

GUIDELINES FOR ADMINISTERING OIL AND GAS ACTIVITY ON STATE FOREST LANDS



pennsylvania
DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES

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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

Background Information

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 uses and values. Among them are scenic beauty, recreational opportunities, timber, plant and animal habitats and the environmentally sound extraction of mineral resources.

The Bureau of Forestry's mission statement clearly states 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

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.

the Commonwealth's forests and to conserve native wild plants.

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 and states, "The department is hereby empowered to make 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 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 surface and subsurface rights on approximately 1,804,000 acres (82%) of state forest land. The Bureau has entered into 123 active lease agreements which encompass approximately 385,940 acres. The leases permit the development of oil and gas resources and/or storage of natural gas.

There are approximately 286,620 acres (18%) of state forest land where the subsurface rights are privately owned (i.e., severed rights). These lands present a complex 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 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. 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. Specifically, these guidelines will provide information for:

- Bureau staff: to manage oil and gas activities consistently across the 20 state forest districts
- Operators: to clearly communicate the Bureau of Forestry’s mission, expectations, and protocols for managing natural gas development activities in an environmentally-sound manner
- Public: to provide transparency in the management of their state forest lands

2. Key Principles

Administering Oil & Gas Activities on State Forest Lands

According to the Bureau of Forestry's *State Forest Resource Management Plan*, "...The extraction of mineral resources on state forest lands will be managed and utilized by exploration and development using wise and sound conservation practices for the long-term good of the citizens of the Commonwealth." 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 and not require specific actions—rather they should consider the *mission statement* of the Bureau of Forestry and 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 protecting natural resource values and uses on state forest lands where multiple activities occurring in close proximity may present conflicts. The Bureau strives to balance those potential conflicts to ensure the long-term viability of those resources for the Commonwealth.
- The safety of workers and the general public will be foremost when making 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."
- Bureau staff and operators should work cooperatively to establish constructive relationships to enable 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.
- Whenever feasible, the placement of roads, pipelines, impoundments, compressor stations, well pads and associated oil and gas infrastructure should utilize 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.



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
- freshwater acquisition and transportation
- wastewater treatment, storage, transportation, and disposal
- re-vegetation
- site reclamation and restoration
- monitoring of oil and gas activities
- community contact
- other tasks that accompany oil and gas management

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

Deputy Secretary's Office:

(717) 787-2703

Bureau of State Parks:

(717) 787-6640

Director's Office:

(717) 787-2703

Division of Resource Planning & Inventory:

(717) 787-2703

Division of Operations and Recreation:*(717) 787-2703***Division of Forest Fire Protection:***(717) 787-2703***Rural & Community Forestry Section:***(717) 787-2703***Communications Section***(717) 787-2703***Silviculture Section:***(717) 787-2703***Ecological Services Section:***(717) 787-2703***Minerals Division:***(717) 787-2703***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 – [Lackawanna 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

Introduction

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 currently accounts for the highest use 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 non-motorized forms of recreation, such as sight-seeing, hiking, hunting, fishing, horse-back riding, and cross-country skiing; while others utilize the same area for motorized and 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 conflicting 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.

Leases, mineral development and new rights-of-way will be prohibited on designated state forest wild and natural areas; with the exception that subsurface oil and gas rights may be leased where no surface use or disturbance will occur. 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 61 state forest natural areas and 14 state forest wild areas which

account for 11% of state forest lands. Other areas excluded from surface activity include State Parks in which the Commonwealth owns the subsurface rights.

Recent lease offerings established *Areas of Special Consideration* which include scenic vistas and viewsheds. Surface disturbances in these areas will be extremely limited and reviewed individually.

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](#))

State forest lands provide the citizens of the Commonwealth with the opportunity for the types of healthful, dispersed, outdoor recreation that can only be obtained from large forested areas. As such, natural gas activities will be restricted within primitive and semi-primitive non-motorized zones as identified through the Recreation Opportunity Spectrum (ROS) inventory and planning tool.

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. 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 (see [Appendix: Bureau Approved 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.



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.

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.



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

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.

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.

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

- A. Since the safety of the public and gas operators is paramount, consideration should be given to temporary closures of roads or trails where conflict is inevitable and no reasonable compromise exists.
- B. 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.

- 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. Provide alternative trail routes when substantial natural gas activity is occurring in the immediate vicinity. Temporary re-routes will allow recreational enthusiasts to avoid gas development during the peak of activity when the greatest potential for conflict exists. Those portions of the original trail can be re-opened once the well pad is completely developed.
- F. Co-locate recreational trails within rights-of-way corridors where appropriate. Gas operators are encouraged to utilize existing disturbances, such as road networks, when siting infrastructure. Many portions of the snowmobile trail system are located on joint-use roads which may be plowed to provide for safe vehicular passage. Relocating portions of these snowmobile trails onto rights-of-way corridors allows both activities to occur with minimal impact to the other user. [\(See Roads\)](#)
- G. 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.
- H. Forest District Managers should coordinate the timing of oil and gas activities with the operator to avoid public conflict and to minimize 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.

- I. During the following holidays and high visitor use periods there should be no heavy hauling (i.e., rig moves, water trucking, sand trucking, etc.) 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
- 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
- Opening day of deer archery season
- Opening day of youth/special use hunting
- Opening day of early muzzleloader
- Opening day of general small game

- J. Operators must abide by the [State Forest Rules and Regulations](#).
- K. Public access to dangerous surface structures or equipment (primarily during active drilling and completion operations) should be restricted by posting, gating, and/or fencing to provide for public safety and protection. Each operator is expected to be responsible for onsite security, wherein direct access to an active well site pad or water impoundment will be the responsibility of the operator. The operator should post a copy of [State Forest Rules and Regulations](#) at the entrance to operations (i.e. well pad).
- L. 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.

5. Ecosystem Management and Resource Sustainability

Introduction

Part of the Bureau of Forestry's mission is to sustain the long-term health, viability and productivity of Pennsylvania's forests. All aspects of forested ecosystems are important. Although forests are chiefly known for providing timber and other wood resources, they also support many other non-commercial uses. These include providing habitat for plants, wildlife, insects, and microorganisms; nutrient cycling; aesthetics and recreation; water regulation; carbon storage; and oil and gas extraction.

Approximately 700,000 acres of state forest lands are located within the shale gas extraction region. Oil and gas development should ensure that ecological resources and their associated ecosystems are sustained. An ecological approach to resource management is core to the Bureau's management philosophy.

Practices

Oil and gas exploration and development will be conducted in a manner that minimizes adverse impacts to water, soil, flora, and fauna resources and is compatible with other uses of state forest land such as timber management, watershed protection and recreational activities. The Bureau uses the general approach of avoid, minimize, mitigate, and monitor to manage the adverse effects of natural gas development. As such, the following practices should be adhered to:

A. Avoid

Operators should employ early planning to avoid impacting important resources on state forest lands. Through early planning, the Bureau is provided with a landscape-level perspective, facilitating the placement and location of infrastructure that avoids sensitive areas. Operators should use existing disturbances when possible to limit forest fragmentation. The operator will be provided maps that delineate areas of ecological or recreational importance. In these areas, surface disturbances will be prohibited or strictly limited.

Use Existing Disturbances:

Oil and gas development and associated infrastructure should utilize existing disturbances such as road networks or rights-of-way corridors in order to minimize fragmentation on state forest lands. For example, in cases where public safety, recreation, aesthetics, and ecological resources are not affected; pipelines should be placed along existing roads or right-of-way corridors, thereby limiting fragmentation and additional land conversion.

Maximize Protection on Legacy Leases:

Bureau of Forestry staff will work to maximize the protection of state forest resources, uses and values in instances where legacy leases do not include those provisions found in the current lease.

Comprehensive Planning and Review:

Within state forest lands, gas extraction boundaries are delineated into tracts. These tracts may have several well pads and associated infrastructure located on them. Managing at a tract-level, the Bureau and operators are able to focus on landscape-level planning rather than piecemeal approach, such as a well pad by well pad basis.

The Bureau of Forestry should review the operator's unconstrained conceptual site plan as early in the development process as possible, allowing for the utilization of ecosystem management and other planning tools. Comprehensive site plans may be dynamic, but they afford the opportunity to consider potential impacts from a landscape perspective. To aid Bureau staff, the following plans should be requested from and submitted by the operator:

- Unconstrained conceptual development plans (includes pads, roads, pipelines, compression needs, 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

B. Minimize

Each activity on state forest lands goes through a review process to minimize (or avoid) impacts to species, habitats, and recreational resources. Bureau of Forestry staff will work to minimize potential adverse impacts to resources and values by avoiding them altogether, appropriately buffering them or minimizing the impacts by incorporating techniques such as timing restrictions.

Setbacks:

The following set-backs are used to maximize the protection of state forest resources in current, legacy or non-leased areas. In the event of disparate setback distances, the most stringent is applied. No earth disturbance activities associated with natural gas development should occur on the surface within:

1. 200 feet of any building
2. 200 feet of 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 of 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 state forest picnic area or sheltered area which has been so designated by DCNR
6. 300 feet of any trail, road, existing right-of-way, or defining line of any viewshed or municipal watershed
7. 300 feet of any area of historic value, tree plantation, overlook, vista or fire tower site
8. 300 feet of the boundary line of the leased premises
9. 600 feet of the boundary line of state park lands or of designated wild and natural areas on state forest lands
10. Any requested buffers for endangered, threatened, rare, candidate or tentatively undetermined species or communities of special concern as requested by DCNR, the Pennsylvania Game Commission (PGC), the Pennsylvania Fish and Boat Commission (FBC) or US Fish and Wildlife Service (USFWS)

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.

11. Additional setback restrictions may be instituted on a case-by-case basis (e.g., steep slopes, high recreation areas or other significant conditions).

Surface disturbances associated with oil and gas development will be prohibited within state forest wild and natural areas and state parks where the Commonwealth owns the oil and gas rights. Waivers will not be considered for such instances.

C. Mitigate

After disturbance activities conclude, mitigation will be necessary to offset adverse impacts to the forest. Mitigation can be accomplished in several ways—but at a minimum, it needs to comply with state erosion and sedimentation control requirements. Mitigation opportunities include but are not limited to: reforestation; reclamation; species habitat enhancements; or invasive species removal. The goal is to restore the site to the point where it is a self-sustainable and functional natural community.

D. Monitor

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 and water resources, as well as changes in social and recreational values. Findings will be published in periodic *Shale Gas Monitoring Reports* that will be used to summarize and communicate any changes to state forest land and facilitate adaptive management that addresses these findings.

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 [Restoration](#).

The Bureau's gas management approach of avoid, minimize, mitigate and monitor 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.

Implementing Ecosystem Management and Resource Sustainability

The proceeding 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

Introduction

Seismic data facilitate successful exploration and development of gas reservoirs in Pennsylvania. The acquisition of seismic data is considered integral to understanding the complex lithologies and reservoirs that exist. Additionally, the acquisition of seismic data is inseparable from shale gas exploration and development rights.

Seismic surveys can be thought of as ultrasounds for developing images of rock layers below ground. Sound waves are generated, travel underground, and bounce back to data recorders on the surface (i.e., geophones) whenever they transition between rock layers and rock properties change. By measuring the amount of time it takes for the sound wave to bounce back to the geophone, the depth of different rock layers, and any existing faults or fractures can be calculated.

Two methods commonly used for seismic surveys in Pennsylvania are:

(Explosive surveys): utilized for cross country surveys where road access is limited; drill buggies, heli-portable drills or tracked machines drill a 20 foot “shot-hole” every 220 feet along a linear survey route; data collection receivers (or geophones) are placed at fixed intervals and data is collected

(Vibroseis surveys): utilized when a sufficient road network exists; large weighted trucks strike the road surface and collect data in a similar fashion described above

Seismic data are typically acquired in two forms:

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 which collect the reflection signals from points outside the plane of the energy source to produce a “cube-like” profile of the subsurface. Multiple seismic lines collecting data simultaneously are required to produce a three dimensional image. 3-D surveys are more complex, labor intensive and require more land-base.



The following should be considered with seismic surveys:

1. Seismic operators are highly encouraged to employ the least intrusive technologies available for gathering seismic survey data. This includes the utilization of new technologies and advancements as they become

available; as well as the simple practices of tying vegetation back (as opposed to cutting) and manually installing seismic lines and receivers.

2. The use of mulchers or all-terrain vehicles to clear vegetation or to lay cables should be avoided. The Bureau may consider the use of this equipment on state forest lands under 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.
3. Exclusion areas containing sensitive resources should be clearly delineated by the operator 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. 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.
4. Drill buggies used for dynamite surveys should avoid all sensitive and wet areas.
5. Operations should be planned and scheduled appropriately to avoid unnecessary conflict including:
 - High visitor use periods (i.e., hunting seasons 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.
6. Seismic activity should adhere to requested [setbacks and established buffers](#)
7. Use existing roads and infrastructure to the maximum extent possible when accessing shot and receiver lines.
8. Position shot and receiver lines and access routes to eliminate stream crossings and the encroachment on important riparian buffers.
9. Use low impact vehicles that will not disturb the soils and vegetative root systems.

The following process will be used by the Bureau to review seismic survey requests on state forest land:

1. *The company submits its application to the Bureau:*
 - location (i.e., boundaries of project)
 - acres affected
 - narrative and justification for project
 - proposed methodology of acquisition
 - target formation and depth of sampling

2. *The Bureau performs a preliminary review of the project and decides if its justification is warranted.*
3. *If the project is accepted, the operator should submit an operational seismic survey plan to the Bureau. The operational plan should include:*
 - map depicting the location of survey lines and charges
 - standard operating procedures for working in and around sensitive areas
 - communication protocol for notifying field crews of exclusion areas
4. *The 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 contractor with the following information prior to the initiation of any field work:*
 - known exclusion areas delineated as orange polygons in ArcGIS format
 - a list of suspected sensitive resources and their anticipated location
 - A list of operational restrictions and/or avoidance measures pertaining to each exclusion area

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.

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 be required to 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 field work. Additional meetings may be warranted depending on the complexity of the proposed seismic project.

B. Well Pad Sites

Introduction

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.



A typical shale gas well pad is approximately 3.5-7 acres in size and can host up to 12 individual wells. Drainage area for a given well is determined by the length of the well bore and the reservoir characteristics. Modern drilling rigs weigh several thousand tons and require construction of a solid pad that can adequately support their weight and maneuverability needs.



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. 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). 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.

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.

In aesthetically sensitive areas, locations should be selected that provide for vegetative and topographic screening. Consider supplemental plantings of white pine, or similar trees, to establish or enhance vegetative screening.

Well pad spacing

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. However, the Bureau recognizes that economic, technological, and geologic constraints may influence the size and number of pads.

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 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. Pads are constructed to be relatively level and compact in order to support the drill rig and 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.

Standard 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



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, and should not be stored under plastic, which can greatly reduce 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 drilling 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, which allows for recycling of drilling fluids and the separation of rock cuttings into containers to be hauled off location and 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. Pipeline rights-of-way and access roads are not considered part of the well pad.

Following well completion, only the equipment that is necessary for production should remain on the well pad. On state forest lands, common facilities which remain on the pad for the life of the wells are wellheads, meters, natural gas processing units, dehydrators and produced water tanks. The Bureau encourages operators to cluster and centralize production infrastructure on the well pad to the maximum extent possible, without jeopardizing safety, in order to facilitate restoration of the unoccupied portions of the pad. This is also a [Marcellus Shale Coalition Recommended Practice](#).

Pad organization

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

Operational 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 double wall tanks for collecting produced water
- 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.

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. However, when the surface or groundwater withdrawal point is located within state forest lands and the Commonwealth owns the surface and subsurface rights, the terms for accessing the water withdrawal site are set forth in the lease agreement. On the other hand, when the surface or groundwater withdrawal point is located within state forest lands and the Commonwealth owns the surface rights and a private party owns the subsurface rights, the terms for accessing the water withdrawal site are customarily contained in a surface use agreement.

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 and in close proximity to the well site throughout this process. Centralized fresh water storage facilities and temporary pipelines for transporting water is preferred over the traditional method of housing multiple storage tanks on the well pad and filling them via truck. 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
- a third party supplier and trucked on site
- groundwater well withdrawals

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:

1. Surface water withdrawals are preferred over trucking water to the site or ground water withdrawals.
 - a. Surface water withdrawals are readily monitored, provide high yields, and can be controlled during low flow conditions.
2. 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.
3. 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.

- a. Siting round 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.
- b. 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 both. Above-ground pipelines should be placed in a manner to reduce aesthetic impacts, vegetation damage, and the potential for vandalism. When feasible, buried pipelines should minimize additional earth disturbances by being co-located with existing pipelines, buried in the ditchline or vegetated berm, or trenched and buried beneath the running surface of the road.

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; typically 3-5 acres in size, and can serve multiple well pads
- Above-ground Storage Tanks: semi-portable, bolt together, cylindrical tanks that are often set on concrete pads; typically 2-3 acres in size, and can serve more than one well pad



Earthen Impoundment Being Constructed



Earthen Impoundment

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

The following should be considered when determining water storage needs:

1. Place freshwater storage facilities within existing non-forested openings, reducing new landscape disturbances.
2. Utilize double-line water impoundments to reduce leaks and tears during pumping.
3. 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.
4. Prevent stored fresh water from becoming septic by installing aeration systems.
5. Install an under-drain system to cycle any occurring leaks back into the impoundment thereby reducing the chances that leaks go undetected.
6. Install sufficient exclusionary fencing to keep wildlife from falling into the impoundments. Incorporate deterrents when the fences alone are not consistently successful.
7. Install jute matting along the top, inside edge of an impoundment to enable amphibians and small mammals to exit the slippery plastic-lined impoundments.

Note:

In the Golden Rules for a Golden Age of Gas the International Energy Agency also describes three alternative techniques that either reduce or eliminate the use of water as a hydraulic fracturing fluid.

1. Use of more viscous and traditional fracturing fluids reduce the volume of water needed to pump down the well but do require a complex suite of chemicals.
2. Fracturing fluid created from foaming water with nitrogen or carbon dioxide (with surfactants) reduces water volumes necessary, as 90% of the fracturing fluid exists as a gas. This fracturing fluid has “very good proppant-carrying properties.”
3. Hydrocarbon based fracturing fluids (e.g., propane, gelled hydrocarbons) can eliminate the need for water but their flammability can be a safety concern at well pad sites.

