, and every three years thereafter for the life of this agreement.
- 1.3 The Licensee and its botanical consultant shall meet with Bureau of Forestry staff prior to initiation of the first post-disturbance monitoring inventory. At this time, the Bureau of Forestry will provide the licensee with standardized invasive plant inventory and reporting protocols that must be followed.
- 1.4 The Licensee shall document the presence of **invasive plants** and provide a report, including all associated data and GIS shapefiles, to the Bureau of Forestry within 30 business days of the completion of the monitoring inventory.
- 1.5 The Bureau of Forestry reserves the right to use all data and reports submitted by the Licensee or its designee.
- 1.6 Bureau of Forestry personnel may monitor the **disturbed area** at any time for **invasive plants**. If invasive plants are discovered, the Bureau of Forestry will provide written notification of their existence to the licensee within 10 business days of the detection.

2. Treatment and Eradication of Invasive Plant Species

- 2.1 After an invasive plant population is reported by the Licensee or by Bureau of Forestry personnel, the Bureau of Forestry will determine if it is considered a **prioritized species**.
- 2.2 The Bureau of Forestry will develop a written required treatment prescription for each **prioritized species** population and will provide the prescription to the licensee. Each **prioritized species** population subject to required treatment shall be treated at least once annually until **eradicated**.
- 2.3 The Licensee shall be responsible for implementing the written prescription and **eradicating** all populations of **prioritized species** identified within the **disturbed area** for the term of the right-of-way agreement.
- 2.4 The Licensee is responsible for complying with all local, state, and/or federal laws and regulations regarding the use of herbicides.
 - a. Only herbicides identified in the written prescription may be used on state forest lands.
 - b. All herbicide applications on state forest land will be tracked and legible application log sheets will be provided to the Bureau of Forestry within 10 business days of treatment.
- 2.5 The Licensee will provide the Bureau of Forestry with written notification of the anticipated treatment location and start date a minimum of 10 business days prior to treatment.

B.Planting and Seeding Provisions

1. All soil stabilization and site rehabilitation activities on state forest lands shall conform to the most recent version of the Bureau of Forestry's *Planting and Seeding Guidelines*. This document is dynamic and expected to change over time when necessary in order to carry out the Bureau of Forestry's adaptive management practices.
2. The Bureau of Forestry may provide other written instructions for planting or seeding requirements.
3. The Licensee shall submit a soil stabilization plan to the Forest District Manager for approval, prior to any soil disturbance activities, which identifies the species and materials (including mulch, soil amendments, or other erosion control materials) planned for erosion control.
4. All site rehabilitation activities on state forest lands shall conform to the site-specific, long-term restoration plan and prescription developed by the Bureau of Forestry.
5. The Licensee shall provide the Forest District Manager with all seed mix tags, identifying the species composition and seeding rates utilized, within seven (7) business days of final seeding.
6. The Licensee shall ensure that tree and shrub plantings sustain a seventy percent (70%) survival rate for two growing seasons following planting.
 - a) If the Forest District Manager determines its necessary, replacement seedlings shall be planted between April and June of the third growing season.
 - b) Planting outside of this window or at other times during the life of this agreement shall be at the discretion of the Forest District Manager.

Appendix D: Site Rehabilitation

Purpose

Development on State Forest land leases and severed rights areas results in the disturbance of plant and wildlife habitat, especially to core and interior forest habitats. With effective planning and implementation, suitable habitat can be created for many species of plants and wildlife during the interim reclamation and final restoration of oil and gas-related sites, reducing any long-term ecological impacts across the forest landscape.

The purpose of this appendix is to offer planning considerations and rehabilitation guidelines on oil and gas development sites in order to regain a functioning ecosystem. These guidelines encourage approaches to site rehabilitation that result in tree species diversity, appropriate species selection for a particular site, and maintenance of habitat structure. The proceeding recommendations and information are offered as a guide for rehabilitation and each case should be evaluated and decided upon first at the site level and then within the context of the forest landscape. In addition to these recommendations, the Bureau of Forestry's Planting and Seeding Guidelines also serve as a guide for planting during revegetation, reclamation, and restoration practices.

Even successful ecological restoration may take years or decades; however, the long timeframe underscores the need to look at every step in the process as an opportunity for restoration and enhancement of habitat.

Section I: Defining Revegetation, Reclamation, and Restoration

A. Explanations of Terms

The terms revegetation, reclamation, restoration, and rehabilitation are often used interchangeably, but have different meanings to the Bureau of Forestry. The definitions become important when determining final goals for a site and for clarification of expected outcomes. The word restoration is used throughout this document, but often in the short term, interim reclamation is taking place in the field, with final restoration to be completed in the future. The terms are clarified below. A full ecological restoration project often involves all steps defined below.

Rehabilitation: Rehabilitation refers to the overarching act of mitigating some type of land-use change or disturbance, which may involve tree cutting, vegetation removal, soil disturbance, and/or loss of ecosystem function. Rehabilitation is a sliding scale, with required stabilization at the "low" end and complete ecological restoration at the "high" end. Rehabilitation projects often seek to stabilize soils, increase plant and wildlife diversity, and/or improve ecosystem

functions. Additional considerations for planning all types of rehabilitation projects are given in Section II.

Passive rehabilitation: Passive rehabilitation is an activity where the degradation causes are identified and removed and the area recovers without further assistance to a more desirable condition. This activity is often appropriate for communities that have only been slightly impaired. This often involves opportunistic forb, shrub and tree species colonizing the site without human aid.

Active rehabilitation: Active rehabilitation in highly disturbed communities or degraded sites includes the application of management techniques such as soil stabilization, grass establishment, invasive plant control, and shrub or tree planting. These applications are undertaken with a desired final landscape in mind. All forms of rehabilitation that involve site preparation, soil remediation, or stabilization and planting are active rehabilitation projects.

Revegetation: Revegetation refers to planting grasses and legumes over a disturbed site or bare soils. This is the site stabilization required by DEP regulations to protect exposed soils at the site from accelerated erosion and sedimentation. The Bureau of Forestry considers this only the starting point for expected site rehabilitation. The Bureau's Planting and Seeding Guidelines (Appendix D) provide additional considerations for revegetation projects.

Reclamation: Reclamation reduces the overall size of the disturbed area by using native forbs, shrubs, and trees to begin to rebuild organic topsoil, improve native plant diversity, and encourage site use by native insects and early successional wildlife. Reclamation projects often seek to re-establish the original form of the vegetation community at the site and begin the process of rebuilding full ecological function. Aside from ecological reclamation, disturbed sites could also be used for other state forest purposes, such as trailheads. Additional considerations specific to reclamation projects are given in Section III.

Interim Reclamation: Interim reclamation refers to minimizing the original disturbance footprint by rehabilitating all portions of the site not needed for immediate production operations, while also maintaining safety and space for safe operation of active portions of the site. For example, interim reclamation is possible when temporary workspace for a right-of-way is no longer needed, or when the size of a pad can be reduced to only that which is necessary for operation and maintenance.

Final Reclamation: Final reclamation refers to the practice of reclaiming a majority or the entire disturbed site by removing infrastructure, fencing and aggregate material; spreading topsoil and re-contouring the site; and planting native grasses, shrubs and trees. Final reclamation is, in essence, the beginning of restoration. At this point, the site can proceed through natural

processes toward the final restoration of all ecosystem functions that existed prior to the initial disturbance.

Restoration: The Bureau of Forestry defines restoration as the return of a disturbed site to the functioning ecosystem state prior to disturbance. Ideally, this functioning state would be the same as what existed at the site prior to disturbance; however, depending on ecological conditions, this may not always be possible. In these cases, the Bureau may seek to provide similar ecosystem functions towards a completely restored state. This type of rehabilitation accelerates the recovery of an ecosystem's health and sustainability, and provides the appropriate pathways for ecosystem functions to become self-sustaining. Merely recreating the landscape without ecosystem functions does not constitute restoration. Additional considerations specific to restoration projects are given in Section IV.

