Commonwealth of Pennsylvania
Department of Conservation and Natural Resources
Bureau of Forestry

Guidelines for Administering Oil and Gas Activity on State Forest Lands

VERSION 2011-1

April 26, 2011

This document will be updated periodically as new information becomes available.

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A. Purpose

Administering Oil & Gas Activities on State Forest Lands

The Bureau of Forestry (BOF) manages Pennsylvania's State Forest lands (SFL) for an array of resources and values including plant and animal habitats, recreation, timber, and oil and gas production. 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. The purpose of this document is to establish a set of "guidelines," that provide protocol and guidance on managing State Forest lands towards our mission.

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

The Commonwealth is fortunate enough to own the subsurface rights to most State Forest lands; yet approximately 15% of these rights are owned by private interests. These lands present a complex challenge to land managers as management of the surface lands can, at any point in time, be impacted by the rights of the subsurface owner to reasonably develop their property. Considering the variety of complicating factors involved in oil and gas development, it is important for Bureau of Forestry staff to have a detailed understanding of the applicable lease, private lease holder agreements and goals set forth in the SFRMP to successfully manage oil and gas activities on State Forest lands.

B. Key Principles

Administering Oil & Gas Activities on State Forest Lands

According to the policy statement in the 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:

Overarching Principle: 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.

1. The Bureau of Forestry is responsible for managing and protecting natural resources on State Forest land, especially species of concern, ecologically significant communities, and primitive recreation zones in a multiple use environment where competing activities on State Forest lands may be in opposition.

2. The safety of workers and the general public will be foremost when making management decisions.

3. The *Lease* is a binding contract and the Bureau of Forestry is obligated to enforce the *Lease* provisions on behalf of the Commonwealth.

4. In situation 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 fostering a close working relationship with the private owners and educating them about State Forest management including the principles of ecosystem management. It is paramount that BOF staff recognizes and understands the rights of private subsurface owners and not require specific actions, but they should also consider the *mission statement* of the Bureau of Forestry and strive to make decisions which are in the best interest of the resource and the citizens of the Commonwealth, for which these lands are managed. In addition, the Bureau will make every attempt to secure a *Surface Use Agreement* with private subsurface interests to ensure their use of the surface coincides with the State Forest management goals.

5. These guidelines are intended to help Bureau staff administer oil and gas activity. However, certain instances might require staff to deviate from these guidelines and make decisions based on their training, experience, and professional judgment.

6. These guidelines should be considered minimum standards as more restrictive requirements may be necessary on a case-by-case basis. Operators are required to comply with all state and federal laws and regulations.

7. The siting of roads, pipelines, impoundments, compressor stations, well pads and associated oil and gas infrastructure should consider existing disturbances such as road networks, rights-of-

way corridors, or abandoned mine lands in order to minimize fragmentation, invasive plant species introduction and long-term impacts on State Forest lands.

8. Operators will provide the Bureau with work plans relating to oil and gas development, production, and transmission prior to the initiation of the activity. The Bureau will work with the operator to plan the development in a manner which minimizes impacts to State Forest land and its resources.

9. Bureau of Forestry staff will follow monitoring or inspection guidance by inspecting disturbance activities associated with oil and gas development on a weekly basis. More frequent inspections should occur as operations and weather conditions dictate. Site inspections are considered a very high priority for the District.

C. Bureau of Forestry Gas Management Team

The Bureau of Forestry has created a Gas Management Team (GMT) in order to facilitate the management of its extensive gas drilling and development program across State Forest lands, which involves the majority of the Forest Districts in the system and a significant part of the headquarters staff. This team is a natural outgrowth of the recent Gas Summit Meeting. 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, new well pad approvals and location, seismic survey approvals, water impoundment approvals and location, new road construction and condition monitoring, gathering pipeline approvals and construction, water withdrawals and transport, community contact, and all other various miscellaneous tasks that accompany gas well development, production, and site restoration. The management of the gas program includes all leases issued by the Commonwealth and all oil, gas and mineral (OGM) activity on SFL under private ownership not subject to a surface use agreement with the operator.

GMT meetings will occur once a quarter, and will involve training in oil and gas issues and information exchange regarding the activity in the various districts. As with the operator meetings we will review the past quarter for hindsight opportunities and discuss the coming quarters for informational purposes. Problem solving and pollution events will be highlighted. The Minerals Section will be the lead in planning and hosting the quarterly meetings and disseminating general knowledge.

The following Bureau staff members have current assigned positions within the GMT and have duties that directly relate to management of some aspect of gas activity or management of staff with gas activity responsibilities:

Headquarters:

Deputy Secretary's Office: *(717) 787-2703*	Vacant
Bureau of State Parks: *(717) 787-6640*	Lori Nygard Bob Barth
Director's Office: *(717) 787-2703*	Dan Devlin Mike Lester Bradley Elison
Division of Resource Planning & Inventory: *(717) 787-2703*	Matt Keefer Craig Chapman Paul Roth Joe Petroski

Division of Operations and Recreation: *(717) 787-2703*		Chris Plank Dave Mong Matt Reed
Division of Forest Fire Protection: *(717) 787-2703*		Randy White
Rural & Community Forestry Section: *(717) 787-2703*		Rachel Billingham
Communications Section: *(717) 787-2703*		Seth Cassell
Silviculture Section: *(717) 787-2703*		John Hecker
Ecological Services Section: *(717) 787-2703*		Ellen Shultzabarger Chris Firestone Mark Faulkenberry
Minerals Section: *(717) 787-2703*		Ted Borawski Amy Randolph John Piekara Arianne Proctor (PRR staff position)

Core Marcellus gas districts:

D9 - Moshannon State Forest: *(814) 765-0821*	DF: ADF: Gas Forester:	Bob Merrill Martin Lentz Jason Cotton
D10 - Sproul State Forest: *(570) 923-6011*	DF: ADF: ADF: Gas Forester:	Doug D'Amore Rich Kugel Dennis Sorgen Bob Fitterling
D12 – Tiadaghton State Forest: *(570) 753-5409*	DF: ADF: ADF: Gas Forester:	Jeff Prowant Tom Casilio Jason Stellfox Greg Kisko
D13 - Elk State Forest: *(814) 486-3353*	DF: ADF: Gas Forester:	Jeannie Wambaugh John Sidelinger Andy Sidelinger

D15 - Susquehannock State Forest:	DF:	Chris Nicholas
(814) 274-3600	ADF:	John Wambaugh
	Gas Forester:	Ron Doughtie
D16 - Tioga State Forest:	DF:	Roy Siefert
(570) 724-2868	ADF:	Justin Shaffer
	Gas Forester:	Dan Dicamillo
D20 - Loyalsock State Forest:	DF:	Rich Glinski
(570) 946-4049	ADF:	Joe Dotzel
	Gas Forester:	vacant

Peripheral Marcellus gas districts:

D2 - Buchannan State Forest:	DF:	Jim Smith
(717) 485-3148	ADF:	none assigned
	Gas Forester:	Steve Keiper
D4 - Forbes State Forest:	DF:	Ed Callahan
(724) 238-1200	ADF:	Cory Wentzel
	Gas Forester:	Ralph Campbell
D6 - Gallitzin State Forest:	DF:	Terry Stemmler
(814) 472-1862	ADF:	Mark Maser
	Forester:	Dan Snyder
	Forester:	Michael Nelson
D8 – Clear Creek State Forest:	DF:	Gary Frank
(814) 226-1901	ADF:	Mark Bodamer
	Gas Forester:	Walter Visneski
D11 – Lackawanna State Forest:	DF:	Nicholas Lylo
(570) 945-7133	ADF:	none assigned
	Gas Forester:	none assigned
D14 – Cornplanter State Forest:	ADF:	Scott Rimpa
(814) 723-0262		
D19 – Delaware State Forest:	DF:	Nicholas Lylo
(570) 895-4000	ADF:	none assigned
	Gas Forester:	none assigned

Note: A detailed list of contact information for the gas management team will be available at each forest district office.

D. Guidelines for Record-Keeping and Right-To-Know Issues

General communications:

Maintaining an accurate and up-to-date contact list for routine and emergency use is essential to responsible and efficient communications. An initial contact list for all possible state and federal agencies with possible primacy on State Forest lands during oil and gas drilling and production operations is set forth in all lease agreements under **Exhibit "C"**.

Bureau of Forestry staff should strive to 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.

1. Bureau of Forestry staff will openly communicate and provide support when requested to facilitate the oil and gas administration process, minimize adverse impacts and avoid potential conflicts.

2. The Bureau of Forestry will proactively communicate with operators to facilitate the oil and gas administration process, minimize adverse impacts and avoid potential conflicts. The Bureau of Forestry will respond to operator requests in a timely manner.

3. The Bureau of Forestry will maintain its cooperative relationship with the Department of Environmental Protection, Bureau of Oil and Gas Management (DEP-BOGM). State Forest District Offices should coordinate field inspection activities with DEP-BOGM Regional Offices, if possible. The District staff is not responsible for enforcing Department of Environmental Protection (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.

4. District staff should become familiar with the following DEP manuals or permit processes:

    - *DEP's Oil and Gas Operator's Manual*, which provides an overview of statutes, regulations, and recommended practices for oil and gas activities.
    - National Pollutant Discharge Elimination System (NPDES permit process for oil and gas operations (DEP Bureau of Watershed Management). *DEP DOCUMENT NUMBER: 550-2100-008, Policy for NPDES Permits for Stormwater Discharges Associated with Construction Activities at Oil and Gas Wells*, provides guidance concerning the NPDES compliance.

5. Gas foresters should become familiar with the applicable Lease document and its exhibits, and should contact the Subsurface Programs if any questions arise concerning the interpretation of the Lease.

File maintenance protocols:

Bureau of Forestry staff should strive to 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:
    a. Seismic surveys
    b. Pipelines
    c. Roads
    d. Well pad development plan
    e. Erosion and Sedimentation (E&S) plan
    f. Water sourcing and waste handling plan
    g. Site restoration plan
    h. 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 on site at all times.
    a. DEP Bureau of Oil and Gas Management's Well Permit
    b. National Pollutant Discharge Elimination System (NPDES) Permit
    c. Erosion and Sedimentation Control Plan
    d. Preparedness, Prevention, and Contingency Plan
7. Contact information for routine and emergency situations shall be maintained by the district and the operator 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; however, it is also concerned about protecting confidential and proprietary information which is routinely provided by oil and gas operators. This sensitive information is critical to the Bureau's efforts to plan and review oil and gas development on State Forest lands. Records pertaining to oil and gas development are dynamic- information which may be considered proprietary and confidential in the planning stages and is often considered part of the public record upon development and construction. Due to the complexities and

uncertainties surrounding the designation of such information, the following guidance should be adhered to:

> **All information provided to the Bureau by a lessee or private operator should be considered confidential and proprietary. This information may not be released to a third party without written authorization from the lessee or private operator.**

The only exceptions to this guidance are in the event of an emergency or pollution incident where time and information are critical to first responders. In this instance, the staff is empowered to make professional and rational decisions on a case-by-case basis.

This guidance is also applicable when addressing the public. 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 fill this educational role to the best of its abilities while ensuring that confidential and proprietary information is protected.

Operators are highly encouraged to utilize the *Trade Secret/Confidential Proprietary Information Notice* (Appendix 1) for any information provided to the Bureau which is deemed by the operator to be confidential or proprietary in nature.

Right-to-Know laws in Pennsylvania:

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

1. Directly from the operator
2. Informally by following the DCNR Procedure for Informal Requests of Records
3. 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 for requests for records under either DCNR process.

E. Guidelines for Public Safety

1. Operators must abide by the *State Forest Rules and Regulations (Appendix 2)*.

2. Well-site clearing restrictions regarding recreational areas such as State Forest Picnic Areas, trails and vistas will be enforced to provide for public safety and protection.

3. Public access to dangerous surface structures or equipment (primarily during active drilling operations) should be restricted by posting, gating, and/or fencing to provide for public safety and protection. Each operator will 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 will post a copy of *State Forest Rules and Regulations* (Appendix 2) at the entrance to operations (i.e. well pad).

4. 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. 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 such as hunting season or trout season
    - Weather conditions that make the roads impassable
    - Traditionally wet periods when road damage is most probable
    - During the spring frost breakup

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

F. Guidelines for Ecosystem and Multiple-Resource Management

Consistent with the Bureau of Forestry's ecosystem and multiple-resource management policies, 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 following practices should be followed to maintain the BOF's ecosystem and multiple-resource management policies for oil and gas exploration and development:

Use Existing Disturbance: 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; well-sites could be placed along existing roads or in existing openings, 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. For example, recent Marcellus leases limit the total well pad sites allowed on a lease tract but the majority of the Department's historical leases do not reflect such limitations.

Comprehensive Planning and Review: Bureau of Forestry review should occur as early in the development process as possible so that ecosystem management and planning tools are incorporated in oil and gas development and planning. To aid BOF staff, the following plans should be requested from and submitted by the operator:

A. Gas development plans (includes pads, roads, pipelines, water withdrawal, water transport, water storage)
B. Water sourcing, storage, handling and disposal plan
C. Erosion and sedimentation plans for all facilities as it becomes available
D. Completed ecological surveys

Avoid, Buffer or Minimize: Bureau of Forestry staff will work to minimize potential adverse impacts to specific ecological, aesthetic, recreational, or infrastructure resources by avoiding them all together, appropriately buffering them or minimizing the impacts by incorporating techniques such as timing restrictions.

Setbacks: The following set-back restrictions for gas activities found within recent lease agreements are below. Please refer to the specific lease terms for each tract, as setbacks vary within the lease agreement iterations. These setbacks are

used to maximize the protection of State Forest resources in current, legacy or non-leased areas.

a) 200 feet of any building
b) 200 feet of any stream or body of water
c) 300 feet of any exceptional value (EV) stream or body of water (as defined by the EQB)
d) 300 feet of any State Forest Picnic Area or sheltered area which has been so designated by DCNR
e) 300 feet of any trail, road or existing right-of-way
f) 300 feet of any area of historic value, tree plantation, overlook, vista or fire tower site
g) 300 feet of the boundary line of the leased premises
h) 600 feet of the boundary line of State Park lands or of designated Wild and Natural Areas on State Forest Lands

***Additional Setbacks*:** In addition, the following specific restrictions may apply where applicable for appropriately siting gas activities.

a) 200 feet from a wetland, vernal pool, spring seep or other wet areas
b) 300 feet from a wetland, vernal pool, spring seep or other wet areas with a T&E species of special concern
c) 300 feet from designated High Quality (HQ) waterway
d) Any requested buffers for endangered, threatened, rare, candidate or tentatively undetermined species or communities of special concern as requested by DCNR, PGC, FBC or USFWS
e) Additional setback restrictions may be required on a case by case basis (i.e. steep slopes, high recreation areas or other conditions which warrant the area being considered significant)

Note: Requests to encroach upon the identified setbacks may be considered on a case-by-case basis. Whereas, it may be preferable to locate a wellsite within a setback in order to minimize fragmentation or protect a significant resource. Waiver applications for these instances will require State Forester (or their designee) approval. A request to waiver a specific setback may require State Forest Environmental Review (SFER) and Resource Planning should be consulted.

Development and Well Spacing: The operator has agreed to drill wells as reasonably prudent as possible; however, not all leases have well spacing limitations. Newer 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

legacy lease areas or areas without a lease, BOF staff will work with the operators in planning and identifying opportunities to limit conversion and fragmentation to SF lands.

Note: No oil and gas activity of any kind, including but not limited to drilling, pipeline or road construction, shall be permitted, nor shall they be subject to waivers, on the surface of State Forest Wild or Natural Areas or within State Parks where the Commonwealth owns the oil and gas rights.

Long-Term Landscape Restoration: It is important to begin thinking about long-term restoration goals early in the planning processes. Therefore, Bureau staff should coordinate with the operator early in the planning stages and consider long term landscape restoration goals. Often, these goals aid or influence decisions regarding gas related infrastructure and its placement upon the landscape. Additional guidance is provided under the Best Management Practices (BMP's) for restoration.

Note: Drilling or well site clearing refers to all construction activities associated with oil and gas development including: gas well-pad sites; road; water impoundments; water withdrawal areas; pipelines (gas or water); staging/storage areas; and compressor stations.

G. Best Management Practices

1. Seismic Surveys
2. Well Pads Sites
3. Water Storage Facilities
4. Water Disposal Facilities
5. Roads
6. Pipelines
7. Compressor Stations
8. Vegetation Management
9. Invasive Plants
10. Site Restoration
11. Recreation

1. Seismic Surveys

Seismic data are acquired to enable the successful exploration and development of certain oil and gas reservoirs including the Marcellus Shale. The acquisition of seismic data is considered integral to understanding complex lithologies and reservoirs. Additionally, the acquisition of seismic data is inseparable from oil and gas exploration and development rights. Two types of energy sources are commonly used in seismic surveys in Pennsylvania:

- **Dynamite 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 collects data in a similar fashion described above

Seismic data are typically acquired in two-dimensional (2-D) or three-dimensional (3-D) form as evidenced by the image produced of the subsurface.

- 2-D surveys: require an energy source that is in line with the receiver to produce a vertical profile of the subsurface
- 3-D surveys: require a multitude of shot-holes and receivers collecting reflection signals from points outside the plane of the energy source to produce a "cube-like" profile of the subsurface; more complex, labor intensive; and more land-base required

Best Management Practices

a) The use of mulchers or all-terrain vehicles to clear vegetation or to lay cables should be avoided on State Forest lands. These have significant potential to remove T&E plant species and introduce or spread invasive plants. Hand-cutting is the preferred method to remove or clear vegetation for seismic activities.
b) When mulching is necessary or preferred, the request is to be reviewed on a case-by-case basis and a waiver is required. If approved for use, guidance on "no mulch" buffers, establishing blockades (i.e., rock barricades or gates), and other operational protocols will be provided.
c) In areas where sensitive habitats or T&E species occur, have a qualified biologist flag or accompany each survey crew to identify and avoid sensitive areas. It is highly recommended that a meeting between the contractor and Bureau staff occur prior to the initiation of seismic activities.
d) Vibroseis trucks and helicopters (with portable drills) are typically associated with fewer disturbances and are preferred in sensitive areas. Drill buggies used for dynamite surveys should avoid all sensitive and wet areas.

e) Operations should be scheduled to avoid conflicts with visitors (i.e., hunting seasons and holiday weekends) and critical wildlife nesting or mating seasons.
f) Timing operations to avoid activities during wet seasons and wet periods outside of wet seasons will minimize impacts on soils, water, and vegetation. Please see the Recreation BMPs section for timing restrictions.
g) When determining and accessing seismic lines, use existing roads and trails to the maximum extent possible.
h) Position survey lines and access routes to eliminate stream crossings and the encroachment on important riparian buffers.
i) Use low impact vehicles that will not disturb the soils and vegetative root systems. Seasonal timing will aid in minimizing impacts on vegetation.
j) The Bureau of Forestry will monitor and inspect seismic lines to assure compliance with identified areas of avoidance.

2. Well Pad Sites

Marcellus Shale well pads are more developed and much larger in size than those associated with traditional gas development. A typical Marcellus well pad is approximately 3.5-7 acres in size and can host upwards of 12 individual wells with an estimated drainage area of more than 640 acres. The truck-mounted rigs associated with traditional gas development have now been replaced by hi-tech computerized rigs weighing several thousand tons. The sheer size of the rigs requires construction of a solid pad that can adequately support the weight of the equipment and provide for its maneuverability.

Well pads are prepared by removing and stockpiling the topsoil, lining the area with geotextile fabric and covering with several thousand tons of stone. Stone is backfilled and compacted to extreme tolerances to assure a consistently flat surface which allows the rig to "walk" or "skid" from one well to the next. Well pads are large enough to accommodate all components of drilling and completion. The final footprint of the well pad is primarily dictated by the method of water storage utilized by the operator. During the hydro-fracing and completion process, nearly every square inch of the pad is occupied. Well pads may also include a lined reserve pit or series of steel tanks which capture the drilling mud and materials removed from the bore hole. Pipeline rights-of-way and access roads are not considered part of the well pad.