D. Wastewater Treatment, Storage, Transportation, and Disposal

Introduction

Shale gas wells, such as Marcellus and Burket, require an average of 4 to 5 million gallons of water for hydraulic fracturing operations. After fracing is complete, approximately 10 to 15 percent of this water returns to the surface during initial flowback. This “flowback” or “produced” wastewater contains dissolved salts, dissolved metals, chemical additives, bits of rock fragments and minerals which must be properly disposed of or treated before reuse in subsequent completion operations. In April 2011, the PA Department of Environmental Protection asked natural gas drilling operators to voluntarily stop disposing of flowback and produced water 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 flowback water through minimal treatment and blending with fresh water for future well completion. The Bureau supports the recycling of flowback water, reducing the overall amount of freshwater consumed for shale gas operations.



Current Operations

Currently, oil and gas operators on state forest land are managing their flowback and production water by:

- transporting it off-site for disposal
- transporting it off-site for minimal treatment and eventual reuse
- treating it minimally on-site for eventual reuse according to DEP OG-71 authorization

The following guidance should be considered when managing flowback and produced water:

1. Flowback and produced water may be flowed directly into a set of steel tanks for temporary storage and then trucked offsite to an approved facility for treatment and disposal.
2. Flowback into lined, open pits is not permitted on State Forest land.
3. For DEP OG-71 authorized operations: The fluid may be flowed directly into a set of steel tanks for temporary storage and then filtered and treated onsite, mixed with additional fresh water, and reused in subsequent completion operations.

4. All wastewater handling infrastructure, such as valves, tanks, piping should be tested frequently for connectivity and seal integrity. During blending operations, frequent inspections should be performed to ensure the continued integrity of the operation.
5. All wastewater handling infrastructure and operations should utilize adequate secondary containment. This containment should be frequently inspected.
6. In addition to mandatory reporting to DEP, all spills should be reported to the Bureau, promptly per the [Emergency and Pollution Incidents](#) guidelines.

Potential Future Operations

Recently, several oil and gas operators have proposed additional methods for managing flowback and produced water on state forest land, including installing centralized treatment systems and centralized storage areas. While similar to the activities occurring under the OG-71 authorization, because of the centralized nature, these operations require the DEP WM-123 permit. The DEP WM-123 permit is administered by the DEP Waste Management Program and 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.

After significant review and discussion, the Bureau of Forestry has determined that these 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. For example, facilitating treatment and reuse of oil and gas wastewater should help to reduce the overall amount of freshwater consumed for oil and gas operations. Additionally, centralized treatment and storage systems should help to reduce heavy truck traffic, which is often cited as a negative impact of shale gas development, both on the State Forest and in neighboring communities.

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 does not support large-scale, for-profit wastewater projects on state forest Lands. Wastewater operations are to be temporary in nature. The Bureau will consider all proposals. However, 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

Introduction

An efficient, sustainable, and environmentally sound road system is critical to the administration and management of Pennsylvania's state forest system. The infrastructure provides necessary access for the general public as well as those working within the forest. 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. Scenic driving ranks as one of the highest recreational uses of the state forest system.



State forest roads are not public roads like other federal, state, or municipal roads. Rather, they are considered administrative roads that are open to public travel unless gated or posted closed. Many of these roads are “*joint-use*” open for travel by licensed motor vehicles and snowmobiles 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. The commercial use of state forest roads is prohibited without a *Road Use Agreement* per [State Forest Rules and Regulations](#).

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, and user experience; and 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:

1. **Safety:** Hazardous and unsafe conditions will not be created or sustained. Public safety is always the first priority.
2. **Accommodate or account for shared use:** 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.
3. **Practices, Techniques and Materials:** Practices, techniques and materials must be compatible with the Bureau's specifications. Consistency is expected within and between state forest districts.
4. **Future Maintenance Costs:** Nonstandard construction or maintenance practices, overbuilt roads, or the use of substandard materials will dramatically affect future maintenance activities and cost.
5. **Environmental Sensitivity:** Environmentally sound maintenance techniques should be utilized on state forest land.

Planning/Siting

The right of the ingress and egress to private subsurface estates is provided for by law and includes the right to construct new roads as necessary. The Bureau works with private subsurface owners to use existing roads whenever feasible, reducing the need for additional clearing and new road construction. The use of state forest roads by private subsurface operators requires a *Road Use Agreement*. A *Road Use Agreement* is also required for lessees using state forest roads outside of their lease boundaries.

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 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 any joint-use roads. The objective should be to promote public safety while minimizing conflict.

Plowing Snow:

Plowing, applying anti-skid, or snow melting materials to state forest roads without prior authorization is prohibited, except as permitted under the Bureau's *Joint-Use Road Plowing Strategy*. Permission for plowing joint-use roads requires a *Letter of Authorization* or *Road Use Agreement*, including specifics such as dates, snow depth to remain, and the number and width of plowed lanes. Openings or breaks in the plowed snow bank (i.e., berm) should be created to facilitate water runoff during thaw events.

Long Term Disruption:

Long term disruption of the snowmobile trail system should be anticipated and sustainable solutions should be sought. Any impacted segment disrupts the entire trail loop. Joint-use roads that provide substandard trail conditions should be avoided. It may be necessary to remove a segment from the snowmobile trail system when a compromise cannot be found. Other roads, trails or right-of-way corridors may provide suitable alternative routes. The Bureau maintains a [website of current snowmobile trail conditions](#). The state forest district should contact the Recreation Section when conflicts exist or are anticipated, so that the public website may be updated.

Modification/Improvement**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.

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 non-potable 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. However, too much shade on the road may produce undesirable road conditions during wet periods.

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. Emerging mineral and synthetic oil based products show promise for dust suppression. A pilot application of one such material has been completed on state forest land, but more observation and testing is needed before the Bureau adopts general 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 fracking 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.

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, 2RC or DSA placed over the modified road base to a depth of 8 to 12 inches.

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

Maintenance:**Bureau maintenance responsibilities:**

The Bureau is responsible for the expense of road materials and maintenance. Maintenance activities are performed at the district level by a staff of skilled employees. 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. All road construction or modifications should be consistent with the Bureau's maintenance and construction techniques.

Rehabilitation:

All state forest roads shall be restored to equal or better condition than existed previously (i.e., pre-gas). The Forest District Manager will determine what restoration efforts are required and if the restoration results are acceptable. It is vital that final restoration is compatible with the Bureau's maintenance practices, and a comprehensive approach (i.e., aesthetics and structure) should be utilized by the operator.

F. Pipelines

Introduction



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 market place requires significant planning, engineering and infrastructure development. Gathering pipelines move natural gas from multiple well pads to centralized marketing pipelines. Marketing pipelines flow to transmission pipelines, which transport large volumes of gas over long distances to distribution centers or storage facilities.

Existing pipeline infrastructure and capacity may be inadequate for current and anticipated gas production needs. When compared to other aspects of gas development pipeline construction has the greatest potential to cause forest conversion and fragmentation, due to their extent and quantity. Therefore, careful pipeline planning should occur early in the development process to address production needs, while minimizing impacts and implementing ecosystem management. Midstream pipelines accommodate multiple operators thereby reducing additional rights-of-way needs, decreasing costs and unnecessary impacts, and improving efficiency.

Right-of-Way requests

Lessees or subsurface owners have the right to construct pipelines to transport oil and gas produced on state forest land. 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 project meets the criteria for a 'large project' as established by the PNDI review
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.

The following principles should be considered when planning pipeline construction on state forest lands:

- New pipelines should minimize the conversion of forestland and the creation of new corridors. Existing disturbances or rights-of-way should be utilized whenever feasible.
- Combine uses such as electricity, water, and gas when possible.
- Marketing pipelines can be strategically positioned to accommodate the production of multiple operators thereby reducing disturbances and minimizing pipeline construction costs.
- Habitat management on rights-of-way can promote and enhance species of special concern, such as the Allegheny woodrat and timber rattlesnake. Please refer to [Appendix: Planting and Seeding](#) and [Appendix: Restoration](#) for additional information.



Pipeline in State Forest co-located with existing road

Pipeline crossings

Pipeline crossings of streams, wetlands, roads, or other resources should be assessed on a case-by-case basis before operators apply for permits. Some options may be more appropriate for certain situations. Below are options for pipeline crossing methods and a succinct description of each:

Horizontal Directional Drill (HDD):

- potentially minimizes disturbance in sensitive areas and water bodies
- requires weeks for construction period
- may require staging areas on each side of the stream or waterbody
- requires a relatively flat staging area; risk of inadvertent return of drilling fluids to streams, wetlands, domestic water wells, or other water bodies

Subsurface Boring (Pipe Jacking or Micro-tunneling):

- potentially minimizes disturbance in sensitive areas and waterbodies
- can require a week for construction
- requires bore pit/disturbance area
- risk of creating under-drain below a stream or waterbody

Pipe Ramming:

- minimizes disturbance in sensitive areas and water bodies
- no water required for jetting
- drilling fluids not required for shorter bores
- most suitable for short distances
- not appropriate for boring through bedrock

Open Cut / Dry Water Body Crossing:

- riparian zone disturbed during crossing
- continuous stream flow maintained throughout construction
- existing damages to riparian zone re-vegetated; riparian zone generally must remain as grassy vegetation after construction
- requires little soil excavation
- often the quickest means for pipeline crossing installation

G. Compressor Stations

Introduction

Compressor stations are commonly used in association with gas production and pipelines. Gas well pressures and volumes steadily decline over the life of production. Similarly, gas moving through steel pipelines creates friction and pressure is lost. 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.



During production, compressors draw gas from the well bore as production volumes decrease and discharge it at higher pressure through the gathering pipeline. Secondary compression may be necessary, depending on the length of the gathering line, to increase pressure as the gas enters larger marketing or transmission lines.

The footprint of a compressor station is variable. Compressors are specifically engineered for the situation at hand. Numerous compressors are often required at a site to generate the desired level of compression. These sites may also include gas

related infrastructure such as separators which capture undesirable particles, 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. Chemicals necessary to aid production during cold temperatures are stored on site.

There are currently two strategies for providing 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. Ambient noise 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. Compressor stations are 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:

1. Compressor stations are inconsistent with primitive and semi-primitive non-motorized Recreational Opportunity Spectrum (ROS) classes and will not be located in these zones.
2. 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.
3. Required setback distances from ecological, recreational or other important resources should be enforced.
4. Cluster with existing infrastructure and development, limiting the size of the footprint to what is necessary.
5. Siting location within the landscape can dramatically affect the distance sound travels.
6. Vegetative screening, such as evergreen plantings, help to minimize the visual and noise impacts associated with the compressor infrastructure.
7. Recommended colors for the facades of all buildings include: forest green, brown, gray, black or natural stain.

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. Revegetation and Native Planting

Introduction

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 revegetation projects on state forest land. Native species provide wildlife habitat and forage, biodiversity values, and 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.

Revegetation and supplemental planting is a common practice on state forest lands after timber harvesting, rights-of-way creation, and gas development activities. Native plant species are preferred, but at times it may be more appropriate to utilize non-native plant species. Non-native plants generally establish quickly, stabilize sites, and warrant use when erosion and sedimentation is critical. 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.

However, not all non-native species are appropriate on state forest land. To ensure ecologically-sound use of non-native plants, refer to the [Appendix: Planting and Seeding](#)

The following should be considered when planting native (or non-native) species on state forest lands:

1. Native grass and herb mixes for cover and stabilization should be used within the disturbed construction areas when possible.
2. The seed mix used for re-vegetation should provide for immediate stabilization and reduce the chance of invasive plant species establishment.
3. A cover crop may be planted while a grass and/or herbaceous seed mix is being applied (e.g., oats or barley for spring plantings, wheat or wild rye for fall plantings).
4. Species with rare, threatened or endangered status (PA Natural Heritage Program (PNHP) species of special concern) generally should not be planted unless the Bureau has developed a recovery plan for that specific species.
5. Native plant (including tree and shrub) species with no special status (PNHP species of special concern) may be planted although Pennsylvania stock should be used whenever feasible.
6. Seed of all planting stock used on state forest land should be native to Pennsylvania and care should be taken to plant all vegetation within its natural geographic range.

7. Justification and stringent monitoring will be required for use of non-native planting stock or seed including cultivars and hybrids on state forest land.

I. Non-native Invasive Plants

Non-native invasive plants (NNIPs) have fast become one of the largest threats to natural ecosystems in Pennsylvania. These plants grow quickly and aggressively, displacing or outcompeting native plants. NNIPs are usually introduced into a region far from their native habitat and therefore there may not be any natural enemies, pests, or diseases to keep the population under control in Pennsylvania. NNIPs can severely degrade forests, riparian habitats, and ecosystem functions.

Although the core forested areas in PA have been minimally affected by invasive plant species, gas activity has the potential to significantly alter these areas through the introduction and spread invasive species. Construction activities associated with gas development (e.g., well pads, pipelines, roads) create pathways and new disturbances which provide opportunities for NNIPs to colonize. Movement of equipment and vehicles facilitates the spread of NNIPs invasive plants.

Prevention

The phrase “an ounce of prevention is worth a pound of cure” is the epitome of NNIP 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
- [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 uninhabited areas
- Utilizing weed-free material (i.e., seed, soil, gravel, mulch)
- Pre-treating established populations prior to disturbance reduces potential spread during and after construction

Detection

A pre-construction inventory will determine if NNIPs are already present. On-going early detection identifies new occurrences when they are easier to manage and facilitates the implementation of rapid control measures that increases the effectiveness of treatment while reducing costs. Identifying populations promotes the development of a comprehensive management control plan.

Control

The operator should implement management and control measures for all new infestations discovered. 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 pesticide 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: Non-native Invasive Plant Management](#) for the complete guidelines regarding non-native invasive plant management.

J. Site Reclamation and Restoration

Introduction

Gas development and drilling activities will disturb and fragment state forest land. The Bureau's goal is to reduce the impact of fragmentation and gas development by restoring sites to their original habitat or creating habitat for plants and wildlife. With proper planning and effective, thoughtful implementation, suitable habitat can be created for many species of plants and wildlife during partial and complete restoration of gas-related sites.

Restoration may be in many forms including: re-vegetation for erosion and sedimentation control; reforestation; reclamation; habitat enhancement; and invasive plant removal. The objective is to restore the site to a self-sustaining natural community that provides ecological benefits.

Restoration Planning

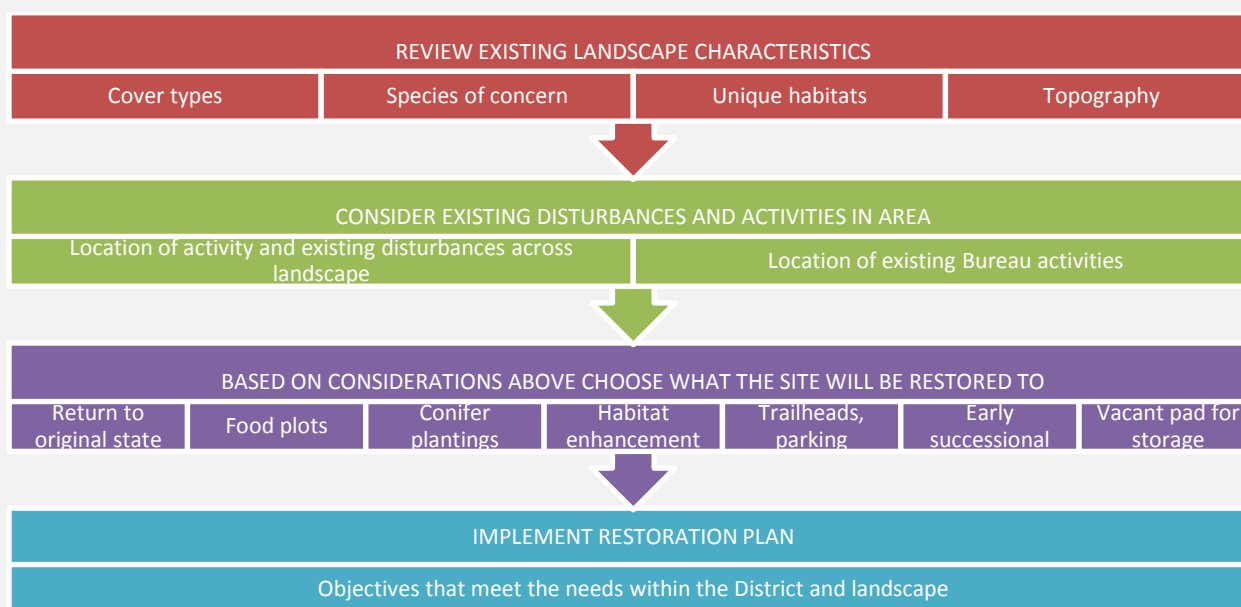
Long term restoration goals should be developed early in the site planning process. Objectives for site restoration should be formulated based on an assessment of the site's quality, soil function, community type, natural features, and plant and wildlife species. Landscape-scale assessments and the site's surrounding habitat and natural community types should be considered.

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 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 repair following disturbance activities. Soil compaction, erosion and sedimentation, and vegetation removal will adversely impact the site at varying scales. The level of restoration should be commensurate with the degree of impact to the site.

The Bureau should identify restoration goals and objectives for the entire development area and communicate those to the operator early in the planning process. Goals are the ideal states and conditions that restoration attempts to achieve. Objectives are specific actions undertaken to achieve the goal. Written goals and objectives provide the foundation for restoration activities and clearly identify the Bureau's expectations for site restoration to the operators.

When developing goals and objectives for the site or tract, take these issues and questions into consideration:



Throughout partial and complete restoration, opportunities for habitat enhancement should be utilized whenever possible. Examples of habitat enhancement include:

- Using brush and rock piles at forest, stream and wetland edges near the site to enhance wildlife habit
- 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.
- Creating nesting opportunities for raptors and other birds using artificial nest structures such as platforms and nest boxes.
- Planting at least two types of trees on site to provide soil stability, species diversity, and opportunities for early-successional wildlife.