B. Goals and Objectives

The general **goal** of rehabilitation is to assist the recovery of an ecosystem that has been degraded, damaged, or destroyed. Work to achieve this goal may take many forms and be a step-wise process over the life of the site. Goals are the ideal states and conditions that an ecological rehabilitation efforts attempt to achieve. Statements of ecological goals should candidly express the degree to which recovery can be anticipated to return to a former state, condition, or trajectory. Rehabilitation goals will often take into consideration what was determined to be the need and level of rehabilitation, and what was found during pre-project monitoring.

The Bureau of Forestry's mission is to ensure the long-term health, viability and productivity of Pennsylvania's forests and to conserve native wild plants. Therefore, final restoration will not be complete unless the proper interactions upon which the integrity of the ecosystem depends are functioning.

The **objectives(s)** of site rehabilitation should be to:

- Establish vegetation that can aid in controlling erosion
- Allow recruitment by native plant species for increased diversity
- Fix Nitrogen (N) from the atmosphere
- Create wildlife habitat
- Minimize invasion of by invasive plant species
- Develop the area into a productive ecosystem dominated by native species

To truly restore a site, the historical species and structure should be maintained and sustained into the future. All types of rehabilitation will likely be necessary to achieve final restoration. During the planning stages, discussions should take place in regards to whether or not an active

strategy is worth the cost, the likelihood of success, and the degree of ecological and financial risk.

C. Where and when to use these site rehabilitation options

The guidelines presented in this document should be considered as options during interim reclamation and final restoration for gas-related infrastructure on State Forest land, including:

- 1) Well pads
- 2) Staging areas
- 3) Freshwater Impoundments
- 4) Rights-of-Way
- 5) Compressor stations
- 6) Retired roads, widened roads, and access roads

The information presented in this document could be considered at any stage following disturbance. This includes revegetating for erosion and sedimentation control planning, reclamation, and restoration.

Section II: Rehabilitation Planning

A. Planning Considerations

The first thing to consider in developing a rehabilitation plan is the long-term desired condition for the landscape and site. This could be based on managing to revert back to pre-disturbance conditions, fill a lacking habitat, managing for a priority species, or creating special habitat enhancements. Before implementing management actions, operators, district personnel, and Ecological Services should create clear long-term objectives for the landscape. These objectives and options for rehabilitation should consider the following:

1. Conduct pre-project monitoring as needed to identify the kind of ecosystem to be rehabilitated, focusing on existing site conditions and describing the biota of the site.

Often it is useful to obtain baseline measurements on such parameters as wildlife and plants using the site conditions, soil quality, water quality, and any other information that may be pertinent during all rehabilitation activities. This information is especially important if the site is different or unique from the surrounding landscape. This step should be conducted prior to earth disturbance since sites may not begin final restoration activities for 5-20 years after initial earth disturbance.

Descriptors that should be documented to facilitate communication at the time of rehabilitation planning include:

- Presence of invasive species
- The moisture conditions (hydric, xeric, etc)
- Site class
- Stand/community type
- Existing vegetation on site (vegetation types, species lists, community structure).
- A landscape review of available habitats within the associated Landscape Type Association (LTA) and adjacent LTAs.
- Wildlife species and plant communities currently using the area and those with the potential to use the area based on the habitat present, emphasizing community indicator species.
- Ecologically important features, such as a complex of vernal pools or wetlands that may influence the option chosen for rehabilitation.
- Species of special concern that may be impacted by disturbance and rehabilitation activities.
- Soil quality and type

2. Identify physical site conditions in need of repair following disturbance.

Many ecosystems in need of rehabilitation are dysfunctional on account of damage to the physical environment, such as soil compaction, soil erosion, or surface water diversion. The physical environment must be capable of sustaining viable, reproductive species populations that comprise the plant and animal life of the rehabilitated ecosystem. This will be especially important to consider when determining how the site will be reseeded, reclaimed and restored.

3. Identify the need for ecological restoration and the level of rehabilitation.

It may be important to describe the ecological functions that are anticipated to return to the site following final restoration and initial rehabilitation. This is important because site rehabilitation can be conducted in several contexts. The appropriate context should be identified in the project goals in order to underscore the intent of all rehabilitation stages. A few relevant contexts of rehabilitation for oil and gas development might include:

- Recovery of a degraded or damaged ecosystem to its former state
- Replacement of an ecosystem that was entirely destroyed with one of the same kind. The new ecosystem must be entirely reconstructed on a site that was denuded of vegetation.
- Transformation of another kind of ecosystem from the bioregion to replace one which was removed from a landscape that became irreversibly altered.

4. *Identify rehabilitation goals and objectives.*

Goals are the ideal states and conditions that an ecological rehabilitation efforts attempt to achieve. Written expressions of goals provide the basis for all rehabilitation activities, and later they become the basis for project evaluation.

5. *Identify and list the kinds of ecological interventions that are needed.*

Many rehabilitation projects require manipulation of the biota, particularly vegetation, to reduce or eradicate unwanted species and to introduce or augment populations of desirable species for successful rehabilitation. Invasive plant species generally require eradication. Other species, invasive or non-native, may be removed if they retard or arrest succession. Species that may need introduction include mycorrhizal fungi, N-fixing bacteria, or other soil microbiota. Animals can be enticed to colonize projects by providing perches, nest boxes, distributing coarse detritus for small animal cover, and/or providing talus rocks.

6. *Identify biotic resource needs, sources, and considerations.*

Prior to rehabilitation it will be important to consider what biotic resources (i.e. seeds, other plant propagules, etc.) will be needed for establishment at the project site with the rehabilitation goals taken into consideration. When determining seed choices consider the following:

- Source of seeds
 - Use appropriate seed for the region
- Native/non-native
 - When planting natives, make sure the species being planted is native to Pennsylvania, and when practical, native to the ecoregion where planting is taking place.
- Planting success
 - Use appropriate species for the site considering sunlight requirements, soil disturbance, soil type and quality, etc.
- Amount of management necessary
 - Depending on what is being planted, varying amounts of management may be required. If planting high maintenance species, also consider the proximity to necessary equipment and tools, as well as a reliable source of funding and manpower.
- Original and potential future forest community type trajectories to support the long-term desired condition.
- Soil quality, type and amount of compaction

- Bureau of Forestry's Planting and Seeding Guidelines
- Bureau of Forestry's Pipeline Right-of-Way Wildlife Habitat Guidelines
- Bureau of Forestry's Right-of-Way Vegetation Management Guidelines
- Plant Diversity
 - Diverse vegetation composition provides for a resilient food web and more viable wildlife populations.

7. *Perform monitoring as required to document the attainment of project goals and objectives.*

An evaluation should compare the reseeded, reclaimed, or restored ecosystem to its condition prior to the initiation of rehabilitation activities. The evaluation should determine whether or not the ecological goals were met, including the ecological attributes of similar rehabilitated ecosystems. Data should be required when it will be meaningful for decision making and then results of analysis should be documented in writing. Ecological evaluations may need to occur at various points as the system recovers.

Section III: Additional Reclamation Considerations***Interim reclamation***

Interim reclamation consists of minimizing the footprint of disturbance by reclaiming all portions of the gas related infrastructure site no longer needed for active operations and maintenance. Some rehabilitation features, such as shrubs and trees, take time to mature and achieve value to wildlife. Interim substitutes can be used to serve the functions intended for the permanent features. There are several practices that could potentially be implemented that may help alleviate the impacts of oil and gas development and provide habitat enhancements. Several suggestions include re-contouring and revegetating any area of the site not being used, reducing the amount of edge on a site, providing wildlife habitat with brush piles, and planting native warm season grasses and wildflowers.

Re-contour and revegetate where feasible

The portions of the well site not needed for operational and safety purposes could be re-contoured to either a final or intermediate contour that blends with the surrounding topography as much as possible. Soil compaction should be avoided and minimized, and soil should only be graded enough to achieve the desired grade. Only compact fill material where stability is a risk, and only enough to ensure stability. (ARRI FRA 3, VA Coop Ext) Fills less than 6 feet in height should not be compacted at all. At least 4 feet of un-compacted material should be at the surface of any compacted fill material. (ARRI FRA 3, VA Coop Ext) Topsoil may even be able to be spread over areas not needed for operations and revegetated after ripping the subsoil.