Best Management Practices:

Site selection and design

a) Current site conditions, to include landscape conditions and characteristics, should be evaluated and documented prior to disturbance. This will provide baseline data on the original conditions for restoration at a later date.
b) Operations should avoid riparian areas, floodplains, lakeshores, wetlands and areas subject to severe erosion and mass soil movement.
c) Well sites should be designed to fit within the landscape and minimize excessive "cut and fill" construction practices. In many cases, well sites may be designed in an irregular shape, not rectangular.
d) In visually sensitive areas, locations should be selected that provide for vegetative and topographic screening. If that is not possible, vegetative species that provide screening, such as white pine, should be planted.
e) If feasible, well pads should be located in a manner that reduces impacts to forested areas (e.g., areas adjacent to existing roads).
f) Well pads should be sloped to collect/contain spills when possible; suitable alternatives include: ditching, to provide appropriate surface drainage; or secondary containment controls, to capture, contain and isolate discharges. If necessary, additional controls for the collection of storm water and other

mechanical fluids should be implemented to minimize the possibility for contamination.

g) Portions of the well pad exposed to chemicals, fuel, non-freshwater fluids, or active operations should be lined with an impervious geotextile liner to deter chemicals or fluids from reaching the groundwater in the event of a leak or spill.

Construction

a) On-site crew leaders for all logging crews working on State Forest land must be trained under the Pennsylvania Sustainable Forestry Initiative.
b) Topsoil should be segregated and stored separately from subsurface materials to avoid mixing during construction, storage, and interim restoration. Topsoil stockpiles should be vegetated with a native seed mix to minimize erosion and maximize reclamation potential. Topsoil stockpiles should not be stored under plastic, which may kill the seedbank stored in the original topsoil.
c) Rocks, stumps, tops or slash should be pushed to the edge of the opening and used for wildlife habitat enhancement wherever possible. Please consult the Ecological Services Section for specific recommendations on enhancement opportunities. In those instances where vegetative debris cannot be incorporated, guidance will be provided on other beneficial uses (e.g., chipping or stockpiling) if applicable.
d) Matting typically used for erosion control may entangle or cause injury or mortality to wildlife. The properties of natural jute matting allow the threads to move and the openings to expand. Natural jute matting is preferred and should be used in place of the stiff, synthetic netting.
e) The importation or spread of invasive plants can cause significant ecological degradation and should be prevented. Please refer to the invasive plant BMPs section for more information.

Spill Safety

The following BMP's are intended to protect ecological and recreational resources on and off State Forest lands and should be adhered to. These measures are *required* in sensitive areas or sites within 300ft of a wetland, seep, vernal pool, stream, T&E species or habitat, or as directed by the Department, to decrease the likelihood of an off-location spill:

a) Use double-wall tanks for the storage of chemicals and liquids.
b) Wherever possible, store chemicals and liquids inside storage trailers. In the event that a liquid needs to be stored in a well ventilated environment, the storage facility should employ secondary containment controls. Storage or secondary containments should be underlain with impervious geotextile. Product and hazard labels should be legible at all times and replaced as necessary.

c) Install concrete sump collection boxes downslope of all gravel-lined diversion channels. Collection boxes provide containment for the purpose of using the on-site spill vacuum to permanently pump out spills.

Aesthetics:

a) Aesthetics should be considered when siting gas infrastructure. In visually sensitive areas, locations should be selected that provide for vegetative and topographic screening. Siting within the established aesthetic buffer (300 feet) of heavily used public use roads and high use recreation areas should be avoided. Consider supplemental plantings of white pine, or similar species, to establish or enhance vegetative screening.

3. Water Acquisition, Transport and Storage

The water intensive nature of the Marcellus shale play requires significant, advanced planning. A comprehensive oil and gas development 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. DEP and corresponding interstate River Basin Commissions have jurisdictional responsibility for surface water resources and associated withdrawal requests; however, the Bureau of Forestry has ultimate authority for decisions which affect State Forest lands. The utilization of water resources on State Forest lands is considered a privilege and not a right.

Water use in association with gas activities on State Forest lands may take the following forms:

- surface water withdrawal (by Lessees)
- surface water withdrawal (by non-Lessees)
- groundwater well withdrawal
- earthen or temporary water impoundments
- permanent or temporary pipelines that transport water between withdrawal sites, impoundments and gas well pad sites
- permanent or temporary pumping stations

The development of a single Marcellus well requires 2-6 million gallons of water for the completion (i.e., fracing) process. This quantity of water must be readily available and in close proximity to the well site during the extent of this process. Water storage requires substantial resources for the volume of one million gallons of water is equivalent to 3.069 acre feet or 133,685.24 cubic feet. As such, the means and location of water storage has a significant impact on the amount of land utilized for oil and gas development. Traditionally, dozens of tanks were set upon the well pad for storage and the water was transported via trucks to fill them. Alternative methods have been proposed and are currently being utilized which reduce or eliminate truck traffic, decrease the size of wellpads, and make use of existing, non-forested openings. When impoundments are properly sited, they can accommodate the needs of several well pads and dozens of individual wells.

Best Management Practices:

Water Acquisition

Groundwater wells may be used from time to time as a supplemental source of freshwater for completion operations. Groundwater wells will be reviewed and approved on a case by case basis as determined through a multi-discipline review process. The review includes determining the hydrologic 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.

Water Transportation

a) Whenever feasible, freshwater should be moved from centralized storage facilities to an active location(s) through the use of piping. This practice significantly reduces the frequency of heavy hauling across State Forest lands minimizes the possibility of vehicular conflicts and decreases air and dust pollution.
b) The piping of freshwater may involve above-ground or buried water pipeline networks, or a combination of both. Above-ground piping should be laid out in a manner to reduce aesthetic impacts and the potential for vandalism to the extent possible. Where applicable, buried piping should minimize additional earth disturbance and be co-located with natural gas 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 and should be reviewed chosen on a case by case basis:

- Earthen impoundments: non-portable, open pit that may involve significant construction operations; typically 5-12 acre disturbance
- PortaDams: semi-portable, above-ground impoundment consisting of heavy duty liners on a steel framework; perimeter can be lined with frac tanks for screening and additional storage capacity; typically 3-5 acre disturbance
- Above-ground Storage Tanks: semi-portable, bolt together, cylindrical tanks that are often set on concrete pads; typically 2-3 acre disturbance

a) Water impoundments should be double-lined to reduce leaks and tears during pumping
b) Use of 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
c) Fresh water storage should be prevented from becoming septic. Aeration systems can be installed to deter the water from becoming septic.
d) An under-drain system should be installed to cycle any possible leak back into the impoundment until the leak can be fixed. This would deter the leak from going undetected.
e) Effective exclusionary fences or nets should be installed to keep wildlife from falling into the impoundments. If a problem persists the use of deterrents could be incorporated.

f) Jute matting should be used along the top, inside edge of an impoundment to enable amphibians and small mammals to exit the slippery plastic lined impoundments.

4. Water Disposal

The fluids returned to the surface from a given Marcellus well after the completion will contain a solution of dissolved salts, dissolved metals, chemical additives, undissolved bits of rock and minerals and water. Approximately 15% of the water volume used during the fracing process is returned to the surface during initial flowback. The flowback fluid also contains natural gas which will be flared or sent directly to market if a pipeline is available on the pad site.

The spent frac water is disposed of via one of the methods described below:

1. The fluid may be flowed directly into a set of steel tanks for temporary storage. The fluid is then trucked offsite to an approved facility for treatment and disposal. (Note: flowback into lined, open pits is not permitted on State Forest land)
2. The fluid may be flowed directly into a set of steel tanks for temporary storage. The fluid is then filtered and treated onsite, mixed with additional fresh water and reused in subsequent frac operations.

   Note: Closed loop systems are strongly recommended in lieu of reserve pits for all drill fluids and cuttings. This information represents current best management practices and will be revised as necessary to accommodate changes and advances in technology which perpetuate environmental quality and minimize impacts to State Forest land.

The use of fresh water, the reuse of the spent frac waters, and the 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.

Best Management Practices:

a) The reuse of frac water through blending methods should be implemented wherever possible to limit the need for additional freshwater; this practice may be best utilized when completing several wells on a common well pad.
b) The recycling of frac water through evolving technologies should be implemented wherever possible to maximize the use of waters.
c) In the reuse and recycling processes mentioned above, all valves and associated piping should be tested for connectivity and seal; during blending operations, frequent inspections should be performed to ensure the continued integrity of the operation.

5. Roads

The Bureau of Forestry maintains State Forest roads for administration and management of Pennsylvania's State Forest system. Primarily dirt and gravel in nature, many State Forest roads were cut from the forest or converted from old railroad grades by the Civilian Conservation Corps of the 1930s. Today, their continual maintenance is a costly but necessary investment by the Bureau of Forestry.

Many State Forest roads are open to the public, and they have a long history of providing primary access to often remote tracts of public lands. It is essential to understand the importance of these roads to the general public, and to respect the public's time honored expectation to use these roads as a means of access.

Accountability for road maintenance and associated road costs ultimately falls upon the Bureau and the Bureau's staff. Road maintenance is carried out at the district level and performed by a skilled staff of maintenance employees under each district's direction. The Bureau has developed and adopted dirt and gravel road maintenance techniques that maximize efficiency and minimize costs. The Bureau also works closely with The Pennsylvania State University's *Center for Dirt and Gravel Road Studies* to select and adopt best practices for road maintenance and construction. Any action taken to construct or modify a road should be compatible with the Bureau's road maintenance and construction techniques.

As guiding principles, the following themes are important to keep in mind when making decisions regarding use, maintenance, and construction of roads:

- Safety – unsafe or hazardous conditions shall not be created or sustained.
- Accommodate or Account for Shared Use – all users must be considered and in some cases, restrictions may be necessary. State Forest roads must be maintained to a standard allowing safe passage for two wheel drive vehicles.
- Compatible Methods and Materials – materials and methods must be compatible with the Bureau's current specifications and practices.
- Future Maintenance Costs – nonstandard construction or maintenance practices, overbuilt roads, or substandard materials or practices can cause undue increases in future maintenance costs.
- Consistency – to the extent that it is practical, consistency is expected and required throughout a district as well as between districts.
- Environmentally Sensitive – The Bureau endorses and prefers the utilization of environmentally sensitive road maintenance practices whenever possible.

New Road Construction

Although the preferred method of gaining access to natural gas drilling pads and facilities is by way of existing State Forest roads, at times it may be necessary to construct a new permanent or temporary roadway. A properly located and constructed road will be more cost efficient and will have limited adverse impacts on water resources, including wetlands and aquatic and riparian habitats. Well-drained and properly surfaced forest roads built on solid bases minimize erosion and allow for more optimal access during the spring frost break up and other wet weather conditions. Furthermore, properly constructed and maintained forest roads will save money in the long run by lengthening maintenance cycles and reducing the down time that will occur if roadways become an environmental liability.

Using Best Management Practices for construction of forest roads will ensure opportunities for safe, efficient and profitable operations, and a well-planned and properly constructed forest road is necessary to effectively protect the forestland and water quality when moving to and from the drilling site.

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 districts lack sources of quality surface aggregate, while others have abundant commercial sources of crushed limestone and/or sandstone. Regardless of the specific type of materials found locally, always use *the most suitable and highest quality* that is available. The Forest Manager will advise as to the location and availability of the best materials available for new road construction, and may, if the original road is lacking a standard adequate base, offer 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 course material will generally have larger stone and a minimal amount of clay or fine material, thereby providing for good strength and permeability. Top road layers will be a well graded mixture of stone sizes that includes a significant percentage of fines that are the binding component.

DSA is designed to bind together mechanically without the negative qualities associated with aggregates containing clay and silt, such as pumping and rutting during the wet season or excessive dust during the dry season. If DSA is not locally available, a "dirty" 2A (also known as 2A modified) can often provide satisfactory performance if processed and placed correctly. 2RC aggregate may be selectively used, but this broad specification, which can include significant percentages of clay and silt, can allow for a wide range in product consistency from region to region or within the same production facility.

Geotextile

Geotextile is a generic name for tough woven or nonwoven, porous or impervious industrial polymer fabric. Often referred to as separation fabric, it is used to underlay base aggregate layers on soft sections of roads that are likely to rut excessively. Most newly constructed forest roads will incorporate the use of geotextiles.

Sandwiched between the native road sub-base and the introduced road materials, the geotextile not only allows water on the road surface to flow through the aggregate layers, fabric and into the ground, but also keeps the sub-base material from working up through the layers (or "pumping") and contaminating the gravel road surface as trafficking occurs. Fabric also serves to distribute vehicle weight more evenly across the base material. This dramatically reduces rutting and mud transfer. The use of geotextiles can also significantly decrease the amount of crushed rock necessary to stabilize a road and keep it serviceable.

Several types of geotextile are available in various sized rolls depending on material composition and thickness. For maximum effectiveness, a geotextile should be installed on critical/targeted forest road sections before trafficking begins or rutting occurs. The Forest District Manager may require the use of geotextiles on all new road construction. General installation includes establishing crown or cross-slope in the road subgrade and clearing it of any large stones or other sharp objects that could puncture the fabric; then carefully rolling it out, keeping it approximately 2 feet from the edge of the cartway. 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. Repeat this process until the geotextile is covered with the desired depth of base aggregate. If at all possible, vehicles should not drive directly on the geotextile as the aggregate is being spread. 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). Careful road planning, along with the proper use of geotextile to underlay crushed rock, where appropriate, decreases road failure and equipment damage, eliminates problems with mud on public roads, and increases commercial production and profitability. The width of the restored road once heavy hauling is completed should also be taken into consideration when installing geotextile (see section on *maximum width*).

1. Roll out the fabric, keeping the fabric in approximately *2* feet from the edge of the cartway.
2. 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.
3. Repeat this process until the geotextile is covered with the desired depth of base aggregate.
4. 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).

Geogrids

The use of geogrids in new road construction, or in the reinforcement of existing roads, can have the following advantages over traditional road construction methods, especially in situations where the cost or availability of quality road materials is a factor, or when considering road width or permit 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 subgrades.
- Provides additional traffic support over, and protection of, proposed or existing drainage features (crosspipes, cross-drains, culverts).

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 severely hamper vehicular mobility and controllability. 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 a great deal of costly maintenance 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 to vehicular controllability 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)
	Low	7
0 to 5	Medium	6
	High	5
	Low	9
5 to 10	Medium	7
	High	6
	Low	12
10 to 25	Medium	9
	High	7
	Low	15
25 to 50	Medium	12
	High	9

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

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 18 feet with 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 of 28 feet with a 26 foot running surface. In all cases, roads must be returned to the 16 foot width when the need for the expanded roadway ends as determined by the Forest District Manger. Roadways reduced to the maximum of 16 foot running surface will allow the Bureau of Forestry to properly maintain the roadway in the future without the need for excessive materials, grading times, etc.

Crown and Cross-Slope

Proper road shape is necessary in order to drain water from the road surface. Determining 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 (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)

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.

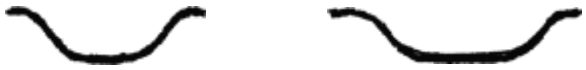
Ditch Size and Location:

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:

Ditches must have some means to anchor the soil from washing away, such as vegetation or rock lining. Ditches that lack such protection, or are too narrow or incorrectly shaped, 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.

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.

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.

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.

Modifications of Existing State Forest Roads

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/sandstone
- Any kind of rock spoil
- Bank run gravel
- Concrete waste
- Spent sandblasting sand

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.

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.

Road Widening

Clearing must only be wide enough to allow the construction of a road having a maximum width of 18 feet with a 16 foot wide running surface. However, at the discretion of the Forest District Manager, road widths may be widened up to 28 feet with a 26 foot running surface. 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."

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.

Road Restoration

All State Forest roads shall be restored to a condition equaling or better than their condition prior to utilization for resource extraction activities. The Forest District Manager will determine what restoration efforts are required and if the restoration results are acceptable. Based on their experiences and practices in other regions, lease holders and operators may have a different definition of restoration than that of the district manager. It is vital that final restoration is compatible with Bureau of Forestry maintenance practices. Final restoration must be fundamentally sound and not solely based on cosmetic considerations. Adherence to the information in these guidelines will help achieve successful road restoration.

Ideally all restored State Forest roads (Z1) will be surfaced with DSA during the restoration process. At a minimum, those portions of State Forest roads (Z1) that were DSA surfaced prior to gas activities shall be restored with a running surface of DSA that meets material specifications using a track mounted paver. After placement, the material is to be compacted using a vibratory roller (10 ton minimum) and to be crowned to DCNR's requirements. Drivable Trails (Z2) and Administrative Roads (Z3) will be restored to a running surface consisting of 2RC, 2A, or DSA aggregate based on the Forest District Manager's terms.

Note: If surface aggregate is to be added to repair a section of a road, and not to the entire road, it must be of the same type used predominantly in existing construction. Adding non-DSA to a DSA road, and vice –versa, can create unsafe driving conditions.

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 subgrades, 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.

Note: 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.

Dust Control

Numerous requests for application of dust suppressants associated with Marcellus operations necessitated the development of guidelines for a Bureau-wide approach to dust control. In addition to this, PA Code § 123.1 regulates dust particles that are considered fugitive emissions. These guidelines will serve both managers and companies utilizing State Forest roads by

reviewing the Bureau's philosophy, offering consistent dust control practices, and addressing the requirements of the law.

Philosophy

First and foremost, the Bureau recognizes that dust forms as traffic grinds the fines in the road surface into particles small enough to become airborne. As a result of these fines leaving the driving surface, our State Forest roads deteriorate and their longevity is reduced.

Studies have shown that dust control measures can reduce dust by 30-80%, and can cut aggregate loss by 25-75%. Also, a dust control program has the potential to save 25-75% of the cost associated with routine maintenance. Additional cost savings may be realized from reduced vehicle maintenance, as abrasive dust wears mechanical parts. The Bureau also acknowledges that other types of benefits exist from establishing a dust control program, such as safety and an improved environment.

Despite these benefits, district-wide dust control programs do not exist, as many of our State Forest roads traditionally see fewer than 15 vehicles per day on average. In addition, operational budgets, equipment limitations, and staffing do not allow for widespread dust control programs. This situation often results in addressing only those road sections that receive public complaints. With the increase in traffic produced by shale gas extraction, dust has begun to affect traditional users and has created safety concerns due to low visibilities.

Guidelines

The following dust control guidelines apply to State Forest roads:

A number of different control measures may be applied in unison to form an environmentally sensitive dust control program. The most basic measures include:

1. Reducing speeds – *State Forest Rules and Regulations* prohibit speeds in excess of 25mph, and no exceptions will be made, regardless of the road width or sight distance.
2. Staging of trucks to allow sufficient time between individual passages to allow dust to settle.
3. Applying non-potable water as a dust suppressant.
    a. Potable water can retain chemicals that injure plant and aquatic life.
    b. Water effectively suppresses dust, but often requires multiple applications daily during dry periods.
    c. Brine or other produced fluids SHALL NOT be applied to State Forest roads.
4. Selective maintenance of forest and roadside vegetation will help to shade the road surface and lengthen the road's drying time. The result is less dust, saved aggregate replacement costs, and the reduction of large canopy-breaks in our interior forests.

Application of Driving Surface Aggregate (DSA)

If dust control with water becomes inefficient or ineffective, the alternative could entail paver-placing DSA. After the DSA is in place, periodic blading, watering, and compaction of the new road surface, in combination with the basic measures listed above will help to control dust. This tier in an effective dust control program may be met with some resistance due to the initial costs involved. However, this will likely be the most cost effective protocol if long term operations and heavy hauling are anticipated. If there is significant resistance to the use of DSA, managers should point out that it is in everyone's best interest to comply with the four basic steps listed above.

When heavy hauling associated with the construction and fracking phases ceases within an area, and road restoration commences, the Bureau will require that State Forest roads receive a top dressing of DSA. Therefore, companies will eventually need to make this level of investment. By explaining this requirement to the companies, it may facilitate the application of DSA at an earlier point and emphasize the need for periodic maintenance of our roads. It can also engage the companies, and those working for them, to become better stewards of our resources.