Partial Restoration

After well completion and stimulation activities have concluded a significant portion of the well pad is no longer necessary. Partial restoration can begin with the transition into the production phase. It is important that the Bureau and operators communicate restoration plans for sites to achieve long term restoration goals. Partial restoration consists of minimizing the original disturbance footprint by restoring all portions of the site not needed for immediate production operations, while also maintaining safety.

Sites should be ripped and materials used to surface the well pad should be removed. Efforts should be made to recreate the original contours of the site that existed pre-disturbance. Stockpiled topsoil should be redistributed and graded with low compaction 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 NNIPs.

Complete Restoration

Complete 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. Sites should then be evaluated for success at meeting objectives, and routinely monitored to ensure long term goals are met.

Please refer to [Appendix: Restoration](#) for the complete guidelines.

6. The Review and Approval Process

Introduction

The Bureau conducts an extensive review of all gas activities and infrastructure proposed by the operator. To facilitate these reviews 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 plan for known areas of concern or potential conflicts and coordinate with the operator to develop an infrastructure layout that minimizes negative impacts to state forest land while facilitating efficient extraction of gas.

Reviews are performed in cooperation with the state forest district and several divisions within the central office. The focus is on minimizing impacts to state forest resources from proposed locations of gas activity and infrastructure, and determining if well sites are geologically sound and in compliance with lease terms.

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, in cooperation with central office program areas, prior to a field visit with the operator. 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
- 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 the Ecological Services Section, 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

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

Any deviation from conditions specified in leases or agreements requires an approved waiver. It's also recommended that operators submit waiver requests when their activities will not be consistent with the Bureau's guidelines. 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.

The Bureau will consider waivers that minimize impacts to the state forest resources, uses and values and are in the best interest of the Commonwealth. The State Forester has final approval authority for all waiver requests. Each waiver will be reviewed on a case-by-case basis.

Waiver Process

A. Waiver Request Submission

The operator can submit a request to deviate from conditions specified in leases, agreements or guidelines. Waivers requests should be submitted in writing to the state forest district and include:

- Identification of the specific condition for which a waiver is sought
- Description of the proposed deviation
- Justification of the need to deviate from the identified condition
- Identification of alternatives considered and investigated
- Evidence that deviation will not cause detrimental impact to resource or condition for which the waiver is requested
- Any necessary mapping including GIS data where applicable

B. District Review

The district will review the waiver request to determine: 1) if it reduces impacts to the state forest resources, uses and values; 2) if it is in the best interest of the Commonwealth; and 3) if it is consistent with local management objectives. Suggested modifications should be provided to the operator.

C. Central Office Review

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.

D. 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

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.

provided with written notification of the waiver decision. Some waivers may be conditionally approved and subject to additional provisions.

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 recent 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—or mark "NA" if activities completed and site restoration approved.																			
Date earth disturbance or construction activities began:								Inspected by (initials)											
								Dates Inspected											
Access and Safety	Public-use roads safe for public travel																		
	Access roads good, passable condition																		
	Gates appropriately opened or closed																		
	Dangerous equipment posted or fenced																		
	Dangerous areas posted or fenced																		
	Other potential safety hazards																		
Permits and Information	DEP Well Permit/Well ID posted on site																		
	ESCGP-1 Permit posted on site																		
	E & S Control Plan posted on site																		
	PPC Plan posted on site																		
	Consumptive Water Use Permit posted																		
	MSDS Sheets available on site																		
	Emergency contact info posted																		
	Other																		
Environmental Control	Public-use road drainage / E & S																		
	Access road drainage / E & S conditions																		
	Well-pad conditions																		
	Water storage conditions tanks/ponds																		
	Pipeline ROW conditions																		
	Logging and/or skidding operations																		
	Water conditions (streams)																		
	Other E & S problems																		
	Noticeable wildlife habitat impacts																		
	Noticeable vegetative impacts																		
	Noticeable invasive plant infestation																		
	Indication of leak or spill (pad, road, etc.)																		
	Other environmental impacts																		
Property Protection	Damage to forest growth																		
	Damage to infrastructure																		
	Artifacts protected if discovered																		
	Fire protection																		
	Sanitation of site(s)																		
	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:
		1. Description of unsatisfactory conditions and corrective action taken
		2. Work completed and site restoration satisfactory
		3. Survey for non-native invasive plants conducted and actions needed
Other comments:		

9. Record-Keeping and Right-To-Know Issues

Introduction

Maintaining an accurate and up-to-date contact list for routine and emergency use is critical to communications. An initial contact list for all state and federal agencies with possible primacy on state forest lands during oil and gas operations is set forth in all lease agreements.

Bureau of Forestry staff should maintain accurate records of internal and external communications for all projects and investigations. A permanent file will be maintained and include legible copies of all documents and records.

The following principles should be considered regarding communication:

- A. Bureau of Forestry staff will communicate and provide support when requested in a timely manner, facilitating the oil and gas administration process, and minimizing adverse impacts and conflicts.
- B. The Bureau of Forestry will maintain its cooperative relationship with the DEP, Office of Oil and Gas Management. State forest district offices should coordinate field inspection activities with DEP-Regional Offices, if possible. The 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.
- C. District staff will become familiar with [DEP's Oil and Gas Operator's Manual](#), and the [National Pollutant Discharge Elimination System \(NPDES\): Regulation of Oil and Gas Construction Activities](#).
- D. Gas foresters will become familiar with the applicable Lease document and its exhibits, and contact the Minerals Division if any questions arise concerning the interpretation of the lease.

File maintenance protocols

Bureau of Forestry staff should maintain accurate records of internal and external communications for all projects and investigations. A permanent file will be maintained for every area of development (typically on a tract basis) to include:

1. Copies of all correspondence
2. A copy of the executed lease
3. Plans submitted by operators:
 - Seismic surveys
 - 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 (these may be obtained by contacting the operator)
4. Other maps or drawings
 5. Pennsylvania Natural Diversity Inventory (PNDI) report(s)
 6. Inspection reports that will indicate whether or not the operator has obtained or completed the following required DEP permits and plans. These items are also required to be posted or available on-site at all times.
 - DEP Bureau of Oil and Gas Management's Well Permit
 - ESCGP-1, ESCGP-2 permits
 - Preparedness, Prevention, and Contingency Plan
 7. Contact information for routine and emergency situations should be maintained by the district in an up-to-date status at all times.

File security & proprietary data handling

The Bureau of Forestry is committed to making public records easily available to persons requesting them. Sensitive information provided routinely by the operators facilitates the Bureau's administration of oil and gas development on state forest lands. Records pertaining to oil and gas development may be considered confidential and proprietary in the planning stages but are often considered part of the public record upon development and construction.

Information provided to the Bureau by a lessee or operator will be treated as confidential and proprietary when designated as such by the lessee or operator. Typically, this information may not be released to a third party without written authorization from the lessee or operator. One of the exceptions to this guidance includes emergency or pollution incidents, when time is critical for first responders.

When addressing the public, Bureau staff should be cognizant of confidential and proprietary information. The Bureau has a basic educational role regarding the Commonwealth's natural resources, including oil and gas activity. As such, the Bureau will continue to fulfil this educational role to the best of its abilities while ensuring that confidential and proprietary information is protected.

Right-to-Know Law in Pennsylvania

Third parties may request records regarding oil and gas activity on state forest lands using the following methods:

- Directly from the operator
- Informally by following the [DCNR Procedure for Informal Requests of Records](#)
- Formally pursuant to Pennsylvania's Right-To-Know Law by following the [DCNR Policy for Responding to Right-To-Know Law Requests](#)

Certain fees may apply to requests for records under either DCNR process.

10. Medical Emergencies and Pollution Events

Oil and gas operators should 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 events that may occur. Bureau staff will provide support for the operator or jurisdictional authorities.

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*.

Bureau staff should not attempt to access the well site in the event of a major fire or other hazardous situation. Assessments should be conducted far away 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.

Management of Pollution Events

Pollution events may vary in nature and severity, but are generally defined as the unintended release of hazardous, regulated, or other substances with the potential to cause negative environmental effects (e.g., diesel fuel, misc. petroleum products, frac fluid, chemical additives, flowback water, brine water). Failures of erosion and sedimentation control measures, which pollute or imminently threaten to pollute a water body, are considered pollution events. Inadvertent returns are also considered pollution events. 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 for pipeline crossings. Pollution events 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.

Operators and Bureau staff should be alert at all times for pollution events. The public has an expectation that these events be identified, documented, and managed to safeguard public health and the environment. If a

pollution event is discovered, the first concern should be public safety. DEP is the jurisdictional agency for response and remediation of pollution events. Management decisions will be coordinated by Bureau personnel, DEP, and the operator, and consider stakeholder values.

Applicable Regulations

DEP is the jurisdictional authority responsible for enforcing regulations regarding pollution events. Review [DEP Policy](#) for spills and releases at oil and gas well sites.

Act 2 prescribes uniform cleanup standards for spills and pollution events. It is the Bureau's expectation that the residential statewide health standard (assuming a used aquifer with total dissolved solids less than 2500) will be applied to state forest lands. State forest lands should be afforded the highest possible level of protection, which is consistent with the "non-residential" designation of Act 2. The Act 2 "background standard" should be used for any substance that does not have a current statewide health standard.

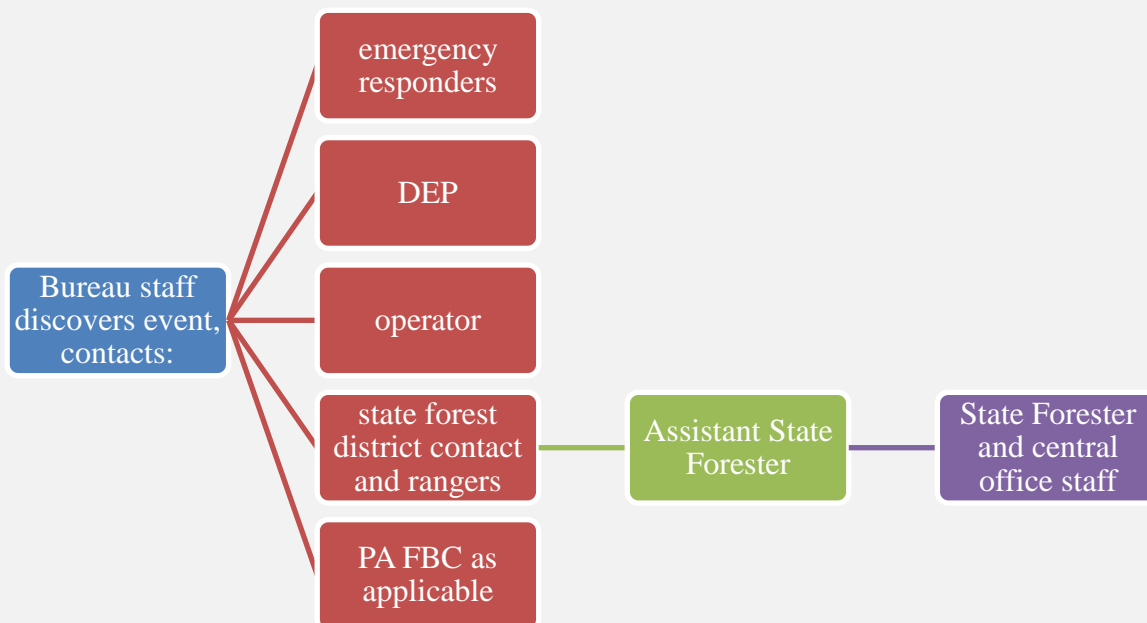
Operator Roles and Responsibilities

Operators must immediately notify DEP and appropriate emergency response personnel of pollution events, as prescribed in [DEP Policy](#). After that call, the operator should contact the Bureau via the Bureau's Notification Hotline (855-378-6629). Copies of all laboratory analyses, documentation and pollution reports should be provided to the Bureau coincidental to DEP submission. Site characterization or remediation activities planned by the operator (or its designated subcontractor) should be coordinated with the appropriate DEP office and State Forest District.

Bureau of Forestry Staff Roles and Responsibilities

Public safety is the primary concern during a pollution event. Bureau staff should not act as first responders and should maintain a safe distance from the site. Bureau staff should promptly notify emergency response officials, DEP, the operator, DCNR Rangers, and the appropriate state forest district contact. The PA Fish and Boat Commission should be notified if there is an imminent threat to waters of the Commonwealth. [Contact information](#) will be kept in all Bureau vehicles. The Bureau's primary role in a spill event is to function as support staff for jurisdictional authorities and other emergency response officials. Ancillary responsibilities include the facilitation of public communication as directed by the jurisdictional authorities in coordination with the Communications Section. Staff members should provide local knowledge of extant resources, uses, or values to jurisdictional authorities to aid in decision making. Established internal contact and communication protocols should be followed.

The following flow chart illustrates the Bureau's notification process



Initial Documentation

If a pollution event causes an imminent safety threat, Bureau staff should not engage in event documentation until given proper clearance by authorized personnel. If safety is not a concern, the pollution event and subsequent remedial measures should be confirmed and documented. If conditions are safe: obtain contact information, request copies of all documentation, and plan remedial measures or additional sampling.

Event 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*.

Pollution events are tracked by subsurface program staff and include the following information:

- Date and time of the event
- Tract, county, and forest district of the event
- Operator responsible for the event
- Event 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 tracked spatially in 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			
<input type="checkbox"/>	gas drilling or well pad site	<input type="checkbox"/>	other (please describe in box below)
<input type="checkbox"/>	gas pipeline / pipeline installation		
<input type="checkbox"/>	timbering (ex. fuel spill from truck)		
<input type="checkbox"/>	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
<input type="checkbox"/> 911 (only if an absolute emergency)			
<input type="checkbox"/> DCNR Ranger			
<input type="checkbox"/> District Point-of-Contact (see contact list)			
<input type="checkbox"/> DEP General Emergency Line: 800-541-2050			
<input type="checkbox"/> 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			
<input type="checkbox"/> Responsible Operator/Contractor (if known)			
<input type="checkbox"/> PA F&BC: 855-347-4545 (if threat to surface water)			
<input type="checkbox"/> Others (list names)			

Appendix

Appendix A: Bureau Approved Signage

Guidance to Operators Regarding State Forest Road Signs

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 vary from main travel to minimum standard low speed, low-volume routes. They 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."

With the passage of Act 9, many natural gas access roads have been or are in the process of being named in order to have the emergency signage as close to the well pad as possible. Traditional state forest road name signs now need to be installed for each of the new access roads. The Operator will be responsible for the manufacturing and installation of the road signs. These signs will aid county emergency responders in their ability to locate these new access roads and associated well pads.

Please provide to the District Forester for approval, a template or example of the road sign design and the proposed location of all new signs. In addition, please consult with the District Forester to determine if there may be any variations from the following specifications.

Specifications:

- Signs will be constructed of wooden stock, primarily **red or white oak** and pretreated with latex or acrylic stain. The signs will be **1 ½** inches thick by the proper length and width as according to the road name and proper lettering spacing.
- Wooden posts are to be 4 by 4 inches and pressure treated
- Road sign height should be approximately at eye level with the motorist. As a general rule, height should be **40"** from ground level to the middle of the sign.
- Wooden posts should be seated below the frost line with soil compacted in the hole and around the post
- Solid rectangular shape of routed wood (BOF utilizes a 7/8 inch "V"- router bit that is adjusted to follow the stenciled width of the letter. Routed depth may vary from 1/8 to ½ inch.)
- Signs may be variable dimensions, depending on the number of lines, wording, and size of letters.
- Signs will have a brown background, matching as nearly as possible to Sherwin Williams DeckScapes Acrylic-based Russett Brown.
- Signs will have reflective white letters (reflectivity created by adding glass beads to the white paint).
- Letter sizes are normally 2"
 - On higher speed roads (40 MPH and over), letter size may have to be increased to 3" or 4".
- Refer to Figure 1 for example of sign installation.

- Refer to Figure 2 for chart to determine sign length and letter size.
- Refer to Figure 3 for pictures showing hardware to use for sign mounting and an example of a sign.
- Where traffic control devices are placed, we will maintain standardization as closely as possible, although some deviation from placement or height guidelines may be needed to meet the constraints of our terrain and visibility.

Abbreviations

The following approved abbreviations may be used, but only if limited space will not permit the full names. The following are commonly used:

Boundary: Bdy	Lake: L	Number: No	Rock: Rk
Branch: Br	Lakes: Lks	Peak: Pk	South: S
Brook: Brk	Little: Lit	Point: Pt	Spring: Spr
Creek: Cr	Lookout: LO	Post Office: PO	Station: Sta
East: E	Meadow: Mdw	Railroad: RR	Stream: Str
Elevation: Elev	Middle: Mid	Ranger Station: RS	Trail: Tr
Fork: Fk	Mount: Mt	Reservoir: Resvr	West: W
Gulch: Gul	Mountain: Mtn	River: R	Yards: Yds
Highway: Hy	North: N	Road: Rd	

Letters and Spacing

In determining the required letter size for signs, horizontal space requirements are particularly important. Following is a list of average horizontal space requirements for various letter sizes.

<u>Letter height</u>	<u>Horizontal Space Required Size (for one letter and one space)</u>
6"	5"
5"	4"
4"	3"
3"	2-1/4"
2"	1-1/2"
1"	

Numbers require the same spacing as letters. Always allow one letter space between words and at each end of the sign for margin.

Finishes

The primary finish used on wooden signs an acrylic stain. Since Sherwin Williams products were placed on contract, all routed wooden signs are coated with their Sherwin Williams Sher-cryl acrylic latex finish coat. A-100

Primer is used in the routed sign groves in advance of the white or yellow colors used for the lettering. A-100 primer is not used on the wooden sign blank itself only the letter channels prior to the Sher-Cryl finish coat. Glass beads purchased from suppliers and used for the letter groves give the signs their reflectivity.

