United States Department of the Interior
Bureau of Land Management
Northeastern States District Office
LLESM03200

Environmental Assessment

NEPA #: DOI-BLM-Eastern States-0030-2016-0002-EA

Oil and Gas Leasing, Wayne National Forest, Marietta Unit of the Athens Ranger District, Monroe, Noble, and Washington Counties, Ohio

Date:	October 2016
Type of Action:	Oil and Gas Leasing
Locations:	Benton, Center, Green, Jackson, Lee, Perry, Summit, Washington, and Wayne Townships, Monroe County, Ohio Lawrence and Liberty Townships, Washington County, Ohio Elk Township, Noble County, Ohio

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MISSION STATEMENT

It is the mission of the Bureau of Land Management to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

Table i. Technical review.

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EXECUTIVE SUMMARY

The Bureau of Land Management (BLM) has prepared this Environmental Assessment (EA) to evaluate the anticipated environmental impacts of the Proposed Action to lease federal mineral estate within the proclamation boundary of the Wayne National Forest (WNF), Athens Ranger District, Marietta Unit. The Marietta Unit is located within Monroe, Noble, and Washington Counties in Ohio. The parcels that could be leased as part of the Proposed Action consist of all federal mineral estate underlying National Forest System (NFS) lands and total approximately 40,000 acres. The proposed parcels would be leased for potential future oil and gas development. Maps depicting the location of the Proposed Action are included in Chapter 6 of this EA.

The purpose of the Proposed Action is to support the development of oil and natural gas resources that are essential to meeting the nation's future needs for energy. The oil and gas leasing program managed by the BLM encourages the sustainable development of domestic oil and gas reserves which reduces the dependence of the United States on foreign sources of energy as part of its multiple-use and sustainable yield mandate. The Proposed Action is consistent with the BLM's mission and requirement to evaluate nominated parcels and hold quarterly competitive lease sales for available oil and gas lease parcels. In depth analysis of the purpose and need of the Proposed Action can be found in Chapter 1 of this EA.

Interested parties, such as private individuals or companies, may file Expressions of Interest (EOIs) to nominate parcels for competitive bid and leasing by the BLM. The BLM has received at least 50 EOIs to nominate parcels on the Marietta Unit of the WNF. Any nominated parcels reviewed and approved for competitive leasing by the BLM and United States Forest Service (Forest Service) after the initial lease sale, in which parcels are auctioned, would be addressed with a Determination of NEPA Adequacy (DNA) document to confirm the analysis in this EA is still adequate. Once the DNA is complete, approved lease parcels would then be auctioned at future BLM Eastern States competitive oil and gas lease sales.

A federal oil and gas lease is a legal contract that grants exclusive rights to the lessee to develop federally-owned oil and gas resources, but does not authorize surface-disturbing activities or obligate the lessee to drill a well on the parcel in the future. Should the parcel be leased and a detailed plan for oil and gas development on the parcel be identified, the BLM and Forest Service would conduct future site-specific environmental analysis and any required consultations, prior to any ground disturbing activities. The site-specific analysis and additional consultations would occur at the Application for Permit to Drill (APD) stage. The Proposed Action evaluated in this EA is described in further detail in Chapter 2.

Chapter 3 of this EA describes the environment that would be affected by implementation of the Proposed Action, as required by the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 CFR Parts 1500-1508). The discussion in Chapter 3 focuses on the relevant resources and issues and only those elements of the affected environment that have the potential to be impacted are described in detail.

The anticipated environmental consequences associated with direct, indirect, and cumulative effects of the Proposed Action and No Action Alternative are examined in Chapter 4. The Proposed Action of

leasing parcels would, by itself, have no direct impact on any resources in the lease area since there would be no surface disturbing activities. All anticipated resource impacts would be associated with potential future oil and gas development. As previously stated, additional site-specific NEPA analysis would be conducted at the (APD stage prior to ground disturbing activities, if actual mineral development on a lease parcel(s) is proposed.

This EA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969; the CEQ regulations implementing NEPA (40 Code of Federal Regulations [CFR] Parts 1500-1508), the United States Department of the Interior (DOI) NEPA requirements (Department Manual 516, Environmental Quality) and the BLM NEPA Handbook H-1790-1. The information presented within this document serves as the basis for the BLM Authorized Officer to decide whether the Proposed Action would result in significant impacts to the environment. Significant impacts would require the preparation of an Environmental Impact Statement (EIS). If the BLM Authorized Officer determines that no significant impacts would occur, a Finding of No Significant Impact (FONSI) would be issued.

The Proposed Action and alternatives are in compliance with the *Final Revised Land and Resource Management Plan, Wayne National Forest* (2006 Forest Plan) (U.S. Forest Service, 2006). Since the BLM was a cooperating agency in development of the 2006 Forest Plan, this EA incorporates, where appropriate, the information from that plan and associated NEPA documentation. This EA also incorporates the information from a related review effort resulting in a Supplemental Information Report (SIR) on potential oil and gas development in the WNF (U.S. Forest Service, 2012). The SIR was prepared by the Forest Service in coordination with the BLM.

The anticipated environmental impacts of the Proposed Action and No Action Alternative are summarized in Table ii. Table ii is a summary; more detailed analyses are found in the chapters that follow.

Table ii. Anticipated environmental effects of Proposed Action and No Action Alternative.

Resource	No Action Alternative	Proposed Action
Air Resources/Climate	No effect	No direct effects from leasing. Effects can be expected from emissions associated with potential future construction activities and well completion, including National Ambient Air Quality Standards (NAAQS) criteria contaminants and hazardous air pollutants. Effects from emissions may include health hazards, reduced visibility, and contribution to global greenhouse gas emissions. Effects minimized by Standard Operating Procedures (SOPs), best management practices (BMPs) and conditions of approval (COAs) at the time of drilling.
Plant and Animal Habitat and Populations	No effect	No direct effects from leasing. Potential for minor to moderate habitat modification through clearing vegetation for potential future construction of roads, pads, and other infrastructure. Potential effects dependent on locations of proposed wells. Some clearing would be temporary, and all areas would be restored during interim or final reclamation. Effects minimized by 2006 Forest Plan's measures protecting sensitive species and habitats.
Geology and Mineral Resources	No effect	No direct effects from leasing. Low risk of induced seismicity from potential future oil and gas development. Over time, there is the potential for mineral depletion.
Soils	No effect	No direct effects from leasing. Potential for minor soil compaction, increased erosion, and polluted runoff from potential future mineral development. Future reasonably foreseeable effects would be minimized by lease stipulations and BMPs.
Water Resources and Water Quality	No effect	No direct effects from leasing. Potential for large surface water withdrawals for drilling and completion associated with potential reasonably foreseeable future development. Some risk of chemical spills and erosion from roads and well pads. Future reasonably foreseeable effects minimized by Forest Service policies for water withdrawal and waterway protection and soil-conservation measures. Additional protections required by the Onshore Orders.