Dust Suppressants

Among other concerns, chemical dust suppressants have been known to change the chemical properties of dirt and gravel roads to the extent that the road itself hardens and becomes impossible to maintain using the Bureau's standard maintenance practices. When the road reaches this condition, the only alternative is to completely rehabilitate the road through full depth reclamation. If all the measures listed above fail in satisfactory dust suppression, and the Forest District Manager feels that the operators have made a good faith effort in maintaining the road, only then should Forest District Managers consider the use of chemical dust suppressants. In all instances, chemical dust suppressants should be considered a temporary measure. Usage should be limited to the smallest possible time frame. When companies express an interest in taking this step, managers should clearly convey to them that they shall be responsible for restoring the road surface to a satisfactory condition should the physical characteristics of the road change after such applications. When making such requests, companies should consider selection of the chemical dust suppressant carefully. Suggestions include:

1. Avoiding asphalt cutbacks (petroleum emulsions). Repeated applications have produced roads that exhibit the same surface characteristics as paved roads, making the surface exceptionally difficult to maintain with a grader.
2. Avoiding applications of any of the chlorides (sodium, calcium, and magnesium) as suppressants or stabilizers, because they can have negative effects on plant and aquatic

life, and cause corrosion of metals. In addition, chlorides can exaggerate and extend the "mud season. "

3. Avoiding soy oils, as their use draws wildlife to the road.
4. Paraffin dissolved in mineral oil is merely a petroleum product dissolved in mineral oil and should not be mistaken to be wax.

Recently, mineral and synthetic oil based products have emerged. Some of these products show promise for use as dust suppressants. 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 the products.

Operators shall not apply chemical dust suppressants without a district's prior approval. A waiver is not required for the application of chemical dust suppressants. However, the Bureau wishes to monitor the usage of chemical dust suppressants. Prior to the application of any chemical dust suppressant, the district shall provide notification by submitting an electronic Dust Suppressant Notification form as provided on the Bureau's Intranet web site. The notification form should be submitted at least three days prior to the chemical application.

Best Management Practices for Construction, Modification, and Maintenance of State Forest Roads

a) While reviewing and approving requests to modify roads, the district should consider what will be required for proper road restoration.
b) 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.
c) 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.
d) 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.
e) 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.).

f) 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.
g) 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.
h) On highly erodible soils, grades should not exceed 8%. Graveling native road surfaces can help maintain stability.
i) Where haul roads intersect highways, use appropriate gravel, mats, or other means to keep mud off of the highway.
j) If needed, install rip rap or other devices at the outlets of culverts and dips to absorb and spread water.
k) Use brush barriers or check dams as needed along roads and sensitive areas to filter sediment.
l) Ensure that the surface drainage system remains open and functional at all times, and that it is not impeded during hauling operations.
m) Inspect roads at regular intervals to detect and correct potential maintenance problems.
n) If a new road must cross a stream, it should be done at a ninety degree angle.

Joint-Use Roads and the State Forest Snowmobile Trail System

Certain State Forest roads are utilized as part of the snowmobile trail system that DCNR provides to the recreating public. State Forest roads that are open to motor vehicles and snowmobiles at the same time are termed *joint-use roads*. These joint-use roads play an integral role in the overall Commonwealth State Forest snowmobile trail network. 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. When gas development activities will impact joint-use roads, the effects on the snowmobile trail system must be considered. Planning that addresses snowmobile trail system impacts should be done as far in advance of the snowmobile season as possible. Waiting until after the snowmobile season has opened to address impacts has a much greater likelihood of generating conflict. When gas activities impact roads that are part of the snowmobile trail system, the district must look at what available options may provide the best solution to minimize potential conflicts and maximize the safe use of the resource. Safety is a major consideration for any joint-use road situation.

Plowing Snow

In certain limited situations, plowing can be permitted as per the Bureau's *Joint-Use Road Plowing Strategy*. Plowing is not an appropriate long term solution, and it adversely impacts trail conditions for the public (e.g., snowmobile enthusiasts). Plowing creates the potential for conflict between user groups who have different expectations regarding State Forest road use. Plowing any State Forest road without prior authorization is a violation of *State Forest Rules and Regulations* (21.70a). Permission for plowing joint-use roads should be granted in the form of a Letter of Authorization and should include specifics such as dates, remaining snow depth (if applicable), and the number and width of plowed lanes permitted.

Long Term Disruption

When long term disruption to a joint-use road is anticipated a long term solution should be sought. In some instances, an alternate road or trail can be found. In cases where gas operators are placing pipelines next to the road, it may be possible to use that space as a snowmobile trail. It is important to work with the operator in these situations. As a last resort, and where a compromise cannot be found, it may be necessary to remove the road from the snowmobile trail system. This may be preferred over providing substandard conditions to the snowmobiling public. The Recreation Section of the Bureau is available for advice and guidance regarding snowmobile trail strategies, route selection, and impact mitigation.

The Bureau maintains a website of current snowmobile trail conditions. If a change to a joint-use road is planned or has occurred (including plowing), it is vital to provide the Bureau's Recreation Section with that information as soon as possible, so that the public website can be updated. This is particularly important if a change occurs during the open snowmobiling season, so that the public can be alerted to the changes to the trail system BEFORE they show up at the location.

Best Management Practices for Joint-Use Roads

a) Anticipate and plan for impacts to joint-use roads in advance of the snowmobiling season.
b) Safety is the major consideration for joint-use situations.
c) Plowing, as per the Bureau's Joint-Use Road Plowing Strategy, may be an option in certain situations, but it is a compromise solution.
d) Closing a road to snowmobile use or removing it from the snowmobile trail system, either temporarily or permanently, may be unavoidable.
e) In order to minimize the disruption to the existing snowmobile trail system, look for opportunities to provide alternate routes.
f) Notify the Bureau's Recreation Section as soon as possible concerning changes (including plowing) that affect the snowmobile trail system.
g) Avoid "plowing one lane" solutions – either plow the entire surface or do not plow at all.

h) Operators may be required to open berms along plowed roads in advance of the spring thaw to alleviate channelized surface and ditch flow of melt water, especially on grades.
i) Any anti-skid or snow melting materials to be placed on roads should be approved by the Forest District Manager, keeping in mind the potential impact to snowmobiles, the road surface and the drainage system post thaw.

Erosion & Sedimentation Pollution Control (Chapter 102) and NPDES (Chapter 92)

Roadway maintenance activities are currently defined per Chapter 102 as earth disturbance activities within the existing road cross-section, such as grading and repairing existing unpaved road surfaces, cutting road banks, cleaning or clearing drainage ditches and other similar activities.

Through policy, and until the current Chapter 102 regulations are revised, it is the intention of the Bureau to implement the following definition/clarification of roadway maintenance activities. This definition has received public comment as a part of the Chapter 102 regulation revisions.

a) Road Maintenance Activities—earth disturbance activities within the existing road cross-section or railroad right-of-way including: shaping or re-stabilizing unpaved roads, shoulder grading, slope stabilization, cutting of existing cut slopes, inlet and endwall cleaning, reshaping and cleaning drainage ditches and swales, pipe cleaning, pipe replacement, support activities incidental to resurfacing activities such as minor vertical adjustment to meet grade of resurfaced area, and other similar activities.
b) When applying an overlay (any type) to a roadway surface (any type) the term minor vertical adjustment is intended to capture those situations where the depth of placement is from 2 to 6 inches ±. This accounts for a base/binder course and or a wearing course. The activity in question is the placement of the shoulder backup material at a slope that promotes positive drainage away from the roadway and eliminates an unsafe drop-off condition. Provided the shoulder backup material does not expand the width of the existing cross section of the roadway and the slope of the shoulder does not cause an unsafe condition the vertical adjustment would be considered minor. There is no minimum or maximum, it is based upon the cross section NOT being expanded (width).
c) The roadway cross-section is not defined in the current Chapter 102 regulations, but will be interpreted as: the existing road cross-section consists of the original graded area between the existing toe of fill slopes and top of cut slopes on either side of the road and any associated drainage features. Filling the road profile that is entrenched qualifies as long as it is within the road cross-section.

d) Earth disturbance activities are defined as: A construction or other human activity which disturbs the surface of the land, including but not limited to, clearing and grubbing, grading, excavations, embankments, land development, agricultural plowing or tilling, timber harvesting activities, road maintenance activities, mineral extraction, and the moving, depositing, stockpiling, or storing of soil, rock or earth materials.

e) Milling asphalt is not an earth disturbance activity UNLESS it is full depth milling into the sub-base. Full depth milling can be a maintenance activity. Stockpiling milled material in a windrow or windrows along the roadway is an earth disturbance activity and the footprint of the material should be calculated and added to the total earth disturbance quantities for permit threshold comparison.

It is important to note that road maintenance activities, within the existing road cross-section, are exempt from DEP regulations. Activities such as paving (concrete or bituminous), concrete patching and tar and chip are construction activities; however they are not earth disturbance activities. Placing shoulder backup material is contained within the definition of earth disturbance activities and includes the moving, depositing, stockpiling, or storing of soil, rock or earth materials.

Road maintenance activities are not limited to "dirt" roads. All roads require some type of maintenance and the type of surface cover is not relevant other than to determine if its placement is an earth disturbance or a construction activity.

1. Persons conducting road maintenance activities with greater than 5,000 square feet of earth disturbance, but less than 25 acres of earth disturbance over the life of the project are required to prepare, have on-site and implement a written E&S Plan, which has been developed in accordance with Chapter 102 rules and regulations. The regulations contained within Chapter 102 do not require preapproval of the E&S plan by either the DEP or delegated County Conservation District UNLESS the E&S Plan approval is required by another Chapter, such as 105. A county conservation district or regional DEP representative, upon complaint or investigation, may request the E&S Plan be submitted for review and approval to ensure compliance with Chapter 102. There should be a reason for this request.

    - If upon investigation it is determined that the activity or scope of work is not road maintenance but is instead an NPDES construction activity, the property owner and the contractor will be notified immediately that an NPDES permit is required and that construction activity MUST cease until the appropriate authorization is obtained. Road maintenance activities can continue on-site and it is the responsibility of the owner and the contractor to ensure that only road maintenance activities are being performed.

- If after construction is completed it is determined that a permit should have been obtained for a project, the Regional DEP staff should determine if there are any stormwater requirements that need to be addressed. After-the-fact E&S Control or NPDES Permits are not required.
- Road maintenance activities are NOT exempt from Chapter 102 or NPDES requirements, regardless of who the applicant is. (i.e., road maintenance activities CANNOT be authorized by the Erosion and Sediment Control General Permit No.1 (ESCGP-1) for Oil and Gas activities).

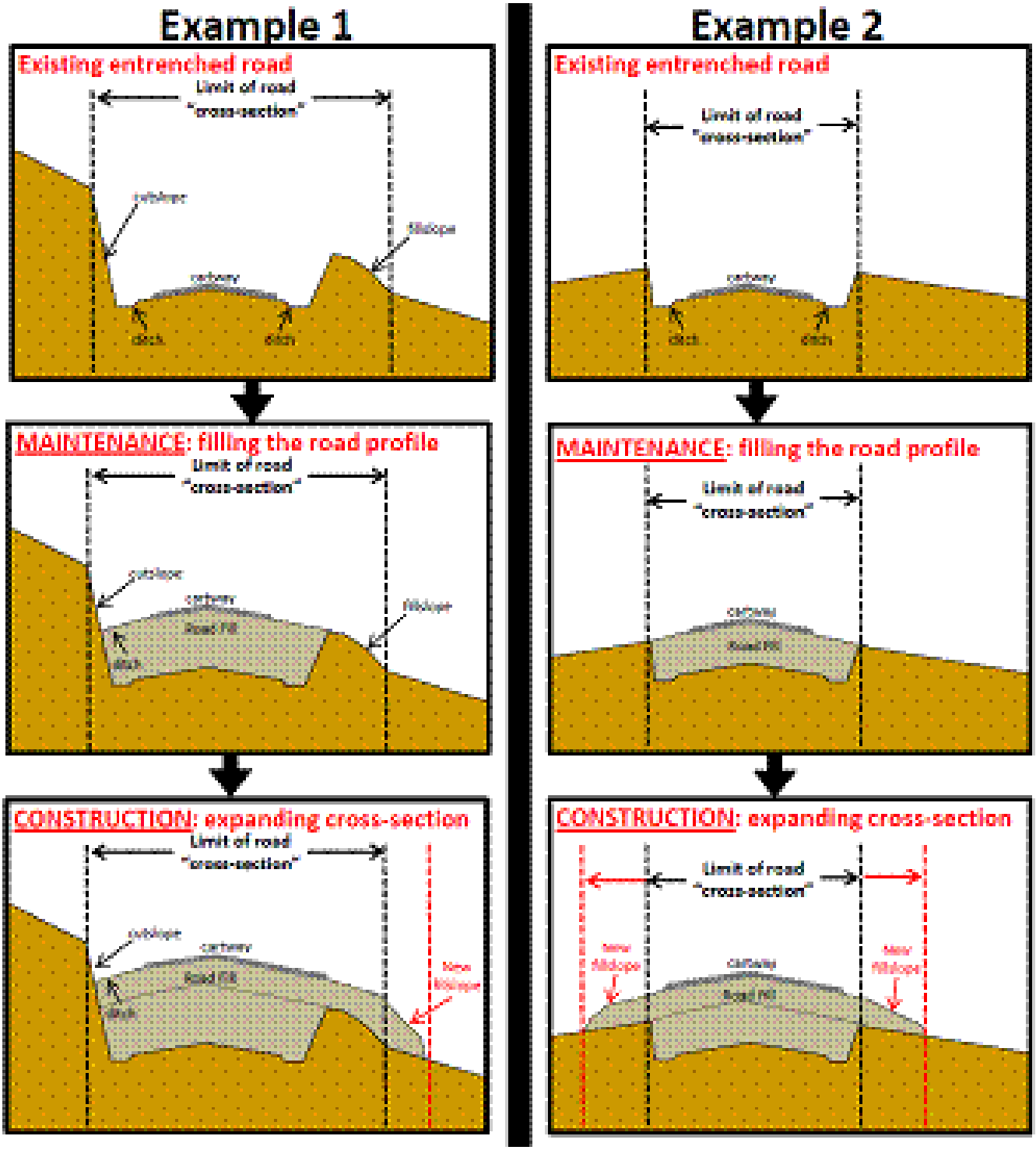
2. Persons conducting road maintenance activities, with 25 acres or more of earth disturbance over the life of the project, are required to obtain an Erosion and Sediment Control Permit, developed in accordance with Chapter 102 rules and regulations.

Earth disturbance activities that extend outside of, or expand the width of the existing road cross-section are not considered maintenance activities and are subject to the permitting requirements of Chapter 102/NPDES, and the acreage thresholds apply. The existing road cross-section consists of the original graded area between the existing toe of fill slopes and top of cut slopes on either side of the road and any associated drainage features. Currently one (1) acre or greater with a point source and less than five (5) acres, or five (5) or more acres of earth disturbance require a permit. The proposed revisions to the Chapter 102 regulations, <u>if approved</u>, will revise the permitting threshold to one (1) acre or more of earth disturbance.

- If an activity located or conducted upon a public roadway rises to the level that the activity creates a need for "excess" maintenance, which may or may not rise to the level of an NPDES permit; the responsible party should be the permittee of any required Erosion and Sediment Control Permit or the permittee for an NPDES permit. The contractor and the owner should both be listed as co-permittee on the NPDES permit.

Increasing the height/profile of a road does not automatically indicate that the activity is not road maintenance. For example: A contractor places 18 inches of DSA on the road surface after grading (road maintenance activity). The placement of DSA is NOT an earth disturbance activity but is a construction activity. The contractor will have to place shoulder back up material beginning at the edge of pavement 18 inches high and taper (at some pre-determined slope) to the existing cross section to promote positive drainage and eliminate the "drop off", which is/can be a safety issue. Placement of the backup material is an earth disturbance activity; however, since it would be placed incidental to the placement of the DSA and according to policy and the expanded definition of Road Maintenance Activities the activity would be considered maintenance <u>as long as the road cross-section was not widened.</u> The existing road cross-section consists of the original graded area between the existing toe of fill slopes and top of cut slopes on either side of the road and any associated drainage features.

- The placement of the backup material is an earth disturbance activity and should be calculated accordingly (L x W). The total area of disturbance is applied to the appropriate threshold for either maintenance (E&S Sediment Control Permit) or construction activities (NPDES Permit).



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

6. Pipelines

The development of oil and gas resources will require the construction pipelines and compressors for delivering the product to market. It is anticipated that most pipeline gathering systems will be built alongside the road system eventually connecting to larger marketing or transmission pipelines in the area.

Requests to locate a pipeline on State Forest lands by an entity other than the subsurface owner or lessee requires a *License for Right-of-Way*. The Bureau has developed a formal process to administer such requests. Right-of-way requests that meet any of the following thresholds will be administered by Central Office in cooperation with the affected State Forest District:

- The project is under the jurisdiction of Federal Energy Regulatory Commission (FERC) or the Pennsylvania Utilities Commission (PUC).
- The project meets the criteria for a 'large project' as established by the PNDI review.
- Projects that cross BOF management boundaries (i.e. forest districts)
- Other right-of-way requests as determined by the District Forester or Central Office

Note: All other right-of-way requests will be administered by the local State Forest district.

Best Management Practices:

a. New pipelines should be combined with existing or proposed roads and certain trails; cross country pipeline corridors should be avoided.
b. Logging crews must be trained under the Pennsylvania Sustainable Forestry Initiative.
c. Combine uses such as electric, water, and gas when possible.
d. Coordination between operators to share infrastructure and limit disturbance and unnecessary capital expenditures is greatly encouraged.
e. Pipeline stream crossings should be assessed on a case-by-case basis, as some options may require more disturbances than others. Below are options for crossings and a little information about each:
    - Horizontal Directional Drill (HDD): minimizes disturbance in sensitive areas and waterbodies; requires weeks for construction period, requires staging areas of 250 ft by 250 ft on each side of the stream; requires flat staging area; risk of surface breach (aka "frac out")
    - Subsurface Boring: minimizes disturbance in sensitive areas and waterbodies; requires a week for construction period; requires bore pit/disturbance area; risk of creating under-drain below stream

- Open Cut / Dry Waterbody Crossing: riparian zone disturbed during crossing; continuous flow maintained via flume pipe, existing damages to riparian zone revegetated/repaired; requires little soil excavation

7. Compressor Stations

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. Compression reduces the volume of the gas and provides the necessary pressure to move gas from one location to another.

During production, compressors are used to 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. Compressor stations utilize turbines, motors, or engines powered by electricity, diesel fuel or natural gas to compress the gas and increase pressure.

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, produce 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 several, 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 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; and as such, should be sited off of State Forest lands wherever possible. The Bureau's objective is to maintain and perpetuate a visitor's anticipated recreational experience on State Forest lands.

The Bureau of Forestry has received substantial input from stakeholders regarding compressor stations on State Forest land. Compression is necessary and vital to the development of natural gas resources but it also has the potential to significantly alter or disrupt the character of the State Forest. In recognition of this fact, the Bureau has actively engaged experts from various disciplines to assist in the development of guidance that meets our goals and objectives and is realistic and attainable from a construction standpoint. The following guidance and BMP's should be adhered to until refined.

Best Management Practices: When no suitable alternatives exist and a compressor station must be sited on State Forest lands, consider the following:

a) Compressor stations are inconsistent with primitive and semi-primitive non-motorized Recreational Opportunity Spectrum (ROS) classes and should not be located in primitive or semi-primitive, non-motorized zones.
b) Cluster with existing infrastructure and development, limiting the size of the footprint to what is necessary.
c) Required setback distances from ecological, recreational or other important resources should be enforced.
d) Siting location on the landscape can dramatically affect the distance sound travels. Ridge tops and open areas exacerbate sound levels and should be avoided when siting.
e) Vegetative screening, such as evergreen plantings, helps to minimize the visual and noise impacts associated with the compressor infrastructure.

Requirements for Compressor Stations:

1. Compressor stations may not be located within semi primitive non-motorized or primitive ROS zones.
2. The operator must quantify the existing ambient noise level at the proposed location by establishing the equivalent sound level (L_{eq}) for a consecutive seven day period during "leaf off" conditions.
    a. The L_{eq} will be measured a point 300 feet from the proposed location of the compressor during project planning stages.
    b. The operating noise level of the compressor shall not increase by more than 10% of the established median L_{eq}. The operator will be required to utilize available technologies and sound mitigation strategies to assure compliance with this standard
3. The operator will establish vegetative screening around the perimeter of the construction footprint at the direction of the Forest District Manager.