NOTE *Due to potential variations of mixing tints and colors by various paint and stain manufactures and dealers, a sample of the stain on signage material should be shown to the forest districts for approval prior to large scale installation of signage in the state forests!*

The Bureau requests that operators use an exterior acrylic latex primer followed by a stain color (or equivalent) achieved from the following mix ratios (per 1 gallon):

Color Mix Utilized for State Forest Signage				
Colorant	OZ	32	64	128
G2-New Green	4	3	1	
L1-Blue		28	1	
R2-Maroon	4	13		1
Y3-Deep Gold		18	1	

An example of this color swatch is from Sherwin Williams DeskScapes Acrylic-based Russett Brown.



Figure 1 – Example of Sign Installation

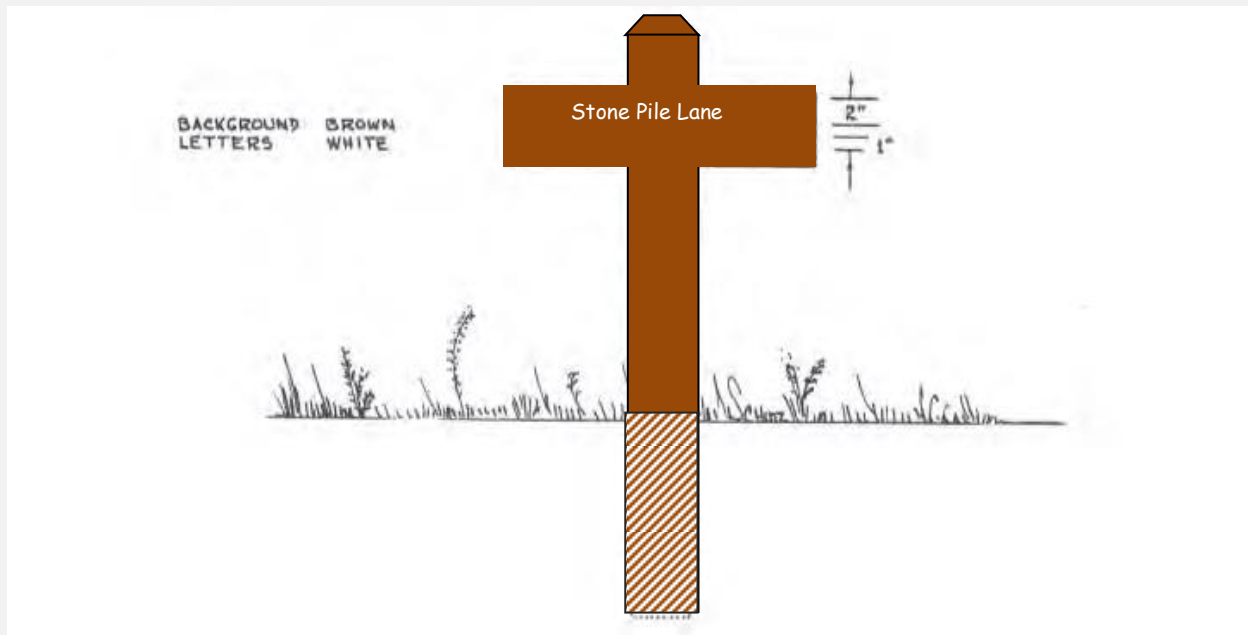


Figure 2 - Chart to determine sign length and letter size

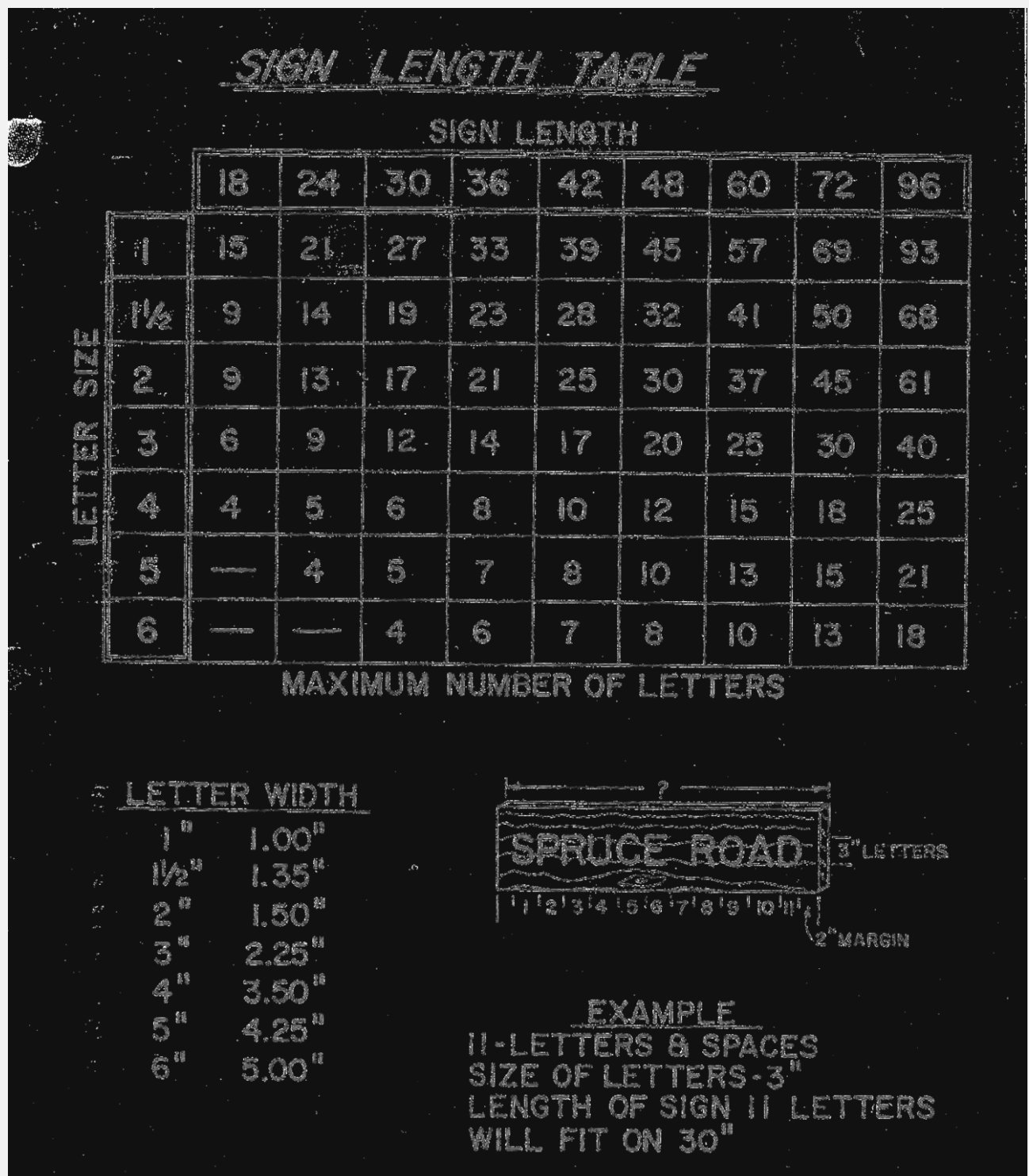


Figure 3 – Photos of hardware and sign mounting





Approved signage layout/design for well pad sites: (note sign size limited to 4 ft (H) x 8ft (L)

Operator Name Operator Info (E+P Company; LP) Operator Address Emergency Contact # 911 Address Township County COP Tract # Rig #	DEP Permit #	We ll Name	Authorized only	SRBC Consumptive Use
			Zoning	

Example of Acceptable Restricted Access Sign



Example of Acceptable Restricted Access Sign



Appendix B: Criteria for Wastewater Treatment Storage System Proposals

Introduction

The Department of Conservation and Natural Resources acknowledges the necessity and importance of reusing flowback and produced water for future completion operations and supports the recycling and reuse of water, which ultimately reduces the demand for freshwater. Treatment and reuse of flowback water also has the potential to decrease heavy trucking on both state forest roads and in adjacent communities.

Treatment and storage of oil and gas wastewater on state forest land will require permitting through the Department of Environmental Protection (DEP). A land owner consent form must be executed by the DCNR prior to a permit being issued by DEP. As part of this permitting process, DCNR will have the opportunity to append special conditions to the permit, which may result in more stringent provisions and operational constraints as permissible under the general permit issued by DEP. For example, traffic routes, timing of transportation of chemicals, wastes, water, etc. may be specified by DCNR in the permit as well as in a separate *Surface Use Agreement for Waste Water Operations*. DCNR will work with the operator and DEP to ensure best management practices are employed and will adapt to future industry BMPs as they are developed.

The Department does not support large-scale, for-profit wastewater projects on state forest Lands. Wastewater operations are to be temporary in nature. DCNR will consider all proposals. However, 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.

Project Proposal Criteria

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. Archeological resources
 - k. Invasive species

Appendix C: Planting and Seeding

Supplemental planting and seeding on state forest land is a common practice. The Bureau encourages the use of native species in supplemental plantings whenever possible. Native species are especially appropriate in areas that support populations of species of concern, contain wetlands, or have a pristine character. However, non-native species are sometimes preferred and justified. For example, many native grasses are slow to establish and may not satisfy erosion and sedimentation plan requirements. These guidelines were developed to provide strategies to land managers on supplemental planting and seeding.

Non-Native Invasive Plant Categories

Non-native plant species fit into three categories for use on state forest land:

- Deemed invasive. Do not plant.
- Potentially invasive (need more information). May plant with caution and monitoring.
- Not invasive. May plant with particular specifications noted.

Deemed Invasive: Do Not Plant

Any plant classified as a **noxious weed** by the Pennsylvania Department of Agriculture is barred for planting use on state forest land. It is illegal to cultivate, sell, transport, or plant any species classified as a noxious weed in PA. For a complete list of plants classified as noxious weeds in PA, visit [Natural Resource Conservation Service Invasive and Noxious Weeds List](#).

Planting of any species on the DCNR Invasive Plant list, including “watch” list species ([DCNR List of Non-native Invasive Plants of PA](#)), is not permitted on state forest land. Although some of these species may have been utilized on state forest land in the past, current standards forbid their use. Please consult the ([DCNR Invasive Plant Tutorial for Land Managers](#)) for comprehensive information regarding non-native invasive plants in Pennsylvania, including species lists, management and control options, measures for prevention, fact sheets, etc.

The following species are **now** considered invasive by DCNR and should be monitored closely, and planting should be **avoided**:

- European alder (*Alnus glutinosa*)
- Tall fescue (*Festuca elatior*)
- Rough bluegrass (*Poa trivialis*)
- Non-native lespedezas (*Lespedeza bicolor*, *L. cuneata*, *Kummerowia stipulacea*)

Potentially Invasive: Plant with caution and monitoring (Monitoring List)

Although the following species may be planted on state forest land, it is currently not clear if they exhibit certain characteristics that increase their potential to become invasive or intrusive on a site. In addition, many of these non-native species do not provide quality wildlife habitat/forage and may not be tree compatible for reforestation. These species may continue to be planted on state forest land, but should be avoided if possible.

This plant with caution list was created through researching Pennsylvania's neighboring states' invasive species lists, communications with specialists, and research on species behavior. The Bureau is monitoring these species to determine their impact on state forest lands.

The following is the plant with caution/avoid if possible list, and suggested alternatives for each.

Plant with Caution or Avoid if Possible	
Cool season grasses	
Kentucky 31 and other exotic bluegrasses	<i>Poa pratensis, P. spp.</i>
orchardgrass	<i>Dactylis glomerata</i>
creeping red fescue	<i>Festuca rubra</i>
perennial rye	<i>Lolium perenne spp. perenne</i>
redtop	<i>Agrostis gigantean</i>
Legumes	
bird's foot trefoil	<i>Lotus corniculatus</i>
Trees	
Norway spruce	<i>Picea abies</i>
sawtooth oak	<i>Quercus acutissima</i>
bristly locust	<i>Robinia hispida var. fertilis</i>
chufa sedge (aka yellow nutsedge)	<i>Cyperus esculentus</i>
Potential Alternatives	
Cool season grasses	
wild rye	<i>Elymus canadensis, E. virginicus, E. riparius, E. hystrix</i> * avoid <i>E. repens</i> (likely invasive)
autumn bentgrass	<i>Agrostis perennans</i>
poverty grass	<i>Danthonia compressa, D. spicata</i>
timothy	<i>Phleum pratense</i>
Legumes	
partridge pea	<i>Chamaechaerista fasciculata</i>
showy tick-trefoil	<i>Desmodium canadense</i>
senna	<i>Senna hebecarpa</i>
native Lespedezas	<i>Lespedeza capitata, L. hirta</i>
Trees	
Native evergreens (pines, spruces, hemlock)	<i>Pinus spp., Picea spp., Tsuga canadensis</i>
scrub oak	<i>Quercus ilicifolia</i>

Not Invasive: May plant on state forest land

The following species are suitable for planting on state forest land. It should be noted that not all species on the list are native to Pennsylvania. There currently is no evidence to suggest that these plants exhibit characteristics that increase their potential to become invasive or intrusive on sites. Additional species that are appropriate for planting on state forest land can be found later in this document, under seed mix suggestions, shrub and conifer plantings, and riparian area plantings.

May be Planted on State Forest Land	
Native Warm Season Grasses	
big blue stem	<i>Andropogon gerardii</i>
deertongue grass	<i>Dicanthelium clandestinum</i>
little bluestem	<i>Schizachyrium scoparium</i>
indiangrass	<i>Sorgastrum nutans</i>
switchgrass	<i>Panicum virgatum</i>
purple top	<i>Tridens flavus</i>
Native Cool Season Grasses	
wildrye	<i>Elymus canadensis</i> , <i>E. virginicus</i> , <i>E. riparius</i> , <i>E. hystrix</i>
autumn bentgrass	<i>Agrostis perennans</i>
poverty grass	<i>Danthonia compressa</i> , <i>D. spicata</i>
Native Legumes	
partridge pea	<i>Chamaecrista fasciculata</i>
showy tick-trefoil	<i>Desmodium canadense</i>
senna	<i>Senna hebecarpa</i>
native Lespedezas	<i>Lespedeza capitata</i> , <i>L. hirta</i>
Native Wildflowers	
black-eyed Susan	<i>Rudbeckia hirta</i>
Pennsylvania smartweed	<i>Polygonum pensylvanicum</i>
ox-eye sunflower	<i>Heliopsis helianthoides</i>
common milkweed	<i>Asclepias syriaca</i>
evening primrose	<i>Oenothera biennis</i>
tall white beardtongue	<i>Penstemon digitalis</i>
purple bergamot	<i>Monarda fistulosa</i>
goldenrod	<i>Solidago spp.</i>
asters	<i>many genera</i>
Misc. species (wetlands)	
fox sedge	<i>Carex vulpinoidea</i>
woolgrass	<i>Scirpus cyperinus</i>
soft rush	<i>Juncus effusus</i>
Pennsylvania sedge	<i>Carex pensylvanica</i>

May be Planted on State Forest Land	
Acceptable Non-native species	
alfalfa	<i>Medicago sativa</i>
alsike white clover	<i>Trifolium hybridum</i>
annual rye	<i>Lolium perenne ssp. multiflorum</i>
Austrian winter pea	<i>Pisum sativum</i>
barley	<i>Hordeum vulgare</i>
buckwheat	<i>Fagopyrum esculentum</i>
Chinese chestnut	<i>Castanea mollissima</i>
crabapples	<i>Malus spp.</i>
crimson clover	<i>Trifolium incarnatum</i>
flat pea	<i>Lathyrus sylvestris</i>
Japanese larch	<i>Larix kaempferi</i>
kale	<i>Brassica oleracea</i>
Ladino white clover	<i>Trifolium repens</i>
medium red clover	<i>Trifolium pratense</i>
millet	<i>Millium</i> or <i>Panicum</i> , some native species
oats	<i>Avena fatua</i>
rape, turnip, swfeed, dwarf essex rape	<i>Brassica napus</i>
rye seed	<i>Secale cereale</i>
timothy	<i>Phleum pratense</i>
white spruce	<i>Picea glauca</i>
winter wheat	<i>Triticum aestivum</i>

Planting Suggestions

Summary:

- Use species representative of the area.
- Native species may not require lime and fertilizer inputs
- Cool season grasses should be used with warm season grasses for quick perennial cover.
- Best time to seed natives is April, but mid-November – April may also be successful.
- Don't expect immediate cover of warm season grasses – these take time to mature.
- Fall may be best time to purchase seed for use in spring.
- Native legumes may provide good cover and nitrogen fixation on poorer sites.

Revegetation and restoration of disturbed areas should be blended into the surrounding forest to the natural contour. In most cases, the restoration objective will be to restore sites to their original composition before disturbance. In others, disturbed areas may be converted to herbaceous openings, successional openings, or a combination depending on landscape characteristics and management objectives.

Tips for using native species in seed mixes

- Native species are typically seeded at **lower rates**. Don't be afraid to cut the rates you're typically used to for non-native species.
- **Soil tests** prior to planting will help in determining the site's capabilities for various revegetation options and indicate if soil integrity was maintained after disturbance.
- In activities that cause a lot of 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 little compaction as possible before seeding (soil ripping may lessen highly compacted soils).
- Lime and fertilizer rates may be determined by site requirements. Native species may not require the lime and fertilizer inputs that are used on non-native 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 and perhaps invasive species.
- Seed may be lightly worked into the soil using a rake or similar tool, but disking will likely bury the seeds too deep and may not be successful.
- Observations of warm season grass plantings suggest **April is the optimum time for planting and establishing native species** in the first growing season. If April is not an option, winter seeding may be successful (November through April), but make sure the seed will not lie wet in winter. If seeds are spread late in the growing season, they may not become established enough to tolerate winter temperatures.
- The best time to purchase native seed is in fall to be sure the supplier has enough in stock. Anticipate ordering seed 6 months in advance to ensure availability.

Mix suggestions

Rates below may be changed when a higher density is desired. However, many of the warm season grasses are much larger in stature at maturity and for wildlife habitat, space between individuals should be allowed where slope is not an issue. For erosion control and on poorer sites, higher rates may be necessary to achieve desired conditions. In addition, rates may need to be higher when broadcast seeding as opposed to using plugs. **Be sure to specify PLS (pound live seed) when ordering seed.**

Temporary Cover Crop Mix

*These should be added to all mixes to establish a quick cover for stabilization and reduce the chance for invasive species to establish. Cover crops can be applied before the desired mix if waiting for the optimum time to plant native seed.