Resource	No Action Alternative	Proposed Action
Wastes, Hazardous or Solid	No effect	No direct effects from leasing. Wastes would be generated from reasonably foreseeable development, with a potential for short- and long-term adverse impacts if wastes are not properly handled, stored, and disposed. SOPs, BMPs, and COAs at the APD stage would minimize risk from spills.
Public Health & Safety	No effect	No direct effects from leasing. From future reasonably foreseeable development, effects include potential exposure to contamination that may cause health conditions in sensitive or susceptible populations. However, federal, state, and local regulations, as well as health standards and protocols ensure that potential operations do not compromise public health and safety.
Transportation	No effect	No direct effects from leasing. Within future reasonably foreseeable development, potential effects to existing roads and traffic may occur. Development of new roads may not be extensive or necessary and traffic patterns may vary depending on use. More traffic could increase traffic related accidents or suspended dust particles that may hamper wildlife or scenery. Vehicle movement would tend to lessen after initial development. Adhering to Forest Service regulations and mitigations would address potential accidents or concerns.
Land Use and Recreation	No effect	No direct effects from leasing. Effects may include minor, short- and long-term changes to land use from reasonably foreseeable development activities due to conversion of undeveloped areas to areas that support oil and gas development. Future reasonably foreseeable effects minimized by stipulations and other Forest Service measures for protecting recreation resources.
Noise	No effect	No direct effects from leasing. Effects of future reasonably foreseeable development activities could include the generation of unwanted sounds, making the area less attractive to residents or visitors while possibly displacing wildlife nearby, therefore affecting surrounding ecosystems. However, noise effects would subside after initial development and drilling. BMPs would minimize potential adverse noise effects.
Cultural Resources/Paleontology/	No effect	No direct effects from leasing. Additional surveys and tribal consultation under the NHPA would be conducted,

Resource	No Action Alternative	Proposed Action
Native American Religious Concerns		as required, at the APD stage.
Visual Resources/Scenic Quality	No effect	No direct effects from leasing. Effects include minor, short- and long-term adverse visual impacts from reasonably foreseeable development associated with the proposed lease parcels.
Socioeconomics and Environmental Justice	Loss, reduction, or delay of revenues generated through leasing and royalties.	Direct effects of leasing would generate revenues that would be shared with counties. Effects based on reasonably foreseeable development may generate additional royalties, economic stimulation in form of additional employment, output, and support services. Environmental justice concerns are not expected. Minority populations are not present. Although there are low-income populations, disproportionate adverse effects are not expected.
Cumulative Impacts	N/A	Minor cumulative effects overall. Forest Service management of WNF provides long-term improvement of all resources through implementation of 2006 Forest Plan. Oil and gas leasing and potential development are considered in the 2006 Forest Plan along with other activities and do not threaten the Plan's desired outcomes or objectives for WNF. Indirect effects may include development of oil and gas resources on non-Federal lands.

Acronyms

AMD - Acid Mine Drainage

AMDAT - Acid Mine Drainage Abatement and Treatment
AML - Abandoned Mine Land
APD - Application for Permit to Drill
ATV - All Terrain Vehicle
BE - Biological Evaluation
BLM - Bureau of Land Management
BMP - Best Management Practice
BO - Biological Opinion
CAA - Clean Air Act
CAIR - Clean Air Interstate Rule
CCS - Carbon Capture Sequestration
CFR - Code of Federal Regulations
CEQ - Council on Environmental Quality
CERCLA - Comprehensive Environmental Response Compensation and Liability Act
CH_4 - Methane
CO - Carbon Monoxide

CO_2 - Carbon Dioxide
CO_2e - Carbon Dioxide Equivalent
COA - Conditions of Approval

CSAPR - Cross-State Air Pollution Rule
CWA - Clean Water Act

DAPC - Division of Air Pollution Control
DNA - Determination of NEPA Adequacy
DOGRM - Division of Oil and Gas Resources Management
DOI - Department of the Interior
DR - Decision Record
EA - Environmental Assessment
EO - Executive Order
EOI - Expression of Interest
EPA - Environmental Protection Agency
ESA - Endangered Species Act
ESO - Eastern States Office
FA - Flow Alteration
FLPMA - Federal Land Policy and Management Act
PSD - Prevention of Significant Deterioration
RCRA - Resource Conservation and Recovery Act

FONSI - Finding of No Significant Impact

FOOGLRA - Federal Onshore Oil and Gas Leasing Reform Act
FWS - Fish and Wildlife Service
GHG - Greenhouse Gas
GWP - Global Warming Potential
HA - Habitat Alterations
HF - Hydraulic Fracturing
HVHF - High-Volume Hydraulic Fracturing
HUC - Hydraulic Unit Code
IBI - Index of Biotic Integrity
ICI - Invertebrate Community Index
LOC - Levels of Concern
LRMP - Land and Resource Management Plan
LUP - Land Use Plan
MACT - Maximum Achievable Control Technology

MBTA - Migratory Bird Treaty Act
MJ - Megajoules
MLA - Mineral Leasing Act
mm - millimeter
NAAQS - National Ambient Air Quality Standards
NAGPRA - Native American Graves Protection and Repatriation Act
NEPA - National Environmental Policy Act
NESHAP - National Emission Standards for Hazardous Air Pollutants
IBI - Index of Biotic Integrity
NFS - National Forest System
NHPA - National Historic Preservation Act

NOx - Nitrogen Oxides
NOI - Notice of Intent for Geophysical Exploration
NSD - Northeastern States District
O_3 - Ozone
ODNR - Ohio Department of Natural Resources
OHV - Off-Highway Vehicle
Pb - Lead
PCBs - Polychlorinated Biphenyls
PM - Particulate Matter
TT - Total Toxics
USC - United States Code
USFWS - U.S. Fish and Wildlife Service
UTV - Utility Task Vehicle