4. Approved colors for the facades of all buildings include: forest green, brown, gray, black or natural stain.

8. Vegetation Management

Logging and supplemental planting is a common practice on State Forest lands. To maintain Forest Stewardship Council (FSC) certification, State Forest managers implement BMP's to remain consistent with FSC's principles of sustainable forestry. These BMP's include revegetating a log landing after harvest, erosion and sedimentation control, forage and cover habitat in wildlife openings and restoration in gas development areas.

On-site crew leaders for all logging crews working on State Forest land must be trained under the Pennsylvania Sustainable Forestry Initiative (SFI). Information relating to this training may be found on the internet at www.sfiofpa.org. Each crew leader operating on the site must present a valid PA SFI Core Level Training card as proof of training to the Forest District Manager prior to beginning logging operations. Comparable training from other states may be accepted in lieu of Pennsylvania Sustainable Forestry Initiative training.

The Bureau of Forestry prefers 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 are ecologically significant. However, native species do not always fully support the revegetation needs. Therefore, the use of non-native species may then be preferred or justified in certain situations but may need to be monitored depending on the non-native species planted. To ensure ecologically-sound use of non-native plants, refer to the Planting and Seeding Guidelines (Appendix 3) for detailed seed mixes and planting specifications.

Best Management Practices:

a) On-site crew leaders for logging operations must be trained under the Pennsylvania SFI.
b) Native grass and herb mixes for cover and stabilization should be used within the disturbed construction areas when possible.
c) The seed mix should provide for immediate stabilization and reduce the chance of invasive plant species establishment.
d) A cover crop may be applied at the same time as the requested grass and/or herbaceous seed mix, such as either oats or barley if the seeding takes place in the spring or wheat or rye if the seeding takes place in the fall.
e) Species with rare, threatened or endangered status (PNHP species of concern) are generally not planted unless the BOF has developed a recovery plan for that species.
f) Native plant (including tree and shrub) species with no special status (PNHP species of concern) may be planted. Pennsylvania stock is preferred, cultivars should generally be avoided and species planted should be in their natural geographic range.

9. Invasive Plants

Gas development activities can temporarily or permanently disturb plants, wildlife and introduce invasive exotic plant species. Prior to construction, the State Forest District, Ecological Services Section and the operator should develop plans for managing invasive plant species and interim and permanent site revegetation and restoration.

State Forest Districts have the authority for approving and administering site restoration practices on all sites and for the prevention of establishment, monitoring and eradication of potential invasive plants in areas disturbed by oil and gas development.

Please refer to Appendix 4 for specific guidelines regarding Invasive Plant Management.

Best Management Practices:

a) A pre-construction inventory should be performed within the anticipated areas of disturbance to determine the appropriate prevention methods, predict control needs and assess its level of responsibility for management.
b) Soil disturbance should be minimized to decrease introduction. Consider co-location within previously disturbed areas and/or alternative construction methods.
c) The operator should clean equipment in an appropriate manner prior to bringing equipment into un-invaded areas or ecologically sensitive areas.
d) It is recommended that the operator use weed-free seed, soil, gravel, and mulch. Failure to use of weed-free material increases the potential to introduce invasive plant species and requires stringent monitoring.
e) Pre-treat invasive plant species infestations that reproduce prolifically from rhizome/root segments prior to disturbance. Pre-treatment may limit the spread of the invasive plant infestations upon completion of disturbance activities.
f) Disturbed areas should be surveyed annually at the appropriate time of year to detect early infestations.
g) Management and control of post-disturbance infestations of invasive plant populations should be species specific. In some situations, it may be best to wait another growing season to assess the spread before moving forward with management techniques.

10. Restoration

After construction and drilling activities have concluded, restoration practices can proceed. Before implementing management actions, clear 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. These assessments will also be made with consideration to surrounding habitats and community types and the larger landscape (please refer to Appendix 5: Ecological Restoration Guidelines). Ecological restoration on State Forest land should aim to ensure long-term ecosystem sustainability is functioning.

Interim reclamation may be carried out on sites where gas activity may return to the pad or pipeline. Interim reclamation consists of minimizing the footprint of disturbance by reclaiming all portions of the well site not needed for immediate production operations. Interim reclamation includes, but is not limited to:

- re-contouring portions of the cleared well site
- spreading topsoil evenly and re-vegetating using a predominately native seed mix
- reducing the amount of edge on a site
- enhancing wildlife habitat (e.g., creating brush piles and rock piling around edges to encourage basking areas for rattlesnakes and other reptiles)
- planning development in a manner whereby existing sites are utilized for multiple purposes instead of creating new disturbances.

Final restoration will begin when the site is inactive and will not be accessed for drilling again in the short-term. Due to the differences in drilling practices, the uncertainty of future development needs, and the use of existing well pad sites as staging areas, there is not a definitive restoration schedule. The District will work closely with the operator to plan restoration activities as early as possible to aid in restoration planning. 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 sources for wildlife
- enhance special habitats

Best Management Practices

General

The first thing to consider in developing a restoration plan is the long-term desired condition for the landscape and site. Before implementing management actions, district personnel and Ecological Services should create clear long-term objectives for the landscape (please refer to

Appendix 5: Ecological Restoration Guidelines). These objectives and options for reclamation should consider the following:

a) Conduct pre-project monitoring as needed. 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.
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.
c) Identify the need and level of restoration. It may be important to describe the improvements that are anticipated following restoration.
d) Identify restoration goals. 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.
e) Identify 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.
f) Perform monitoring as required to document the attainment of project goals and objectives
g) Conduct an ecological evaluation of the newly completed project if possible. 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.

Interim: Interim reclamation consists of minimizing the footprint of disturbance by reclaiming all portions of the well site not needed for production operations.

a) The portions of the cleared well site not needed for operational or safety purposes should be recontoured to a final or intermediate contour that blends with the surrounding original topography as much as possible.
b) Low compaction grading techniques should be used to minimize compacting soils when spreading topsoil. Topsoil should be spread over areas not needed for operations. When practical, the operator should respread topsoil over the entire location and revegetate to within a few feet of the production facilities, unless an all-weather, surfaced, access route or turnaround is needed.

c) Any topsoil not respread should remain stock piled and vegetated to prevent it from eroding and to help maintain its biological viability.
d) 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 feather the edges of the sites. 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.
e) Existing sites not being used could be utilized for storage, staging area or some other use that would eliminate the development of another pad site.

Final: Final restoration can begin once all activity on the site is complete.

a) The site should be recontoured to its original state and blend with the surrounding topography as much as possible.
b) Low compaction grading techniques should be used during final grading to minimize compacting soils. Final grading that leaves a loose soil and a rough surface increases survival of seeds, planted seedlings and forest productivity. Follow Appalachian Regional Reforestation Initiative (ARRI) recommendations.
c) The stockpiled topsoil should be re-spread over the entire site and re-seeded using a mix compatible with the Bureau of Forestry's Planting Guidelines (Appendix 3).
d) A suitable rooting medium (no less than 4 ft deep) should be created for good tree growth.
e) Tree-compatible ground covers should be established for future tree growth, if this is a final restoration goal.
f) In recontouring areas that have been surfaced with gravel or similar materials, the material should be removed and discarded, re-used at on other pad sites as approved by the BOF, or buried deep in the recontoured cut to prevent possible surface exposure.
g) At least two types of trees should be planted on sites where forest restoration is the final goal. Early-successional species for wildlife and soil stability, and commercially valuable crop trees should be planted using proper tree planting techniques and protecting against deer damage where necessary. It is important to select suitable and appropriate tree species. Please refer to the Bureau of Forestry's Planting Guidelines (Appendix 3) for specific species.
h) For permanent forest openings it is important to consider the surrounding landscape (Please refer to Appendix 5: Ecological Restoration Guidelines).
i) Permanent forest openings should be 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.

Habitat Enhancement: Development from gas related activities may provide opportunities for habitat enhancement. Please refer to Appendix 5: Ecological Restoration Guidelines for more information.

a) If possible, rocks and stumps should be piled along the north or northeast edge of the clearing to maximize solar gain, benefiting basking reptiles. Also, if large, flat boulders are present, they should be placed flat (on the horizontal axis) with a cavity beneath them, whenever possible.
b) Artificial nest structures, such as platforms, and nest boxes are commonly used to provide habitat for raptors and other birds. These structures could be constructed during interim or final phases, if the appropriate site is available.
c) 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.
j) Depending on the restoration goals of the site, woody debris (not being used to create brush piles) should be distributed evenly on the well site to aid in soil restoration and enhance wildlife habitat.

11. Recreation

Due to the large, contiguous land area available to outdoor recreationists, State Forest lands provide a unique opportunity for dispersed low-density outdoor recreation that typically may not be attainable on small forested areas or private lands. The Bureau encourages low-density dispersed recreation and strives to promote and provide for these types of activities. 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 State Forest 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. Natural gas activities can dramatically increase the potential for adverse impacts and conflict through: increased traffic volumes; elevated noise levels; and aesthetic impacts. Any potential impact is directly dependent upon a visitor's activity, anticipated recreational experience and location within the State Forest.
To minimize conflicting impacts to these diverse recreation activities, the Bureau of Forestry will follow ecosystem and multiple-resource management practices for all gas-related activities.

The following policies and considerations are intended to minimize potential conflicts or adverse impacts to State Forest recreational activities:

- Leases, mineral development and new rights-of-way will be prohibited on designated State Forest Wild and Natural Areas, provided that subsurface oil and gas rights may be leased where no surface use or disturbance will occur. Rights-of-Way expansion 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 of Forestry 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 includes important viewsheds and vistas. Surface disturbance within these areas is extremely limited and reviewed on a case-by-case basis.
- Aesthetic buffers are established to avoid or minimize potential impacts to recreational resources, uses or values. 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 section F: Setbacks).

- 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.

Best Management Practices:

- The safety of the public and gas operators is paramount. Consider temporary closures of roads or trails where conflict is inevitable and no reasonable compromise exists.
- Gas operators will provide necessary security, safety, and signage measures (as approved by the Department) during operations at no cost to the Department. The gas operator must notify the Department 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 Department who will notify the umbrella user groups, other impacted Lessees, rights-of-way interests and local media.
- Consider the full extent of recreational activities and the seasons in which they occur when planning gas exploration or development.
- Avoid areas of concentrated recreational activity and developed recreational sites when locating gas related infrastructure.
- Provide alternative trail routes when substantial 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.
- 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 BMP's for roads)
- Oil and gas operators will provide a minimum of 10 days notice to the Forest District Manager when flaring activities are anticipated 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 within the designated Dark Sky Area. Whenever feasible, the operator should secure functional pipeline rights-of-ways prior to gas production so that unnecessary flaring is avoided.

- During the following holidays and high visitor use periods there should be no heavy hauling (i.e., rig moves, water trucking, frac equipment) or seismic activity. Any deviations from these guidelines will be reviewed on a case-by-case basis and require a waiver. 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: refer to the PA Game Commission and PA Fish and Boat Commission for season dates

- Opening weekend of trout season
- Opening weekend of youth spring gobbler season
- Opening weekend of spring gobbler season
- Regular bear season
- First three days and both Saturdays of regular firearms deer season

Other Activities:

The following activities may have hauling and seismic restrictions, but will be determined by the District if restrictions are necessary for these 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

H. Guidelines: Review and Approval Process

This section refers to the review and approval of the following gas-related activities on SF lands: well pads, staging areas, impoundments, pipelines, compressor stations, access roads, water withdrawals and infrastructure and seismic activities.

There are two types of review and approval processes for gas development activities in BOF. Surface land review is performed in cooperation with the District, Ecological Services, Planning, Marcellus/Minerals and Recreation. The surface land review strives to appropriately site gas activities in a manner to minimize fragmentation and impacts to State Forest resources, uses and values. The second review type is the Bottomhole review performed by Marcellus and Minerals Sections. This review evaluates if the well site is geologically sound and in compliance with the lease terms; specifically regarding required setbacks and/or well-spacing.

Tracts under lease are required to provide ninety (90) days advance notice to Forest District Managers before conducting operations that will affect forest growth. In addition, the Lessee is required to obtain written final approval before any construction activity will be allowed to commence. Activities and operators that don't fall under a lease are encouraged to submit their notice as early in the planning process as discussed below.

Development Plan Review:

Companies are requested to provide tract-level development plans to the BOF to incorporate landscape-level planning efforts, evaluate cumulative impacts, facilitate office reviews and enable pre-planning for any necessary field reviews.

Development plans should include all gas-related activities—pad sites, access roads, pipelines, compressors, seismic activity, water withdrawal sites, and water lines. Plans will be circulated for review and comment by the District, Ecological Services, Planning, Marcellus/Minerals and Recreation Sections. After review, the Bureau will consult with the operator as necessary to discuss areas of concern within the plan which may include participation in field reviews. Bureau review and comment regarding the development plan does not constitute clearance to begin construction of the gas activities found in the plan.

Site Specific Review And Approval Process:

A. Submissions: At a minimum, the operator should submit the following to the BOF for review purposes:

- Map delineating the planned activity in hardcopy along with ESRI ArcGIS compatible shape files

- Narrative description of the project to include 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. **<u>Preliminary Review:</u>** The Preliminary Review is comprised of the following tasks and completed by the Forest District in consultation with the Ecological Services Section as necessary.

1. ***Desktop Review:*** A desktop review is performed by the Forest District prior to a field visit with the operator. This review determines if the gas activity locations are compliant with required setback distances from resources (i.e. wetlands, streams, T&E species habitat buffers, recreational ammenities), and is appropriate and conducive to State Forest operations. The following must be performed or considered prior to any field views:

- Non-development areas as specified on lease tract maps
- Areas of special concern as specified on lease tract maps
- PNDI review of rare, threatened and endangered plants, animals, communities and invertebrates
- Designation of existing waterways and water bodies
- Wetland mapping and wetland delineation reports (as available)
- 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

Note: Projects involving water withdrawal requests should also be forwarded to Bureau of Topographic and Geologic Survey for sustainability review.

2. ***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 Ecological Services Section when their expertise is needed.

The following should be assessed during the field review:

- Non-development areas as specified on lease tract maps
- Areas of special concern as specified on lease tract maps
- Wetlands, vernal pools and spring seeps
- Cultural resources
- Rare, threatened and endangered habitats and species
- Plant and animal habitat characteristics such as: scree slopes/talus/boulder fields; caves; herbaceous openings in high-quality forage; sunny rock outcroppings; and cliffs
- Presence of invasive plant species
- Exposed limestone or shale
- Stands of at least 100 trees with diameter at breast height > 30 inches
- 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 taking into account the survey season for the target species or resource. These reviews should not occur if there are two or more inches of snow cover. The time of year for the field reviews will be set before the commencement of the project to allow the operator the opportunity to revise its plans for the project, if necessary.

3. ***Preliminary Review Response:*** After the desktop review and necessary field reviews, the District will provide the company with one of three responses:

   a. Yes, the site is acceptable. The operator will continue with their procedures to obtain all permits and required approvals.
   b. Maybe, with further review. The operator may continue with the site approval process; however, further review, analysis or site surveys need to be performed either by BOF staff or the operator/consultant before preliminary approval can be granted. If waivers are required, the waiver review process should begin at this time. Please reference the waiver process.
   c. No, with alternatives. The site is inappropriate -justification and alternatives will be presented to the operator.

   Note: Preliminary approval by the District does not provide clearance or final site approval in reference to threatened and endangered

species and resource reviews. Construction activities will not begin until necessary permits have been secured, required setbacks are satisfied and final approval has been given. Field and species survey reports should be submitted to the Ecological Services Section and the District for review and approval prior to final approval.

C. ***Final Approval Request****:* The operator submits formal request to the Marcellus Program or Minerals Section. Marcellus/Minerals will confirm that all approvals, permits and review requirements have been secured for the proposed activity. Marcellus /Minerals will circulate a formal request to the District and Ecological Services Section for final approval.

D. Bottomhole Review and Approval Process: Marcellus/Minerals staff performs a technical review of each well request consisting of geotechnical considerations, well spacing, property line setbacks and technical compliance with any lease or agreement. Any deficiencies will be discussed and alleviated with the operator prior to approval. Marcellus/Minerals will submit approval directly to operator.

Note: The Bureau of Forestry will make every reasonable attempt to grant well site approval within 30 days of receiving the final request. The 30 day time frame does not accommodate possible PNDI reviews and surveys conducted by the Pennsylvania Game Commission, Pennsylvania Fish and Boat Commission, US Fish and Wildlife Service and the DCNR Wild Plant Program.

I. Gas Program Waiver Requests

Operators may submit waiver requests for certain conditions specified in the lease or guidelines when it is apparent that the deviation from those conditions will provide greater protection to State Forest resources, uses or values than adhering those specified conditions. Any deviation from conditions specified in any of the leases, agreements or guidelines requires an approved waiver.

Requests must be justified and submitted in writing to the State Forester for review and approval. The Bureau of Forestry's intent is to not grant blanket approval for waivers, but to review the waiver requests on a case-by-case basis. The Bureau of Forestry 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 Process

1. District or Marcellus/Minerals Section Receives Request

- The operator submits a waiver request to deviate from conditions specified above to the District or the Marcellus/Minerals Section.
- The operator will identify the need for the deviation and provide justification for the request to the District or Marcellus/Minerals. Waiver request should be submitted in writing and include:
    a) Identification of the specific condition for which a waiver is sought
    b) Description of the proposed deviation
    c) Justification of the need to deviate from the identified condition
    d) Identification of alternatives considered and investigated
    e) Evidence that deviation will not cause detrimental impact to resource or condition for which the waiver is requested
    f) Any necessary mapping including GIS data where applicable

2. ***District Initial Review and Consultation***

- The District will begin review and consultation with the appropriate Central Office staff as needed (Marcellus/Minerals, Ecological Services, Recreation, and Planning Sections).
- Significant Encroachment: If the desktop review shows that resources or buffers may be *significantly* impacted or altered and a waiver may be necessary, the District and appropriate Sections should be alerted prior to submitting the waiver request to Marcellus/Minerals for review.

3. District submits Waiver Request to Marcellus/Minerals

4. Marcellus/Minerals Coordinates Central Office Review

- Marcellus/Minerals will review the waiver request and justification and coordinate with the operator to discuss any issues or concerns at this time. If the request is considered un-satisfactory or insufficient, the operator will be apprised of those deficiencies and asked to resubmit the request.
- The Marcellus/Minerals programs will coordinate a 5-day Central Office review. It is assumed that by this point, any issues would have been discussed or worked out prior to the District submitting the final waiver request.
- After review and consultation with appropriate Bureau staff, if it is determined that the request is not in the best interest of the Commonwealth and does not provide greater environmental protection, the waiver request may be denied before submitting for final review by the State Forester.
- Where the Bureau does not feel a waiver is in the best interest of the Commonwealth and the operator disagrees and intends to move forward with the request, the dispute resolution process would be used.

5. Waiver Request Submitted to State Forester for Review: After initial review and comments are received from the necessary Bureau staff, the District or Marcellus/Minerals Sections will provide the request and appropriate documentation to the State Forester (or their designee) for review.

6. ***State Forester provides waiver Approval/Denial to Marcellus/Minerals Section***: The State Forester (or their designee) will review the waiver request and provide an approval or denial.

7. ***Minerals/Marcellus Section will notify Operator of Waiver Approval or Denial:*** The Minerals/Marcellus Section will submit the approval or denial response to the operator.

Surface disturbance activities related to subsurface exploration or development is prohibited within State Forest Wild and Natural Areas and State Parks where the Commonwealth owns the subsurface rights. There is **no provision** for an operator to obtain a waiver of these restrictions.

J. Guidelines for Conducting Routine Field Inspections

1. Forest District Managers will 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.

2. The Bureau of Forestry will strive to maintain its cooperative relationship with the DEP's Bureau of Oil and Gas Management (DEP-BOGM). State Forest District Offices should coordinate field inspection activities with DEP-BOGM Regional Offices, where 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. In addition, an up to date emergency contacts list shall be maintained by the district and the Operator. An initial contact list may be found in Exhibit C of the Lease and in Appendix 6.

3. 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 power to perform site inspections unannounced. The Forest District Manager should document any problems with photos or video for later use in demonstrating the issue to the Operator, the Subsurface Programs staff and the DEP staff. Routine inspections may be coordinated with the Operator's staff as a courtesy.

4. The following two pages will serve as a form for recording observations while 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 returned to the Commonwealth at the end of the extraction operations.