1-2 bushel/acre: Spring oats (*Avena fatua*) if the seeding in spring (prior to June 15th)
 Winter rye (*Secale cereale*) if the seeding in fall (after June 15th)
 Annual rye (*Lolium perenne*) may be used instead of oats or rye

General Native Seed Mix

General Native Seed Mix	
3lb	big bluestem (<i>Andropogon gerardii</i>)
3lb	little bluestem (<i>Schizachyrium scoparium</i>)
3lb	indiangrass (<i>Sorghastrum nutans</i>)
1lb	switchgrass (<i>Panicum virgatum</i>)
5lb	Virginia wildrye (<i>Elymus virginicus</i>) or other wildryes (<i>Elymus spp.</i>)
TOTAL: 16lb/acre	
For denser cover	
3lb	indiangrass (<i>Sorghastrum nutans</i>)
3lb	big bluestem (<i>Andropogon gerardii</i>)
3lb	little bluestem (<i>Schizachyrium scoparium</i>)
2lb	switchgrass (<i>Panicum virgatum</i>)
3lb	deertongue (<i>Dicanthelium clandestinum</i>)
5lb	Virginia wildrye (<i>Elymus virginicus</i>) or other wild ryes (<i>Elymus spp.</i>)
TOTAL: 19lb/acre	
Potential additions to general grass mixes	
1lb	partridge Pea (<i>Chamaecrista fasciculata</i>)
1lb	senna (<i>Senna hebecarpa</i>)
0.5 lb	showy tick trefoil (<i>Desmodium canadense</i>)
1lb	black-eyed susan (<i>Rudbeckia hirta</i>)
0.5lb	ox-eye sunflower (<i>Heliopsis helianthoides</i>)
8lb	white clover (<i>Trifolium repens</i>) non-native
4lb	timothy (<i>Phleum pratense</i>) non-native , non-persistent cool season

General Native Erosion and Sedimentation Seed Mix

General Native Erosion and Sedimentation Seed Mix	
10lb	deertongue ((<i>Dicanthelium clandestinum</i>) or switchgrass (<i>Panicum virgatum</i>)
5lb	Virginia wild rye (<i>Elymus virginicus</i>) or other wild ryes (<i>Elymus spp.</i>)
5lb	autumn bentgrass (<i>Agrostis perennans</i>) – will tolerate higher shade levels
2lb	partridge pea (<i>Chamaecrista fasciculata</i>)
TOTAL: 22lb/acre	

Wetland areas, waters edges and areas with normal high water flow: This seed mix is appropriate when there is a need to stabilize soil, revegetate quickly, or deter invasive species establishment.

Wetlands and Other Areas with Normal High Water Flow Mix	
5lb	Virginia wild rye (<i>Elymus virginicus</i>) or riverbank rye (<i>Elymus riparius</i>)
1lb	deertongue (<i>Dicanthelium clandestinum</i>) or switchgrass (<i>Panicum virgatum</i>)
0.5lb	shallow sedge (<i>Carex lurida</i>)
0.25lb	fox sedge (<i>Carex vulpinoides</i>)
0.25lb	soft rush (<i>Juncus effusus</i>)
TOTAL: 7lb/acre	

Non-Native Mixes for Game Species

Non-Native Mixes for Game Species	
Ruffed Grouse Society Trail Mix	
50lb	wheat
4lb	Ladino white clover
2lb	white-dutch clover
2lb	bird's-foot trefoil
TOTAL: 8lb legumes/acre, 50lb cover crop/acre	
National Wild Turkey Federation Strut and Rut Triple Threat Clover Mix	
40%	crimson clover
30%	patriot clover
30%	durana clover
TOTAL: 12lb/acre	
National Wild Turkey Federation Annual Summer Mix	
buckwheat	
cowpea	
dove proso millet	
browntop millet	
pearl millet	
black oil sunflower	
TOTAL: One order/acre, ~ equal amounts of each species	

Species Suggestions for Conifer and Shrub Plantings: Conifers and shrubs can provide cover, food, or structure for various wildlife species in herbaceous openings or early successional habitats. The following species may be used in wildlife openings, right of ways, or other suitable places on state forest land.

Species Suggestions for Conifer and Shrub Plantings	
Conifers	
white pine	<i>Pinus strobus</i>
pitch pine	<i>Pinus rigida</i>
Virginia pine	<i>Pinus virginiana</i> – south of route I-80
red pine	<i>Pinus resinosa</i> – north of route I-80
Small fruit-producing trees	
Washington hawthorn	<i>Crataegus phaenopyrum</i>
cockspur hawthorn	<i>Crataegus crus-galli</i>
large-seed hawthorn	<i>Crataegus macrosperma</i>
frosted hawthorn	<i>Crataegus pruinosa</i>
dotted or white hawthorn	<i>Crataegus punctata</i>
American sweet crabapple	<i>Malus coronaria</i>
shadbush	<i>Amelanchier arborea</i>
smooth/allegheeny shadbush	<i>Amelanchier laevis</i>
low shadbush	<i>Amelanchier stolonifera</i>
Mast-producing species	
black locust	<i>Robinia psuedoacacia</i>
American mountain ash	<i>Sorbus americana</i>
blackhaw viburnum	<i>Viburnum prunifolium</i>
American hazelnut	<i>Corylus americana</i>
dwarf chinquapin oak	<i>Quercus prinoides</i>
scrub oak	<i>Quercus ilicifolia</i>
Blackberry/raspberry species	
common blackberry	<i>Rubus allegheniensis</i>
smooth blackberry	<i>Rubus canadensis</i>
black raspberry	<i>Rubus occidentalis</i>
red raspberry	<i>Rubus idaeus</i>
Host species for invertebrates	
blackhaw viburnum	<i>Viburnum prunifolium</i>
nannyberry	<i>Viburnum lentago</i>
highbush blueberry	<i>Vaccinium corymbosum</i>
New Jersey tea	<i>Ceanothus americanus</i>
black chokeberry	<i>Photinia melanocarpa</i>
bush honeysuckle	<i>Diervilla lonicera</i>
pinxter-flower	<i>Rhodendron periclymenoides</i>
staghorn sumac	<i>Rhus typhina</i>
scrub oak	<i>Quercus ilicifolia</i>

Species Suggestions for Riparian Area Plantings: Streams impacted by management activities and the riparian areas may be planted for canopy coverage or habitat enhancement.

- The first two rows adjacent to a stream or body of water should be deciduous broad-leaved trees
- Trees and shrubs may be planted in the second two rows
- Coniferous trees should not total more than 20% of the trees planted and should be avoided in the first two rows
- The use of tree shelters is discouraged, but when used, netting should be placed over the opening to avoid mortality of cavity nesting birds

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

Species Suggestions for Riparian Area Plantings	
Trees	
quaking aspen	<i>Populus tremuloides</i>
American beech	<i>Fagus grandifolia</i>
black willow	<i>Salix nigra</i>
black cherry	<i>Prunus serotina</i>
blackgum	<i>Nyssa sylvatica</i>
eastern hemlock	<i>Tsuga canadensis</i>
shagbark hickory	<i>Carya ovata</i>
red maple	<i>Acer rubrum</i>
sugar maple	<i>Acer saccharum</i>
yellow birch	<i>Betula alleghaniensis</i>
white oak	<i>Quercus alba</i>
tulip poplar	<i>Liriodendron tulipifera</i>
eastern white pine	<i>Pinus strobus</i>
American sycamore	<i>Platanus occidentalis</i>
black spruce	<i>Picea mariana</i>
Small Trees	
serviceberry	<i>Amelanchier</i> spp.
sumac	<i>Rhus aromatica</i> , <i>R. glabra</i> , <i>R. typhina</i>
flowering dogwood	<i>Cornus florida</i>
redbud	<i>Cercis canadensis</i>
Shrubs	
chokeberry	<i>Aronia melanocarpa</i> , <i>A. arbutifolia</i>
buttonbush	<i>Cephalanthus occidentalis</i>
winterberry	<i>Ilex verticillata</i>
silky dogwood	<i>Cornus amomum</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	<i>Viburnum dentatum</i>
blackhaw	<i>Viburnum prunifolium</i>
inkberry	<i>Ilex glabra</i>
Herbaceous Species	
Virginia wild rye	<i>Elymus virginicus</i>
riverbank wild rye	<i>Elymus riparius</i>
deertongue	<i>Dicranthelium clandestinum</i>
switchgrass	<i>Panicum virgatum</i>
ironweed	<i>Vernonia altissima</i>
joe-pye weed	<i>Eupatorium purpureum</i>
Virginia bluebells	<i>Martensia virginica</i>
cardinal flower	<i>Lobelia cardinalis</i>
blue lobelia	<i>Lobelia siphilitica</i>

Appendix D: Invasive Plant Management

Invasive Plant Guidelines:

1. *Pre-construction Inventory and Mapping*

- A. The operator should elect to perform a pre-construction inventory of invasive plants present on the portion of the right-of-way premises where construction is planned to determine appropriate prevention methods, predict control needs, and assess its level of responsibility for management of invasive species and populations. The inventory objective is to locate established invasive plant species populations.
- B. If the operator elects to undertake an inventory as described in above, all areas which may be disturbed by the planned construction and related activities should be inventoried for invasive plant species during the growing season from May through September by a qualified botanist. Plants classified as invasive include those on DCNR's Invasive Plant Tutorial 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.
- C. Inventory data should be collected from the entire area of the planned construction on state forest land and any buffer areas that may be appropriate, in grid cells no greater than 150' x 150' in size. The established grid should be digitized into a GIS layer and printed on maps that will be used for field data accumulation. 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 species within the specified grid cell and a note of the dominant species per plant type (e.g., herbaceous, shrub, tree) should be recorded. For each invasive 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
- D. 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.
- E. For each grid cell, the average height of each invasive species in each grid cell should be recorded.

- F. In addition, the average growth stage should be recorded as the following for each invasive species in each grid cell:
- Seedling
 - Bolt
 - Bud
 - Flower
 - Seed set
 - Mature
- G. An estimate of the percent cover of the five most prevalent species on site (native or invasive) should be completed for each plot. A reasonably complete species list of all species present within measured plots should also be included.
- H. If the operator elects to forego the above described pre-construction survey for invasive species, the operator will be presumed to be the cause of all occurrences of post-construction infestations of invasive species that may be found in the construction area regardless of origin or amount and will be expected to perform management and control activity as described in Section 3 below.

2. Prevention

- A. Where no invasive plants are detected, the operator should use only PA Department of Agriculture certified seed and weed-free soil, dirt, and mulch whenever feasible. Certified seed and weed-free soil, dirt, and mulch may be determined as such by the Forest District Manager/Park Manager and Ecological Services. If materials certified as weed-free cannot readily be obtained, the source of materials being used should be inspected for invasive plants during the growing season by a qualified botanist and used only if deemed weed-free. Please note that weed 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.
- B. Mulching with straw rather than hay is recommended to reduce the possibility of introducing invasive species propagules.
- C. Where heavy infestations of Japanese stiltgrass (*Microstegium vimineum*) are detected during pre-construction surveys, a seed mix of native rye grass (*Elymus* spp.), Autumn bentgrass (*Agrostis perrenans*) and deer tongue (*Dichanthelium clandestinum*) should be planted as aggressive competition against the seed-banked invasive Japanese stiltgrass. Seeding specifications will be provided by the Forest District Manager/Park Manager. Herbicide, such as glyphosate, may be used in combination with seeding to increase the success of Japanese stiltgrass control at the direction of the District Forest/Park Manager.

- D. Prior to bringing equipment into un-invaded areas or onto state forest land, the operator is encouraged to clean its equipment in an appropriate manner to remove plant parts such as rhizomes and seeds that might be carried on tires and the equipment undercarriage, which will help prevent the spread of invasive species 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](#)).
- E. The operator is highly encouraged to plan work according to invasive species 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 species when they are aware of their presence in particular areas.
- F. Pre-treatment of identified invasive species infestations of herbaceous species or species that reproduce prolifically from rhizome/root segments with herbicides prior to construction is encouraged and may be performed at the direction of the Forest District Manager/Park Manager.

3. Management

- A. Management and control of established invasive plant populations should be planned on a species-by-species basis to determine the best method of control. The operator and its consultant should submit a “Management and Control Plan” to Forest District Manager/Park Manager no fewer than three (3) months after the conclusion of all construction activities.
- B. The operator should include a post-construction invasive survey report with the same survey parameters as described in Section 1 above, in the Management and Control Plan. The Forest District Manager/Park Manager and Ecological Services Section will assist the operator in the development of appropriate management methods by species and/or invasive occurrence.
- C. Post-construction invasive species surveys along access roads should be limited to areas where gravel was placed or the existing road was widened for the operator use.
- D. Any new invasive populations will be assumed to be the result of sources other than the operator’s construction activities for a period of five (5) years or until invasive species are not observed on-site for two consecutive years once seed and other re-vegetation activities have become established, whichever is longer. Control of species found will continue until the species are eradicated.

- E. The operator and the Bureau of Forestry will coordinate with the other jurisdictional agencies about species of special concern and the potential impacts invasive species management activity may produce.

4. Monitoring

- A. The operator should make provisions to monitor for invasive species within the area(s) disturbed by the construction activity for a period of five (5) years following construction or until invasive species are not observed on-site for two consecutive years once seed and other re-vegetation activities have become established, whichever is longer.
- B. The operator should perform an annual survey for the presence of invasive species within the construction area, as described in 4.1 above, following major construction. The annual survey should follow the same methods as the pre-construction survey method described in Section 1. The only exception to the method described in Section 1 is the grid cell boundaries only need to be checked occasionally with the GPS to ensure that monitoring alignment is consistent with the original inventory alignment.
- C. If the operator is not able to perform the aforementioned invasive species monitoring, a representative from the state forest district will conduct a broad survey for invasive species during routine site inspections. If invasive species are detected within the time frames described above, the introductions will be assumed as a result of the gas development activities and the operator will be expected to eradicate and control the invasive species.

5. Reporting

- A. The results of all operator annual invasive surveys should be summarized into a report, which should include the following elements:
- methods
 - summary of invasive species detected
 - abundance of each species
 - number of new populations per species
 - number of eradicated populations by species
 - management recommendations for management and control
 - relative success of control efforts
- B. Report and raw electronic observation data should be submitted to Forest District Manager/Park Manager and Ecological Services within 60 days following completion of the report. Submission

of any electronic data should occur simultaneously with the written report submission. Data recording and management should be consistent year-to-year so data can easily be compared by grid cell number. The Department reserves the right to audit the findings of the operator's reports and as a result of any audit, Department may require alternate methods of management and control.

- C. Department may publish reports, raw data, or articles summarizing invasive species management and monitoring efforts from time to time. The operator will be consulted prior to publication of any reports or raw data for comment.

Appendix E: Roads

The following appendix provides more technical guidance regarding the construction and/or modification of State Forest Roads.

I. New Road Construction

A. Materials

The materials used to construct new roads will vary depending on local availability, geology and topography, commercially available sources of aggregate and other factors. 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. If the original road is lacking a standard adequate base, the Forest District Manager may also permit the use of suitable shale or other sedimentary rock “borrow pits” near the drilling operation.

There are two major differences between surface aggregate (top coat) and road base material. Good base material generally consists of larger stone, which provides optimal strength and permeability, and minimal amounts of clay or fine material. Surface aggregate includes a well graded mixture of stone sizes with a significant percentage of fines that bind the material.

Driving Surface Aggregate (DSA) 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 often provide satisfactory performance if processed and placed correctly. 2RC aggregate often includes significantly higher percentages of clay and silt, which may not be the most suitable material available. Product consistency varies from region to region and even within the same production facility. 2RC should be used selectively and consistency should be frequently inspected.

B. Geotextile

Geotextile refers to a general class of industrial fabrics used in construction projects to provide greater soil stability, erosion control, or increased drainage. Permeable by nature, they are typically made of synthetic polymers and are available in woven or non-woven form. Careful road planning and proper use of geotextiles decreases road failure and equipment damage, eliminates problems with mud on public roads and increases commercial production and profitability. Several types and quantities (i.e., rolls) of geotextiles are available depending intended use, material composition and thickness.

Geotextiles are inserted between the native road sub-base and the introduced road materials. This permits the flow of surface water through the aggregate layers and into the ground while preventing the sub-base material from contaminating the road surface. For maximum

effectiveness, a geotextile should be installed on critical/targeted forest road sections before trafficking begins or rutting occurs. Geotextiles also distribute vehicle weight more evenly across the base material, significantly reducing the potential for rutting and mud transfer. The use of geotextiles significantly decreases the amount of crushed rock necessary to stabilize a road and keeps it serviceable. The width of the restored road once heavy hauling is completed should also be taken into consideration when installing geotextile (see [maximum width](#)). Most newly constructed state forest roads incorporate the use of geotextiles.

For general installation of geotextile:

1. Establish crown or cross-slope in the road subgrade and clear it of any large stones or other sharp objects that could puncture the geotextile.
2. Roll out the fabric, keeping the fabric in approximately 2 feet from the edge of the cartway.
3. Anchor the fabric along the edges with rocks or soil, then dump base aggregate along the leading edge and carefully spread it over the fabric with careful blading.
4. Repeat this process until the geotextile is covered with the desired depth of base aggregate.
5. Geotextile fabric should be buried beneath a minimum of one foot of compacted cover (the depth of compacted surface material can be included in this calculation).

C. Geogrids

The use of geogrids in new road construction or in the reinforcement of existing roads offers the following advantages over traditional road construction methods where the cost or availability of quality road materials is a factor or when considering permit and road width requirements:

- Reduced depth of fill required.
- Reduced overall changes in road surface elevation needed to meet heavy hauling requirements.
- Minimized excess roadway widths associated with greater road fill depths.
- Provides additional structural reinforcement in road sections prone to accelerated degradation such as bridge approaches, rail crossings, intersections with paved roads, and areas with poor subgrade.
- Provides additional traffic support over, and protection of, proposed or existing drainage features (crosspipes, cross-drains, culverts).