RFDS - Reasonably Foreseeable Development Scenario
SCC – Social Cost of Carbon
SIO - Scenic Integrity Objectives
SIP - State Implementation Plan
SMS - Scenery Management System
SO_2 - Sulfur Dioxide
SOP - Standard Operating Procedure
SIO - Scenic Integrity Objectives
TMDL - Total Maximum Daily Load
TSS - Total Suspended Solids
VMS - Visual Management System
VOC - Volatile Organic Compound
VQO - Visual Quality Objectives
VRM - Visual Resource Management
WNF - Wayne National Forest
VMS - Visual Management System
TMDL - Total Maximum Daily Load
TSS - Total Suspended Solids

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1. PURPOSE AND NEED

1.1. Introduction

The Bureau of Land Management (BLM) has prepared this Environmental Assessment (EA) to evaluate the anticipated environmental impacts of the Proposed Action to lease federal mineral estate within the proclamation boundary of the Wayne National Forest (WNF), Athens Ranger District, Marietta Unit. The Marietta Unit is located within Monroe, Noble, and Washington Counties in Ohio. The parcels that could be leased as part of the Proposed Action consist of all federal mineral estate underlying National Forest System (NFS) lands and total approximately 40,000 acres. The parcels would be leased for potential future oil and gas development.

Interested parties, such as private individuals or companies, may file Expressions of Interest (EOIs) to nominate parcels for competitive bid and leasing by the BLM. The BLM has received at least 50 EOIs to nominate parcels on the Marietta Unit. Consistent with the BLM mission and requirement to evaluate nominated parcels and hold quarterly competitive lease sales for available oil and gas parcels, this EA would be used as a vehicle to lease parcels in the Marietta Unit for several future oil and gas lease sales. Before each future competitive lease sale; however, the BLM and Forest Service would review and approve nominated parcels and prepare a Determination of NEPA Adequacy (DNA) document to confirm the adequacy of the environmental analysis within this EA and to ensure it is still appropriate to use as a vehicle for leasing.

A federal oil and gas lease is a legal contract that grants exclusive rights to the lessee to develop federally-owned oil and gas resources, but does not authorize surface-disturbing activities or obligate the lessee to drill a well on the parcel in the future. Should the parcel be leased and a detailed plan for oil and gas development on the parcel be identified, the BLM and Forest Service would conduct future site-specific environmental analysis and any required consultations, prior to any ground disturbing activities. The site-specific analysis would occur at the Application for Permit to Drill (APD) stage. The Proposed Action evaluated in this EA is described in further detail in Chapter 2.

This EA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969; the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations [CFR] Parts 1500-1508), the United States Department of the Interior (DOI) NEPA requirements (Department Manual 516, Environmental Quality) and the BLM NEPA Handbook H-1790-1. The information presented within this document serves as the basis for the BLM Authorized Officer to decide whether the Proposed Action would result in significant impacts to the environment. Significant impacts would require the preparation of an Environmental Impact Statement (EIS). If the BLM Authorized Officer determines that no significant impacts would occur, a Finding of No Significant Impact (FONSI) would be issued.

1.2. Location of the Proposed Action

The Proposed Action is located in Monroe, Noble, and Washington Counties within the proclamation boundary of the WNF in Ohio. Location maps are included in Chapter 6 of this EA. Map 1 depicts an

overview of the WNF showing each ranger district/unit proclamation boundary. Map 2 is an overview of the Marietta Unit. Map 3 indicates the locations of EOIs on the Marietta Unit that have been received as of the release date of this EA.

1.3. Purpose and Need of the Proposed Action

The purpose of the Proposed Action is to support the development of oil and natural gas resources that are essential to meeting the nation's future needs for energy. It is the policy of the BLM as mandated by various laws, including the Mineral Leasing Act of 1920, as amended (30 United States Code [USC] 181 et seq.), the Federal Land Policy and Management Act of 1976 (FLPMA), and the Energy Policy Act of 2005 to make mineral resources available for development to meet national, regional, and local needs. The oil and gas leasing program managed by the BLM encourages the sustainable development of domestic oil and gas reserves which reduces the dependence of the United States on foreign sources of energy as part of its multiple-use and sustainable yield mandate.

The leasing of federal minerals is vital to the United States as it seeks to maintain adequate domestic production of this strategic resource. Industry uses the BLM EOI process to nominate federal minerals for leasing. The Proposed Action is consistent with the BLM's mission and requirement to evaluate nominated parcels and hold quarterly competitive lease sales for available oil and gas lease parcels.

1.4. Management Objectives of the Proposed Action

The management objective of the Proposed Action is to make federal minerals available for development in an environmentally sound manner.

1.5. Relationship to Statutes, Regulations, Land Use Plans, and Policy

In addressing environmental considerations of the Proposed Action, the BLM is guided by relevant statutes (and their implementing regulations) and Executive Orders that establish standards and provide guidance on environmental and natural resources management and planning. These include but are not limited to the following:

- NEPA (1969) and the associated Council on Environmental Quality regulations at 43 CFR Parts 1500-1508;
- FLPMA (1976) as amended and the associated regulations at 43 CFR Part 1600;
- Mineral Leasing Act (MLA) (1920), as amended and supplemented (30 USC 181);
- National Historic Preservation Act (NHPA) (1966) as amended and the associated regulations at 36 CFR Part 800;
- American Indian Religious Freedom Act;
- Native American Graves Protection and Repatriation Act (NAGPRA) (1990);
- Endangered Species Act (ESA) (1973) as amended;
- Clean Water Act (CWA) (1972) as amended;
- Clean Air Act (CAA) (1970) as amended;
- Federal Onshore Oil and Gas Leasing Reform Act (FOOGLRA) (1987);
- Migratory Bird Treaty Act (MBTA) (1918);

- Resource Conservation and Recovery Act (RCRA) (1976) as amended;
- Executive Order (EO) 11988- Floodplain Management;
- EO 11990 – Protection of Wetlands;
- EO 12898 – Environmental Justice in Minority Populations and Low-Income Populations;
- EO 13045 - Protection of Children from Environmental Health and Safety Risks; and
- EO 13007 – Indian Sacred Sites.

In addition to the above statutes and regulations, the following BLM and Forest Service policies are applicable to oil and gas leasing:

- Memorandum of Understanding between the USDOI BLM and USDA Forest Service Concerning Oil and Gas Leasing and Operations (Forest Service Agreement No. 06-SU-11132428-052; BLM MOU WO300-2006-07); and
- Oil and Gas Leasing Reform – Land Use Planning and Lease Parcel Reviews (BLM WO IM 2010-117).