Reducing Edge

Infrastructure site development creates habitat fragmentation increases the amount of edge, which can negatively impact certain species. Once a site is no longer being fully utilized it might be beneficial to round the edges of the sites. Square and circular openings will minimize the edge effect. This could also be accomplished by feathering the edges. Feathered edges gradually blend the opening into the adjacent forest. Feathered edges can be created through a variety of techniques including adding several rows of shrubs leading into the forest, or by cutting stumps to ground level in temporary workspaces and allowing them to re-sprout following construction. Typically, edges must be maintained through active management. Many species, including: ruffed grouse, bobwhite quail, turkeys, white-tailed deer, rabbits, raccoons, foxes, coyotes, song sparrows, brown thrashers, gray catbirds, and indigo buntings can benefit from feathered edges (Wilson 2006).

Brush Piles

The woody limbs and stumps from the trees removed to create the site openings could be used to create brush piles. Brush piles are most beneficial to wildlife when they are located at the edges of forest openings. They should be located within 10 feet from the woodland border.

Brush piles could also be placed along streams and marshes within or next to woodlands. When properly located and constructed, brush piles can benefit many species of wildlife, including: bobwhite quail, cottontail rabbit, ruffed grouse, turkey, skunk, raccoon, juncos, and sparrows. Predators such as foxes, bobcats, hawks, owls and coyotes also benefit from the small mammal and bird populations found in or around brush piles.

Section IV: Additional Restoration Considerations

Final restoration can begin once all or most activity on the site is complete (i.e., when a well is plugged or a compressor station is dismantled). Restoration is considered successful when long-term ecosystem sustainability has been obtained. The decision of how to restore the site should be made as early in the planning process as possible, although situations may arise in which adaptive management may have to be utilized. There are several choices when it comes to final restoration on state forest lands. The site may be best suited to:

- Revert back to what it was originally
- Fill a lacking habitat/species
- Provide additional food and hunting opportunities with food plots
- Special habitat enhancement

The details of whether to revert a site to the original habitat prior to disturbance or to choose another option will be best decided at the site level. Regardless of the final choice, the goal should be long-term ecosystem sustainability.

The restoration plan should consider the Bureau of Forestry's Planting and Seeding Guidelines, address the potential for invasive plant species introduction, and be appropriate for overall Bureau of Forestry objectives. Whenever possible, consider the native species that were present prior to disturbance for use in final restoration plantings.

Forest Restoration

Typically, natural processes that lead to restoration of the forest vegetation after a disturbance begin quickly and result in the establishment of another forest over time. However, the quality of a forest and the speed with which it develops depend upon the conditions at the time of initial establishment. Although native forests could eventually be restored in oil and gas development areas by natural succession, this process is slow and centuries may be required (Skousen et al. 2007, Angel 2005) depending on the extent of disturbance. Human-mediated forest restoration provides the opportunity for "setting the stage" for successful establishment of a mature forest over time.

Forest restoration should aim to match original levels of species diversity and sustainability, while planting or encouraging tree species that are known to be originally present prior to disturbance. Reforestation can be accomplished through a combination of passive and active techniques, although more active rehabilitation may be required on some sites which are more highly degraded. Active rehabilitation can shorten the time it takes nature to produce a valuable forest by preparing the site with loose, good quality soils that encourage establishment of volunteer early-successional species; and by planting a mixture of early- and later- successional tree species.

Forest Restoration Considerations

1. *Soil:* The soils on many oil and gas development sites are going to be heavily compacted, making establishing forest vegetation challenging. Some compaction may even occur during the redistribution of stockpiled topsoil to the site. Therefore, low compaction grading processes should be utilized during restoration activities to avoid and minimize compaction (Sweigard 2007, ARRI). Loose dumping of fill material in close piles followed by a single pass with a small dozer will provide a non-compact substrate, given there is a sufficient amount of soil (ARRI FRA 3, VA Coop Ext). The subsoil should be ripped prior to placing the top layer of fill material. If low grading compaction techniques are not used, methods to reduce compaction and aerate the soil may be necessary to create conditions suitable for establishing woody vegetation. Soil should only be graded enough to achieve the desired grade. Only compact fill material if stability is a risk, and only enough to ensure stability (ARRI FRA 3, VA Coop Ext). Fills less than 6 feet in height should not be compacted at all. At least 4 feet of un-compacted material should be at the surface of any compacted fill (ARRI FRA 3, VA Coop Ext). Soil “ripping” may be necessary for successful establishment of trees and shrubs, especially with shallower soils. Sites with the least compacted soils will be the most suitable for re-establishing forest (ARRI FRA 3, VA Coop Ext).
2. *Tree-Compatible Ground Cover:* If future establishment of trees and forest productivity are goals, tree-compatible ground covers should be used. There are many tree-compatible ground covers suitable to control erosion and meet ground cover requirements. Tree-compatible ground cover guidelines include using fewer competitive species, lower seeding rates, less nitrogen (N) fertilizer, and accepting a less-dense herbaceous ground cover in the first few years after seeding. For more information see, “Tree-Compatible Ground Covers for Reforestation and Erosion Control” by Burger et al. 2009.
3. *Community Type and Species selection:* If planting trees is a part of the restoration plan it is important to select suitable and appropriate tree species to regenerate. It may be important to consider the historical community type and the possibility of an adjusted community type trajectory by the time restoration is complete. Other factors to consider include:
 - The ecosystem/sites’ goals and objectives
 - Site capabilities
 - Existing natural regeneration and surrounding community type
 - Historical vegetation
 - Variation in growth rate and seed production
 - Mixing of deciduous and coniferous species
 - Planting a diversity of trees and shrubs

- Sunlight requirements
- Locally adapted seed sources
- Bureau of Forestry planting guidelines

Shrubs and herbaceous species can also be used in conjunction with tree plantings, as they are a natural and important structural element in early-successional forests and in wildlife habitat. Establishing non-tree vegetation around seedlings and saplings will also help prevent the establishment of non-desirable competing vegetation. Consider the plant community when deciding additional species to plant among the regenerating forest.

4. *Management:* On sites that have been significantly disturbed, establishing forest tree regeneration may be difficult. Some species, such as oak and hemlock, may require intensive management for successful regeneration, including: installing deer exclosures, treating competing vegetation, and replanting of failed seedlings. Another challenge to reforestation is controlling rodents. The rodents feed on the bark at the base of young trees, which in most cases kills or severely damage the tree. These restoration options will likely require some level of monitoring to gauge the relative success of planted or naturally regenerated tree seedlings. Using lower rates of native's species that combine cool season grasses, legumes, and warm season grass may create desirable conditions for a wide array of wildlife and be generally easy to maintain.

Natural or assisted regeneration usually involves no or minimal planting, instead encouraging the natural processes of forest succession (Hardwick et al. 2000). This is a passive restoration approach and will work best in areas where disturbance was minimal and not where land was disturbed in a manner that removed rooting systems, and vegetation, including seeds and plant material capable of re-sprouting. Areas targeted for natural succession must also be free of any non-native, invasive plant species in order to increase the likelihood for success.

Ecological succession describes the changes in plant composition at a site over time (Groninger 2007). Vegetation established by restoration, either passively or actively, will most likely be a combination of native grasses, planted and volunteer herbaceous species, shrubs, nurse/wildlife trees, and crop trees. The combination of plantings can be altered and the level of succession arrested to suite the goals of the site.

Some minimal seeding, such as for erosion and sedimentation control or temporary establishment of vegetation, may be necessary where natural regeneration is the preferred restoration option.

Natural Regeneration/Succession Considerations

1. *Potential for arrested succession:* If soil conditions are not suitable or the understory vegetation is too competitive for tree recruitment the site may remain in the grass-herb-shrub stage with only scattered trees for several decades after the disturbance. This stable vegetation state is called “arrested succession,” which is a failure of later successional species to establish and eventually dominate the site (Abrams et al. 1985, The Appalachian Regional Reforestation Initiative, ARRI). This also creates long-term conditions suitable for invasive plant establishment. Arrested succession also occurs in areas where high deer or rodent populations consume or destroy tree seedlings or where invasive plant species dominate the vegetation layer.
2. *Rooting medium quality:* If soil replacement results in a rooting medium that is shallow or has been compacted, the site will be prone to drought and plant nutrition problems. Seeds of unplanted forest species that are carried to the site by wind or wildlife will not germinate and grow if the soil surface is compacted or has chemical properties that are not well suited to their needs (ARRI).
3. *Management:* The vegetation germinating newly disturbed sites should be monitored to be sure undesired vegetation, such as invasive plants, are not present. Treatment of undesirable vegetation should be done with assurance that desirable vegetation will naturally seed in or may be planted.