D. Geocells

Geocells or geowebbs are innovative geosynthetic products used in ground stabilization, road subgrade stabilization, slope erosion control, embankment reinforcement, retaining walls, stream crossings, and erosion control in channels. Geocell looks like a honeycomb but is a lightweight, flexible mat. Installation is simple. Spread the honeycombs and pin them in place. Pack the honeycombs with appropriate fill, such as soil, sand, aggregate, or concrete. The geocell adds structural strength by confining the fill. The use of geocell provides an economical solution for the applications listed above.

E. Maximum Depth

A stable road base is one of the most important fundamentals of road design. Placement of a road surface aggregate over any material that cannot adequately support the weight of traffic will significantly hamper vehicular mobility and control. Moreover, lack of a sufficiently rigid bearing material beneath the road surface will tend to produce excessive rutting, sinking, and overall deterioration of the state forest road, requiring extensive maintenance and cost to keep the road passable. Roads must be built to allow for the passage of the desired weight vehicles and to assure the risk of sediment entering the waterways is minimized. Also, soft or rutted conditions pose a serious threat for vehicular control and create unsafe road segments. Therefore, it is important that stability of the haulage way be guaranteed throughout its length. On some state forest roads, the road surface is underlain by natural strata such as bedded stone formations capable of supporting the weight of any haulage vehicle. In these less common situations, a minimum lift of surface aggregate may be sufficient. Unfortunately, most state forest roads do not have a bedrock base, and adequate base layers of quality fill will be needed. The Forest District Manager will determine the finished depth of road materials given specifics such as the location of the road, the anticipated traffic and the inclusion of geotextiles in the design. The following table offers some very general information for aggregate depth in Pennsylvania (climatic region VI):

Suggested Wearing Course (Driving Surface) Thickness for New or Reconstructed Gravel Roads

Estimated Daily Number of Heavy Trucks	Subgrade Support Condition	Suggested Minimum Gravel Layer Thickness (inches)
0 to 5	Low	7
	Medium	6
	High	5
5 to 10	Low	9
	Medium	7
	High	6
10 to 25	Low	12
	Medium	9
	High	7
25 to 50	Low	15
	Medium	12
	High	9

This designates suggestions for wearing surface course only and does not account for material quality.

F. Maximum Width

In all cases, newly constructed roads must be kept to the minimum width that allows operators to safely gain access to the work site. The maximum width is set at a 16 foot wide running surface. However, if conditions warrant, and with the permission of the Forest District Manager, roads may be widened up to a maximum 26 foot running surface. Ditching as needed on either side of the road will be flat or parabolic in shape to minimize erosion. Sheet flow from the running surface to adjacent grade is preferred. It should be noted that all road widening must

be done in accordance with the appropriate approved DEP permit. *In all cases, roads must be returned to the 16 foot width when the need for the expansion ceases at the discretion of the Forest District Manager.* This reduction will allow the Bureau of Forestry to properly maintain the roadway in the future without the need for excessive materials, grading times, etc.

G. Crown and Cross-Slope

Proper road shape is necessary in order to drain water from the road surface. Determination of proper crown and cross-slope on a gravel surface probably generates more controversy than any other aspect of good maintenance.

Problems develop quickly when gravel roads lack sufficient crown. Water will quickly collect on the road surface during a rain and soften the crust, leading to rutting (which can become severe if the subgrade also softens). Even if the subgrade remains firm, traffic will quickly pound out smaller depressions in the road where water collects creating potholes. A properly built road must have sufficient crown to drain the road surface, yet not so much side slope as to create an unsafe condition in which the driving public does not feel comfortable staying on the right side of the road. Drivers may begin to feel a slight loss of control if their vehicle wants to slide towards the shoulder. Additional risks occur in regions that experience snow and ice cover, as drivers tend to use the middle of the road regardless of the overall road surface width.

Recommendations from supervisors and skilled operators across the country indicate that at least ½ inch of fall per foot of road width (approximately 4%) is the optimal crown. Although it is exceptionally difficult for any operator to maintain an absolutely uniform crown, the operator should strive for as little deviation as possible.

It may be desirable to establish an in-sloped road surface shape where steep side slopes exist. If this is the case, the entire road surface should be sloped to the interior, or up-slope, to a road ditch using the same 4% side-slope. Keep in mind that additional crosspipes will be required when an in-slope design is used. (Refer to the [Informational Bulletin: Crown and Cross-Slope](#))

H. Ditches

When possible, sheet flow is the preferred drainage method when establishing new roads or managing surface drainage on existing roads. This is accomplished by not establishing, or by eliminating, drainage ditches that are parallel to the road surface. On 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. Ditches should be installed or reshaped only during the period of year when there will be sufficient time and moisture for vegetative growth to take hold, unless other specific measures are taken to prevent soil loss. Such measures might include lining ditch bottoms with rip rap, utilizing a design that specifies ditch size, adjusting shape and materials to account for anticipated flows, or by incorporating other similar strategies. Ditch erosion can lead to major road damage and deposit sediments in fragile downslope streams. Road ditches should be designed to handle total volume and velocity of water for the particular road location.

To reduce flow volumes in parallel road ditches, multiple ditch outlets (crosspipes and turn-outs) should be installed where suitable and stable outlet locations exist. Sheet flow is the desired

drainage method, and multiple ditch outlets are the next best option. Too few ditch outlets creates an undesirable situation that can lead to water volumes and velocities that overwhelm and destabilize ditches.

Ditch Size and Location

The width and depth of a ditch should be based on anticipated runoff volume and on the drainage needed for the road base. Water flowing in ditches should never come in contact with, or be permitted to enter the base layers of aggregate supporting the road. Therefore, a rule of thumb is to always allow at least one foot of distance between the edge of the deepest aggregate layer and the constructed ditch.

Ditch Shape

Parabolic or flat bottom ditches spread runoff water over a larger area than V-shaped ditches, helping to reduce erosion by reducing water velocity. In addition, the faster water runs, the better it is at keeping solid particles suspended. A flat bottomed ditch is somewhat self-explanatory in its design. However, keep in mind that the sides of the ditch must be tapered sufficiently to create a stable ditch structure. A parabolic ditch shape can often be obtained by mimicking the shape of an excavator trenching bucket as viewed from the side. In this example, the back of the bucket represents the ditch back-slope, the curl represents the ditch bottom and the floor of the bucket represents the ditch fore-slope, or shoulder.



Parabolic ditch



Flat bottomed ditch

Ditch Stabilization

Vegetated ditches should be utilized to anchor the soil and minimize erosion. Narrow, incorrectly shaped, or unvegetated ditches will continue to erode and compromise the integrity of the road surface. This erosion can be reduced in several ways:

1. Facilitating ditch drainage through the use of culverts, turn-outs and other constructed devices.
2. Widening the ditch channel. The wider and flatter the channel is, the more volume it can handle at a slower velocity. The faster water moves, the greater its ability to pick up and suspend solid particles.
3. Re-vegetating ditches as soon as possible after ditch establishment or ditch cleaning.
4. Where space constraints or excessive grades prevent wide/shallow ditches or effective re-vegetation, providing for a stable ditch bottom by armoring it with rocks or other material. Installing rock lining (rip rap) comparable in size to that left by the storm water is a good design rule of thumb.
5. Geotextiles or geogrids are not recommended for ditch stabilization purposes.

I. Shoulders

The shoulder provides support for the edge of the roadway, and also serves as a safety buffer for motorists, allowing them to maintain control of vehicles that veer off of the road. As a drainage feature, the shoulder also conveys water away from the road surface to the ditch or into the surrounding terrain, in the case of sheet flow drainage. The shape of the shoulder is critical. The shoulder should meet the edge of the roadway at the same elevation, and should taper gradually into the ditches. By maintaining this shape, hazards associated with low shoulders or drop-offs are eliminated. Elevated shoulders that prohibit road surface drainage from moving off of the roadway and into the ditches or surrounding terrain lead to problems. These berms or curbs are very common along gravel roads, and are most often the result of the natural migration of surface material to the road edge (moved by tires), or in some cases are even created by poor grading techniques. This condition concentrates water on the road surface, often causing a secondary ditch to form, and resulting in the deformation of the road and an accelerated loss of surface aggregate. If left unaddressed, severe erosion/loss of materials and subgrade will occur.

J. Surface Aggregate Placement Methods

Proper placement of gravel is essential to creating a road surface that is both functional and durable. Depending on the type of materials available, several methods of placement are typically used. DSA should always be placed with a track mounted motorized paver in one uniform lift to the specified depth. This is essential to achieve maximum compaction. Other types of coarser graded aggregates are typically tailgated along the length of a project and are evenly distributed by a bladed machine. Decisions regarding the placement method on an individual project will vary and are dependent on site considerations and logistics. Each project will differ depending on factors such as the proximity of the road to surface waters and other critical areas, the level of recreational use of the road, the availability of gravel trucks, timing, etc. Therefore much thought must be given to the best possible method of placement at each site.

While spreading gravel on a road surface, caution should be made to avoid casting material off of the road edges where it cannot be recovered. Also, the use of vibratory or static rollers for compaction creates a higher quality gravel road, and is essential for the successful placement of DSA. Regardless of the aggregate used, the material must be compacted at optimum moisture to achieve the maximum benefit. The Forest District Manager will expect the use of a roller on any given project, and will dictate the final thickness of the compacted material.

K. Aesthetics

When planning for construction, the final appearance of the roadway is of the utmost concern to the Forest District Manager. Long after resource recovery and/or other temporary operations are complete, the road may be used primarily for recreational access to State Forest lands. Snowmobile enthusiasts, hikers, hunters, naturalists, and other outdoor recreationists all

will appreciate an aesthetically pleasing roadway that appears as a natural part of the landscape. Care should be taken to avoid excessive dozing and the creation of debris piles, etc., and all root balls and other excessive woody vegetation should be removed. Stone/soil piles created when building drainage devices should either be removed or spread evenly and seeded as determined by the Forest District Manager.

II. Modifications of Existing State Forest Roads

A. Raising the Road Profile

Due to the long term effects of erosion, routine grading, heavy vehicular use, snowplowing, etc.; road elevations often drop below the level of the surrounding forestlands resulting in a condition known as entrenchment. Water falling on or draining to an entrenched road is trapped and concentrated in the road cross-section. Parallel ditches, or tire tracks on the road surface begin to function much like a stream channel for downslope water flow. Entrenched road profiles make installation of crosspipes, turnouts and other drainage features very challenging. Raising the road profile can eliminate the persistent maintenance difficulties associated with an entrenched road.

Materials commonly used for mass filling include native shale or sandstone, rock spoils, bank run gravel, concrete waste, and spent sandblasting material.

Some Important Considerations:

1. Select fill material carefully – be conscious of potentially hazardous materials. Local shale/sandstone is the most abundant and likely candidate.
2. When adding fill material, it is ideal to raise the road enough that drainage is restored to a natural condition. More specifically, ditch flow is replaced by sheet flow from either the downslope side of the road or both sides of the road (depending on topography).
3. Using a roller, place and compact the fill material in successive lifts. Each un-compacted lift should not exceed 12 inches thick.
4. Top-dress with an 8-inch uncompacted lift (6-inch lift minimum) of DSA using recommended methods. If possible, “key” road edges to accept the DSA thus creating adequate shoulders, and allowing for road edge compaction. The DSA will be applied through a tracked mounted paver at the specified width, in one lift, and compacted to 6 inches (or 4 inches using a 6 inch lift) with a minimum 10 ton vibratory roller capable of vibrating to a force of 20 tons.
5. While adding fill is often the bulk of the work in fixing entrenched conditions, there may be a component of rolling back the berms that develop over time. This work will allow positive drainage via sheet flow into the forest. Berm removal can create significant areas of earth disturbance and can result in NPDES permitting issues. Prompt stabilization of disturbed areas is essential (mulch). The best time of year to do this work is late summer/early fall when conditions are generally favorable for re-vegetation, with leaf fall providing a considerable aesthetic value.

B. Use of Geotextiles

As in the construction of new state forest roads, geotextiles will normally be required when modifying existing state forest roads. Woven geotextiles are most widely used for stabilizing roads, as this synthetic layer keeps the layers of subgrade and base materials separate and manages water movement through or off the roadbed. In installations where the roadway will be subjected to severe loads, geotextiles of maximum durability should be selected. When using geotextiles for roadway materials separation, strength and permeability should be considered. Permeable fabrics allow moisture to move freely through the system, thereby avoiding excessive hydrostatic pressures that can cause soil failure.

C. Road Widening

Road clearing should not exceed 16 feet in width including the running surface and associated ditches. However, at the discretion of the Forest District Manager, road widths may be widened up to a 26 foot running surface. It should be noted that all road widening must be done in accordance with the appropriate approved DEP permit. Following completion of heavy hauling needs, the road width will be restored to its former width or a 16 foot wide running surface. This is in compliance with AASHTO (American Association of State Highway & Transportation Officials) geometric guidelines for “very low volume local roads.”

D. Staging / Turnout Areas

If staggered truck staging is anticipated, turnout areas are often requested. A maximum of 24 feet may be permitted, in addition to the road width clearing. Following completion of heavy hauling needs, these areas will be restored to a condition specified by the Forest District Manager. District staff should consider what these terms will entail prior to approving the request and should discuss the terms with the operator in advance.

E. Road Drainage

Without establishing proper drainage, even the best constructed roads are likely to fail and will result in an unsafe, impassable and environmentally destructive condition. In addition, poor road drainage will result in a loss of time and money. Two important drainage systems exist when dealing with roads and road maintenance:

Surface Drainage

The surface drainage system collects water from the road surface, shoulders, banks, and the area up-slope of the road, and then carries it away from the road corridor using sheet flow, parallel ditches, bleeders, and/or culverts. The desired method of surface drainage on state forest roads is sheet flow into the surrounding vegetation; however, due to excessive slope or other factors, sheet flow cannot always be established. Over time a road's profile can drop in relation to the surrounding terrain. Once the road is lower than the surrounding terrain it will naturally collect and concentrate water. Such roads are known as entrenched roads, often developing severe and costly water related problems.

Subsurface Drainage

A significant amount of road failures can be attributed to improper subsurface drainage systems, inferior road subgrade, or a combination of both. Water can enter the road subsurface (sub-base and subgrade) in numerous ways causing catastrophic failure. These seepage from higher ground, percolating through an improperly drained road surface from a rising water table and by capillary action (capillary action can take place even when the water table is considerably lower than the road elevation).

In Pennsylvania, it is typical for water to be a seasonal problem for roads. One of the optimal ways to minimize the risk of road failures is to selectively schedule hauling operations to avoid or minimize travel during the spring thaw and wet weather periods.

In winter, water enters the road profile as materials freeze from the top down, thus drawing water up from below. If the subsurface drainage system does not carry the water away before it freezes, the water will create excessive pressure. This pressure can deflect the road surface, causing frost heaving. Varying soil types and road materials will affect whether or how much the road heaves, and since temperature and soil type are not controllable, focus must be made on improving subsurface drainage. A combination of subsurface drainage techniques and the use of geosynthetic materials results in the most cost effective solution to alleviate frost heaving.

Water trapped in the road creates more significant problems in the spring. As the road thaws, it does so from the top down. The frozen subgrade and sub-base keep the water from infiltrating deeper into the ground. When subsurface water cannot drain from the roadway, it acts as a lubricant that softens the road and reduces its load bearing capacity. In order to avoid this, the road's subsurface drainage system must be comprised of a free draining sub-base and an underground collector, normally referred to as an underdrain or subdrain.

In most situations, underdrains (perforated pipe bedded in clean stone and wrapped in a non-woven geotextile fabric) provide the most cost effective and environmentally sensitive solution to dealing with spring thaw, as well as perennial spring seeps, wet ditches and wet embankments. Furthermore, underdrains keep the clean subsurface water from mixing with sediment loaded water from the surface drainage system.

To create a road with optimal subsurface drainage capability, each road layer (sub-grade, base aggregate, and surface aggregate) should receive an appropriate degree of crown or cross slope. The desired shape of the finished road should be built from the bottom up.

The Forest District Manager reserves the option to limit or prohibit heavy hauling during spring frost breakup. Timing road maintenance operations so that roads receive

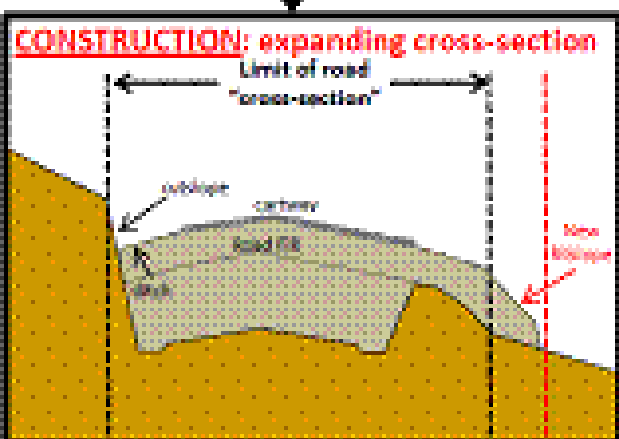
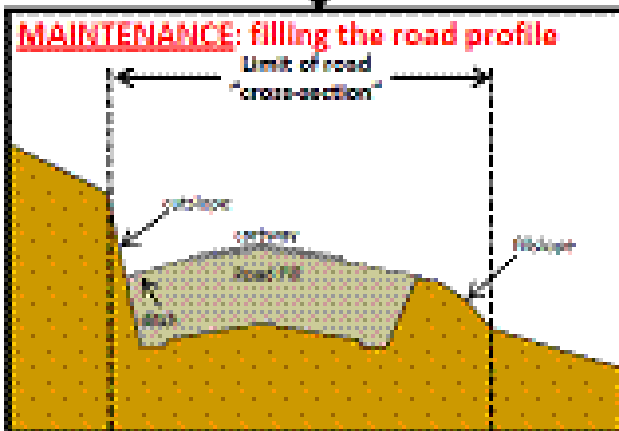
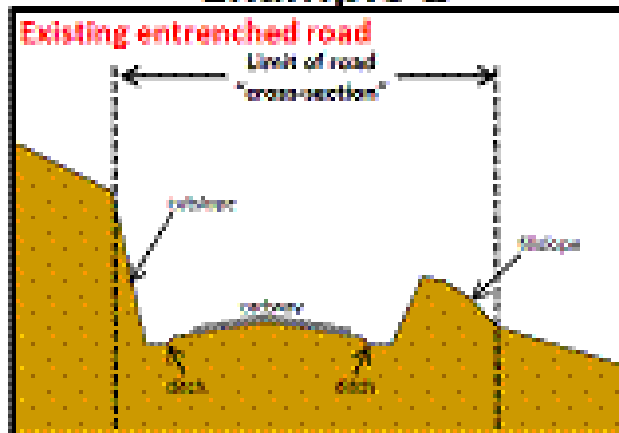
drainage and other upgrades well in advance of winter and spring frost breakup may allow hauling operations to continue during these periods.