5. The inspection form addresses 33 items in four main subject areas:

    - Access and Safety
    - Permits and Information
    - Environmental Control
    - Property Protection

The first page of the form contains a check box for each of the 33 items. If unsatisfactory conditions are observed, items should be marked with "**X**." An explanation of the condition and necessary corrective action(s) should be noted on page two. Additionally,

specific items should be marked with "**√**" to indicate satisfactory completion of activities or marked with "**NA**" to indicate this item is not applicable.

Note: Surveys for invasive plant species (Inspection Item Number 25) should be completed one year after the commencement of earth disturbance activities.

Commonwealth of Pennsylvania
Department of Conservation and Natural Resources
Bureau of Forestry

Oil and Gas Operations Field Inspection Form

Inspections should be conducted weekly (if possible) during active construction projects (roads, pipelines, well pads, staging areas and compressor stations), unless problems or weather conditions dictate otherwise. Enter information for each inspection.

Name of Operator:_____ Tract Number:_____
Facility ID:_____ Latitude:_____ Longitude:_____
District: _____ County: _____ Township: _____

Inspect each item listed below. Mark "**√**" 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	1. Public-use roads safe for public travel													
	2. Access roads in good, passable condition													
	3. Gates appropriately opened or closed													
	4. Dangerous equipment posted or fenced													
	5. Dangerous areas posted or fenced													
	6. Other potential safety hazards													
Permits and Information	7. DEP Well Permit / Well ID posted on site													
	8. ESCGP-1 Permit posted on site													
	9. E & S Control Plan posted on site													
	10. PPC Plan posted on site													
	11. Consumptive Water Use Permit posted													
	12. MSDS Sheets available on site													
	13. Emergency contact information posted													
	14. Other													
Environmental Control	15. Public-use road drainage / E & S conditions													
	16. Access road drainage / E & S conditions													
	17. Well-pad conditions													
	18. Water storage conditions (tanks or ponds)													
	19. Pipeline ROW conditions													
	20. Logging and/or skidding operations													
	21. Water conditions (streams)													
	22. Other erosion & sedimentation problems													
	23. Noticeable wildlife habitat impacts													
	24. Noticeable vegetative impacts													

	25. Noticeable invasive plant infestation													
	26. Indication of leak or spill (pad, road, etc.)													
	27. Other environmental impacts													

Property Protection	28. Damage to forest growth													
	29. Damage to infrastructure													
	30. Artifacts protected if discovered													
	31. Fire protection													
	32. Sanitation of site(s)													
	33. Other damages or problems													

Date	**Item Number**	**Provide explanation:** ▪ **Description of unsatisfactory conditions and corrective action taken** ▪ **Work completed and site restoration satisfactory** ▪ **Survey for invasive plants species conducted and actions needed**

Other comments:

K. Guidelines for Emergency and Pollution Incidents

Oil and gas operators are expected 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 emergency and/or pollution incidents that may occur. Bureau staff will function primarily in a support role for the operator or agencies with jurisdictional authority.

Management of Medical Emergencies:

In the event that district staff is called out to a medical emergency at a construction site, it is imperative that the staff have access to the local emergency phone listings to summon emergency services to the construction site in the shortest time possible. As each county and municipality has its own 911 system and requirements for registering the well pad sites as addresses for 911 purposes, it is beyond the scope of the Guidelines document to try and list all the possible contact information within all the gas districts. Therefore, each district should have an up-to-date Emergency Action Plan, provide training to its staff in using the plan and accessing the contact database, and provide the resources necessary to respond to an emergency in an effective manner. A copy of the district Emergency Action Plan should be kept in all vehicles for quick reference for Bureau staff.

It is expected that the operator will assume the lead role in all medical emergencies at the drill sites, construction sites and facility sites as it is likely the operator's employees will be present at the site of the emergency from its inception. DEP and OSHA require the operators to have emergency plans on site and provide their employees with training for emergency situations. In the case where Bureau staff may be present during a medical emergency, assistance should be offered and the use of the district emergency phone contacts should be offered to the operator's employees if there is confusion regarding the local 911 system and how to summon the necessary help.

In the event that a life flight response is necessary for the emergency, the district should take the lead in directing the flight to the nearest safe landing zone and coordinating the route to that zone by any emergency personnel at the site. Numerous life flight landing sites have been identified in the districts and the locations should be part of the district Emergency Action Plan.

In the event that the incident involves a major fire (blow out event) at the rig or well site and gas has been released and is burning, no Bureau staff should attempt to access the site and assess the situation. Assessment should be carried out away from the site of the fire at a safe distance. Gas well fires are unpredictable in their nature and may flare as the gas release proceeds. The operator's employees and the rig crew are well trained in blow out prevention and management, so the district staff should take their lead from the rig crew and operator's staff. The district may assume a fire-control role to prevent the fire from spreading to the surrounding forest, but the actual gas fire itself will be addressed by professional well fire

fighters in cooperation with the rig crew and the operator. The district may be called upon to lend resources to this effort, but will not likely be called to participate in controlling and extinguishing the well fire.

Management of Environmental Pollution Events and Emergencies:

The expected large number of drill sites combined with the necessary road transport and storage of fluids on a routine basis requires the Bureau staff to be alert at all times to the possible accidental release of any substance being used and handled as part of the drilling and completion activity.

In addition, while drilling of the shallow portion of any well proceeds, there exists the chance that the high pressure air stream used as the drilling fluid to remove rock cuttings and formation water, may enter fractures and joints in the near surface rocks encountered by the well bore and exit at the surface in springs and seeps as turbid flow.

Finally, transport and handling of premixed drill mud and fracing chemicals to the pad sites also involves some risk from accidental spillage or actual road collisions that may release liquids into the environment. Along with the chemicals, large amounts of diesel fuel are stored on site and carried in transport trucks fuel tanks.

The Minerals Section will act as the central point of contact for the Bureau Headquarters for reporting and monitoring all environmental incidents on SF lands. All phone reports, written reports and photos should be sent to the Minerals Section for accumulation and dissemination to the Bureau Management and DCNR Management.

The following general procedures should be adhered to by the district staff upon being called out on a suspected pollution event, a road collision involving gas supply trucking, or any other event that may have the potential to release substances into local waterways, vernal pools, wetlands, or onto the soil on State Forest lands:

1. If no imminent safety danger exists, access the site and confirm a pollution event has occurred. If imminent safety concerns are present or an injury has occurred call 911 and report the situation.

2. Call the DEP hotline for reporting pollution events at the nearest DEP office emergency phone number listed below:

    - **Meadville 800-373-3398**
    - **Williamsport 570-327-3636**
    - **Pittsburgh 412-442-4000**
    - **Wilkes-Barre 570-826-2511**

- **Harrisburg 877-333-1904**
- **Norristown 484-250-5900**

3. Call the well operator if the event is at a well site, or if the event is at facility owned by the operator or is nearby the site of the operator's activity. If you cannot identify the operator, call all the nearby operators to report the event. The complete listing of the emergency contact phone numbers for all Lessees on State Forest lands can be found in Appendix 6.

4. Call the Subsurface Program and the Forest District Manager.

5. Call any other agencies that may need notification, such as the PA Fish and Boat Commission, PEMA, Local Fire Department, local County Conservation offices, and possibly the Susquehanna River Basin Commission Inspector. Contact information for some of the above named agencies can be found in Appendix 6.

   Note: At this point in the communication chain the operator and DEP will be using their own call notification tree, so duplication on our part is not harmful to the process. Additional DEP call numbers are also listed in Appendix 6.

6. Use the "Environmental Incident Report & Notification Form", found at the end of this section, to begin an incident report that may be used to document the incident from the standpoint of the Bureau and its lands. The form is meant to provide an organized means to record the incident in a logical and sober manner for possible later use in unraveling the event.

7. Take ample photos of the site to document the visual impacts and transmit to the Minerals Section when possible.

8. Locate the incident site on a topographic map and transmit to the Minerals Section.

9. Assuming the conditions at the site are safe, and the staff present have been trained in sample acquisition protocol and have the proper sampling containers, take samples of the substance at the pollution site, and along the route the pollution may be following to a local stream. Sample the local stream at the point the pollution enters, also upstream and downstream from the entry point. Each district will have the proper coolers and instructions for submitting samples to DEP labs or private labs as needed.

10. Plan to monitor the situation on a daily basis and file reports with the Minerals Section as the situation continues to unfold.

11. Operators are required to provide Notices of Violations to the Bureau in a timely manner.

    Note: Collect copies of all reports issued by the operator or DEP and forward copies to the Minerals Section.

ENVIRONMENTAL INCIDENT REPORT
AND
NOTIFICATION FORM

Date of Incident (or when first discovered/reported):_____ , 20_____
Approximate Time of Incident (or when first discovered):_____ AM PM
Incident Involved:

- ☐ gas drilling or well pad site
- ☐ gas pipeline
- ☐ timbering (ex. Fuel spill from truck)
- ☐ vehicular accident (ex. Fuel spill)
- ☐ other (describe)_____

Suspected Responsible Party/Company: _____

LOCATION:

District Name:_____ Township:_____ County:_____
(closest) Road/Intersection Name: _____
Closest surface water body if threatened by incident: _____

BRIEF DESCRIPTION OF INCIDENT:

	Contacted Parties		Date	Time	Name of Contact
☐	**911** (only if absolute emergency)				
	DEP Offices				
☐	Meadville	800-373-3398			
☐	Williamsport	570-327-3636			
☐	Pittsburgh	412-442-4000			
☐	Wilkes-Barre	570-826-2511			
☐	Harrisburg	877-333-1904			
☐	Norristown	484-250-5900			
☐	**Suspected Responsible Party**				
☐	**PA Fish & Boat Commission**				
☐	**PEMA**	800-424-7362			
☐	**PA State/Local Police** (circle one)				
☐	**Local Fire Department**				
☐	**Minerals Section**	717-787-2703			
☐	**Others**				

OTHER CONSIDERATIONS:

- Take good notes of incident response including actions of listed parties
- Collect GPS points from the appropriate location(s)
- Take photographs from appropriate location(s)
- Complete online incident form when time permits

L. Appendixes

Appendix 1: 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)

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

- Any information submitted as part of a vendor's cost proposal
- Information submitted as part of a vendor's technical response that does not pertain to specific business practices or product specification
- Information submitted as part of a vendor's technical or disadvantaged business response that is otherwise publicly available or otherwise easily obtained
- 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 2: State Forest Rules & Regulations

RULES AND REGULATIONS

TITLE 17. PENNSYLVANIA CODE, PART I. DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

Subpart C. STATE FORESTS

CHAPTER 21. GENERAL PROVISIONS

Authority

The provisions of this Chapter 21 issued under Section 313 of the Conservation and Natural Resources Act (71 P.S. § 1340.313); and the Crimes Code, 18 Pa.C.S. §§ 7505 and 7506, unless otherwise noted.

PRELIMINARY PROVISIONS

§ 21.1. Definitions. The following words and terms, when used in this chapter, have the following meanings, unless the context clearly indicates otherwise:

Camping–Overnight lodging using standard camping equipment.

Commercial activity–An activity in which a person, organization or association directly or indirectly accepts consideration of value as compensation for the provision of goods or services, including transportation.

District Forester–The Department's Bureau of Forestry employe so designated.

Group activity–An organized activity occurring as a scheduled event and requiring a large land area or unique land formation and which may conflict with normal or traditional uses or pose a potential environmental problem.

State Forest land–Land which is owned or leased by the Commonwealth and which is administered by the Bureau of Forestry.

§ 21.2. Scope. This chapter applies to State Forest land.

§ 21.3. Violations.

(a) A person is guilty of a summary offense under 18 Pa.C.S. § 7505 (relating to violation of governmental rules regarding traffic) if that person commits an act which is prohibited by § 21.21 (relating to motor vehicles).

(b) A person is guilty of a summary offense under 18 Pa.C.S. § 7506 (relating to violation of rules regarding conduct on Commonwealth property) if that person commits an act which is prohibited by this chapter other than those in subsection (a).

§ 21.4. Closure.

(a) Areas or portions of a State Forest or State Forest facilities may be closed or restricted to certain uses by the District Forester or a designee.

(b) The public will be informed of the closed or restricted areas or facilities by any form of communication, which may include posted signs, or by fencing or other enclosure manifestly designed to exclude intruders.

(c) Violation of the closure or restriction notices under subsection (b) is prohibited.

BOATING

§ 21.11. Use. All waters on State Forest land are open for the operation of watercraft unless posted as closed.

§ 21.12. Mooring and launching.

(a) Overnight mooring or storage of watercraft from November 15 through March 31 is prohibited except on lands leased from the Commonwealth. This prohibition does not apply to canoes, kayaks, rafts and other paddle-powered small boats stored overnight at the operator's campsite.

(b) The launching or mooring of watercraft on waters in State Forests requires the appropriate valid State Recreation Area Watercraft Permit affixed aft of amidship on the starboard—right—side.

(c) A current Fish and Boat Commission number and certificate of watercraft registration permits daily launching only.

(d) The Department will establish a schedule of fees for mooring and launching permits. This schedule and any subsequent revisions will be effective upon publication in the *Pennsylvania Bulletin*.

(e) Small, hand-carried boats, rafts and canoes may be launched from any point on the shoreline. Boats on trailers may be launched only at designated launch areas.

(f) Boat mooring is restricted to designated mooring areas.

§ 21.13. Motorized boats. Only electric motors may be used for propulsion of motorized watercraft.

MOTORIZED VEHICLES

§ 21.21. Motor vehicles.

(a) This section pertains to motor vehicles other than those addressed in §§ 21.22, 21.23 and 21.23a (relating to snowmobiles; trail bikes and other motorized off-road vehicles; and all-terrain vehicles).

(b) Operation of motor vehicles on State Forest land in the following manners is prohibited:

(1) Operation of a motor vehicle in careless disregard for the safety of persons or property, or in excess of posted speed limits or, where no speed limit is posted, in excess of 25 miles per hour.

(2) Driving on roads, trails or other areas not specifically designated and posted for motor vehicle traffic unless authorized in writing by the District Forester or a designee.

(3) The use of State Forest roads for commercial purposes without a road use agreement from the Department. An individual or corporation whose property adjoins State Forest land is not required to obtain a road use agreement to use State Forest roads for incidental commercial purposes to make deliveries to the property.

(4) Operating unlicensed, unregistered or uninspected motor vehicles on State Forest land.

§ 21.22. Snowmobiles.

(a) Snowmobiling is permitted in accordance with 75 Pa.C.S. Chapter 77 (relating to snowmobiles) and this section.

(b) Snowmobiles may be operated only on designated snowmobile roads, designated trails and designated and posted areas on State Forest land.

(c) Snowmobiles may be operated on State Forest land from the day following the last day of regular or extended antlerless deer season as established by the Game Commission through the following April 1, or earlier, as determined by the District Forester.

(d) Operation of snowmobiles on a road, trail or area not specifically designated and posted for snowmobile use or at any time of year other than that in subsection (c) is prohibited.

§ 21.23. Trail bikes and other motorized off-road vehicles. This section pertains to motorized off-road vehicles other than those addressed in §§ 21.22 and 21.23a (relating to snowmobiles; and all-terrain vehicles).

(1) Trail bikes and other motorized off-road vehicles may be operated only on roads, trails or other areas that have been specifically designated and posted for their use.

(2) Trail bikes and other motorized off-road vehicles may be operated only during the times of year authorized by the Department's Bureau of Forestry by posted signs.

§ 21.23a. All-terrain vehicles.

(a) The operation of all-terrain vehicles is permitted in accordance with 75 Pa.C.S. Chapter 77 (relating to all-terrain vehicles) and this section.

(b) All-terrain vehicles may be operated only on designated and posted roads, trails and other areas.

(c) All-terrain vehicles may be operated on State Forest land from the Friday before Memorial Day through the last full weekend in September, and from the day following the last day of the regular or extended antlerless deer season as established by the Game Commission through the following April 1.

§ 21.24. Spark arrestors. Operation of any motorized vehicle, all-terrain vehicle, trail bike or other motorized off-road vehicle in, on or through State Forest land without a fully functional spark arrestor is prohibited.

§ 21.25. Parking.

(a) Parking a motor vehicle, all-terrain vehicle, snowmobile, trail bike, other motorized off-road vehicle, boat trailer, camp trailer or other equipment which obstructs a gate, road, trail, footpath, bicycle path, access way, drinking fountain, entrance, exit or road turnaround on State Forest land is prohibited.

(b) A person may not park a vehicle in a parking area on State Forest land designated for handicapped persons, unless the vehicle bears a handicapped or severely disabled veteran registration plate or displays a handicapped or severely disabled veteran parking placard, in accordance with 75 Pa.C.S. §1338 (relating to handicapped plate and placard), and the vehicle is operated by or for the transportation of a handicapped person or a severely disabled veteran.

(c) Violations of this section will be handled as follows:

(1) Prior to the filing of a citation charging a summary offense under

this section, the Department may issue a parking ticket, which will be handed to the violator or placed on the windshield of the violator's vehicle. The violator may avoid criminal proceedings by paying a fine to the Department, equivalent to the maximum fine as provided in 18 Pa.C.S. § 7505 (relating to violation of governmental rules regarding traffic), within 5 days of the violation in the manner specified on the ticket.

(2) When a parking ticket has been issued, the Department may institute criminal proceedings only upon failure of the violator to pay the fine in accordance with the time limit specified in paragraph (1) and in the manner specified on the ticket.

(3) When a parking ticket has not been issued, the Department may institute criminal proceedings by issuing a citation.

FOREST PRODUCTS

§ 21.31. Prohibitions. The following activities are prohibited:

(1) Cutting, picking, digging, damaging or removing, in whole or in part, a living or dead plant, vine, shrub, tree or flower on State Forest land without written authorization of the District Forester or a designee, except that edible wild plants or plant parts may be gathered without authorization if they are gathered for one's own personal or family consumption. Dead and down wood for small campfires may be gathered without prior authorization.

(2) Removing rocks, shale, sand, clay, soil or other mineral products from State Forest land without written authorization of the District Forester or a designee.

(3) Removing peat, sawdust, bark, mulch or other products from State Forest land without written authorization of the District Forester or a designee.

(4) Removing or disturbing historical or archeological resources from State Forest land without written authorization of the District Forester or a designee.

(5) Planting a tree, shrub or plant of any kind without the written authorization of the District Forester or a designee.

§ 21.32. Designated trees. Only designated trees may be cut or removed.

§ 21.33. Cutting practices.

(a) The stump height of cut trees may not exceed the diameter of the stump or 12 inches whichever is smaller.

(b) All tops and slash shall be removed 25 feet from streams, roads, trails and State Forest boundaries.

(c) The blocking of drainage ditches, pipes and other structures with tops and slash is prohibited.

§ 21.34. Removal. The removal of fuel wood and other forest products from the forest by the use of tractors, skidders or any method other than hand carrying is prohibited without written authorization of the District Forester or a designee.

MISCELLANEOUS PROVISIONS

§ 21.61. Camping permit. Camping without a current camping permit issued by the District Forester or a designee is prohibited. Primitive backpack campers not using developed facilities do not need a permit if they stay no more than 1 night at any campsite.

§ 21.62. Open fires.

(a) Subject to the prohibition in subsection (b), small campfires are permitted only where adequate precautions are taken to prevent the spread of fire into the forest. All other fires are prohibited. Campfires shall be attended at all times.

(b) Open fires are prohibited when the forest-fire danger is determined by the District Forester to be High, Very High or Extreme and from March 1 through May 25 and from October 1 through December 1 without authorization from the District Forester or a designee. This prohibition does not apply to small self-contained camp stoves when used in a safe manner.

(c) A person causing a wildfire, in addition to possible criminal penalty, is liable for all damages, costs of extinction and fines.

§ 21.63. Hunting and trapping. Hunting and trapping on State Forest land are permitted in accordance with 34 Pa. C.S. (relating to Game and Wildlife Code) and rules and regulations, unless otherwise posted.

§ 21.64. Fishing. Fishing in waters on State Forest land is permitted in accordance with 30 Pa. C.S. (relating to Fish and Boat Code) and rules and regulations, unless otherwise posted.

§ 21.65. Target shooting. Target shooting with firearms, bows and arrows or devices capable of launching projectiles and causing injury to persons or property is prohibited except where authorized by the District Forester or a designee.