The Proposed Action and alternatives are in conformance with the 2006 *Final Revised Land and Resource Management Plan, Wayne National Forest* (2006 Forest Plan) (U.S. Forest Service, 2006). Goal 10.1 in the 2006 Forest Plan states, "Provide a supply of mineral commodities for current and future generations, while protecting the long-term health and biological diversity of ecosystems. Facilitate the orderly exploration, development, and production of mineral and energy resources on land open to these activities" (2006 Forest Plan, p. 2-41). The BLM was a cooperating agency in development of the 2006 Forest Plan and its related Final Environmental Impact Statement (2006 Forest Plan Final EIS) (U.S. Forest Service, 2005). The Forest Service signed its Record of Decision on December 14, 2005.

This EA is also consistent with a related review effort resulting in a Supplemental Information Report (SIR) on oil and gas (U.S. Forest Service, 2012) that was prepared by the Forest Service in coordination with the BLM. This EA incorporates by reference the relevant information from the 2006 Forest Plan, Final Environmental Impact Statement and the 2012 SIR, in accordance with 40 CFR 1502.21. All of the documents are available to the public for inspection at the following location: http://www.fs.usda.gov/main/wayne/landmanagement/planning.

1.6. Decision to be Made

The BLM must decide whether to make available for lease present and future parcels that total approximately 40,000 acres of federal minerals within the Athens Ranger District, Marietta Unit of the WNF at future competitive oil and gas lease sale(s). These acres encompass all the possible EOIs, and their respective parcels, that may be approved by the Forest Service in the future. The BLM, in coordination with the Forest Service, must also determine which stipulations and notices must be attached to such leases to promote oil and gas development if it meets the guidelines and regulations set forth by the NEPA of 1969 and other subsequent laws and policies passed by the U.S. Congress.

1.7. Scoping, Consultations, and Issues of Importance

1.7.1. Internal scoping

A BLM interdisciplinary team consisting of Land Law Examiners, Natural Resources Specialists, NEPA Specialists, Geologists, GIS Specialists, and Cultural Resources Specialists contributed to this EA in coordination with Forest Service personnel. The interdisciplinary team used various sources of information to prepare the EA, including existing data inventories, peer-reviewed studies, online resources, and information collected onsite. The BLM conducted site visits on October 26 and 27, 2015 within portions of the Marietta Unit that have already been requested for leasing to document the physical characteristics of the area and collect information on baseline conditions. The BLM did not identify any issues of concern from internal scoping or the site visits.

1.7.2. Agency and Tribal Consultations

1.7.2.1. NHPA and Tribal Consultation

The BLM conducted required consultation with the Ohio State Historic Preservation Office (SHPO) and tribes. The BLM initiated consultation with the Ohio SHPO under Section 106 of the NHPA, by letter dated November 16, 2015. To date, the SHPO has not responded to the letter, indicating that they have found no adverse effects within the scope of the Proposed Action. Further consultation would occur at the APD phase prior to ground disturbing activities. On November 6, 2015, the BLM sent certified letters to seven federally recognized tribes who have a known connection to the area notifying them of the Proposed Action and asking to identify any concerns with respect to the Proposed Action. To date, the BLM has received no responses to these letters. The following tribes were contacted:

- The Delaware Tribe of Indians;
- The Delaware Nation;
- The Shawnee Tribe;
- The Eastern Shawnee Tribe of Oklahoma;
- The Absentee Shawnee Tribe of Indians;
- The Wyandotte Nation; and
- Peoria Tribe of Indians of Oklahoma.

1.7.2.2. ESA Section 7 Consultation

The Forest Service has consulted with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Endangered Species Act with respect to federally listed species in the development of the 2006 Forest Plan/ EIS. As part of this consultation, the Forest Service completed a Biological Evaluation (BE) and the USFWS issued its Biological Opinion (BO) on November 22, 2005. The BO established a tiered approach to the Section 7 consultation. The programmatic (Tier I) BO (November 22, 2005) covers all the activities described in the 2006 Forest Plan/EIS at a programmatic, non-site-specific level. Because the BLM was a cooperating agency in the 2006 Forest Plan and EIS, the consultation conducted with respect to the 2006 Forest Plan and EIS applies to the Proposed Action analyzed in this EA.

As part of the 2012 SIR, the Forest Service reviewed new information related to hydraulic fracturing and whether there could be additional effects to threatened and endangered species that had not been previously analyzed in the 2006 Plan/ EIS. The Forest Service and the USFWS concluded that no further analysis or consultation was needed and that the consultation conducted under the 2006 Plan/EIS was still valid.

As the BLM analyzes individual projects pursuant to the Forest Plan, the BLM is responsible for reinitiating consultation and providing the USFWS with additional information; this process is called Tier II consultation. The BLM would submit a Tier II Biological Assessment to the USFWS when it receives an APD, if it determines that potential effects to critical habitat, fish or wildlife could occur. In order to reinitiate the consultation the FS should submit to the USFWS a:

- description of the Proposed Action and area affected;
- list of the species that may be affected and their locations;
- description of the nature of the potential effects;
- determination of the effects;
- cumulative total of incidental takes to date under the Tier I BO; and
- description of additional actions that were not described in the Tier I BO.

More recently, a BO was issued by the USFWS in 2016 for the 4(d) rule for the federally listed, threatened northern long-eared bat. This rule exempts incidental take of northern long-eared bat for federal actions that adhere to certain, basic conservation measures. The Forest Service operates under this BO and therefore the Proposed Action is also covered under the BO.

1.7.3. Public involvement

Consideration of the views and information of all interested persons promotes open communication and enables more informed decision making. Therefore, the BLM invites public participation in the NEPA process. All agencies, organizations, and members of the public having a potential interest in the Proposed Action, including minority, low-income, disadvantaged, and Native American groups, are encouraged to participate in the decision making process.

The BLM conducted external scoping for the Proposed Action through a series of public meetings, requesting public comments, and through close coordination and data sharing with the Forest Service. Public notices appeared in local newspapers including the *Marietta Times*, *Athens Messenger,* and the *Ironton Tribune* for two consecutive weeks starting on November 1, 2015. The BLM also issued a press release to various news outlets on November 2, 2015, notifying the public of dates, times, and locations of the public meetings. Public meetings were held on November 17, 2015 in Marietta, November 18, 2015 in Athens, and November 19, 2015 in Ironton. The primary purpose for those public meetings was to provide information and gather public input regarding issues that the BLM should consider in this EA. At each meeting, the BLM and the Forest Service provided information regarding proposed oil and gas leasing activities throughout the WNF; displayed maps showing locations of requested leases and

posters detailing the administrative processes associated with EOIs, leasing, and the NEPA; and answered inquiries regarding the project.