The following should be considered for construction, modification, and maintenance of state forest roads:

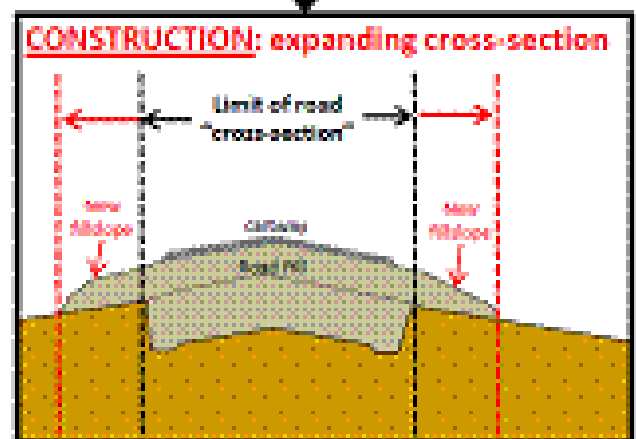
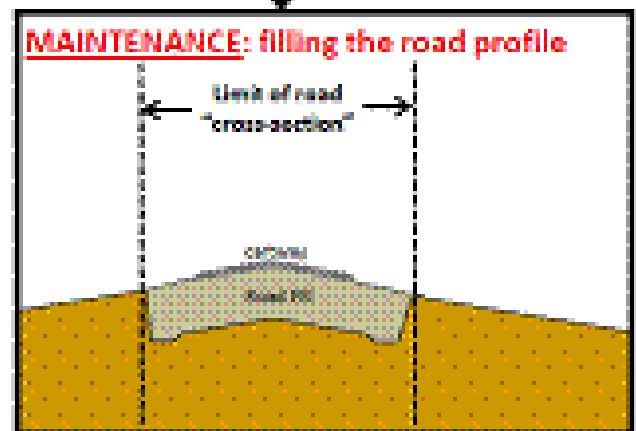
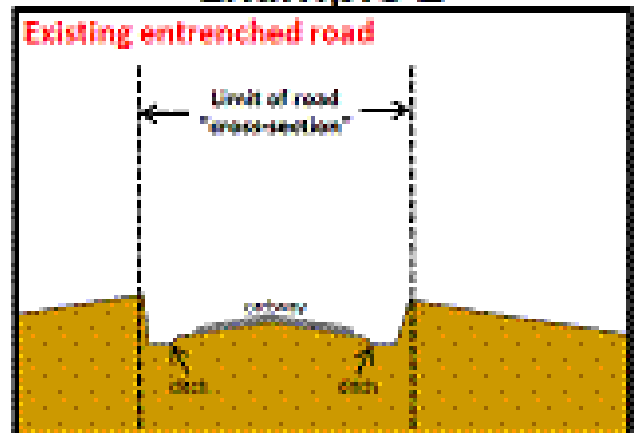
1. While reviewing and approving requests to modify roads, the district should consider what will be required for proper road restoration.
2. Forest roads should utilize ditch elimination and sheet flow whenever the road gradient and profile will permit usage. Sheet flow allows surface water to drain off the road quickly and disperse into the surrounding terrain, minimizing erosion potential.
3. Use in-sloping when constructing a road where road gradients are greater than 10%, or toward sharp curves, or when constructed on clay and/or slippery soils. In such cases, the use of a sufficient number of under-road culverts positioned at a 30° angle to ensure drainage to a stable up-slope ditch is recommended. The use of broad-based or rolling (grade) dips is also encouraged.
4. Install water turnouts prior to a stream crossing at a distance far enough to eliminate direct connectivity of road drainage to the stream. Outlets should be stable and well vegetated. Re-vegetation or rock placement may be necessary to stabilize a ditch outlet. Road gradients approaching water crossings should be changed to disperse surface runoff water at least 50 feet from the stream. Distance is measured from the bank to the edge of soil disturbance or, in the case of fills, from the bottom of the fill slope.
5. In areas where it is unavoidable to route ditchwater into a sediment management zone, bleeders should be lined with limestone aggregate of sufficient size to disrupt flow velocities (#4 or bigger) and voids in aggregate should be filled with a limestone sand to filter water thoroughly. In all cases, select vegetated and stable locations for surface drainage outlets (culverts, turn-outs, dips, etc.).
6. All road located within 50 feet of watercourses should be surfaced with erosion resistant materials. Cut banks and fill should be stabilized immediately using vegetation, rock, erosion blankets, or other suitable material. Install silt fence barriers at outlets of any drainage structures that are constructed.
7. Roads should follow contour as closely as possible with road grades between 2-10%. Steeper gradients of up to 15% are permissible for up to 200 feet. By reversing or changing grade frequently, and incorporating rolling grade breaks in the road alignment, fewer erosion problems will result.
8. On highly erodible soils, grades should not exceed 8%. Graveling native road surfaces can help maintain stability.
9. Where haul roads intersect highways, use appropriate gravel, mats, or other means to keep mud off of the highway.
10. If needed, install rip rap or other devices at the outlets of culverts and dips to absorb and spread water.
11. Use brush barriers or check dams as needed along roads and sensitive areas to filter sediment.

12. Ensure that the surface drainage system remains open and functional at all times, and that it is not impeded during hauling operations.
13. Inspect roads at regular intervals to detect and correct potential maintenance problems.
14. If a new road must cross a stream, it should be done at a ninety degree angle.

Example 1



Example 2



Note: Although this information was developed to provide Chapter 92 and 102 guidance relating to roadway issues indirectly from shale gas exploration and development activities, it is applicable statewide and for all roadway maintenance projects.

Appendix F: Restoration

Restoration Guidelines and Options for Reclaiming Gas Development Sites

Part 1: Introduction

Purpose of the Document

As demands for energy continue to grow, the development of gas-related activities on State Forest land will continue to increase. These increases will result in the disturbance of a significant amount of plant and wildlife habitat, especially core and interior habitats. However, there is the possibility of reducing the impact, as well as, utilizing these sites for enhancement of wildlife and plant habitat through restoration. With proper planning and effective, thoughtful implementation, we can create suitable habitat for many species of plants and wildlife during the interim and final restoration of gas-related sites.

The purpose of this document is to offer “planning considerations” and restoration guidelines on gas development sites to regain a functioning ecosystem. This document also works in conjunction with the Bureau of Forestry’s Best Management Practices manual for gas development and Planting Guidelines. These guidelines encourage approaches to restoration 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 restoration and each case should be evaluated and decided upon at a landscape level.

Ecological restoration may take years or decades to reach the management objective; however, this means it is vital to look at every step in the process as an opportunity for restoration and enhancement of habitat.

Where and When to use these Restoration options

The guidelines presented in this document should be considered as restoration options during interim and final restoration for several of the gas-related activities being conducted on State Forest land, including restoration of:

- 1) Well-pads
- 2) Staging areas
- 3) Impoundments
- 4) Right-of-Ways
- 5) Temporary compressor stations
- 6) Retired roads

The information presented in this document could be considered during any stage of restoration following disturbance. This includes initial stages of restoration, such as erosion and sedimentation control planning.

This document is currently an initial version. Through time a standardized approach of how to implement these guidelines consistently across State Forest land will be developed. This will include an outline of roles and responsibilities for Bureau of Forestry district and central office staff.

Part II: Defining Restoration, Rehabilitation, Reclamation

Explanations of Terms

The terms restoration, reclamation and rehabilitation are often used interchangeably, but have different meanings. The definitions may become important when determining final goals for an area and for clarification of a final outcome. The word restoration is used throughout this document, but often reclamation or rehabilitation will really be taking place in the field. The terms are clarified below.

Ecological Restoration: Restoration is typically defined as the return of a functioning ecosystem to its original state. This type of restoration accelerates the recovery of an ecosystem's health and sustainability. Merely recreating the landscape without ecosystem functions does not constitute restoration.

Rehabilitation: Rehabilitation is often referred to as being an act of returning a landscape to a previous condition or state. Landscapes that are rehabilitated are not expected to be in as original or as healthy a state as if it had been restored. It is typically thought of as an improvement from a degraded state.

Reclamation: Reclamation has an even broader application than rehabilitation. Reclamation usually indicates a return of the land to what, within the regional context, is considered to be a useful purpose. Replacement may therefore be involved rather than restoring to a previous condition. Revegetation, which is normally a component of land reclamation, may entail the establishment of only one or few species. Reclamation projects that are more ecologically based can qualify as rehabilitation or even restoration.

Goals and Objectives

The general **goal** of ecological restoration is to assist the recovery of an ecosystem that has been degraded, damaged, or destroyed.

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, if possible, restoration should not be complete unless the proper interactions upon which the integrity of the ecosystem depends

is functioning. In most cases, ecological restoration is complete once the assistance of a restoration practitioner is no longer needed to ensure long-term ecosystem sustainability.

The **objectives(s)** of restoration 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 exotic species
- Develop the area into a productive ecosystem dominated by native species

Types

The various contexts of restoration may involve degrees of work and maintenance. Ecological restoration can be defined as either passive or active.

Passive restoration: Passive restoration 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. Passive approaches have been shown to be ineffective for restoring highly degraded systems and active methods may often be necessary.

Active restoration: Active restoration includes management techniques such as planting, weeding, and thinning that are undertaken with a particular image of desired final landscape in mind and may be necessary in highly degraded communities.

To truly restore a site the historical species and structure should be maintained and sustained into the future. All types of restoration may be necessary to achieve full restoration. It will have to be decided whether or not an active strategy is worth the cost, the likelihood of success and the degree of risk.

Part III: Planning

Planning Considerations

The first thing to consider in developing a restoration 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 or manage for a priority species (Appendix IV), providing additional food and hunting opportunities with food plots, or conducting special habitat enhancements. Before implementing management actions, district personnel and Ecological Services should create clear

long-term objectives for the landscape. These objectives and options for reclamation should consider the following:

A. Conduct pre-project monitoring as needed to identify the kind of ecosystem to be restored, existing site conditions and describe the biota

Often it is useful to obtain baseline measurements on such parameters as wildlife and plants using the site, soil quality, water quality and any other information that may be pertinent during restoration. 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 because sites may not begin restoration activities for 5-20 years after initial earth disturbance.

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

- 1) The names of a few characteristic or conspicuous species
- 2) The quality of that habitat
- 3) The community structure (woodland, forest, etc), life form (herbaceous perennial, succulent, shrub, etc), predominant taxonomic categories (coniferous, graminaceous, etc), and moisture conditions (hydric, xeric, etc)
- 4) The distribution of vegetation types and age classes
- 5) A landscape review of available habitats within the associated Landscape Type Association (LTA) and adjacent LTAs
- 6) Overall landscape level habitat conditions
- 7) Current forest community type
- 8) Wildlife species and plant communities currently using the area and those with the potential to use the area based on the habitat present ,including species of special concern
- 9) Ecologically important features, such as a complex of vernal pools or wetlands that may influence the option chosen for restoration
- 10) PNDI review for species of special concern that may be impacted by disturbance and restoration options
- 11) Soil quality and type

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

Many ecosystems in need of restoration 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 restored ecosystem. This will be especially important to consider when determining how the site will be restored.

C. Identify the need for ecological restoration and the level of restoration

It may be important to describe the improvements that are anticipated following restoration. This is important because restoration can be conducted in several contexts. The appropriate context should be identified in the project goals in order to underscore the intent of restoration and avoid conflict. A few relevant contexts of restoration for gas development might include (SER):

- 1) Recovery of a degraded or damaged ecosystem to its former state
- 2) 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 or its benthos.
- 3) Transformation of another kind of ecosystem from the bioregion to replace one which was removed from a landscape that became irreversibly altered.

D. Identify restoration goals and objectives

Goals are the ideal states and conditions that an ecological restoration effort attempts to achieve. Written expressions of goals provide the basis for all restoration activities, and later they become the basis for project evaluation. Statements of ecological goals should candidly express the degree to which recovery can be anticipated to a former state or trajectory. Restoration goals will often take into consideration many of the following guidelines, such as what was determined to be the need and level of restoration, and what was found during pre-project monitoring.

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

Many restoration 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 restoration. Invasive, non-native species generally require eradication. Other species, invasive or non-native, may be removed if they retard or arrest biotic succession. Species that may need introduction include mycorrhizal fungi, N-fixing bacteria, or other soil microbiota (SER). Animals can be enticed to colonize projects by providing perches, nest boxes, distributing coarse detritus for small animal cover, and/or providing talus rocks (See Appendix I-III).

F. Identify biotic resource needs, sources, and considerations

Prior to restoration 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 restoration goals taken into consideration. When determining seed choices consider the following:

- 1) Source of seeds
 - Use appropriate seed for the region
- 2) Native/non-native

- When planting natives, make sure the species being planted is not only native to Pennsylvania but native to the area of restoration
- 3) Planting success
 - Use appropriate species for the site considering sunlight requirements, soil disturbance, soil type and quality, etc.
- 4) 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.
- 5) Original and potential future forest community type trajectories to support the long-term desired condition
- 6) Soil quality, type and amount of compaction
- 7) What is required to encourage the appropriate communities
- 8) Bureau of Forestry's Planting Guidelines
- 9) Bureau of Forestry's Right-of-Way Planting Guidelines
- 10) Variety
 - Plant diversity is important for wildlife. The more diverse an area the more wildlife species will be attracted to that area.

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

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.

H. Conduct an ecological evaluation of the newly completed project

This guideline requires satisfaction for the goals and objectives of the site. The evaluation should compare the restored ecosystem to its condition prior to the initiation of restoration activities. The evaluation should determine whether or not the ecological goals were met, including the ecological attributes of restored ecosystems. A final report may be a good way to document successful restoration of a site.

Part IV: Partial Restoration**Introduction**

Partial restoration consists of minimizing the footprint of disturbance by reclaiming all portions of the well site not needed for production operations. Some restoration features, such as shrub stands 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 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, provide wildlife habitat with brush piles, re-using the sites for storage instead of developing a new site.

Re-contour and revegetate where feasible

The portions of the well site not needed for operational and safety purposes could be recontoured to either a final or intermediate contour that blends with the surrounding topography as much as possible. Topsoil may even be able to be spread over areas not needed for operations and revegetated.

Reducing Edge

Habitat fragmentation increases the amount of edge, which can negatively impact certain species. If a site is not 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. 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 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.

Re-use of site

In order to reduce the amount of fragmentation a site temporarily not being used could be utilized for storage, staging area or some other use that would eliminate the development of another pad site.

Part V: Complete Restoration Options**Introduction**

Complete restoration can begin once all activity on the site is complete. Restoration is considered successful when long-term ecosystem sustainability has been obtained. However, there are a lot of choices that can be made in the process of restoration. The decision of what to restore the site to should be made as early in the process as possible, although situations may arise in which adaptive management may have to be utilized. There are several choices when it comes to 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 following restoration options describe several methods and things to consider in establishing various types of habitat and are based on the degree of management. This document should help in making a well-informed decision on how best to restore a site. The details of whether to revert a site to the original habitat or to go with 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 Guidelines and Best Management Practices manual for gas development, address the potential for invasive species introduction, and be appropriate for overall Bureau of Forestry objectives. Whenever possible, consider the native species that were present prior to disturbance for a restoration option and limit the use of non-natives, unless suitable for the determined objectives.

Forest Restoration

Typically, natural processes that lead to restoration of the forest vegetation after a disturbance usually begins quickly and result in development of another forest. However, the quality of that forest and the speed with which it develops depend upon the conditions created by the gas development and restoration process. Although native forests will eventually be restored on such 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.

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. Reforestation can be accomplished through a combination of passive and active restoration. Although more active restoration may be required on some sites which are more highly degraded. More active restoration 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.

Things to Consider

1. *Soil:* The soils on many 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 (Sweigard 2007, ARRI). 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 “ripping” may be necessary for successful establishment of trees and shrubs, a practice commonly used in strip mine reclamation. Sites with the least compacted soils may be the most suitable for establishing forest.
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 less 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:
 - a. The ecosystem/sites’ goals and objectives
 - b. Site capabilities
 - c. Existing natural regeneration and surrounding community type
 - d. Historical vegetation
 - e. Variation in growth rate and seed production
 - f. Mixing of deciduous and coniferous species
 - g. Planting a diversity of trees and shrubs
 - h. Sunlight requirements
 - i. Locally adapted seed sources
 - j. 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 resprouting.

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.

Things to Consider

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 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).

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.

Permanent Forest Opening/Right-of-Way

Ecological succession describes the changes in plant composition over time (Groninger 2007). Vegetation established by restoration, either passively or actively, will most likely be a combination of planted and volunteer herbaceous species, 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.