§ 21.66. Destruction of property. Damaging, defacing or removing any sign, structure, equipment or other material is prohibited.

§ 21.67. Posting and soliciting. Posting of signs or soliciting without written authorization of the District Forester or a designee is prohibited.

§ 21.68. Littering and disposal. Littering or disposal of garbage, paper, household refuse, waste or other material of any kind is prohibited.

§ 21.70a. Snow plowing. The plowing or removal of snow from State Forest land without authorization of the District Forester or a designee is prohibited.

§ 21.72. Closure because of fire danger.

(a) If the forest-fire danger rating is Very High or Extreme, all or portions of the State Forest may be closed to certain specified uses.

(b) Violation of a closure notice under subsection (a) is prohibited.

§ 21.73. Pets. Pets are permitted on State Forest land if they are kept under control and attended at all times.

§ 21.74. Disorderly conduct. The following are prohibited:

(1) Fighting or other behavior that is threatening, violent or tumultuous.

(2) The possession or consumption of alcoholic beverages by persons under 21 years of age.

(3) Creating an unreasonable noise that may disturb other visitors to State Forest land.

§ 21.75. Sanitation.

(a) Washing in water outlets, springs, lakes or waterways is prohibited.

(b) Discharging of trailer, camper or motor home sewage, sink water or bath water on or into ground or surface waters is prohibited.

§ 21.76. Feeding of wildlife.

(a) Feeding of wildlife, except for elevated songbird feeders of less than one-half bushel capacity, is prohibited on State Forest land from 30 days prior to the beginning of spring gobbler season through the end of flintlock muzzleloader deer season.

(b) Placing of wildlife feeders of more than one-half bushel combined capacity on State Forest land without the authorization of the District Forester or a designee, is prohibited.

§ 21.77. Commercial activity. Selling, distributing, delivering, servicing, guiding or renting any equipment, material or commodity or otherwise engaging in commercial activity on State Forest land without written authorization of the District Forester or a designee is prohibited.

§ 21.78. Group activities. Group activities are prohibited without written authorization of the District Forester or a designee.

§ 21.79. Structures. Building or erecting a structure or memorial, or engaging in construction or excavation activity, without written authorization of the Department is prohibited.

§ 21.80. Trespass.

(a) A person who violates this chapter or disregards instructions or warnings given by a State Forest officer or interferes with a State Forest officer in the performance of the duties of the officer may be ordered to leave State Forest land.

(b) A person who refuses to leave State Forest land, after receiving an order to leave from a State Forest officer, commits an act of criminal trespass under 18 Pa.C.S. § 3503(b) (relating to criminal trespass).

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Appendix 3: Planting and Seeding Guidelines

Planting and Seeding Guidelines on State Forestlands

Background

Supplemental planting on state forestland is a common practice for activities such as re-vegetating a log landing after harvest, erosion and sedimentation control, forage and cover habitat in wildlife openings, and restoration in gas development areas. The Bureau of Forestry (BOF) oversees the Wild Plant Program in Pennsylvania and 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, native species do not always fully support the purpose of the planting and non-native species may be preferred and justified. For example, many native grass species do not rapidly colonize a site for two growing seasons, which may not satisfy erosion and sedimentation plan requirements. To ensure ecologically-sound use of non-native plants, these guidelines were developed to assist foresters and land managers in deciding the appropriate use of non-native plantings on state forestlands.

According to the federal Executive Order 13112 of February 3, 1999, "An 'invasive species' is defined as a species that is 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health." In the sustainable management of forest ecosystems in Pennsylvania, plants classified as 'invasive' are likely to cause environmental harm through decreasing native biodiversity, hindering regeneration process, altering wildlife habitat, or threatening natural processes. Not all non-native plants that become naturalized in PA forests cause environmental harm, and therefore, are not considered invasive.

While DCNR has determined several species to be invasive due to experience, on-going research or other factors, not enough information has been compiled on other non-native species to consider their potential 'invasiveness'. However, some non-native species used on state forestland may be deemed invasive in surrounding states or have similar characteristics as invasive species, but have not been fully assessed for invasive potential in PA. The purpose of these guidelines is to determine parameters around which non-native plants are examined for 'invasive potential' and subsequently permitted or barred for use on state forestland. These guidelines will change over time, as monitoring results inform land managers on the consequences of using particular non-native species in forest management.

The BOF administers state forests in Pennsylvania, which are certified with the Forest Stewardship Council (FSC). In doing so, we are committed to the sustainable use of state forestlands, which includes protecting and conserving native plant communities and making wise decisions about state forest management. As part of the FSC requirements, the BOF will

track, justify, and monitor the use of non-native species on state forestlands through these guidelines. In addition, these planting guidelines may extend beyond state lands to other state and private lands, including programs that encourage environmentally-sound forest management practices, such as the Forest Stewardship Program.

Planting of non-native species

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

1. Determined invasive. Do not plant.
2. Potentially invasive (need more information). May plant with caution and monitoring.
3. 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 forestland. 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 . This includes *Sorghum bicolor* cv. *drommundii* (shattercane) and *Sorghum halepense* (Johnsonweed). Often, seed distributors do not list the particular species of sorghum they sell. To reduce the risk of introducing a noxious weed on state forestland, do not plant *any* sorghum species. Some sorghum species may also be toxic to wildlife.

For the purposes of these planting guidelines, plant species are deemed invasive if they are found on the DCNR Invasive Plant list (DCNR Invasive Plant Tutorial for Land Managers). Some of these species may have been planted on state forestland in the past. However, current standards forbid the use of these plants on state forestland. *Do not plant* any of these species without a waiver from Ecological Services. Species on the DCNR 'Watch' list (e.g. *Miscanthus sinensis*, Chinese silvergrass or *Poa trivialis*, rough bluegrass) are also considered on the *do not plant* list because they invasive qualities in natural situations have been documented in these species in PA.

Some of the plant species DCNR now considers undesirable and invasive have a long history of being planted on state forestlands. Autumn olive (*Elaeagnus umbellata*), Japanese barberry (*Berberis thunbergii*), and Oriental bittersweet (*Celastrus orbiculatus*) were popular plantings in wildlife openings, rights-of-way, and around building facilities. However, after a few decades on the landscape, these species did not remain confined to where they were planted and spread to forestlands and other habitats, directly competing with native flora and decreasing wildlife habitat quality. Recently (past 5 years), the following species have been planted on state forestland, but are now considered invasive by DCNR or should be watched for invasiveness:

a. European alder (*Alnus glutinosa* – now deemed invasive)

b. Tall fescue (*Festuca elatior* – now deemed invasive)
c. Rough bluegrass (*Poa trivialis* – watch list)

Plant with caution and monitoring (Monitoring List)

Many plants have been used in seed mixes on state forestland with relative success and little signs of aggressiveness. However, more information may suggest that some of these species may become invasive or jeopardize native plant communities or wildlife habitat. These species may continue to be planted on state forestland, but need to be monitored to assure they are not becoming invasive (see attached protocol).

Common name	**Scientific name**	**Rare*?**	**Species of Concern (PNDI)**	**Rationale**	**Potential habitats where aggressive**
Bird's-foot trefoil	*Lotus corniculatus*			Invasive in VA, TN, MO, IL, WI, MN, WA, OR, CA.	Prairies, disturbed areas, roadsides, high seed production in burned areas.
Kentucky and other exotic Bluegrass	*Poa pratensis P.* spp.	Yes	*Poa autumnalis P. languida P. paludigena*	Any bluegrass should be avoided in plantings unless native and from native seed source.	Meadows, fields, and semi-open woods; more mesic to rich soils.
Bristly locust	*Robinia hispida* var. *fertilis*			Native to southern US, but not PA. Monitor for now.	May act aggressively, similar to black locust.
Chufa sedge, yellow nutsedge	*Cyperus esculentus (all varities)*			Classified as a noxious weed in many western states. Mentioned as a 'serious weed' in Plants of PA.	Wet or moist soils.
Creeping red fescue seed	*Festuca rubra*			Native to US, but not PA. Seems like a 'shady lawn' species and should be avoided. All fescues should be avoided unless native to PA and from native seed source.	Threat to native prairies and other open habitats.
Korean lespedeza	*Kummerowia stipulacea*	No		Invasive in KY and TN.	Threat to native prairies and other open habitats.
Norway spruce	*Picea abes*			On many 'watch' lists. Will naturalize along with native vegetation, perhaps not show invasive characteristics, but should document this.	In and surrounding areas where planted.

Common name	Scientific name	Rare*?	Species of Concern (PNDI)	Rationale	Potential habitats where aggressive
Orchard grass	*Dactylis glomerata*	No		Clumping and recommended in our leases, but listed as invasive in: MD, VA, TN, VA, SD, WY, CO, UT, AZ, WA, OR	Threat to native prairies and other open habitats. Areas where native warm season grasses are preferred.
Perennial rye	*Lolium perenne* ssp. *Perenne*			Similar to annual rye but should remain on monitoring list. The perennial is known to be more aggressive.	Disturbed ground, permanent openings, etc.
Rape	*Brassica rapa, B. campestris* spp. *rapa*			Considered noxious weed in MI and with USCOE. Known to poison livestock, Inv: MD, VA, TN, TX. *B. napus* does not need monitored.	Threat to native prairies and other open habitats.
Redtop	*Agrostis gigantea*			Very fast growth, not recommended at high seed rates. Inv: NY, VA, TN, OR.	Wet to moist soils in open areas, open riparian areas.
Sawtooth oak	*Quercus acutissima*			Invasive in MD, VA, TN, SC. Discourage planting, but may with thorough monitoring. Suggest scrub oak as an alternative.	Food plots and other open areas adjacent to forest land. Potentially in dry forest land.
Sericea lespedeza	*Lespedeza cuneata*	No		Noxious weed in CO, KS. Spread throughout the eastern US.	Threat to native prairies and other open habitats.

*Members of genus are rare, but may not be the species used in plantings. Avoid or consult with Ecological Services when planting rare species.

Currently, this document does not contain a protocol for monitoring. Please consult with monitoring botanists in Ecological Services and the Inventory Section for a specific protocol. At this time, the protocol is being developed as part of the state-wide monitoring efforts.

A species on the Potentially Invasive list may be moved to the Not Invasive list when they have been adequately monitored to determine that the species is not expanding past the original seeded/planted site and jeopardizing native plant communities or wildlife habitat. Conversely, a species on this list may be moved to the 'Invasive: Do not plant' list if it consistently exhibits invasive qualities by becoming established beyond the originally intended seeded/planted site and posing a threat to native plant communities or wildlife habitat. A species may be restricted from planting only in particular situations, but allowed in most plantings based on the results

(e.g. a species may not be planted in a geographic region of the state due to its distinct behavior in this region compared to the rest of the state).

The final determination to move species off the 'Potentially Invasive' list will be determined by Ecological Services as a result of the monitoring and other information. Ecological Services will notify the districts of any species changes among these lists.

Not Invasive: May plant with particular specifications noted.

The following list of plants has been planted on state forestland in the past. Some are native to Pennsylvania, some are not native. However, there is little to no evidence to suggest these species will have invasive tendencies. Until further documentation is presented to suggest otherwise, these species may be planted on state forestland. No monitoring is necessary; however, records should be kept that includes the rate and location of **all** species planted on state forestland.

Common name	Scientific name	Native?	Species of Concern (PNDI)	Rationale for no monitoring
Alfalfa	*Medicago sativa*	No		Not listed in nearby states, minor in Canada, no longevity on site, shade intolerant.
Alsike white clover	*Trifolium hybridum*	No		Not listed as invasive in neighboring states. Not drought hearty, shade intolerant. A lot of input required to maintain clover where planted.
Annual rye**	*Lolium perenne* ssp. *Multiflorum, Lolium temulentum*			'Lesser threat' in KY, concerns on invasiveness in HI, AK, OR, CA. Need monitoring results.
Asters	Many genera	Yes/No	Several species in different genera (see PNHP website)	Do not plant PNDI species, unless of local genetic origin. Please consult with Ecological Services if interested in planting asters.
Austrian winter pea	*Pisum sativum*	No		No evidence to suggest invasive.
Autumn bentgrass	*Agrostis perennans*	Yes		
Barley	*Hordeum vulgare*	No		No evidence to suggest invasive. ID only state to list as invasive.
Big bluestem	*Andropogon gerardii*	Yes		
Blackeyed susan	*Rudbeckia*	Yes	*Rudbeckia fulgida*	Avoid planting *R. fulgida* unless from local genetic origin.

Common name	Scientific name	Native?	Species of Concern (PNDI)	Rationale for no monitoring
Bottlebrush grass	*Elymus hystrix*	Yes		
Buckwheat	*Fagopyrum esculentum*	No		Known to exude allelopathic chemicals. Low rating from Weed Risk Assessment for Hawaii.
Chinese chestnut	*Castanea mollissima*	No		Not listed as invasive on any lists. UFL notes 'little, if any invasive potential at this time'.
Crabapples, apples	*Malus* spp.	No		Should not act aggressively. May escape and naturalize, but not become invasive.
Crimson cover	*Trifolium incarnatum*	No		Not listed as invasive in neighboring states. Not drought hearty, shade intolerant. A lot of input required to maintain clover where planted.
Deer-tongue grass	*Dicanthelium clandestinum*	Yes		
Flat pea	*Lathyrus sylvestris*	No		Not listed on any invasive species lists, except 'potentially invasive' on NRCS website.
Fox sedge	*Carex vulpinoidea*	Yes		
Goldenrod	*Solidago* spp.	Yes	*Solidago errecta, S. curtisii, S. rigida, S. roanensis, S. simplex, S. speciosa, S. uliginosa*	Be careful to not plant species of concern, unless of local genetic origin.
Hairy wild rye	*Elymus villosus*	Yes		
Hawthorns	*Crataegus* spp.	Yes/No		No monitoring needed if using species specified on list as OK (see below). Do not plant near species of concern in same genus.
Japanese larch	*Larix kaempferi*	No		Not listed as invasive on any lists. SFL plantings have not expanded beyond their original boundaries.
Kale	*Brassica oleracea*	No		No evidence to suggest invasive.
Ladino/Dutch white clover	*Trifolium repens*	No		Not listed as invasive in neighboring states. Not drought hearty, shade intolerant. A lot of input required to maintain clover where planted.
Medium red clover	*Trifolium pratense*	No		Not listed as invasive in neighboring states. Not drought hearty, shade intolerant. A lot of input required to maintain clover where planted.

Common name	Scientific name	Native?	Species of Concern (PNDI)	Rationale for no monitoring
Milkweed	*Asclepias* spp.	Yes	*Asclepias rubra, A. variegata*	Just be careful to not plant species of concern, unless of local genetic origin.
Millet	*Milium or Panicum*	Yes/No	*Panicum amarum* var. *amarulum, P. flexile, P. longifolium*	Panicum may be native and OK (SOSC in surrounding states). Little evidence of *Milium* being invasive in eastern US.
Oats	*Avena fatua*	No		Will escape on disturbed/waste grounds, but annual species and should not act aggressively.
Partridge pea	*Chamaecrista fasciculata*	Yes		Good substitute for trefoil.
Pennsylvania sedge	*Carex pensylvanica*	Yes		Good native species to use in shaded conditions.
Pitch x loblolly pine hybrid		No		Not preferred if native pure pitch pine will suffice, but may be planted if deemed a need.
Rape, turnip, swede, dwarf essex rape	*Brassica napus*	No		Little evidence of invasive tendencies and not on invasive plant lists in US. *B. rapa* on monitoring list, however.
Red pine	*Pinus resinosa*	Yes/No		Not native in all the places it is planted in the state, but OK to plant. Does not frequently escape or expand its range.
Riverbank wild rye	*Elymus riparus*	Yes		
Rye seed	*Secale cereale*	No		Inv: WA, OR. Annual winter cover crop. Likely OK.
Side oats gramma	*Bouteloua curtipendula*	Yes	*Bouteloua curtipendula*	Use genetically local source when planting this species. Please consult with Ecological Services for more information.
Switchgrass	*Panicum virgatum*	Yes		
Virginia wild rye	*Elymus submuticus, Elymus virginicus*	Yes		
White spruce	*Picea glauca*	No		Not native to PA, but little invasive potential and useful in many plantings. Do not allow to over take the importance of planting native conifers.
Wild rye	*Elymus* spp.	Yes	*Elymus trachycaulus*	
Winter Wheat	*Triticum aestivum*	No		Only inv in Death Valley, CA. Annual grass. Good cover crop.

Additional Planting Guidelines

In addition to the above restrictions on specific species/genera, the following planting guidelines are to be followed on state forestlands:

a. Species with rare, threatened or endangered status (PNHP species of concern) are generally not planted unless we have a species recovery plan for that species. In general these plans specify that genetic stock originate from as close to the planting site as possible. If it is not possible to obtain local genetic material, selections are made from ecologically similar environments. Special exceptions may be made within the framework of research agreements. Please consult with Ecological Services when planting a species of concern.

b. Native tree species with no special status (PNHP species of concern) may be planted. Pennsylvania stock is preferred and cultivars should be generally avoided. Use Penn Nursery as the primary supplier of seedling stock, which is grown from open pollinated district sources on SFL or from our own seed orchards.

c. Currently, the BOF does not allow planting of non-natives in Natural or Wild Areas, though this judgment is under review due to the loss of hemlock. Please consult with Ecological Services if interested in using a non-native species in a Natural or Wild Area.

d. Former plantations of exotic species (after recent harvests of lands with vegetation typing indicating plantation) may be replaced by the same species if deemed important for local reasons. Conversion to natural native stands is encouraged unless there is a special local attachment to the plantation area (e.g. CCC plantation surrounding picnic area). These historical and replacement plantings need not be monitored if the historical significance is documented.

e. Species not used before (experimental plantings) are approved on a case by case basis and logged and monitored as a research agreement. Please consult with Ecological Services if interested in planting a species that was not used before.

f. Make every effort to use weed-free seed, dirt, gravel, and mulch in plantings. This will significantly decrease the likelihood invasive species are accidentally introduced in the materials used. Where possible, encourage the use of straw over hay to reduce the likelihood of weed seed. In the past, some foresters have inspected farm fields to verify the source stock does not contain weeds. The resulting dense timothy seen on some log landing sites is suspected to have been from the mulch (straw/hay) used on the seed, not the seed mix itself, so weed-free mulch is also important.

g. The species found in this document were researched based on past use on state forestland. Other species other than those included on the above lists may be included in plantings on state forestland. If you are aware of another species that is commonly used on your district, but was not found in this document, please contact Carrie Gilbert, 717-783-0383, cagilbert@state.pa.us or Chris Firestone, 570-724-8149, cfirestone@state.pa.us. Likewise, if you are interested in using a species that is not mentioned in this document, contact Ecological Services for more information.

h. For some additional suggestions on alternatives to invasive species, visit Ohio's Division of Wildlife suggestions.

Planting Suggestions

- Use species representative of the area.
- Native species may not require lime and fertilizer inputs.
- Cool season grasses should be mixed in with warm season grasses for quicker perennial cover.
- Although the optimum time to seed natives is in April, mid-November through April may also be successful.
- Do not expect immediate cover of warm season grasses, as these take time to mature.
- Fall may be the best time to purchase seed for its use in spring.
- Native legumes may provide good cover and nitrogen fixation on poorer sites.

Revegetation and restoration of temporarily disturbed areas should be blended back into the surrounding forestland. The resulting plant communities and structure should be representative of pre-disturbance conditions, support long-term landscape management objectives, and provide for a variety of native flora and fauna. The actual seed mixes, shrub plantings, and wildlife habitat improvement options are decided upon by foresters and other district personnel on a case-by-case basis. Some vegetation choices may have implications on plant and animal species of concern, and assistance from botanists and biologists in Ecological Services (BOF) is encouraged in determining appropriate revegetation and restoration goals.

In many cases, it may be suitable to restore areas back to their original composition before disturbance. In addition, disturbed areas may be converted to permanent herbaceous openings, successional openings of shrubs or trees, coniferous groupings, or a combination, depending on the pre-disturbance character of the land and long-term management objectives.

Conifers may be used as screens or thermal cover plantings and can be utilized on the disturbed side of a work/construction area when it parallels an existing opening and on both/all sides when work/construction areas do not parallel an existing opening (e.g. when pipeline ROWs

parallel and existing ROW, conifers should be planted on the side adjacent to the undisturbed forest). Conifers should not be planted near rock piles constructed for timber rattlesnake basking areas.