The BLM also created a project website for the EA in November 2015 that is accessible through the BLM national NEPA register at:

http://go.usa.gov/xKHCh

The website provides links to documents, opportunities for public involvement, including methods for comment submission, maps, EOI information, and links to additional project information.

The BLM Eastern States Office (ESO) leasing process and policy incorporates a mandatory 30-day public comment period on all completed EAs and unsigned FONSIs. The documents were made available for public review and comment from April 28, 2016 through May 31, 2016 (to account for the Memorial Day holiday).

In addition to the public involvement activities conducted for this Proposed Action, the WNF previously conducted extensive public outreach for the development of the 2006 Forest Plan and EIS. Public involvement activities included comment periods on the Notice of Intent, Draft EIS and Proposed Revised Forest Plan, public meetings, and collaborative workshops (see page 1-9 and Appendix A of the Final EIS; U.S. Forest Service, 2005). The WNF published a news release for the Finding for the Supplemental Information Report on August 27, 2012. All of these documents are available online at: http://www.fs.usda.gov/main/wayne/landmanagement/planning.

1.7.4. Issues identified through public scoping

The BLM received approximately 3,400 comments during its scoping period (November 1, 2015 to January 22, 2016), which included three public meetings in November 2015. Many of these comments reflected common themes, which are summarized below:

1. Oil and gas activities will disturb forestlands and degrade the wildlife habitats of the WNF;
2. Oil and gas activities will cause toxic chemicals to be spilled or be discharged into the environment, threatening wildlife populations, degrading water quality, and harming human health;
3. Oil and gas activities will create air pollution;
4. Oil and gas activities will degrade recreational opportunities and the visual character of the WNF;
5. Leasing should be delayed until the oil and gas market improves;
6. Enabling oil and gas activities will provide private landowners the opportunity to develop their minerals, and withholding leasing the federal minerals will pose an obstacle to development of private minerals; and
7. Restricting development of oil and gas minerals prohibits economic growth for the state of Ohio.

The BLM has carefully considered comments received during the scoping period and 30-day comment period on the Draft EA in the development of this Final EA.

1.7.5. Public Comment Period for the Draft EA

The public had the opportunity to review and comment on the BLM Draft EA between April 28, 2016 and May 31, 2016. Approximately 13,700 comments were received by email and 480 comments by U.S. postal service or FedEx. Approximately 300 substantive comments were identified including:

- air quality and climate change (≈50 comments),
- hydraulic fracturing (≈50 comments),
- water quality (≈25 comments),
- cumulative impacts (≈20 comments).
- the validity of the NEPA process in development of the EA (≈50 comments),
- public health (≈10 comments),
- traffic & noise (≈10 comments),
- environmental justice (≈10 comments),
- seismic risk (≈10 comments), and
- waste disposal (≈10 comments).

Comments were addressed by either expanding existing sections or creating new ones that either included more information or synthesized already existing information. Additional changes to the Draft EA are summarized in a comment matrix attached in Appendix A to this document.

2. PROPOSED ACTION AND ALTERNATIVES

The CEQ's *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act* (CEQ, 2016) establish a number of policies for federal agencies, including "using the NEPA process to identify and assess reasonable alternatives to the Proposed Action that would avoid or minimize adverse effects of these actions on the quality of the human environment" (40 CFR 1500.2 (e)). This chapter provides a detailed description of the Proposed Action and alternatives carried forward for analysis in the EA, as well as the alternatives considered but dismissed.

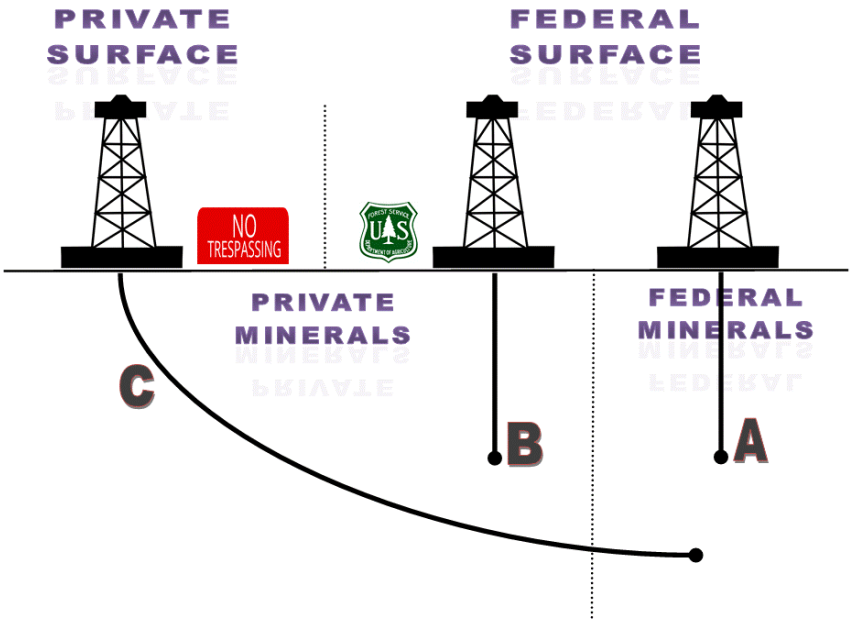
2.1. Proposed Action

The Bureau of Land Management (BLM) proposes to make available for lease up to approximately 40,000 acres of federally-owned mineral estate located in the Wayne National Forest, Athens Ranger District, Marietta Unit in Monroe, Noble, and Washington Counties in Ohio. This approximate acreage represents the total amount of federally-owned minerals that could be nominated and potentially be made available for leasing on the Marietta Unit. Although this EA analysis assumes that both oil and gas may be produced in the future within the Marietta Unit, natural gas is more likely to be produced.