Things to Consider

There are many things to consider before deciding whether an artificially created forest opening should be made permanent. First, make sure you have identified your goals and objectives for the site. It is important to know when 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)
 - a. 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.
 - b. Assess you 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:
 - a. The type of habitat provided by the opening
 - b. The types of wildlife locally and regionally present
 - c. 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. For instance, small isolated patches less than two acres are not large enough for species such as New England cottontails, yellow-breasted chats, and field sparrows to survive. However, they are large

enough for species that have small home ranges including various butterflies, dragonflies, and some song-birds such as chestnut-sided warblers. Typically, openings should be:

- a. At least 50' wide or, if possible, about 100' wide to provide nearby escape cover and create an even amount of shaded and sunlit areas (MacGowan 2003). This is because small mammals seldom venture more than 50 feet from escape cover.
 - b. At least twice as long as they are wide (MacGowan 2003).
 - c. Long, rectangular shaped openings will maximize the amount of edge, if you are managing for edge specific species
 - d. Square and circular openings will minimize edge effects, if you are managing for species in which edge could be detrimental
 - e. Limit the number of straight-sided rectangular openings. Nature seldom creates straight lines.
4. *Soil*: The soils on many 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. 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*: There are a lot of plant species and things to consider when determining what type of permanent opening to maintain. It will be important to consider the plant community type on the site and surrounding landscape. Other factors to consider include:
- a. The sites goals and objectives
 - b. Site capabilities
 - c. Historical vegetation
 - d. Variation in growth rate and seed production
 - e. Mixing of herbaceous plants and shrubs
 - f. Sunlight requirements
 - g. Soil type and moisture
 - h. Locally adapted seed sources
 - i. 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:

- a. 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.
 - b. 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.
 - c. 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). If the goal is to maintain a food plot these openings will need to be disked seeded, and possibly fertilized every year.

Wetlands

A restoration 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 may 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):

- a. 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
- b. 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
- c. Consider the slope. An area with less than 3% slope works best for construction

- d. 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.
- e. 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.

Part VI. Summary

Although gas development has the potential to create ecological impacts, with proper planning and effective, thoughtful implementation, we can hopefully use some of this activity to create suitable habitat for many species of plant and wildlife during the interim and final restoration of gas-related sites. By following the Bureau of Forestry's Best Management Practices for Oil and Gas Activity on State Forest Land, Planting Guidelines, and this document successful restoration of sites will be on track for long-term ecosystem sustainability.

Each case should be evaluated and decisions made at a landscape level based on the surrounding habitats, overall habitat conditions, and what is needed during the restoration process to encourage the appropriate community response. Whether the choice at a site is to revert back to pre-disturbance conditions, fill a lacking habitat/species, provide additional hunting and food opportunities with food plots or create special habitat enhancement, the objectives should be to establish vegetation that can aid in controlling erosion, allow recruitment by native plant species for increased diversity, fix N from the atmosphere, create wildlife habitat, minimize invasion of exotic species, and develop 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 gas development impacts and enhance habitat for plants and wildlife.

Part VII. 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 siskinpine 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, dDeer, 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 racoons

deer, elk, redpolls, siskins, goldfinches, beavers

Appendix

I. Nest Boxes

Nest boxes such as bluebird boxes can be placed to enhance habitat for wildlife. Boxes can be placed around the edges of herbaceous openings and food plots and will be used by a variety of canopy-nesting species including bluebirds, chickadees, tree swallows, house wrens, and deer mice.

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.

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.

II. 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.

III. 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.

IV. Manage Priority Species by District

The following list of priority species for each State Forest District was adapted from the Pennsylvania Game Commission's priority list of each Species of Conservation Concern. 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.

	PGC Wildlife Management Unit Codes and District Forests for Species of Conservation Concern																														
Common Name	1 5A	2 4A	2 4B	3 4B	4 2C	5 4A	5 4D	6 2C	7 4D	8 2D	8 2F	9 2E	9 2G	10 2G	11 3D	12 4D	12 2G	13 2G	14 1B	14 2F	15 2G	15 3A	16 2G	16 3A	16 3B	17 5B	17 5C	18 4C	18 4E	19 3D	20 3B
Allegheny Woodrat	1	3	3	3	3	3	3	3	3	1	1	2	3	3	1	3	3	3	A	1	3	1	3	1	1	1	A	3	3	1	1
Delmarva Fox Squirrel	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1-A ^a	A	A	A	A
Small-footed Bat	1	3	3	3	2	3	3	2	3	2	1	3	2	2	3	3	2	2	2	1	2	1	2	1	3	1	2	3	3	3	3
Indiana Bat	3	3	3	3	3	3	3	3	3	3	1	1	1	1	2	3	1	1	1	1	1	1	1	1	2	3	3	3	2	2	2
WVA Water Shrew	1	3	1	1	3	3	A	3	A	1	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Appalachian Cottontail	2	2	2	2	3	2	3	3	3	2	3	3	3	3	3	3	3	3	1	3	3	2	3	2	3	1	A	3	3	3	3
Spotted Skunk	1 ^b	3 ^b	1 ^b	1 ^b	3 ^b	3 ^b	A	3 ^b	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1 ^b	A	A	A	A	A
Least Shrew	3	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1
Northern Flying Squirrel	1	A	A	A	2	A	1	2	1	2	3	2	3	3	3	1	3	3	3	3	3	2	3	2	3	1	A	3	2	3	3
Rock Vole	A	1	1	1	1	1	2	1	2	1	A	1	1	1	3	2	1	1	A	A	1	A	1	A	3	A	A	3	1	3	3
Silver-haired Bat	1	2	2	2	2	2	2	2	2	2	3	2	3	3	3	2	3	3	1	3	3	3	3	3	3	1	1	2	2	3	3
Southeastern Fox Squirrel	3	2	3	3	1	2	A	1	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	2	2	A	A	A	A
Eastern Red Bat	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Fisher	1	2	2	2	3	2	3	3	3	2	2	3	3	3	2	3	3	3	1	2	3	1	3	1	2	1	1	2	2	2	2
Hoary Bat	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Least Weasel	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	1
Northern Water Shrew	1	1	1	1	1	1	3	1	3	1	2	3	2	2	2	3	2	2	1	2	2	1	2	1	2	A	A	3	3	2	2
River Otter	2	3	3	3	3	3	3	3	3	2	3	1	2	2	3	3	2	2	2	3	2	1	2	1	2	3	1	1	3	3	2
Showshoe Hare	A	1	1	1	1	1	2	1	2	1	3	1	3	3	3	2	3	3	2	3	3	3	3	3	3	A	A	2	3	3	3

^aBetween April 1987 & October 1988, twenty fox squirrels were released at a single site in Chester County. No recent records are known for the area and it is believed that these squirrels are absent from all management units.

^bNo recent records, may be absent from all units.

1=Low Priority; 2=Medium; 3=High; A=Presumed Absent

V. Manage by Wildlife Species

These are simply short informational paragraphs on certain species of interest and wildlife action plan 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.

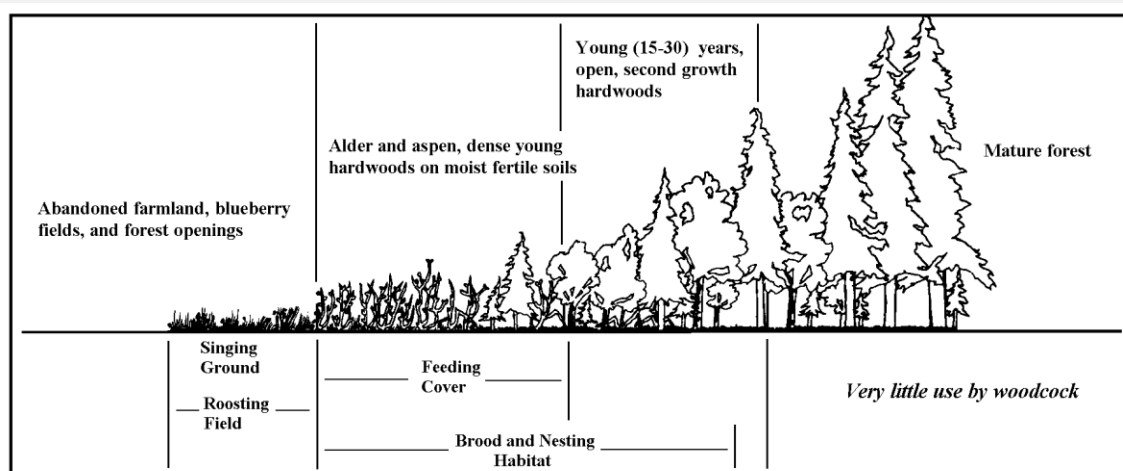


Fig. 2. The stages of forest succession used by woodcock. (from Sepik, et al, 1981).

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 and coniferous forests. The 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 sideoats gramma provides 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, native lespedezas, milk pea, and butterfly pea. Grasses that provide quality seed include panicgrasses and foxtail grasses. Good shrubs include blackberry, wild plum, 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. Food choices might include sunflowers, soybeans, oats, winter wheat, corn, buckwheat, clover, or alfalfa to provide food. 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 your woods 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 you make 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.

Most of the cool-season forage plots listed for white-tailed deer will attract wild turkeys as well, especially **clovers**. If you want to manage for turkeys and quail along with deer, use **wheat** instead of oats in the forage mixtures listed for deer.

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. A few examples of habitat creation for the Allegheny woodrat (PA-Threatened) and the timber rattlesnake (PA-candidate species) are given below.

Allegheny Woodrat

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 little packrats 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. 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 food plots, 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.

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Appendix G: Emergency Contact Information

General Emergency Contact Information	
Operator	Emergency Number
American Exploration Company	(724) 388-4309
Anadarko	1-800-738-9816
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
D&L Energy, Inc.	(888) 343-4427
Dominion Transmission Inc.	1-888-264-8240
Eastern American Energy	(724) 463-8400
Energy Corporation of America	(724) 463-8400
EOG Resources	(724) 465-3314
EXCO Resources (PA), Inc.	1-888-788-3781
ExxonMobil	(713) 656-6300
KSM Energy, Inc.	(412) 967-0164
NCL	(814) 571-4180
PGE	(814) 723-3230
Penn Virginia Oil & Gas	1-888-292-5017
Range Resources	(724) 825-9755
R E Energy Development	(814) 321-2115
Seneca Resources	(814) 715-5525
Talisman Energy	(800) 530-5392
Ultra Resources	(570) 439-7127
XTO Energy	1-877-829-8521
Zenith Exploration Company	(740) 922-0923

Appendix H: Trade Secret/Confidential Proprietary Information Notice

Instructions:

The Commonwealth may not assert on behalf of a third party an exception to the public release of materials that contain trade secrets or confidential proprietary information unless the materials are accompanied, at the time they are submitted, by this form or a document containing similar information.

It is the responsibility of the party submitting this form to ensure that all statements and assertions made below are legally defensible and accurate. The Commonwealth will not provide a submitting party any advice with regard to trade secret law.

Name of submitting party:

Contact information for submitting party:

Please provide a brief overview of the materials that you are submitting (e.g. bid proposal, grant application, technical schematics):

Please provide a brief explanation of why the materials are being submitted to the Commonwealth (e.g. response to bid #12345, application for grant XYZ being offered by the Department of Health, documents required to be submitted under law ABC)

Please provide a list detailing which portions of the material being submitted you believe constitute a trade secret or confidential proprietary information, and please provide an explanation of why you think those materials constitute a trade secret or confidential proprietary information. Also, please mark the submitted material in such a way to allow a reviewer to easily distinguish between the parts referenced below. (You may attach additional pages if needed)

The following information will not be considered trade secret or confidential proprietary information:

1. Any information submitted as part of a vendor's cost proposal
2. Information submitted as part of a vendor's technical response that does not pertain to specific business practices or product specification
3. Information submitted as part of a vendor's technical or disadvantaged business response that is otherwise publicly available or otherwise easily obtained
4. Information detailing the name, quantity, and price paid for any product or service being purchased by the Commonwealth

Acknowledgment

The undersigned party hereby agrees that it has read and completed this form, and has marked the material being submitted in accordance with the instructions above. The undersigned party acknowledges that the Commonwealth is not liable for the use or disclosure of trade secret data or confidential proprietary information that has not been clearly marked as such, and which was not accompanied by a specific explanation included with this form.

The undersigned agrees to defend any action seeking release of the materials it believes to be trade secret or confidential, and indemnify and hold harmless the Commonwealth, its agents and employees, from any judgments awarded against the Commonwealth in favor of the party requesting the materials, and any and all costs connected with that defense. This indemnification survives so long as the Commonwealth has possession of the submitted material, and will apply to all costs unless and until the undersigned provides a written statement or similar notice to the Commonwealth stating that it no longer wishes to exempt the submitted material from public disclosure.

The undersigned acknowledges that the Commonwealth is required to keep all records for at least as long as specified in its published records retention schedule.

The undersigned acknowledges that the Commonwealth reserves the right to reject the undersigned's claim of trade secret/confidential proprietary information if the Commonwealth determines that the undersigned has not met the burden of establishing that the information constitutes a trade secret or is confidential. The undersigned also acknowledges that if only a certain part of the submitted material is found to constitute a trade secret or is confidential, the remainder of the submitted material will become public; only the protected information will be removed and remain nonpublic.

If being submitted electronically, the undersigned agrees that the mark below is a valid electronic signature.

Signature

Title

Date

Appendix I: Definitions

ADF: Assistant District Forester (aka Forest Assistant Manager) = This individual is responsible for assistance in directing the activities of a Forest District Office in the Bureau of Forestry, Department of Conservation and Natural Resources, and assists the Forest District Manager in planning, developing, implementing, and coordinating programs designed to manage, protect, and conserve forest resources within the assigned geographical area.

ARRI: Appalachian Regional Reforestation Initiative = Coalition comprised of citizens, members of the coal industry, and government; focused on restoring forests on coal mined lands in the Eastern United States.

BOF: Bureau of Forestry = A bureau within the Pennsylvania Department of Conservation and Natural Resources responsible for managing Pennsylvania's State Forest lands for an array of resources, including plant and animal habitats, recreation, timber, and oil and gas production.

DCNR: Pennsylvania Department of Conservation and Natural Resources = This agency is charged with maintaining and preserving the 117 state parks; managing the 2.1 million acres of state forest land; providing information on the state's ecological and geologic resources; and establishing community conservation partnerships with grants and technical assistance to benefit rivers, trails, greenways, local parks and recreation, regional heritage parks, open space and natural areas.

DEP: Pennsylvania Department of Environmental Protection = This agency is responsible for protecting and preserving the land, air, water, and energy resources of Pennsylvania through enforcement of the State's environmental laws.

DF: District Forester (aka Forest District Manager). This individual is responsible for directing the activities of a Forest District Office in the Bureau of Forestry, Department of Conservation and Natural Resources. The Forest District Manager plans, develops, implements, evaluates, and coordinates programs designed to manage, protect, and conserve forest resources within the assigned district.

DSA: Driving Surface Aggregate = A mixture of crushed stone designed by Penn State University's Center for Dirt and Gravel Road Studies as a surface wearing course for unpaved roads.

E&S: Erosion and Sedimentation Control Plan = A site specific plan composed of two components (drawings and a narrative) that together identify best management practices to minimize accelerated erosion and sedimentation before, during and after earth disturbance activities.

EV: Exceptional Value = "A stream or watershed which constitutes an outstanding national, state, regional, or local resource, such as waters of national, state or county parks or forests, or waters which are used as a source of unfiltered potable water supply, or waters of wildlife refuges or state game lands, or waters which have been characterized by the Fish Commission as 'Wilderness Trout Streams,' and other waters of substantial recreational or ecological significance." (State Forest Resource Management Plan, DCNR, Bureau of Forestry)

FBC: Pennsylvania Fish and Boat Commission = An independent state agency responsible for the management of the Commonwealth's fishing and boating resources, including the conservation and protection of fish, reptiles, amphibians and aquatic organisms.

FSC: Forest Stewardship Council = An accredited, independent certification body established in 1993 focused on promotion of environmentally appropriate, socially beneficial, and economically viable forest management.

GMT: Gas Management Team = Team created by the Bureau of Forestry in order to facilitate the management of gas exploration and development across Pennsylvania State Forest lands which is responsible for day to day management of the gas program

HQ: High Quality = "A stream or watershed which has excellent quality waters and environmental or other features that require special water quality protection." (State Forest Resource Management Plan, DCNR, Bureau of Forestry)

NPDES: National Pollutant Discharge Elimination System = A permitting program authorized by the Clean Water Act that regulates point sources that discharge pollutants into US waters.

PEMA: Pennsylvania Emergency Management Agency = This agency plans responses to, prevents loss from, communicates news about, coordinates resources for and help communities recover from natural and manmade disasters and emergencies.

PGC: Pennsylvania Game Commission = An independent state agency responsible for the management of the Commonwealth's wild birds and mammals, to include the conservation, protection, and restoration of wildlife populations and their associated habitats, and the administration and management of State Game Lands.

PHMC: Pennsylvania Historical and Museum Commission = This agency is responsible for the collection, conservation, and interpretation of Pennsylvania's historic heritage, through the Pennsylvania State Archives, the State Museum of Pennsylvania, the Bureau of Historic Sites and Museums, the Pennsylvania Trails of History, the Bureau for Historic Preservation, and the Bureau of Management Services.

PNDI: Pennsylvania Natural Diversity Inventory = An environmental review tool designed to identify potential conflicts or impacts to threatened or rare plants, animals, natural communities, and geologic features in Pennsylvania. The Pennsylvania Department of Conservation and Natural Resources (Bureau of Forestry), Pennsylvania Game Commission, Pennsylvania Fish and Boat Commission, and US Fish and Wildlife Service are the jurisdictional agencies that review each PNDI project for impacts to species or resources of concern.

PNHP: Pennsylvania Natural Heritage Program = Partnership between the Pennsylvania Department of Conservation and Natural Resources, Western Pennsylvania Conservancy, Pennsylvania Game Commission, and the Pennsylvania Fish and Boat Commission focused on the collection and dissemination of information and statuses on important ecological resources in Pennsylvania.

ROS: Recreational Opportunity Spectrum = A recreational inventory and planning tool created by the US Forest Service and adopted by the Pennsylvania Bureau of Forestry. The version adapted by the

Bureau of Forestry defines five recreation classes for the state forests (primitive, semi-primitive non-motorized, semi-primitive, semi-developed, developed).

SFER: State Forest Environmental Review = State Forest Environmental Reviews are conducted for projects having the potential to disrupt, alter, or otherwise change the natural environment or character of State Forest Lands.

SFRMP: State Forest Resource Management Plan = The PA Bureau of Forestry's comprehensive document guiding the management of the State Forests.

T&E: Threatened and Endangered Species = Generally a threatened species is one that may become endangered in the foreseeable future throughout their range unless factors causing their decline are reduced or stopped. Generally an endangered species is one that is in imminent danger of extinction or extirpation throughout their range if factors causing their decline continue.