The following seed mixtures are simply suggestions for use on state forestland. They have been developed for and used in other projects. The seeding rates are rough and may be amended for each situation. Lime and fertilizer rates may be determined by site requirements at the discretion of the forester. If you have a question about a species or mix that may not be on this list, feel free to contact Ecological Services for more information. In all plantings on state forestland, please attempt to use native seed mixes whenever possible. Many of these species are available through Ernst Conservation Seeds, and Ecological Services is working towards developing more local seed mix sources for the districts.

In order to establish a quick cover for stabilization and reduce the chance for invasive species to establish, a cover crop may be mixed in with any of the mixes. The cover crop will either be oats if the seeding takes place in the spring (prior to June 15th) or grain rye if the seeding takes place in the fall (after June 15th). This can be applied at the same time with the mixes below and can be done with the hydro seeder. The cover crop should be applied at one (1) bushel/acre. Seeding needs to be completed as soon as possible. Optimum seeding times are before mid-April or after mid-September, if possible, for the best chance of successful established cover. No permanent seeding should be conducted between June 30th and August 31st. Annual rye grass may be substituted for cover crop, but this species needs to be monitored.

Native grass and forb mix suggestions

Percentages are given below instead of rates to account for different environmental situations. For native grasses, a lower rate should be adequate over time for establishment (15-30lb per acre). Many of the warm season grasses are much larger in stature at maturity and to maintain their wildlife component, some 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.

General Native Seed Mix*

15% Indian Grass (*Sorghastrum nutans*)
10% Big Bluestem (*Andropogon gerardii*)
15% Little Bluestem (*Schizachyrium scoparium*)
10% Switchgrass (*Panicum virgatum*)
5% Deertongue (*Dicanthelium clandestinum*)
30% Bottlebrush grass (*Elymus hystrix*)

15% Spring Oats (*Avena fatua*) or Grain Rye (*Secale cereale*)
OR Annual Rye (*Lolium perenne* ssp*. multiflorum* or *L. temulentum*)

*This mix was developed by the National Park Service in West Virginia for reseeding along a gas transmission line. It has not been tested on State Forest lands, but may be successful for ROW vegetation establishment.

Native Grass and Herb Mix

20% Little Bluestem PA ecotype (*Andropogon scoparius*)
10% Big Bluestem variety "Niagra" (*Andropogon gerardii*) (genetic origin is NY)
15% Virginia Wild Rye PA ecotype (*Elymus virginicus*)
10% Indiangrass PA ecotype (*Sorghastrum nutans*)
10% Deertongue variety "Tioga" (*Panicum clandestinum*)
5% Switchgrass variety "Shelter" (*Panicum virgatum*) (genetic origin is WV)
5% Partridge Pea PA ecotype (*Chamaecrista fasciculata*)
3% Showy Tick Trefoil PA ecotype (*Desmodium canadense*)
5% Ox-eye sunflower PA ecotype (*Heliopsis helianthoides*)
2% Autumn bentgrass PA ecotype (*Agrostis perennans*)
2% Woolgrass PA ecotype (*Scirpus cyperinus*)
3% Soft Rush PA ecotype (*Juncus effusus*)
5% Pennsylvania smartweed PA ecotype (*Polygonum pensylvanicum*)
5% Common Milkweed PA ecotype (*Asclepias syriaca*)

General Native Erosion and Sedimentation Seed Mix

30% Virginia Wild Rye PA ecotype (*Elymus virginicus*) or Switchgrass variety "Shelter" (*Panicum virgatum*) (genetic origin is WV)
30% Autumn bentgrass (*Agrostis perennans*) or ticklegrass (*A. scabra*) (both will tolerate more shade)
20% Partridge Pea PA ecotype (*Chamaecrista fasciculata*)
20% Spring Oats (*Avena fatua*) or Grain Rye (*Secale cereale*)
OR Annual Rye (*Lolium perenne* ssp*. multiflorum* or *L. temulentum*)

Areas with higher moisture and shade

20% Virginia wild rye (*Emylus virginicus*)
20% Riverbank wild rye (*Elymus riparius*)
Canadian wild rye (*Elymus canadensis*) may be used in place of riverbank wild rye at the same rate on drier soils
20% Pennsylvania sedge (*Carex pensylvanica*)
15% Tioga deer tongue (*Panicum clandestinum*)

10% Redtop (SPECIFY THIS SPECIES: *Panicum rigidulum*)
15% Spring Oats (*Avena fatua*) or Grain Rye (*Secale cereale*)
OR Annual Rye (*Lolium perenne* ssp*. multiflorum* or *L. temulentum*)

Wetland areas, waters edges and areas with normal high water flow

40% Virginia wild rye (*Elymus virginicus*) or Riverbank wild rye* (*Elymus riparius*)
40% Fox sedge (*Carex vulpinoides*)
20% Redtop (SPECIFY THIS SPECIES: *Panicum rigidulum*)

Topsoil from disturbed wetlands should be stock piled until construction is complete. Topsoil should be replaced on the disturbed area and allowed to reseed naturally by surrounding vegetation when conditions allow. Seed mixes on wetland areas may be used when there is a need to stabilize soil, revegetate quickly, or deter invasive species establishment. *It is important for district personnel to review proposed seed mixes for use near wetland areas, waters edges, or areas with normal high water flow because many suggestions by contractors or consultants have included the use of invasive wetland species (e.g. reed canary grass and tall fescue).*

Native/non-native grass and legume mix

These seed mix suggestions may be used when all-native mixes are not deemed the most appropriate for the situation.

Slopes greater than 15%

Timothy (*Phleum pretense*)	6 lbs. per acre
Canada wild-rye (*Elymus canadensis*) *	6 lbs. PLS per acre
Little bluestem (*Schizachyriukm scoparium*)**	3 lbs. PLS per acre
Big bluestem (*Andropogon gerardii*)	3 lbs. PLS per acre
Indian grass (*Sorghastrum nutans*)**	3 lbs. PLS per acre
Switchgrass (*Panicum virgatum*)	2 lbs. PLS per acre
White clover (*Trifolium repens*)	8 lbs. PLS per acre
Deer tongue (*Panicum clandestinum*)	5 lbs. per acre
Showy tick-trefoil (*Desmodium canadense*) or senna (*Senna hebecarpa*)**	2 lbs. PLS per acre
Partridge pea (*Chamaecrista fasciculata*)	1 lbs. PLS per acre
Black-eyed Susan (*Rudbeckia hirta*)	0.5 lbs. PLS per acre

Slopes less than 15%

Timothy (*Phleum pretense*)	4 lbs. per acre

Virginia wild-rye (*Elymus virginicus*) *	6 lbs. PLS per acre
Little bluestem (*Schizachyriukm scoparium*)**	2 lbs. PLS per acre
Big bluestem (*Andropogon gerardii*)	2 lbs. PLS per acre
Deer tongue (*Panicum clandestinum*)	4 lbs. PLS per acre
White clover (*Trifolium repens*)	8 lbs. per acre
Showy tick-trefoil (*Desmodium canadense*) or senna (*Senna hebecarpa*)**	2 lbs. PLS per acre
Partridge pea (*Chamaecrista fasciculata*)	1 lbs. PLS per acre
Black-eyed Susan (*Rudbeckia hirta*)	0.5 lbs. PLS per acre

*Riverbank wild-rye (*Elymus riparius*) or bottlebrush grass (*Elymus hystrix*) may be substituted for either wild-rye species in more mesic to wet and shady situations.

**These species may be limited in the very northern counties in the state. This does not mean they will not be successful here, but they are not known to commonly naturally occur in this area.

Conifer/Shrub Groups

Pockets of shrubs may be planted in construction areas no longer being used and may be planted intermittently along ROWs where disturbance had taken place. These plantings can vary in size, but should be at least 200 square feet (10'x20'). Below represents shrub group suggestion that may be used depending on conservation or management objectives. Shrub groups should be alternated along right of ways with each group selected by the District Forester/Park Manager. These plantings should be fenced to protect from damage by browsing herbivores but fencing may be waived by the District Forester/Park Manager or designee.

a. Group 1: Conifer group

- White Pine (*Pinus strobus*)
- Pitch Pine (*Pinus rigida*)
- Virginia Pine (*Pinus virginiana*) – south of route I-80
- Red Pine (*Pinus resinosa*) – north of route I-80

b. Group 2: Hawthorn/Crabapple group

- Washington Hawthorn (*Crataegus phaenopyrum*)
- American Sweet Crabapple (*Malus coronaria*)
- Cockspur Hawthorn (*Crataegus crus-galli*)
- Large-seed Hawthorn (*Crataegus macrosperma*)
- Frosted Hawthorn (*Crataegus pruinosa*)
- Dotted or White Hawthorn (*Crataegus punctata*)

c. Group 3: Serviceberry Group

- Shadbush (*Amelanchier arborea*)
- Smooth/Allegheny Shadbush (*Amelanchier laevis*)
- Low Shadbush (*Amelanchier stolonifera*)

d. ***Group 4 : Mast Producing Group***

- Black Locust (*Robinia psuedoacacia*)
- American Mountain Ash (*Sorbus americana*)
- Black Haw Viburnum (*Viburnum prunifolium*)
- American Hazelnut (*Corylus americana*)
- Dwarf Chinquapin Oak (*Quercus prinoides*)
- Scrub Oak (*Quercus ilicifolia*)

e. Group 5: Blackberry/Raspberry Group

- Common Blackberry (*Rubus allegheniensis*)
- Sawtooth Blackberry (*Rubus argutus*)
- Smooth Blackberry (*Rubus canadensis*)
- Black Raspberry (*Rubus occidntalis*)
- Red Raspberry (*Rubus idaeaus*)

f. Group 6: Host Group

- Black-haw (*Viburnum prunifolium*)
- Nannyberry (*Viburnum lentago*)
- Highbush Blueberry (*Vaccinium corymbosum*)
- New Jersey Tea (*Ceanothus americanus*)
- Black Chokeberry (*Photinia melanocarpa*)
- Bush Honeysuckle (*Diervilla lonicera*)
- Pinxter-flower (*Rhodendron periclymenoides*)
- Staghorn Sumac (*Rhus typhina*)
- Scrub Oak (*Quercus ilicifolia*)

The Bureau of Forestry expects a minimum of 75% survival rate for the first year for tree and shrub seedlings. Replacements will be planted the following spring of the year. Attached are tree planting notes that will help to ensure success.

Non-native legume mix for food plots

A non-native legume mix or native grass and herb mix can be used in revegetating disturbed work areas. These areas are to be located at the discretion of the wildlife forester or district personnel with input from Ecological Services. The non-native legume plots should be three to five acres in size and not to exceed one food plot per 8 miles of ROW. Many food plots already exist on state forestland, and non-native legume plots should only be used when it is determined there is a need on a landscape-scale.

Non-Native Legume Mix for Herbivores

15% Ladino Clover (*Trifolium repens*)
15% White Dutch Clover (*Trifolium repens*)
15% Alsike Clover (*Trifolium hybridum*)
40% Birdsfoot trefoil* (*Lotus corniculatus* var. *norcen*)
*This species would need to be monitored. May replace with partridge pea for similar wildlife value.
15% Spring Oats (*Avena fatua*) or Grain Rye (*Secale cereale*)
OR Annual Rye (*Lolium perenne* ssp*. multiflorum* or *L. temulentum*)

Stream crossings

Streams impacted by management activities may be planted for canopy coverage with trees and shrubs or just shrubs. Plant material should be from stock native to the Allegheny Ridge and Valley Region (central Pennsylvania), the Allegheny Plateau Region (western Pennsylvania). These plantings may need to be protected from browsing herbivores with an eight (8) foot woven wire fence. The use of tree shelters is discouraged, but when used, netting should be placed over the opening to avoid mortality of cavity nesting birds. Below are a few species suggestions for stream crossings.

Species for Stream Crossings

Black Willow (*Salix nigra*)
Black Chokeberry (*Aronia melanocarpa*)
Winterberry (*Ilex verticilata*)
Silky Dogwood (*Comus amomun*)
Red Maple (*Acer rubrum*)
Yellow Birch (*Betula alleghaniensis*)
White Oak (*Quercus alba*)
Tulip Poplar (*Liriodendron tulipifera*)
Eastern Hemlock (*Tsuga canadensis*)
Arrow-wood (*Viburnum dentatum*)

Other species may be listed in these guidelines. However, it is best to check with Ecological Services that the species is not Endangered, Threatened, or of ecological concern for another reason (e.g. the species is a host for a disease that adversely affects another species).

Appendix 4: Invasive Plant Management Guidelines

A. Invasive Plant Guidelines:

1 Pre-construction Inventory and Mapping

1.1 Licensee 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.

1.2 If Licensee elects to undertake an inventory as described in Section 1.1, 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.

1.3 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

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.

For each grid cell, the average height of each invasive species in each grid cell should be recorded.
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

1.4 If Licensee elects to forego the above described pre-construction survey for invasive species, Licensee shall be responsible for 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 required to perform management and control activity as described in Section 3 below.

2 Prevention

2.1 Where no invasive plants are detected, Licensee 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 District Forest/Park Manager and Ecological Services. If materials certified as weed-free cannot readily be obtained, the source of materials being used shall 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.

2.2 Mulching with straw rather than hay is recommended to reduce the possibility of introducing invasive species propagules.

2.3 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 District Forester/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.

2.4 Prior to bringing equipment into un-invaded areas or onto state forest land, the licensee 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).

2.5 Licensee 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 licensee should seriously consider cleaning equipment between entries. District personnel may assist contractor or Licensee in planning construction activities in relation to invasive species when they are aware of their presence in particular areas.

2.6 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 District Forester/Park Manager.

3. Management

3.1 Management and control of established invasive plant populations shall be planned on a species-by-species basis to determine the best method of control. Licensee and its consultant shall submit a

"Management and Control Plan" to District Forester/Park Manager no fewer than three (3) months after the conclusion of all construction activities.

3.2 Licensee shall 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 District Forester/Park Manager and Ecological Services Section will assist Licensee in the development of appropriate management methods by species and/or invasive occurrence.

3.3 Post-construction invasive species surveys along access roads shall be limited to areas where gravel was placed or the existing road was widened for Licensee use.

3.4 Any new invasive populations will be assumed to be the result of sources other than the Licensee'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 revegetation activities have become established, whichever is longer. Control of species found will continue until the species are eradicated.

3.5 Licensee 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

4.1 Licensee shall 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 revegetation activities have become established, whichever is longer.

4.2 Licensee shall 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.

4.3 If the Licensee 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 Licensee shall be responsible for eradication and control.

5. Reporting

5.1 The results of all Licensee annual invasive surveys shall be summarized into a report, which shall 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

Report and raw electronic observation data shall be submitted to District Forester/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 Licensee's reports and as a result of any audit, Department may require alternate methods of management and control.

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

B. Revegetation Guidelines (Linear Corridor Activities)

Right-of-way (ROW) projects across lands managed by DCNR have the potential to disturb sizable acreage. The revegetation goals for this disturbed acreage include:

- erosion and sedimentation control,
- adhering to long-term ROW maintenance specifications,
- creation of sustainable wildlife habitat,
- blending the disturbance into the surrounding landscape and native plant communities, and
- aesthetics.

The following revegetation guidelines provided by DCNR will address these goals. These guidelines give various seed options for revegetation under different environmental conditions. However, the revegetation/restoration strategy should be decided upon in coordination with the District Forester/Park Manager to address state forest or park vegetation and habitat goals.

1.1 Revegetation disturbed work areas are meant to blend into the surrounding landscape. The intended long-term plant communities should be representative of the sites' environmental and geographic conditions. When developing a long-term revegetation strategy, please refer to the *Restoration Options for Reclaiming Gas Devlopment Sites* to provide information of plant community and animal habitat creation information.

1.2 All revegetation strategies should adhere to the BOF Planting Guidelines set forth on state forestland. In summary, the BOF Planting Guidelines include the following considerations:

- Use species representative of the area.
- Native species may not require lime and fertilizer inputs.
- Cool season grasses should be mixed in with warm season grasses for quicker perennial cover.
- Optimum time to seed natives is April. However, mid-November through 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.

1.3 No permanent seeding should be conducted between June 30th and August 31st unless agreed to by the District Forester/Park Manager or their designee.

1.4 Prior to bringing equipment onto state forest land and prior to moving equipment from heavily invaded areas (identified during the pre-construction inventory) into un-invaded areas, equipment should be cleaned in an appropriate manner to remove plant parts such as rhizomes and seeds that might be carried on tires, equipment undercarriage, etc. (see Prevention section above).

1.5 A native and non-native grass mix for the appropriate situation should be the main component of the revegetation efforts and will be used for cover and stabilization in the disturbed ROW. This

mix is suggested, however, and another mix may be used in accordance with the BOF's Planting Guidelines at the discretion of the District Forest/Park Manager or their designee. If species on the monitoring list in the Planting Guidelines are chosen by the ROW company, the ROW company is responsible for the monitoring. If a species on the monitoring list is chosen by the District/Park, they will be responsible for the monitoring.

1.6 In order to establish a quick cover for stabilization and reduce the chance for invasive species to establish, a cover crop may be mixed in with any of the mixes. The cover crop will either be oats if the seeding takes place in the Spring (prior to June 15th) or grain rye if the seeding takes place in the Fall (after June 15th). This can be applied at the same time with the mixes below or beforehand if waiting for the optimum time to plant native seed (February through April) and can be done with the hydro seeder. The cover crop should be applied at one (1) bushel/acre. Seeding of the cover crop needs to be completed as soon as possible.

1.7 No permanent seeding should be conducted between June 30th and August 31st unless agreed to by the District Forester/Park Manager or their designee. The District Forester/Park Manager or designee may substitute annual rye grass for the cover crop.

1.8 The seeding rates provided below are estimated and may be amended for each situation. Lime and fertilizer rates may be determined by site requirements at the discretion of the District Forest/Park Manager or their designee. Native species should not require the lime and fertilizer inputs that are used on non-native mixes. This will help to cut the cost. If lime and fertilizer are used, keep in mind that these often promote weedy species and control of undesirables may be necessary.

Native/Non-Native Grass and Legume Mixes

Slopes greater than 15%

Timothy (*Phleum pretense*)	6 lbs. per acre
Canada wild-rye (*Elymus canadensis*) *	6 lbs. PLS per acre
Little bluestem (*Schizachyriukm scoparium*)**	3 lbs. PLS per acre
Big bluestem (*Andropogon gerardii*)	3 lbs. PLS per acre
Indian grass (*Sorghastrum nutans*)**	3 lbs. PLS per acre
Switchgrass (*Panicum virgatum*)	2 lbs. PLS per acre
White clover (*Trifolium repens*)	8 lbs. PLS per acre
Deer tongue (*Panicum clandestinum*)	5lbs. per acre
Showy tick-trefoil (*Desmodium canadense*) or senna (*Senna hebecarpa*)**	2 lbs. PLS per acre
Partridge pea (*Chamaecrista fasciculata*)	1 lbs. PLS per acre
Black-eyed Susan (*Rudbeckia hirta*)	0.5 lbs. PLS per acre

Slopes less than 15%

Timothy (*Phleum pretense*)	4 lbs. per acre
Virginia wild-rye (*Elymus virginicus*) *	6 lbs. PLS per acre
Little bluestem (*Schizachyriukm scoparium*)**	2 lbs. PLS per acre
Big bluestem (*Andropogon gerardii*)	2 lbs. PLS per acre
Deer tongue (*Panicum clandestinum*)	4 lbs. PLS per acre
White clover (*Trifolium repens*)	8 lbs. per acre
Showy tick-trefoil (*Desmodium canadense*) or senna (*Senna hebecarpa*)**	2 lbs. PLS per acre
Partridge pea (*Chamaecrista fasciculata*)	1 lbs. PLS per acre
Black-eyed Susan (*Rudbeckia hirta*)	0.5 lbs. PLS per acre

*Riverbank wild-rye or bottlebrush grass may be substituted for either wild-rye species in more mesic to wet and shady situations.

**These species may be limited in the very northern counties in the state. This does not mean they will not be successful here, but they are not known to commonly naturally occur in this area.