Surface land and sub-surface mineral ownership within the boundaries of the Wayne National Forest (WNF) falls into four categories:

- Federal Land/Private Minerals - Approximately 59% of the WNF surface ownership is underlain by private minerals, as in scenario B in Figure 2.1., below. Partial mineral interest accounts for approximately 18,200 acres underlying National Forest Service lands on the Marietta Unit. There would be very little federal oversight in the development of private minerals under federal surface, as this development is subject to State of Ohio regulations (see Appendix C: Permitting of Oil and Gas Operations on Non-Federal Surface).
- Federal Land/Federal Minerals - Approximately 41% of surface ownership is underlain by federal minerals, as in scenario A in Figure 2.1, below. The federal government owns a 100% mineral interest in approximately 10,000 acres of the WNF. Leasing and development of federal minerals under federal surface is subject to more stringent federal government regulation than non-federal minerals.
- Federal Land/Future Federal Minerals - An additional 13,000 acres of reserved minerals will revert to the federal government over the next 20 years that will fall under this Proposed Action. When these sub-surface minerals revert to the federal government, they will then be subject to the same federal regulation as current full mineral interest lands.
- Private Land/Private Minerals – Within the Wayne National Forest boundaries, there are also inholdings of private land with private minerals. These lands and minerals were not included in the Proposed Action, but are acknowledged as a potential cumulative action (see Section 4.16).

Figure 2.1. Mineral and surface ownership scenarios on Forest Service lands



The Proposed Action only applies to the federal minerals regardless of the amount of federal mineral interest. The Forest Service has authority to purchase lands, which may add to the total acreage of federal minerals that are available for lease.

Industry uses the BLM Expression of Interest (EOI) process to nominate federal minerals for leasing. To date, industry has submitted over 50 EOIs totaling approximately 18,000 acres for parcels located on the Marietta Unit (see Map 3 in Chapter 6 of this EA). The BLM and the U.S. Forest Service (Forest Service) review deeds on a parcel-by-parcel basis to verify federal mineral ownership as leasing nominations are received. The BLM plans to lease some parcels now and make the rest available for the future.

In accordance with 43 CFR 3120, approved parcels would be identified, along with any attached stipulations and notices, through a Notice of Competitive Lease Sale that is posted at least 45 days prior to a lease sale. Oil and gas leases are issued for a 10-year period and continue for as long thereafter as oil or gas is produced in paying quantities.

A federal oil and gas lease is a legal contract that grants exclusive rights to the lessee to develop federally-owned oil and gas resources, but does not authorize surface-disturbing activities or obligate the lessee to drill a well on the parcel in the future. Before conducting any surface disturbing activities, the lease owner/operator is required under 43 CFR 3162 to obtain approval of an application for permit to drill (APD). Upon receipt of an APD, the BLM conducts an onsite inspection with the applicant in cooperation with the landowner. The BLM also conducts site-specific NEPA analysis and consultations under the ESA and NHPA prior to approving the APD.

Although there would be no surface disturbance from the action of leasing, the EA analyzes a reasonably foreseeable development scenario (RFDS) to address the potential environmental effects from potential future oil and gas development. For example, estimates can be made on the most likely number of wells that could be constructed, but the specific locations cannot be determined until APDs are filed. The detailed RFDS is included as an appendix to the 2006 Forest Plan EIS (Appendix G of the EIS), and a summary of the RFDS is included below in Section 2.2.

2.2. Reasonably Foreseeable Development Scenario (RFDS) for Potential Oil and Gas Development

This EA uses the 2006 RFDS (Appendix G of the 2006 Forest Plan/EIS) and the updated 2012 SIR for oil and gas to project the anticipated impacts of future oil and gas development in the Marietta Unit. The 2012 SIR covered several resources of concern in relation to the use of horizontal drilling and high-volume hydraulic fracturing (HVHF) technology:

- Water resources;
- Wildlife;
- Fragmentation (an impact that affects wildlife habitat);
- Botany;
- Waste disposal;

- Noise and light pollution;
- Air quality;
- Infrastructure/transportation;
- Public safety;
- Heritage; and
- Soils.

The 2006 RFDS projected a total of 135 acres of disturbance (see Table 2-1, below) to federal surface in the Marietta Unit from exploration and production activities, regardless of mineral ownership (scenarios A and B in Figure 2.1.), with 121 acres needed to support long term production. The analysis assumed that after exploration and production ceased, 151 acres would be reclaimed per state and federal requirements. The projected surface disturbance included all acreage potentially affected by future oil and gas development activities, such as road construction, well pad construction, construction of turnaround/production facility areas, pipelines, and other related activities.

For the Marietta unit, the 2006 RFDS projected up to 110 vertical well pads (2006 Forest Plan EIS, p. G-1), and the 2012 SIR projected 10 horizontal well pads (SIR, p. 3). The 2012 SIR was issued because horizontal wells were becoming more of the standard approach to mineral development on private surface in the area. The surface disturbance projected for 10 horizontal well pads is approximately 55 acres, substantially less than what was initially projected under the 2006 RFDS. As shown in Table 2-1, approximately 10 acres have already been disturbed from oil and gas development in the Marietta Unit; therefore, the remaining acreage of surface disturbance that could occur within the Marietta Unit that is analyzed in this EA, is approximately 70 acres. Of those 70 acres, approximately 40 acres of disturbance would persist for the long term, until final reclamation is completed. This disturbance is still well within the projected disturbance of the RFDS from the 2006 Forest Plan EIS.

While the RFDS does not project any disturbance on private lands, this EA analysis covers the potential impacts of future oil and gas development on both the Forest Service lands and on adjacent private lands within the Marietta Unit to allow for maximum NEPA flexibility and coverage in case conditions should change in the future.

Table 2.1. Potential Disturbance in the Marietta Unit Projected by the RFDS

	2006 RFDS projection of acres disturbed	**2012 SIR forecast of acres disturbed by horizontal wells**	**Acres disturbed to date from oil and gas development**	**Net surface disturbance below 2006 RFDS**
Total initial acres of surface disturbed by oil and gas drilling before reclamation	135	55	10	70 (135-65) = 70
Total acres of surface needed to support long term production (i.e. remaining	59	13.8	5	40.2 (59-18.8) = 40.2

disturbance after reclamation)				

Reasonably foreseeable activities that could occur as a result of future oil and gas development associated with leasing in the Marietta Unit include surface disturbance associated with preparation for drilling including construction of a road, drilling pad, and reserve pit. Constructed access roads normally have a running surface width of approximately 12 to 16 feet; the length is dependent upon the well site location in relation to existing roads or highways. The average length of road construction is approximately 0.5 miles per well pad. Therefore, approximately two acres would likely be affected by road construction. Typically from 3 to 5.5 acres are cleared and graded level for the construction of the drilling pad. If horizontal drilling occurs, each drilling pad could have up to eight lateral lines. If the well produces natural gas, and the flowline is in the road, another 0.5 acres may be affected by flowline construction. These disturbances are typical for private or federal ownership well pad locations but may be subject to adjustment based on site-specific conditions, which have not yet been determined. The excavation reserve pit is typically about five feet deep and is lined with bentonite clay to retain drilling fluids, circulated mud, and drill cuttings. Plastic or butyl liners (or an equivalent), that meet state standards for thickness and quality, are used on occasions when soils are determined incapable of holding pit fluids.