Section V: Permanent Forest Opening/Right-of-Way Rehabilitation Considerations

There are many things to consider before deciding whether an artificially created forest opening should be made permanent. First, goals and objectives for the site must be clearly defined. It is important to know if creating permanent openings will be beneficial or detrimental to the ecosystem and overall landscape. Therefore, it may be important to consult Ecological Services prior to determining whether a permanent opening and what kind is established. The following is a list of things to consider when deciding whether creating a permanent forest opening is the best option.

1. *Juxtaposition*: Juxtaposition refers to the arrangement (the placement) of habitats. This is an important concept when managing an area for wildlife, especially wildlife with relatively small home ranges. Therefore, it is important to consider proximity to and arrangement with other habitat types (including other early-successional habitats)
 - Generally, for species with small home ranges (e.g. rabbits, bobwhites, small mammals), creating openings in close proximity to one another might be preferred. On the other hand, highly mobile species such as deer, turkeys, bears, and some species of birds will readily use widely scattered opening.
 - Assess your current habitat conditions in conjunction with your management objectives to help decide whether to maintain, how many to maintain, or to restore the openings to forest.
2. *Particular Wildlife Species of Interest*: The type of wildlife species and type of habitat that will use a particular opening depends on a variety of factors including:
 - The type of habitat provided by the opening
 - The types of wildlife locally and regionally present
 - Topography and hydrology
3. *Patch Size and Right-of-Way Width*: Even though the size and shape of the site may already have been established, it may benefit the success of the site to alter these factors. Typically, openings should be:
 - Square and circular openings opposed to linear features will minimize edge effects
 - Limit the number of straight-sided rectangular openings. Nature seldom creates straight lines.
4. *Soil*: The soils on many oil and gas development sites are going to be heavily compacted. On some sites where compaction is the most severe, herbaceous or successional plantings may be the most appropriate restoration strategy. Low compaction grading techniques should be implemented during restoration activities. Similarly, the amount of available organic topsoil may be low. Consider using native warm season grasses, which help create and accumulate organic

material that becomes topsoil over time. Soil pH and type should also be considered if food plots and certain plant species are of interest.

5. *Slope*: The slope of the opening will determine the amount of sunlight and should be taken into consideration when determining plant species success. A south facing slope is the most desirable location because it will provide more ground area exposed to the sunlight. However, it will tend to be drier in the summer heat. In early spring many species will use openings with a south-facing slope because green browse will appear there first as the snow melts.
6. *Species selection*: It is essential to consider the plant community type on the site and surrounding landscape. The foundation for restoring ecological function or improving wildlife value at a site is a healthy and diverse native vegetation community. Other factors to consider include:
 - The sites goals and objectives
 - Site capabilities
 - Historical vegetation
 - Variation in growth rate and seed production
 - Mixing of herbaceous plants and shrubs
 - Sunlight requirements
 - Soil type and moisture
 - Locally adapted seed sources
 - Bureau of Forestry Planting Guidelines
7. *Food plots*: Planting food plots is a popular habitat management practice. Quality food plots can provide valuable digestible energy and protein. Prior to starting a food plot, it is important to understand how food plots should be used to augment the quantity and quality of naturally occurring foods, not take the place of them. Keep in mind that:
 - Food is only one component of habitat and it might attract wildlife, but cover will hold them. Hard-and soft-mast bearing trees and shrubs may need to be planted to provide additional food and cover.
 - Single, small isolated food plots that contain an annual crop have little impact on the overall supply of food and typically benefit only a small number of individual animals.
 - Food plots can also increase predation on small mammals as wildlife can become concentrated around food plots. In some locations with high deer concentrations, deer may eat the food plot before it even develops or matures.
8. *Maintenance*: Once a good forest opening has been established it will require maintenance. The necessary maintenance will depend on what type of opening has been established. When succession has reached the desired stage, it will have to be set back by disking, mowing, prescribed fire, or some other management technique. If the goal is to establish the opening as

herbaceous, succession will have to be stopped by killing regenerating trees. If the goal is to have a permanent early-successional opening and allow trees to regrow, the opening's effect on early-successional wildlife species will last less than 15 years (Lanier 2006).

Section VI: Wetland Rehabilitation Considerations

A rehabilitation consideration may be to try and create wetlands. This option may be possible in certain circumstances such as:

- Enhancing degraded wetlands
- Creating or restoring a wetland in a wetland complex
- Creating habitat for lacking species

A variety of techniques can also be used to create a vernal pool. The complexity of this work often depends on the site and the desired size of the pond. Typically if projects fail it is because the ponds do not hold water long enough for aquatic plants to become established and for aquatic animal larvae to completely develop. Building a pond that fails to hold water is generally due to permeable soils, a poorly constructed core under the dam, or the failure to compact soil during construction. Some other things to consider include (Biebighauser 2002):

- Know the area and the soils. In general, it is easier and less expensive to create a wetland in an area that has soils that can be made to hold water without using a synthetic liner.
- Look for construction fill. If the area has been filled with waste rock, gravel, stumps, and logs, it will be more permeable making it difficult to construct a wetland unless a synthetic liner is used
- Consider the slope. An area with less than 3% slope works best for construction
- Consider the surrounding landscape. A greater variety and number of species can be expected to use a wetland if it is built near other wetlands. However, a variety of species will use a wetland that is built in most any location.
- Avoid conflicts. Other considerations in deciding where to build a vernal pool should include the long-term management and maintenance of the completed wetland. Avoid placing vernal pools in areas where disturbance cannot be avoided.

Section VII. Summary

Although oil and gas development has the potential to create ecological impacts, with proper planning and effective, thoughtful implementation, sites used for gas infrastructure can be used to create suitable habitat for many species of plant and wildlife during the interim and final rehabilitation of gas-related sites.

Each project should be evaluated and decisions made at a landscape level based on the surrounding habitats, overall habitat conditions, and what is needed during the rehabilitation process to encourage the appropriate community response. Many rehabilitation choices exist at a site, including: reverting back to pre-disturbance conditions, filling lacking habitat/species, providing additional hunting and food opportunities with food plots, or creating special habitat enhancement. The objectives at a site should be to establish vegetation that can aid in controlling erosion, allowing recruitment by native plant species for increased diversity, fixing N from the atmosphere and creating organic topsoil, creating wildlife habitat, minimizing establishment of invasive plant species, and developing the site into a productive forest dominated by native species. There is no doubt that restoration will take years or decades to reach the management objective; however, this means it is even more important to look at every step in restoration as an opportunity to reduce oil and gas development impacts and enhance habitat for plants and wildlife.

