

**Reducing Ecological Impacts  
of Shale Development:  
RECOMMENDED PRACTICES  
FOR THE APPALACHIANS**

# RESOURCES

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Using the resources listed in this document and the [scientific literature](#), The Nature Conservancy developed a [series of documents](#) that describe the ecological impacts of shale oil and gas development and offer science-based recommended practices to reduce them. These resources also provide additional information, including lease guides for landowners, mapping and decision-support tools that can be used when siting infrastructure, and general information about shale oil and gas development.

## CONSERVATION PRACTICES FOR OIL AND GAS DEVELOPMENT

### Practices and Guidance Documents

The Nature Conservancy derived existing conservation practices from the resources below to populate the practices presented in each summary document. The Conservancy does not necessarily recommend the adoption of all practices within these documents.

**American Petroleum Institute** – [Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing](#) (2011) and [Water Management Associated with Hydraulic Fracturing](#) (2010).

**Appalachian Regional Reforestation Initiative** – [Forest Reclamation Advisories](#)

**Bureau of Land Management** – [Oil and Gas Best Management Practices](#)

**Colorado Division of Wildlife** – [Actions to Minimize Adverse Impacts To Wildlife Resources](#) (2008).

**Intermountain Oil and Gas BMP Project** – [searchable database](#) of mandatory and voluntary Best Management Practices recommended in Colorado, Montana, New Mexico, Utah, and Wyoming.

**Marcellus Shale Coalition** – [Recommended Practices: Site Planning, Development, and Restoration](#) (2012).

**Maryland Department of the Environment** – [Marcellus Shale Safe Drilling Initiative Study](#) (2014) and [Recommended Best Management Practices for Marcellus Shale Gas Development in Maryland](#) (2013).

**New York State Department of Environmental Conservation** – [Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program](#) (2011).

**Ohio Department of Natural Resources** – [Best Management Practices for Oil and Gas Well Site Construction](#) (2013).

**Pennsylvania Department of Conservation and Natural Resources** – [Guidelines for Administering Oil and Gas Activity on State Forest Lands](#) (2013).

**Pennsylvania Wilds** – [Design Guide Supplement for Oil and Gas Best Practices](#) (2013).

**Pinchot Institute for Conservation** – [The Marcellus Shale: Resources for Stakeholders in the Upper Delaware Watershed Region](#) (2010).

**The Nature Conservancy** – [Evaluating the Scientific Support of Conservation Best Management Practices \(BMPs\) for Shale Gas Extraction in the Appalachian Basin](#) (2012).

**University of Massachusetts** – [North Atlantic Aquatic Connectivity Collaborative](#)

**US Forest Service, USDA, and Penn State Center for Dirt and Gravel Road Studies** – [Environmentally Sensitive Road Maintenance Practices For Dirt and Gravel Roads](#) (2012).

**Vermont Fish and Wildlife Department** – [Aquatic Organism Passage at Road/Stream Crossings](#)

**Wyoming Fish and Game Department** – [Recommendations for Development of Oil and Gas Resources within Important Wildlife Habitats](#) (2010).

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## Additional Supporting Documents by Topic

The Nature Conservancy drew from the resources below, in conjunction with the above guidance documents and scientific literature, to produce a suite of science-based TNC Recommended Conservation Practices.

### General

**Appalachian Shale Recommended Practices Group** – [Responsible Standards and Practices](#) (2012).

**Center for Sustainable Shale Development** – [Performance Standards](#).

**Shale Gas Roundtable: Deliberations, Findings, and Recommendations** (2013).

**USDA, Natural Resources Conservation Service** – [Conservation Practices](#)

### Ecological Buffers

**Metropolitan Conservation Alliance, Wildlife Conservation Society** – [Best Development Practices Conserving Pool-Breeding Amphibians in Residential and Commercial Developments in the Northeastern United States](#) (2002).

**Pennsylvania Department of Environmental Protection** – [Riparian Forest Buffer Guidance](#) (2010).

### Invasive Plants

**National Park Service, U.S. Fish and Wildlife Service** – [Plant Invaders of Mid-Atlantic Natural Areas](#) (2010).

**Pennsylvania Department of Conservation and Natural Resources** – [Invasive Plant Management Tutorial](#)

**The Nature Conservancy** – [Protecting Native Plants and Animals](#)

**USDA, Forest Service** – [Vehicle Cleaning Technology for Controlling the Spread of Noxious Weeds and Invasive Species](#) (2005).

**U.S. Department of Agriculture** – [National Invasive Species Information Center](#)

### Noise & Artificial Lighting

**International Dark-Sky Association** – [Provides resources on light pollution and wildlife](#).

**Pennsylvania Department of Conservation and Natural Resources** – [Compressor Noise on State Forest Land](#)

### Pipeline Development

**Right-of-Way Stewardship Council** – [Integrated Vegetation Management Framework and Standards](#) (2005, 2008).

**Electric Power Research Institute** – [Electric Transmission Right-of-Way Post-Blackout Vegetation Management Strategies](#) (2007).

**U.S. Fish & Wildlife Service** – [Arkansas best management practices for natural gas pipeline construction and maintenance activities in the Fayetteville Shale area, upper Little Red River watershed](#) (2009).

**Tennessee Gas Pipeline Company, Commonwealth of Massachusetts** – [Five-year Vegetation Management Plan 2011-2015](#)

### Road Development

**Pennsylvania Department of Environmental Protection** – [Erosion and Sediment Pollution Control Program Manual](#) (2012).