Drilling typically continues around the clock. Once drilling is completed, excess fluids are pumped out of the pit and disposed of, along with the drill cuttings, in a state authorized disposal site. The RFDS assumes that wells would be drilled by rotary drilling using mud as the circulating medium. Mud pumps would be used to force mud down the drillpipe, thereby forcing the rock cuttings out the wellbore. Water would likely be obtained from a local surface water source, such as the Ohio River, through a pipe laid on the surface or by tanker trucks. Approximately 1,500 barrels of drilling mud would be typically kept on the location. If water production is expected, then processing facilities may be needed on or off site.

During well pad construction, the topsoil would likely be stockpiled for use during restoration activities. If the well is successful, the drill pad would be reduced to about 100 feet x 100 feet with the remaining surface area, including the reserve pit, re-graded and restored as per the surface owner requirements. A lease notice for the proposed lease encourages the use of non-invasive cover plants during all restoration and stabilization activities. Final seed mixtures and plantings are determined with recommendations from BLM with approval of the land owner. The remaining 100 feet x 100 feet pad would be maintained for the life of the well. The life of a productive well may be 25 years. Following abandonment, the pad is subject to the same restoration parameters.

Chapter 5 of this EA contains the lease stipulations and lease notices that are applicable to surface acreage owned by the WNF. These recommended lease stipulations and notices have been developed to provide general habitat protection and setbacks to exclude sensitive habitats from oil and gas development. Additional surveys or consultations may be required after site-specific proposals have

been received by BLM during the development phase. In addition, if some development were to occur on privately owned surface federal and state regulation do exist in order to address any potential concerns regarding contamination or spills. However, if the development occurs on private lands and pipelines or well development reaches federal minerals, the BLM would ensure that the construction of such well is in compliance with all applicable safety standards.

2.2.1. Phases of Oil and Gas Development

In this section, additional information on the phases of oil and gas development is presented. While site-specific activities are not yet proposed or known, the following types of activities have been considered in this EA for NEPA analysis:

Geophysical exploration and exploratory drilling occur in the first phases of mineral development. Geophysical exploration is used to obtain detailed geologic information. A variety of exploration methods may be employed, ranging from placing electrodes in the ground, using geophones and lines, detonating explosives to create shockwaves, and/or employing specially constructed off-road vehicles to produce vibrations. Exploratory drilling begins the actual development of the lease. An access road and a well pad are constructed for each well, if needed. Minimal or no geophysical exploration is expected in the Marietta unit since there is a long history of oil and gas development.

In-field drilling of additional exploration wells typically occurs when initial exploratory drilling has located oil and gas, to define the limits of the oil and gas reservoir. The process of in-field drilling is the same as that employed for initial exploratory drilling, although new roads and well pads may not be required in every instance. Wells may be drilled vertically, if the end of the well (bottom hole location) is directly below the well pad; or directionally, if the well pad is not directly above the bottom hole location. For example, federal minerals under a state park with a “no surface occupancy” stipulation (i.e., no surface disturbance from mineral development is allowed on the state park itself) can be accessed by either directional or horizontal drilling from a surface location outside of the park. In horizontal drilling the wellbore may extend several thousand feet through the rock formation. For the purpose of this analysis, the BLM has assumed a typical maximum horizontal length of 7,500 feet.

Roads are typically cleared to a width of 24 feet, with a running surface width of 12 to 16 feet. The length is dependent upon the well pad location in relation to existing roads or highways. Land is cleared and graded for pad construction. If the well is productive, additional land may be affected by pipeline construction. The total number of disturbed acres for well pads for vertical wells drilled to the target formations in the Marietta Unit is expected to be 0.69 to 1.1 acre, and well pads for horizontal wells drilled to the Utica/Point Pleasant or Marcellus Shales are 3 to 5.5 acres and may contain up to 8 wells. However, very little in-field drilling is expected.

Well Stimulation/Hydraulic Fracturing. Well Stimulation may be used to enhance oil and gas recovery. Several methods of well stimulation could be used. If the parcels are developed the wells would likely be completed using hydraulic fracturing (HF) techniques. HF is one of the well stimulation methods that is reasonably foreseeable for leases on this sale. HF is the process of applying high pressure to a

subsurface formation via a wellbore, to the extent that the pressure induces fractures in the rock. Typically the induced fractures are propped open with a granular "proppant" to enhance fluid connection between the well and formation. The process was developed experimentally in 1947 and has been used routinely since 1950. The Society of Petroleum Engineers (SPE) estimates that over one million hydraulic fracturing procedures have been pumped in the United States and tens of thousands of horizontal wells have been drilled and hydraulically fractured (IOM, 2014; King, 2012). The development of these hydraulic fracturing methods and the drilling technology in which it is applied (in particular, long wells drilled horizontally within the targets) can greatly increase the yield of a well, enabling production of oil and gas from tight formations, something that was formerly not economically feasible.

Following hydraulic fracturing, which takes a few hours to a few days, there is a period where the hydraulic fracturing fluid is allowed to flow back to the surface where it is collected for disposal, treatment, or reused until a certain point, after which it becomes irredeemable (Rubenstein, 2015). During well stimulation activities, the types of chemicals that may be used include acids, hydrocarbons, thickening agents, lubricants and other additives that are operator and location specific. However, water and sand are the largest components of the HF fluids. Nevertheless, the federal government and the state of Ohio require operators to disclose all chemical additives on the FracFocus website, which is available for public viewing at https://fracfocus.org/.

The use of large volumes of water in HF is understood and closely monitored by the BLM before, during and after the drilling of wells. No wells would be drilled on these parcels until the operator submits an APD. The filing of an APD triggers a site-specific environmental analysis on the impacts of drilling a well.

The APD establishes:

1. The well location and plat;
2. Drilling plan per BLM Onshore Order #2;
3. Surface plan for the drilling site;
4. Bonding;
5. Operator Certification;
6. Onsite inspection plan; and
7. Other information as noticed to the operator by the BLM.

At the APD stage, geologic and engineering reviews are performed to insure that proposed mud, cementing, and casing activities are adequate to protect all downhole resources.