Section VIII. Species/Habitat Relationships**Dry-Oak Mixed Hardwood (AD)****When Appropriate:**

Common throughout the state

Better on less acidic sites

Should support a good diversity of spring ephemerals

Dominant Species:

native oaks

native hickories

sweet birch

red maple

sugar maple

basswood

flowering dogwood

hornbeam

serviceberry

redbud

mountain laurel

tick-trefoil

Pennsylvania sedge

Important Wildlife Species:

black bear, blue jay, deer, nuthatches, ring-necked pheasants, ruffed grouse, wood duck, woodpeckers

bats (esp. shagbark hickory), red-bellied woodpeckers, rose-breasted grosbeaks

beaver, black-capped chickadee, porcupine, ruffed grouse

bats, deer

deer, porcupines, snowshoe hare, numerous bird species

upland game birds, songbirds, porcupine and foxes
older, dying and dead basswood trees provide dens for many animals

songbirds, upland game birds, foxes, black bear, beaver, skunks, deer, provides shelter and habitat for many wildlife species

beaver, bobwhite, fox squirrels, ring-necked pheasants, ruffed grouse, songbirds

deer, rabbits, thrushes, many other songbirds, rodents, small mammals, bear, grouse, turkey, squirrels, chipmunks, beaver, foxes

cardinals, ring-necked pheasants, rose-breasted grosbeaks, white-tailed deer, bobwhites, bees

ruffed grouse, provides good winter (thermal) cover

bobwhite quail, deer, ring-necked pheasant, turkeys

horned lark, ruffed grouse, turkey

Dry-Oak Heath (AH)**When Appropriate:**

Common throughout the state

Better on acidic soil

Herbaceous layer typically sparse and dominated by ericaceous shrubs

Fire has been a historic disturbance in the maintenance of this vegetation type

Dominant Species:

native oaks

-primarily chestnut oak

sassafras

black gum

sweet birch

red maple

native hickories

Virginia pine

eastern white pine

mountain laurel

huckleberry

Pennsylvania sedge

blueberry

maple-leaved viburnum

sweet-fern

teaberry

Important Wildlife Species:

black bear, blue jay, deer, nuthatches, ring-necked pheasants, ruffed grouse, wood duck, woodpeckers

crested flycatchers, quails, turkeys, kingbirds, mockingbirds, sapsuckers, pileated woodpeckers, yellowthroat warblers, phoebes, black bears, beaver, deer

black bears, foxes, wood ducks, turkeys, woodpeckers, mockingbirds, brown thrashers, thrushes, flickers, deer, beaver; provides cavity and nesting sites for a variety of birds and mammals

beaver, black-capped chickadee, porcupine, ruffed grouse

bats, deer

bats (esp. shagbark hickory), red-bellied woodpeckers, rose-breasted grosbeaks

woodpeckers, pine siskin pine grosbeak, songbirds, deer

yellow-bellied sapsuckers, pine warblers, red crossbills, beaver, porcupine, deer, snowshoe hare, bald eagles

ruffed grouse, provides good winter (thermal) cover

ruffed grouse, quail, turkey, scarlet tanager, eastern towhee, fox squirrels, deer, host for the larva of the huckleberry Spinx (*Paonias astylus*), butterflies including brown elfin and Henry's elfin, bumblebees and wild bees

horned lark, ruffed grouse, turkey

ruffed grouse, black bear, quail, bluebird, scarlet tanager, foxes, deer, thrushes, skunks, fox squirrels

deer, skunks, ruffed grouse, ring-necked pheasants, turkeys, beaver

foliage is one food source of apple sphinx caterpillar (*Sphinx gordius*)

deer, turkey, ruffed grouse, ring-necked pheasant, black bear, red fox

Northern Hardwood (BB)**When Appropriate:**

Common throughout the northern portion of the state
 Sites where sugar maple is dominant likely contain more basic soils
 Should support a good diversity of spring ephemerals
 Less than 25% cover of conifers

Dominant Species:**Important Wildlife Species:**

American beech	black bears, foxes, ruffed grouse, ducks, chickadees
red maple	bats, deer
sugar maple	deer, porcupines, snowshoe hare, numerous bird species
black cherry	passerine birds, game birds, and mammals including foxes, black bears, raccoons
sweet birch	beaver, black-capped chickadee, porcupine, ruffed grouse
yellow birch	snowshoe hare, deer, ruffed grouse, red squirrels, beaver, porcupines
native oaks red oak	black bear, blue jay, deer, nuthatches, ring-necked pheasants, ruffed grouse, wood ----primarily duck, woodpeckers
witch-hazel	ruffed grouse
hornbeam	beaver, bobwhite, fox squirrels, ring-necked pheasants, ruffed grouse, songbirds
Canada mayflower	deer, ruffed grouse and other birds, chipmunks and other rodents
hobblebush	deer, beaver, skunks, ruffed grouse, turkeys, cardinals, cedar waxwings, thrushes, brown thrashers
Serviceberry	deer, rabbits, thrushes and many other songbirds, rodents, small mammals, bear, grouse, turkey, squirrels, chipmunks, beaver, foxes
New York fern	provides cover
rhododendron	cover for deer, black bears, snowshoe hares, ruffed grouse, turkeys, songbirds
native alders	deer, elk, redpolls, siskins, goldfinches, beavers

Hemlock (White-Pine) - Northern Hardwood (FB)**When Appropriate:**

Common throughout the state

Mid to lower slopes or cool, moist terrain on plateau

Typically late successional, not directly developing from early successional forest

At least 25% cover of conifers and often a rich bryophyte layer

Dominant Species:

eastern hemlock

sassafras

eastern white pine

American beech

sweet birch

red maple

sugar maple

yellow birch

witch-hazel

rhododendron

Viburnum spp.

New York fern

black cherry

native alders

Important Wildlife Species:

Ninety-six bird and forty-seven mammal species are associated with hemlock

crested flycatchers, quails, turkeys, kingbirds, mockingbirds, sapsuckers, pileated woodpeckers, yellowthroat warblers, phoebes, black bears, beaver, deer

yellow-bellied sapsuckers, pine warblers, red crossbills, beaver, porcupine, deer, snowshoe hare, bald eagles

black bears, foxes, ruffed grouse, ducks, chickadees

beaver, black-capped chickadee, porcupine, ruffed grouse

bats, deer

deer, porcupines, snowshoe hare, multiple bird species

snowshoe hare, deer, ruffed grouse, red squirrels, beaver, porcupines

ruffed grouse

cover for deer, black bears, snowshoe hares, ruffed grouse, turkeys, songbirds

deer, beaver, skunks, ruffed grouse, turkeys, cardinals, cedar waxwings, thrushes, brown thrashers

provides cover

passerine birds, game birds, and mammals including foxes, black bears, and raccoons

deer, elk, redpolls, siskins, goldfinches, beavers

Section IX: Specific Considerations for Restoring Wildlife Habitat Structures**Nest Boxes**

The booklet “Woodworking for Wildlife” (PGC, fourth edition) has a variety of nest box plans and instructions on proper placement. Boxes do require periodic maintenance and replacement, but can prove valuable for many wildlife species.

Bat boxes, which typically house summer maternity colonies of little brown or big brown bats, can be erected on posts in wildlife openings if water is nearby. The boxes must receive at least 7-8 hours of direct sunlight per day and as such should not be placed on trees.

Dead and Down Woody Material

Dead and down woody material is valuable to many different species of wildlife. Numerous types of invertebrates, reptiles, amphibians, and mammals can be found on, in, or under fallen logs. These logs may be used as nesting sites, feeding sites, or escape cover. Ruffed grouse use logs for drumming sites as a part of their mating rituals. A lot of small mammals use this habitat type for hiding and food caches. Several salamander species spend just their adult life phase in a rotting log foraging for invertebrates and hiding, whereas a few species may spend their entire life in a single log. Coarse woody debris is host to a huge number of insects, approximately 400, and an unknown but large number of non-insect invertebrates. Therefore, it is important to maintain some level of down woody material on the forest floor. The larger and less decayed material is best, however, any size can usually be utilized by some species.

Brush Piles

When natural cover is limited in wildlife habitat, brush piles may be provided. Brush piles could be a by-product of other land management activities. Timber harvest and timber stand improvements provide the woody limbs suitable for brush piles. Brush piles are most beneficial to wildlife when they are located at the edges of forest openings. They should be located within 10 feet from the woodland border. Brush piles could also be placed along streams and marshes within or next to woodlands. When properly located and constructed, brush piles can benefit many species of wildlife, including bobwhite quail, cottontail rabbits, ruffed grouse, wild turkeys, skunks, raccoons, juncos, and sparrows. Predators such as foxes, bobcats, hawks, owls, and coyotes also benefit from the small mammal and bird populations found in or around brush piles.

Materials used for brush piles will largely depend on what is available. Hardwoods, including oak and locust, are rot resistant and make durable bases. Other suitable materials include large stumps, cull logs, old fence posts and stones. Brush piles are usually mound shaped and ideally, should be six to eight feet high and 15 feet in diameter. Covering brush piles with evergreen boughs will provide wildlife with additional cover. Brush piles are relatively short lived (six to eight years) and new ones should be created periodically.