1.9 Make every effort to use weed-free seed, dirt, gravel, and mulch in revegetation and restoration activities. This will significantly decrease the likelihood invasive species are accidentally introduced in the materials used. Use straw instead of hay to

reduce the likelihood of weed seed. The source fields for mulch and other seed may be physically examined to determine the presence/absence of invasive species or other weeds. For example, timothy may become an undesirable major component of resulting vegetation if its seed is present in the mulching materials, even if not present in the seed mixes.

1.10 Basking habitat for the timber rattlesnake should be created throughout the ROW corridor whenever materials and habitat are available and at the discretion of the District Forester/Park Manager and Ecological Services. 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 (north or east side of opening). Large flat slabs, aminimum of 4' x 6', should piled horizontally one or two layers high and about 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.

1.11 Habitat for the Allegheny woodrat should be created where appropriate by placing rock materials excavated during construction adjacent to existing, forested rock areas found next to the temporary work space. Some conifers may be planted near the habitat creation, but deciduous, mast-producing trees are more desirable. Please consult with Ecological Services for additional information regarind Allgheny woodrat habitat creation in the ROW corridor.

1.13 Conifers may be used as aesthetic or thermal screens. The conifers should be planted in a staggered fashion at approximately 6' by 6' spacing. Conifers should not be planted near existing or created timber rattlesnake basking areas. Conifers may include white pine (*Pinus strobus*), pitch pine (*Pinus rigida*), Virginia pine (*Pinus virginiana*, south of route 80), and red pine (*Pinus resinosa*, north of route 80).

1.14 Pockets of shrubs may be planted where existing scrubby shrub habitat exists adjacent to the ROW to extend this important

wildlife habitat. Native species that are found in the adjacent scrubby shrub may be used in the extension of this habitat. Native species appropriate for the landscape and ecosystem may be used to augment these planting, including, but not limited to:

- Hawthorns (*Crataegus* spp.)
- Crabapples (*Malus* spp.)
- Serviceberries (*Amelanchier* spp.)
- Black Locust (*Robinia psuedoacacia*)
- Mountain Ash (*Sorbus americana*)
- Black Haw, Hobblebush, and other Viburnums (*Viburnum* spp.)
- Blackberries/Raspberries (*Rubus* spp.)
- Scrub oak (*Quercus ilicifolia*) and dwarf chinquapin oak (*Quercus prinoides*)
- American hazelnut (*Corylus americana*)
- Blueberries (*Vaccinium* spp.)
- New Jersey tea (*Ceanothus americanus*)
- Black chokeberry (*Photinia melancarpa*)

1.15 The Bureau of Forestry expects a minimum of 75% survival rate for the first year for tree and shrub seedlings. Replacements will be planted the following spring of the year.

1.16 Metal gates painted black and yellow will be installed and follow Bureau of Forestry's specifications.

C. Revegetation Guidelines (non-linear Corridor Activities)

1.1 Revegetation and restoration of disturbed gas pads, pipelines, retired roads, and other disturbed work areas associated with gas drilling are meant to blend the disturbed areas back into the surrounding forestland. The resulting plant communities and structure should be representative of pre-disturbance conditions, support long-term landscape management objectives, and support a variety of native flora and fauna. When developing a long-term revegetation strategy, please refer to the *Restoration Options for Reclaiming Gas Development Sites* to provide information of plant community and animal habitat creation information. The BOF sets forth Planting Guidelines on all

plantings on state forestland which are summarized in Appendix 4.

1.2 The revegetation/restoration strategy should be decided upon in coordination with the District Forester/Park Manager to address state forest or park vegetation and habitat goals. Often, construction and development activities need to consider the subsequent restoration in design. Therefore, the Licensee shall begin working with district and park personnel in developing a restoration strategy during the pre-construction planning process (refer to *Restoration Options for Reclaiming Gas Devlopment Sites* for more information). Some vegetation choices may have implications on plant and animal species of concern, and assistance from personnel in Ecological Services (BOF) is encouraged in determining appropriate revegetation and restoration goals.

1.3 No permanent seeding should be conducted between June 30th and August 31st unless agreed to by the District Forester/Park Manager or their designee.

1.4 Prior to bringing equipment onto state forest land and prior to moving equipment from heavily invaded areas (identified during the pre-construction inventory) into un-invaded areas, equipment should be cleaned in an appropriate manner to remove plant parts such as rhizomes and seeds that might be carried on tires, equipment undercarriage, etc. (see Prevention section above).

1.5 It is recommended that the operator utilize a native grass and herb mix for cover and stabilization within the disturbed construction areas when possible. The district will request or review all seed mixes or other plantings proposed for any revegetation activities, to be sure they are compliant with the BOF Planting Guidelines. Seed mixes and species plantings should provide for immediate stabilization and reduce the chance of invasive species establishment.

1.6 Conifers may be used as aesthetic or thermal screens. The conifers should be planted in a staggered fashion at approximately 6’ by 6’ spacing. Conifers should not be planted near existing or created timber rattlesnake basking areas.

1.7 The Bureau of Forestry expects a minimum of 75% survival rate for the first year for tree and shrub seedlings. Replacements will be planted the following spring of the year.

1.8 Metal gates painted black and yellow will be installed and follow Bureau of Forestry’s specifications.

1.9 Make every effort to use weed-free seed, dirt, gravel, and mulch in revegetation and restoration activities. This will significantly decrease the likelihood invasive species are accidentally introduced in the materials used. Use straw instead of hay to reduce the likelihood of weed seed. The source fields for mulch and other seed may be physically examined to determine the presence/absence of invasive species or other weeds. For example, timothy may become an undesirable major component of resulting vegetation if its seed is present in the mulching materials, even if not present in the seed mixes.

Appendix 5: Restoration Guidelines

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 better regain a functioning ecosystem. This document is also meant to work 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 recommendations and information which follow 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 even more important to look at every step in restoration 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:

- Well-pads
- Staging areas
- Impoundments
- Right-of-Ways
- Temporary compressor stations
- 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:

a. The names of a few characteristic or conspicuous species
b. The quality of that habitat
c. 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)
d. The distribution of vegetation types and age classes
e. A landscape review of available habitats within the associated Landscape Type Association (LTA) and adjacent LTAs
f. Overall landscape level habitat conditions
g. Current forest community type
h. 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
i. Ecologically important features, such as a complex of vernal pools or wetlands that may influence the option chosen for restoration
j. PNDI review for species of special concern that may be impacted by disturbance and restoration options

k. 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):

a. Recovery of a degraded or damaged ecosystem to its former state
b. 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.
c. 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:

a. Source of seeds
    - Use appropriate seed for the region
b. 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
c. Planting success
    - Use appropriate species for the site considering sunlight requirements, soil disturbance, soil type and quality, etc.
d. 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.
e. Original and potential future forest community type trajectories to support the long-term desired condition
f. Soil quality, type and amount of compaction
g. What is required to encourage the appropriate communities
h. Bureau of Forestry's Planting Guidelines
i. Bureau of Forestry's Right-of-Way Planting Guidelines
j. 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: Interim Restoration

Introduction

Interim 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: Final Restoration Options

Introduction

Final 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.

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).

3. *Management:* The vegetation germinating newly disturbed sites should be monitored to be sure undesired vegetation, such as invasive plants, are not present. Treatment of undesirable vegetation should be done with assurance that desirable vegetation will naturally seed in or may be planted.

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.

<u>Things to Consider</u>

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 reforesting 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.

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:	**Important Wildlife Species:**
Native oaks	Black bear, Blue jay, Deer, Nuthatches, Ring-necked pheasants, Ruffed grouse, Wood duck, woodpeckers
Native hickories	Bats (esp. shagbark hickory), Red-bellied woodpeckers, Rose-breasted grosbeaks
Sweet birch	Beaver, Black-capped chickadee, Porcupine, Ruffed grouse
Red maple	Bats, Deer
Sugar maple	Deer, Porcupines, Snowshoe hare, many spp. of birds feed on bark, buds, twigs and fruit
Basswood	Upland game birds and songbirds, Porcupine and Foxes eat the seeds or the bark, Deer feed on the twigs and leaves, Older, dying and dead basswood trees provide dens for many animals, including Porcupines and Raccoons
Flowering dogwood	Songbirds, Upland game birds, Foxes, Black bear, Beaver, Skunks, Deer, Provides shelter and habitat for many wildlife species
Hornbeam	Beaver, Bobwhite, Fox squirrels, Ring-necked pheasants, Ruffed grouse, Songbirds
Serviceberry	Twigs, leaves and buds are eaten by deer and rabbits. The fruits are eaten by thrushes, many other songbirds, rodents, small mammals and bear. Grouse, turkey, squirrels, chipmunks, beaver and foxes will eat twigs, buds and fruits at various times.
Redbud	Cardinals, ring-necked pheasants, rose-breasted grosbeaks, white-tailed deer, and bobwhites have been observed feeding on the seeds. Flowers of the tree are regarded as important in the production of honey by bees.
Mountain Laurel	Ruffed grouse may eat leaves and buds, provides good winter cover

Tick-trefoil	Bobwhite quail, Deer, Ring-necked pheasant, Turkeys
Pennsylvania Sedge	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:	Important Wildlife Species:
Native oaks -primarily chestnut	Black bear, Blue jay, Deer, Nuthatches, Ring-necked pheasants, Ruffed grouse, Wood duck, woodpeckers
Sassafras	Crested flycatchers, Quails, Turkeys, Kingbirds, Mockingbirds, Sapsuckers, Pileated woodpeckers, Yellowthroat warblers, Phoebes, Black bears, Beaver, Deer
Black Gum	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
Sweet birch	Beaver, Black-capped chickadee, Porcupine, Ruffed grouse
Red maple	Bats, Deer
Native hickories	Bats (esp. shagbark hickory), Red-bellied woodpeckers, Rose-breasted Grosbeaks
Virginia pine	Woodpeckers, Pine siskin, Pine grosbeak, Songbirds, Deer
Eastern white pine	Yellow-bellied sapsuckers, Pine warblers, Red crossbills, Beaver, Porcupine, Deer, Snowshoe hare, Bald eagles
Mountain Laurel	Ruffed grouse may eat leaves and buds, provides good winter cover
Huckleberry	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

Pennsylvania Sedge	Horned lark, Ruffed grouse, Turkey
Blueberry	Ruffed grouse, Black bear, Quail, Bluebird, Scarlet tanager, Foxes, Deer, Thrushes, Skunks, Fox squirrels
Maple-leaved viburnum	Deer, Skunks, Ruffed grouse, Ring-necked pheasants, Turkeys, Beaver
Sweet-fern	Foliage is one food source of apple sphinx caterpillar, Sphinx gordius
Teaberry	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, Cover for Chickadees
Red maple	Bats, Deer
Sugar maple	Deer, Porcupines, Snowshoe hare, many spp. of birds feed on bark, buds, twigs and fruit
Black cherry	Fruits are important food source for numerous species of 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 -primarily red oak	Black bear, Blue jay, Deer, Nuthatches, Ring-necked pheasants, Ruffed grouse, Wood duck, woodpeckers
Witch-hazel	Ruffed grouse
Hornbeam	Beaver, Bobwhite, Fox squirrels, Ring-necked pheasants, Ruffed grouse, Songbirds
Canada mayflower	White-tailed deer, ruffed grouse and other birds, chipmunks and other rodents
Hobblebush	Deer, Beaver, Skunks, Ruffed grouse, Turkeys, Cardinals, Cedar Waxwings, Thrushes, Brown thrashers
Serviceberry	Twigs, leaves and buds are eaten by deer and rabbits. The fruits are eaten by thrushes, many other songbirds, rodents, small mammals and bear. Grouse, turkey, squirrels, chipmunks, beaver and foxes will eat

	twigs, buds and fruits at various times.
New York fern	Provides cover
Rhododendron	Cover for Deer, Black bears, Snowshoe hares, Ruffed grouse, Turkeys, Songbirds

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:	**Important Wildlife Species:**
Hemlock	Ninety-six bird and forty-seven mammal species are associated with hemlock
Sassafras	Crested flycatchers, Quails, Turkeys, Kingbirds, Mockingbirds, Sapsuckers, Pileated woodpeckers, Yellowthroat warblers, Phoebes, Black bears, Beaver, Deer
Eastern white pine	Yellow-bellied sapsuckers, Pine warblers, Red crossbills, Beaver, Porcupine, Deer, Snowshoe hare, Bald eagles
American beech	Black bears, Foxes, Ruffed grouse, Ducks, Cover for Chickadees
Sweet birch	Beaver, Black-capped chickadee, Porcupine, Ruffed grouse
Red maple	Bats, Deer
Sugar maple	Deer, Porcupines, Snowshoe hare, many spp. of birds feed on bark, buds, twigs and fruit
Yellow birch	Snowshoe hare, Deer, Ruffed grouse, Red squirrels, Beaver, Porcupines
Witch-hazel	Ruffed grouse
Rhododendron	Cover for Deer, Black bears, Snowshoe hares, Ruffed grouse, Turkeys, Songbirds
Viburnum	Deer, Beaver, Skunks, Ruffed grouse, Turkeys, Cardinals, Cedar Waxwings, Thrushes, Brown thrashers
New York fern	Provides cover
Black cherry	Fruits are important food source for numerous species of Passerine birds, Game birds, and Mammals including Foxes, Black bears,

	Raccoons
Native alders	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	3	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

[a]Between 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.

[b]No 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.

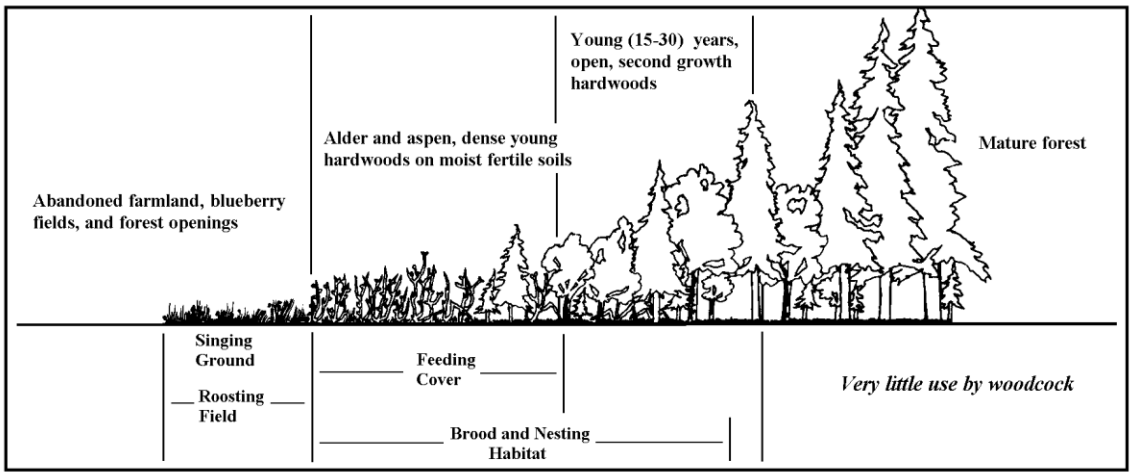

Fig. 2. The stages of forest succession used by woodcock. (from Sepik, etal, 1981).

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.

Litte 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 cares. 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 Alleghany 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 6: Emergency Contact Information

COMPANY EMERGENCY CONTACT LISTING			
COMPANY NAME	**24/7 Emergency #**	**Other #**	**Name(s)**
American Exploration Company	**(724) 388-4309**		Jason Clark - field supervisor
		(814) 787-8235	Benezette office
Anadarko	**(409) 383-5403**	(409) 200-4335 cell	Benny Hailey
Atlas America/Atlas Energy	**(412) 262-4613**		**Executive Offices**
		(724) 662-0300	Mercer County office
		(724) 564-2360	Fayette County office
BG Production, LLC	**(412) 309-3457 cell**		Scott Walker - field representative
	(412) 289-9310 cell		Greg Rohrer - field representative
Chesapeake Appalachia, LLC	**(607) 738-4101 cell**	(607) 846-3143 office	Greg Garrison - EHS Field Specialist, Operations - Marcellus North
Chief Oil and Gas	**866-947-6447**		Drilling emergencies
		866-947-6448	Pipeline emergencies
D&L Energy, Inc.	**888-343-4427 (M-F)**	**888-524-2975**	Mark Sitch - Safety Director & Dave Rice - field supervisor
Devonian Resources (Admin)			
Dominion	**1-888-264-8240**		Dominion Transmission Gas Control
		(304) 627-3072	Senior Dispatcher
		(304) 627-3073	Dispatcher
Eastern American Energy	**(724) 463-8400**	none	Mark Fry or Mike Cochran
Eberly Natural Gas Company			
Energy Corporation of America	**(724) 463-8400**	none	Mark Fry or Mike Cochran
EOG Resources	**(724) 465-3314**	(724) 349-7620	Indiana Field Office (M-F, 8:00-5:00)
		(412) 289-7177	Len Ferguson, Area Production Mgr.

		(412) 309-3792 (412) 309-1614 (724) 388-6057	Nathan Wells, Sr. Safety and Env. Rep. Jim Cunkleman, Production Foreman Greg Shaffer, Construction Foreman
EXCO - North Coast **EXCO Resources (PA), Inc.**	**1-888-788-3781** **1-888-788-3781**		EXCO Call Center EXCO Call Center
ExxonMobil	**(713) 656-6300**		
Hunt Oil	**(214) 978-8000**		
KSM Energy, Inc.	**(412) 967-0164 office**	(412) 576-8205 cell	Robert Golier - emergency contact
NCL	**(814) 571-4180** **(281) 467-2108**		Ryan Cramer - field ops, PA Mark Clavenna - Texas
PGE	**(814) 723-3230**		
Penn Virginia Oil & Gas	**1-888-292-5017**	(423) 341-7121 cell (484) 947-6111 cell	Jim Burns, Operations Manager Charity Fleenor, Environmental & Safety Mgr.
Range Resources			
R E Energy Development	**(814) 321-2115** **(814) 730-8194** **(717) 443-7098**		Timothy Beattie, Sr. VP and Appalachian Basin Mgr. James Taydus, Production Supervisor Melissa Hamsher, Director of Env., Health, and Safety
Seneca Resources	**(814) 715-5525** **(814) 771-0281 (K)** **(814) 715-1049 (C)**	 (814) 389 - 7318 (W) (814) 661-4280 (D)	Every Emergency **Steve "Andy" Woodward - Primary Contact** plus also call one of the contacts below as applicable **Environmental Emergencies** (K) = Doug Kepler - primary contact (W) = Ben Williams - backup contact **Well-Related Emergencies** (C) = Steve Conley - primary contact (D) = David Doles - backup contact

	(814) 541-4126 (H)	(814) 715-4587 (P)	**Pipeline/Production Emergencies** (H) = Doug Hartle - primary contact (P) = Nick Perkins - backup contact
Southwell, William		(814) 723-5178	only known phone #
Talisman Energy	**800-530-5392**	(607) 425-5664	company on-call manager cell #
Texas Keystone	**(724) 349-8130**	(412) 337-9574	(412) AC # is for Vern Fuller
UGI Corp			
Ultra Resources	**(570) 439-7127**	(303) 645-9809	John Vidrine and Nick Soileau - PA safety team Mary Pobuda - Regulatory Specialist
XTO Energy	**1-877-829-8521**		
Zenith Exploration Company	**(740) 922-0923**		

Pennsylvania Department of Environmental Protection Contact Information

Pennsylvania Department of Environmental Protection: Bureau of Oil and Gas Contact Information

Appendix 7: Abbreviations key for guidelines

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.

BMP: Best Management Practice

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.

BOGM: Bureau of Oil and Gas Management = A bureau within the Pennsylvania Department of Environmental Protection that is responsible for statewide oil and gas conservation and environmental programs to facilitate the safe exploration, development, and recovery of Pennsylvania's oil and gas reservoirs.

D: refers to 20 Department of Conservation and Natural Resources designated forest districts of Pennsylvania (e.g., D10 equals District 10)

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.

GIS: Geographic Information System

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)

MSDS: Material Safety Data Sheets

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.

OSHA: United States Department of Labor: Occupational Safety and Health Administration

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.

PLS: Pure Live Seed

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).

SF: State Forest lands belonging to the Commonwealth of Pennsylvania

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.

USDA: NRCS: United States Department of Agriculture: Natural Resources Conservation Service

USFWS: United States Fish and Wildlife Service