**Penn State University** – [Center for Dirt and Gravel Road Studies](#)

**USDA, Forest Service** – [Low-Volume Roads Engineering: Best Management Practices Field Guide](#) (2003).

**West Virginia Department of Environmental Protection** – [Erosion and Sediment Control Field Manual](#) (2012).

### Stream Crossings

**Maine Audubon** – [Stream-Smart](#)

**Massachusetts Department of Fish and Game** – [Stream Crossings Handbook](#)

**New York State Department of Conservation** – [Stream Crossings](#)

**USDA, Forest Service** – [Designing for Aquatic Organism Passage at Road-Stream Crossings](#)

**USDA, Forest Service** – [Portable Timber Bridges as a Best Management Practice in Forest Management](#)

## Water Withdrawals

**Ceres** – [Hydraulic Fracturing and Water Stress -Water Demand by the Numbers](#)

**The Nature Conservancy** – Ecosystem Flow Recommendations for Major Basins in the Appalachian Region:

- [Delaware River Basin](#)
- [Susquehanna River Basin](#)
- [Tributaries of the Great Lakes in New York and Pennsylvania](#)
- [Upper Ohio River Basin](#)

**Stockholm International Water Institute** – [Shale Gas and Hydraulic Fracturing: Framing the Water Issue](#)

**U.S. Geological Survey** – Methods to estimate surface water availability in the Appalachian region.

- [Pennsylvania Baseline Streamflow Estimator \(BaSE\)](#)
- [The StreamStats Program](#)

## Other

**American Bird Conservancy** – [Golden-winged Warbler Habitat Best Management Practices for Forestlands in Maryland and Pennsylvania](#) (2011).

**Pennsylvania Department of Conservation and Natural Resources** – [2010-2015 Brook Trout Conservation Plan](#)

**Pennsylvania Game Commission and Fish & Boat Commission** – [Pennsylvania Wildlife Action Plan, 2015-2025](#)

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## LEASE GUIDES FOR LANDOWNERS

The following guides are intended to act as resources for landowners who are considering leasing their property for shale oil and gas development. These guides aim to inform landowners of possible environmental and health impacts, issues and protective provisions that can be addressed in a lease, and approaches aimed at protecting conservation features on the property.

**Pennsylvania Environmental Council** – [Marcellus Shale Lease Guide](#) (2011).

**Western PA Conservancy** – [Conservation Guidance for Landowners on Natural Gas Development](#) (2010).

**Harvard Law School, Emmett Environmental Law & Policy Clinic** – [A Landowner's Guide to Hydraulic Fracturing: Addressing environmental and health issues in oil and gas leases](#) (2014).

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## MAPPING AND DECISION-SUPPORT TOOLS

The following resources can be used to help reduce ecological risks associated with siting surface infrastructure for shale development.

**The Nature Conservancy's** [Development by Design](#) approach provides a smarter way to meet human infrastructure needs while maintaining healthy, functional natural systems. [LEEP](#), the Conservancy's Appalachian siting tool, can help reduce ecological impacts from the placement of shale oil and gas infrastructure.

**NatureServe** is an international network of [natural heritage programs](#) that gather and provide information on the location and status of important ecological resources. Members in the Appalachian region include the [Maryland](#), [Ohio](#), [Pennsylvania](#), and [West Virginia](#) Natural Heritage Programs.

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## SHALE OIL AND GAS DEVELOPMENT

The following resources provide information about environmental, economic, and other aspects of shale oil and gas development.

**The Nature Conservancy** conducted the [Pennsylvania Energy Impacts Assessment](#) and also released an [Appalachian-wide study](#), unprecedented in its scope and scale, that shows where likely future energy development from coal, shale oil and gas, and wind energy overlaps with important natural resources.

The **American Petroleum Institute** provides [publications, articles, and presentations](#) on a variety of issues associated with oil and natural gas.

The **Environmental Defense Fund** links science, economics, and law to create innovative, equitable, and cost-effective solutions to urgent environmental issues, including [shale oil and gas development](#).

**Exploreshale.org** seeks to enhance the public's understanding of the basic science surrounding the Marcellus Shale by providing a [fact-based interactive learning experience](#).

**FracTracker Alliance** shares [maps, data, and analyses](#) to communicate impacts of the global oil and gas industry and informs actions that positively shape our energy future.

The **Marcellus Shale Coalition** works with partners in the Appalachian region to address [issues surrounding shale gas development](#) and provides information to various stakeholder groups.

**NPR's State Impact** covers the [fiscal and environmental impact](#) of Pennsylvania's booming energy economy, with a focus on Marcellus Shale drilling.

The **Pennsylvania Environmental Council** (PEC) works on [environmental and energy issues statewide](#). In addition, PEC advances innovative and collaborative conservation, recreation, and watershed initiatives throughout Pennsylvania.

**Penn State University** has several resources. The [Marcellus Center for Outreach and Research](#) addresses the complete range of issues associated with shale development. The [Marcellus Shale Electronic Field Guide](#) provides information on ecological concepts, pre-development issues, sample leases, best management practices, picture galleries, and much more. The College of Agricultural Sciences offers additional resources, including [publications](#) and an [illustrated guide](#) to drilling equipment and practices in Pennsylvania.

**Pennsylvania Department of Conservation and Natural Resources** has established a [Shale Gas Monitoring](#) program to monitor, evaluate, and report the impacts of shale-gas development to the state forest system and its stakeholders. The program aims to provide objective and credible information to the public and inform and improve shale-gas management efforts.

The **U.S. Department of Energy**, Office of Fossil Energy [Shale Gas 101](#) explains the basics, including what shale gas is, where it's found, why it's important, how it's produced, and challenges associated with production. Within the Department of Energy is also the [National Energy Technical Laboratory](#), which implements a broad spectrum of energy and environmental research and development programs.

The **U.S. Geological Survey** Energy Resources Program has published a series of reports that quantify the landscape changes as a result of gas development in Pennsylvania from 2004 to 2010. *The reports are available [here](#) by searching for "landscape consequences of natural gas extraction".*