Section X: Considerations for Specific Wildlife Species

If you are interested in managing for a particular species please contact Ecological Services and the jurisdictional agency, the Pennsylvania Game Commission or Pennsylvania Fish and Boat Commission.

American Woodcock

Woodcock abundance is closely related to the availability and quality of four distinct types of habitat. Clearings are important to provide courtship areas for males. Near the clearings there should be good nesting and brood rearing cover consisting of young, second growth hardwoods. Also of great importance is the need for abundant feeding covers made up of alders or dense stands of young aspen on moist, rich soils. Lastly, woodcock require large fields to roost in at night. Woodcock management generally works best on forestlands with a good amount of aspen and birch mixed with a few old farm fields, several forest openings, and a few brush lowland areas. Forests dominated by maples, oaks, pines, or spruce typically do not provide high-quality woodcock habitat.

The woodcock feeds on invertebrates by probing the soil with its long bill. Woodcocks are opportunistic and consume a variety of invertebrates. Earthworms make up 50-90 per cent of the woodcock's diet. Alders and second growth forest located on fertile, moist soil are favorite feeding sites. Other animal foods, such as beetles and fly larvae are also eaten. Planting shrubs such as alder, hawthorn, gray dogwood, spicebush, silky dogwood, black haw and dentate viburnum around ponds, along streams, and in wet bottom lands or marshes will provide adequate cover in these areas where soil fertility and earthworm production is good.

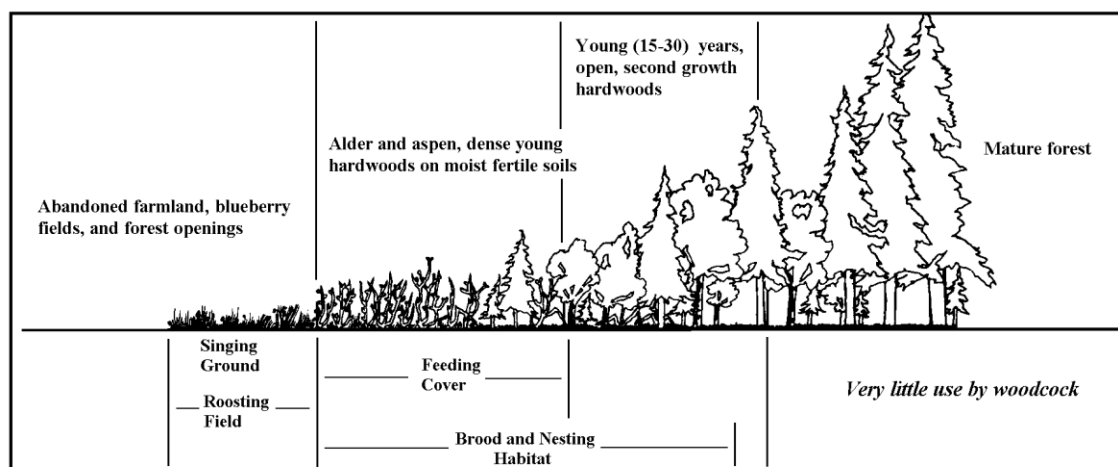


Fig. 2. The stages of forest succession used by woodcock. (from Sepik, et al, 1981).

Appalachian Cottontail

The Appalachian cottontail is more specialized than the eastern cottontail. Appalachian cottontails are typically found at higher elevations and are often associated with coniferous forests and dense understory forests. They are the only cottontails known to feed heavily on conifer needles. They are known to inhabit brushy habitat, especially birch/red maple forests, hemlock and rhododendron areas within oak-hickory forests, blueberries, mountain laurel thickets, and coniferous forests. These rabbits

are sometimes especially abundant in five to ten year old clear-cuts, and around brushy edges of mountain balds.

Bobwhite Quail

Bobwhite quail require their habitat needs to be in close proximity. It is important that nesting cover, brooding cover, loafing cover, and escape cover must be close— generally within a 40-acre area. Therefore, it will be important to concentrate on improving quality cover and proximity of required cover types to meet the year-round needs of these game birds.

Little bluestem and side oats-gramma grasses provide excellent structure for nesting for bobwhite quail. Nesting habitat should be adjacent to brooding habitat. Fields intended for quail should be relatively open with a forb canopy overhead. Forbs that should be encouraged for bobwhites include ragweed, pokeweed, partridge pea, milk pea, and butterfly pea. . Good shrubs including blackberry, wild plum, and elderberry should be scattered throughout the field to provide protective cover for loafing and escaping.

Elk

Elk are primarily grazers and prefer open brushlands and grasslands for foraging and forested areas for winter and security cover. Ideal elk habitat is comprised of a mosaic of brushland and grassland with islands of forest that are interspersed with agricultural land. Food preferences of elk vary with the time of year. Among natural foods, grasses and forbs make up the bulk of the diet during the snow-free period. Woody browse is used during late fall and winter when herbaceous forage is less abundant. Elk also utilize agricultural crops, particularly those adjacent to wild land where they can feed without venturing far from cover. Sunflowers, soybeans, and oats are favored crops, while corn, wheat and barley are also utilized. Alfalfa is utilized during spring green-up and late in the fall. Forest openings for Elk should be from 3 to 40 acres in size. Aspen cover and early successional shrubland provide good habitat for elk and other wildlife as well.

Golden-winged Warbler

The Golden-winged warbler prefers higher elevation, early successional habitat with patches greater than 20 acres in size. Suitable habitat for golden-winged warblers is areas with small, interspersed patches of herbs and multi-stemmed shrubs or root-suckering trees, plus a forested edge. During winter it seems to favor semi-open or less dense forests, forest borders, and gaps. The males arrive on the breeding ground a few days ahead of the females. The female usually selects a nest site on the ground, which she will build.

They typically eat leaves and twigs, often concentrating its foraging at dead leaf clusters. They will sometime be seen hanging upside-down like a chickadee while foraging. It often focuses on moths, their larvae and pupae. Most foraging takes place in the upper half of trees and shrubs in the perimeter of the branches on the breeding ground.

Ruffed Grouse

Ruffed grouse require a number of vegetation stages or types. Optimum ruffed grouse habitat should include brushy areas, young aspen stands, mature aspen stands with an understory of hazel or ironwood, and dense sapling aspen stands.

Aspen trees are an important habitat component for ruffed grouse. Aspen trees 15 years and older provide the most important year-round food sources in the form of green leaves, flower buds, and catkins. During winter the flower buds of aspen become the staple grouse food, but winter catkins of hazel and those of willow and birch are also eaten.

Aspen younger than 12 or 15 years provide the thick, dense cover that helps protect nesting grouse and hens with broods from aerial predators (hawks and owls) and land predators (foxes and coyotes). Therefore, the key to more grouse is to create varying ages of aspen, when possible, and a variety of hardwoods and brushy covers when aspen is not available. A grouse can be sustained in 10 to 20 acres if the habitat is ideal.

Species composition and density also determine the long-term capabilities of a forest in sustaining grouse. Tall shrubs, greater than 5 feet, provide year round food and cover. Recommended species include hazel-nut, dogwood, witch hazel, serviceberry, and nannyberry. Maintenance of dense young forest should be the highest priority of grouse habitat management. In addition, ground cover such as blown down trees and debris also provide substantial cover and necessary drumming sites.

If there are no aspen, oak, or lowland hardwoods, grouse may still be attracted to woody plants such as apples, crabapples, hawthorn, wild plums, dogwoods, nannyberry, raspberry, blackberry, sumac, grape, willow, cherry, hazelnut, and ironwood. Make small clearcuts no larger than 2 1/2 acres in size in the interior of the woods, sparing the above species. The result will be an explosion of dense thickets of young trees and shrubs, which will attract grouse.

Whenever creating a clearcut for grouse, be sure to leave one log per acre as a potential drumming site. The log must be at least 10 inches in diameter and cut at least 3 feet from the ground so as to leave a sufficiently sized stump. Eventually young trees will grow over the log, and a drumming site will develop.

Snowshoe Hare

Snowshoe hare are active year-round, mostly at dawn, dusk, or at night. They seek shelter next a ledge or large rock, or under tree roots, hollow logs, or fallen trees. This shelter will often be used by the same hare throughout the year. Hare are typically active within a core area of 5-10 acres, but they may range up to 25 acres. Hare populations are cyclical, with peaks usually occurring every 9-11 years.

Snowshoe hare typically avoid open areas, but may be found in cut-over areas including clearcuts, blowdowns, and burns. Cover is very important habitat component for hare. They require good base cover, which is the dense softwood cover where they spend the day. Softwood stands with tree heights of 8-15 feet and low lateral visibility (5,000-13,000 stems per acre) is good base cover. Travel cover is also important and is used to move from their daytime cover to a food source. Good travel cover includes tree heights of 15-46 feet with a more open understory (1,000-3,000 stems per acre). General recommendations within a 20-acre management unit can include maintaining 30% base cover, 45% travel cover, 10% herbaceous food source, and 15% regeneration.

In summer hare will often eat clover, grass, dandelions, berries, and ferns. In winter they typically shift to twigs, buds, tender bark of shrubs and trees, and stems of bushes and saplings including aspen, alder, spruce, fir, birch, willow, and pine.

Wild Turkey

Habitat management for turkeys consists of retaining, creating and managing suitable food, cover and water. Turkeys need forestland, with a variety of forest types with open areas well distributed. Adults use openings for resting and feeding. Turkeys usually select areas with dense brush, tall grass, and fallen tree tops for nesting. Important brood habitat includes forested areas with moderate herbaceous understories, forest clearings, power line rights-of-way and a water source. Forest openings for turkeys should be at least 1 acre or more in size, especially in areas with high deer densities. They should be well distributed and located in or near woods.

Choice foods for the late fall, winter and spring are acorns, beechnuts, flowering dogwood, berries, wild grapes, pine seed, as well as, small grains and winter clovers. Use of food plots by wild turkeys increases when they are placed adjacent to favorable cover such as dense brush, tall grass and fallen tree tops.

Food options for summer and early fall are blackberries, mulberries, millet, corn, wheat, insects, and seeds. Mature wheat plots producing seed in May provide a quality food source for birds through the summer. If allowed to remain fallow, these fields can provide excellent brood habitat for turkeys and bobwhites the following summer as a variety of forbs become established from the seed bank. If you plant wheat for turkeys, use a lighter seeding rate as opposed to the heavier seeding rate for deer forage production.

Species of Special Concern

A PNDI review prior to well construction may reveal that a species of special concern such as the Allegheny woodrat or timber rattlesnake are in close proximity to the site. The restored well site could be used to create habitat for these species. Ecological Services can be consulted to assist with the habitat creation effort.

Allegheny Woodrat

Allegheny woodrats are rock-dwelling mammals that are sensitive to forest fragmentation. Fragmented habitats allow predators like the raccoon and feral cats to proliferate. Woodrat populations have become decimated in many areas by the spread of raccoon roundworm that the woodrats acquire through the collection of raccoon feces.

Woodrats leave their rocky denning areas at night to forage for seeds, berries, and herbaceous food sources. Restoring contiguous forest and mast and fruit-producing trees and shrubs near their rocky habits is important. Improving rocky habitat will also benefit the mesopopulation of woodrats. More information is provided in the documents referenced at the end of this paper.

Timber Rattlesnake

Timber rattlesnakes are active mid-April through mid-October and prefer upland forested areas where they forage for small mammals. Dens or hibernacula for this species are hard to locate and may consist of an inconspicuous opening with a few rocks that are completely under tree canopy. These den sites may or may not have rocky, open habitat close by that is used mainly by gravid (pregnant) females for

gestation. Den habitat has not been successfully created, but valuable gestation areas for gravid females and basking areas can be.

The Pennsylvania Fish and Boat Commission have indicated that there are opportunities at, gas well clearings and pipelines to create good gestation habitat. Forest openings created in more remote areas with very minimal disturbance should be the areas targeted for the creation of rattlesnake gestation habitat. Often large rock slabs will be unearthed during the excavation of these openings. Rock placement should be in a position so the rocks receive a daily minimum of 5 to 7 hours of direct sunlight. Large flat slabs (minimum of 4' x 6' piled horizontally one or two layers high) should be placed on the north or east side of the well openings and food plots approximately 5 to 10 yards out into the opening from the existing tree line. It is important to maintain the appropriate amount of shade and sun on these areas to provide proper habitat. Please review the PA Fish and Boat Commission document Guideline for Timber Rattlesnake Habitat Creation (2010) for additional information.

Northern Flying Squirrel

The northern flying squirrel is a nocturnal squirrel occurring north of Interstate-80, in high elevation northern hardwood forests with a conifer component. This squirrel is dependent on a fungal diet, that is associated with red spruce and white pine. Den sites are often in mature yellow birch cavity trees. Red spruce and white pine should be planted at appropriate sites, and yellow birch should be allowed to colonize the area. Please refer to the Bureau of Forestry Northern Flying Squirrel Habitat Guidelines for more information.

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Appendix E: Emergency Contact Information

General Emergency Contact Information	
Operator	Emergency Number
Anadarko	(570)-244-4013
Atlas America/Atlas Energy	(412) 262-4613
BG Production, LLC	(412) 309-3457
Chesapeake Appalachia, LLC	(607) 738-4101
Chief Oil and Gas	(866) 947-6447
Consol Energy (CNX)	1-800-583-3755
D&L Energy, Inc.	(888) 343-4427
Diversified Oil and Gas, Inc.	(724)-471-2030
Dominion Transmission Inc.	1-888-264-8240
Energy Corporation of America	(724) 463-8400
EOG Resources	(724) 430-9902
EQT	1-800-926-1759
EXCO Production Company (PA), LLC	1-888-788-3781
Haddad and Brooks, Inc.	(740) 922-0923
KSM Energy, Inc.	(412) 967-0164
NCL	(814) 387-6060
NFG	1-800-444-3130
PGE	(814) 723-3230
Range Resources	(724) 825-9755
R E Energy Development	(814) 278-7279
Seneca Resources	1-800-526-2608
Talisman Energy	(800) 530-5392
Ultra Resources	(570) 439-7127
XTO Energy	1-877-829-8521

Appendix F: Glossary

Ambient Noise Level: The background sound level at a given location.

Avoidance Measure: An agreed upon policy implemented by the seismic operator to aid in ensuring that a specific area is adequately avoided.

BMP's (Best Management Practices): The procedures that reflect the best practices available to the industry and land managers that consider cost-effectiveness, technology, environmental protection and safety.

Cathodic Protection: A method of protecting metallic pipelines from corrosion as commonly applied to protect buried bare or coated pipelines.

Centralized Compression: A compressor station that serves multiple well pads in a region.

Completion: The process of readying a well for production that may include, but is not limited to, installation of the wellhead, setting casing, cementing and stimulation.

Compression: The act of increasing pressure of the produced gas.

Compressor Stations: The facility that uses one or more compressors to raise the pressure of a gas stream to deliver to market.

Conceptual Development Plan: An overall plan of oil and gas development of the surface based on subsurface geology, which may include pads, roads, pipelines, compression needs, laterals and pad infrastructure and placement.

Corridor: A narrow linear tract of land along a route identified by a specific common purpose.

Development: Permanent or temporary earth disturbance activities related to construction and placement of infrastructure necessary to produce oil and gas not including seismic exploration.

Development Phase: The period during which a well pad is being constructed and prepared for the extraction of natural gas and/or oil.

Distributed Compression: A compressor that may be co-located on the established well pad and service all the producing wells within that pad.

Distribution Pipeline: A pipeline that moves gas from the transmission system directly to the customer, regulated by the Public Utility Commission (PUC).

Drainage Area: The maximum area that may be drained efficiently by one well so as to produce the recoverable oil or gas in the area.

Drill Buggy: A wheeled or tracked vehicle used to drill bore holes in which sources are placed during seismic survey, may also be used to carry and transport equipment to support the survey operations.

Drilling Mud/Drilling Fluids: A mixture of base substance and additives used to lubricate the drill bit, transport cuttings from the drill to the surface, and counteract the natural pressure of the formation.

Dust Suppression: To restrict or control the movement of soil particles from becoming airborne.

Emergency Response Plan: A plan that is developed as a DEP Chapter 78 requirement, by an unconventional well operator, that provides for equipment, procedures, training and documentation to properly respond to emergencies that threaten human health and safety for each well site.

ESCGP-2: DEP Erosion and Sediment Control General Permit for Earth Disturbance Associated with Oil and Gas Exploration, Production, Processing, or Treatment Operations or Transmission Facilities

Exclusion Area: An area in which the Bureau recommends that operational activities be prohibited.

Extraction: Production of oil or natural gas.

FERC (Federal Regulatory Commission): An independent regulatory agency within the U.S. Department of Energy

Field Inspection: An onsite verification of compliance to the terms of lease or conditions of approval.

Flowback Water: Water generated initially in conjunction with oil and natural gas exploration and development activities before the well is brought on line for production. This is typically a high percentage of the hydraulic fracturing fluids injected into the well mixed with a relatively low percentage of native formation waters.

Frac Tanks: portable tanks which can be transported by tractor; capacity is generally 500 barrels (21,000 gallons).

Fragmentation: The process by which a continuous forest habitat is converted to non-forest and becomes separated into smaller, more isolated forest patches.

Gas Storage: Use of a depleted formation to store gas brought in from another field.

Gathering Pipeline: A pipeline that transports oil and gas from a well to a transmission line.

Guideline: A general rule, principle, or recommendation.

Headwater Streams: The source and upper reaches of a stream.

Heavy Hauling: Vehicles with gross weights of more than 10 tons, as used in Road Use Agreements and Road Bonds.

Horizontal Directional Drill (HDD): A pipeline installation technique whereby a steerable assembly is used to bore a shallow horizontal hole between two open pits for the purpose of installing a pipeline without excavating the surface between the pits.

Hydraulic Fracturing: An essential completion technique that facilitates production of oil and natural gas trapped in low-permeability reservoir rocks. The process involves pumping fluid at high pressure into the target formation, thereby creating small fractures in the rock that enable hydrocarbons to flow to the wellbore.

Impoundments: An open air, lined, earthen enclosure used to store fresh water.

Inadvertent Return: Unintentional discharge of drilling mud (primarily water and bentonite) during horizontal directional drill (HDD) of pipeline infrastructure.

Infiltration Basin: A shallow impoundment that stores and infiltrates runoff over a level, uncompacted, (preferably undisturbed area) with relatively permeable soils.

Joint-Use Road: State Forest Public Use (Z1) and Drivable Trails (Z2), which are open to public travel year-round, that are designated for dual snowmobiles and license motor vehicles.

Legacy Lease: An historic or pre-Marcellus lease.

License for Right of Way Agreement on State Forest Land: A right-of-way agreement that can be issued as authorized pursuant to Section 302 (b)(3) of the Conservation and Natural Resources Act, Act of June 28, 1995, P.L. 89, No. 18, 71 P.S. §1349.302(b)(3); it does not provide for a permanent interest in the land.

Midstream Operator: An operator, other than the rights holder, that has the right to gather, transport, process and deliver gas to market.

Mineral Exploration: The phase of operations that covers the search for mineral resources by carrying out detailed geological and geophysical surveys followed up where appropriate by exploratory drilling. (MCOR)

Mineral Development: The act of extracting mineral resources from the subsurface in order to bring them to market.

Mineral Production: The act of processing or transporting mineral resources to market.

Mineral Resource: Quantities of oil, gas, coal and hard minerals estimated to exist in naturally occurring accumulations. A portion of the resources maybe estimated to be recoverable, and another portion may be considered unrecoverable. Resources include both discovered and undiscovered accumulations (MCOR)

Monitoring: The actions of inventorying, documenting and reporting.

Mulchers: A machine that is used to cut and chip small woody vegetation in order to clear a path used for seismic survey.

Native Species: With respect to a particular ecosystem, a species that historically occurred or currently occurs in an ecosystem other than as a result of an introduction.

Natural Areas: A legislatively defined area of unique scenic, historic, geologic or ecological value, which will be maintained in a natural condition by allowing physical and biological processes to operate, usually without direct human intervention.

Non-Native Species: With respect to a particular ecosystem, a species that has not historically occurred in an ecosystem or that currently occurs in an ecosystem only as a result of an introduction

Oil & Gas Lease: A legal document executed between a mineral owner and a company or individual that conveys the right to explore for and develop hydrocarbons and/or other products for a specified period over a given area.

Pad: An area cleared of vegetation and graded as necessary to site infrastructure.

Pollution Events: Unintended release of hazardous, regulated or other substances with the potential to cause negative environmental effects.

Post Construction Stormwater Management (PCSM): The use of BMP's to manage changes in stormwater runoff volume, rate and water quality after earth disturbance activities that have ended and the project site is permanently stabilized.

Proprietary: Information provided to the Department that the operator considers confidential business information or trade secrets.

Protective Coating: A substance or material applied to the exterior of the pipe or a pipeline component to prevent contact with the outside environment.

Public Utility Commission (PUC): The Pennsylvania state regulatory agency that provides oversight, policy guidance and direction to public utilities.

Receiver Line: A single row of geophones placed on the surface used to record energy wave reflections from the subsurface. A seismic survey may consist of one or more receiver lines.

Right-To-Know Law (RTKL): A presumption of openness that every record is subject to being requested and presumably public unless an exemption or other provision of RTKL, which may include proprietary information, permits an agency to withhold it.

ROS (Recreational Opportunity Spectrum): An inventory and planning tool used by recreation managers to assure a diverse range of opportunities from which people can derive various experiences.

ROW (Right of Way): Granted interest that provides access across surface lands.

Seismic Agreement: A legally binding agreement between the Bureau and entity that governs and dictates operational procedures and requirements to conduct seismic survey.

Seismic Survey: A geophysical method used for exploration wherein reflections of energy waves from the subsurface are recorded at the surface to produce an image of the geology.

Separators: Devices designed to take the gross production flow from a well at the surface to separate out the undesirable solids from the liquids and gases.

Severed Rights: An ownership or lease interest in the mineral resource in, on and under a given tract of land owned by a person other than the surface owner.

Shale Gas: Natural gas derived from shale formations that are typically dark, organic rich, and acts as both the source rock and reservoir for the natural gas.

Soil Stabilization: The proper placing, grading, constructing, reinforcing, lining, and covering of soil, rock or earth to ensure its resistance to erosion, sliding or other movement.

Source Line: A single row of devices placed on the surface or in a series of boreholes in order to produce energy waves into the subsurface. A seismic survey may consist of one or more source lines.

State Forest Restoration: To bring back to the original contour/grade, land use and function.

State Forest Reclamation: To change an area used for gas development to another district approved condition, e.g. recreation parking infrastructure, herbaceous opening or forested habitat.

Subsurface Rights: An ownership or lease interest in the mineral resource in, on or under a described tract of land.

Surface Rights: The right of a mineral owner or an oil and gas lessee to use so much of the surface of land as may be reasonably necessary for the conduct of operations under the lease.

Transmission Pipeline: A pipeline that transports gas from a gathering line or storage facility to an oil and gas market, regulated by the Federal Energy Regulatory Commission (FERC).

Vegetative Screening: The use of coniferous or hardwood vegetation, either naturally reproduced or planted, to create vertical structure for minimizing visual and noise impacts.

Waiver: Official and vetted terms of approval, given in formal written consent, granted to lessee separate from the lease

Wastewater: All flowback and produced water that exits the wellbore. All produced water is considered a wastewater by DEP.

Well Pad: The area surrounding an oil or gas wellhead that is subject to earth disturbance and that is used or planned for use for the drilling, production or plugging of the well, including associated support

activities (such as storage of chemicals, wastewater, drill cutting, and equipment). The well pad does not include roads, pipelines, and facilities for the withdrawal, storage, and conveyance of freshwater.

Wetland: Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs and similar areas.

Wild Area: A legislatively defined extensive area which the general public will be permitted to see, use and enjoy for such activities as hiking, hunting, fishing and the pursuit of peace and solitude.

Wild Character: A concept that has different meanings to different people; some components of wild character the bureau considers are scenic viewsheds, undeveloped, “back-country” character, aesthetic buffers, and noise impacts.