In addition, BLM Onshore Order #2 requires the protection of usable water zones. This includes proper casing cementing and plugging (upon abandonment) procedures, making contamination of groundwater resources highly unlikely. Surface casing and cement would be extended beyond usable water zones. Production casings will be adequately cemented within the surface casing to protect other mineral resources in addition to the useable water bearing zones. The strict requirements ensure that drilling

fluids, HF fluids, produced water and hydrocarbons all remain within the wellbore and do not enter groundwater or other formations.

Based on input received during the scoping and public comment period, potential impacts to water resources and concern about induced seismicity associated with HF are areas of public interest and concern. These resources are discussed in detail in Chapter 3 and 4 of this EA (see Surface Water (3.6.1 & 4.6.1); Groundwater (3.6.2 & 4.6.2); Wastes (3.7. & 4.7); and Geology (3.4 & 4.4) sections).

Production begins only if oil and gas can be transported to a market and sold at a profit. Production facilities may include one or more of the following: a well head, pumping equipment, a separation system, pipelines, a metering system, storage facilities, water treatment and injection facilities, cathodic protection systems, electrical distribution lines, compressor stations, communication sites, roads, salt water disposal systems, dehydration sites, and fresh/salt water plant sites. Drilling typically continues around the clock. The RFDS assumes that wells would be drilled by rotary drilling using mud as the circulating medium. Mud pumps would be used to force mud down the drillpipe, thereby forcing the rock cuttings out the wellbore. While it is uncertain at this stage where the drilling water could come from, it would likely come from the Ohio River, but could also come from a local waterway.

Approximately 1,500 barrels of drilling mud would be typically kept on the location in a tank or pit. If water production is expected, then processing facilities may be needed on the site. Once drilling is completed, excess fluids are pumped out of the pit and disposed of in a state authorized disposal site and the cuttings are buried.

Well abandonment may be temporary or permanent. Wells are sometimes shut-in because pipelines or roads needed for production and marketing do not exist and the cost for construction is not justified by the quantity of oil discovered. These wells may later be re-entered when their production can be marketed. The permanent abandonment of a well occurs when the well is determined to no longer have a potential for economic production, or when the well cannot be used for other purposes.

Reclamation involves revegetation and recontouring of disturbed areas. During well pad construction, the topsoil would likely be stockpiled for use during restoration activities. If the well is successful, the drill pad would be reduced to about 100 feet x 100 feet with the remaining surface area, including the reserve pit, re-graded and restored as per the surface owner requirements. The BLM encourages the use of non-invasive cover plants during all restoration and stabilization activities. Final seed mixtures and plantings are determined with recommendations from BLM with approval of the surface owner. The remaining 100 feet x 100 feet pad would be maintained for the life of the well. The life of a productive well may be 25 years. Following abandonment, the pad is subject to the same restoration parameters.

2.3. No Action Alternative

Under the No Action Alternative, the BLM would not offer federal minerals in the Marietta Unit for oil and gas leasing, including both the parcels requested in currently pending EOIs and all other federal

minerals in the Marietta Unit. Without a lease (No Action Alternative), operators would not be authorized to access federal minerals at the time of development but could develop adjacent privately owned minerals, potentially resulting in drainage of federal minerals without benefit to the government. Therefore, not leasing the parcel would not meet the purpose of and need for the Proposed Action. Also, since CEQ guidelines stipulate that a No Action Alternative should be analyzed to assess any environmental consequences that may occur if the Proposed Action is not implemented; the No Action Alternative has been retained for analysis in this EA. This analysis serves also as a baseline for comparing the potential impacts of the Proposed Action.

2.4. Alternatives Considered but not Analyzed in Detail

2.4.1. Offer all leases with a no-surface-occupancy stipulation

Offering all leases with a no-surface-occupancy (NSO) stipulation was suggested through public comment. However, this alternative would not fulfill the purpose and need described in Chapter 1. This alternative would unnecessarily constrain oil and gas occupancy, especially in this highly fragmented landscape, where the ability to cross federal land may be critical to enabling an operator to develop.

2.4.2. Lease minerals for vertical drilling only

Offering all leases with a vertical drilling only stipulation was suggested through public comment. However, this alternative would not fulfill the purpose and need described in Chapter 1. First, a vertical drilling only stipulation would require far greater surface disturbance, and result in the least efficient extraction of Federal minerals. The rule of capture is an oil and gas doctrine that allows one to produce oil and gas from their lands even though said oil and gas flows from the lands of their neighbors. In Ohio, the rule of capture entitles landowners to “offset” wells, or wells that do not need to conform with state conservation standards, when one's neighbor is draining their mineral interest. Second, a vertical drilling only alternative is equivalent to a ban on directional drilling, which in turn would be tantamount to a ban on development of the Utica, Marcellus, and other tight formations underlying the forest. Such tight formations require horizontal drilling to extract trapped oil and gas.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

This chapter describes the environment that would be affected by implementation of the Proposed Action, as required by CEQ regulations for implementing NEPA (40 CFR Parts 1500-1508). The discussion in this chapter focuses on the relevant resources and issues and therefore, only those elements of the affected environment that have the potential to be impacted are described in detail. Under the Proposed Action, operators could choose to locate potential future well pads and other infrastructure on land owned by the WNF. If infrastructure is located on adjacent private lands, federal minerals could be accessed by directional or horizontal drilling. For this reason, the potential area of effect includes the entire proclamation boundary of the Marietta Unit of the WNF (Map 2; see Chapter 6 of this EA).

This chapter includes baseline data from and refers to the 2006 Forest Plan Final EIS and 2012 SIR, with additional updated information where applicable. The 2012 SIR reviewed the projections for oil and gas activity (RFDS) on the WNF and found that potential effects associated with high volume, hydraulic fracturing (HVHF) are not seriously different from those effects analyzed and disclosed in the 2006 Forest Plan Final EIS. An amendment or supplement to the 2006 Forest Plan was determined to be unnecessary at this time (as documented in the Findings Project file, dated August 27, 2012 and located online at http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5387932.pdf). The 2012 SIR also concluded that the Forest Service and BLM could provide for the appropriate protection of natural resources and the public if HVHF were to occur on the WNF (SIR, p. 1). Therefore, the 2006 Forest Plan EIS and 2012 SIR both provide an adequate source for incorporating baseline information into this EA.

Based on a review of the context and scale of the Proposed Action, the following resources are discussed in detail in this EA: Land Use; Air Resources; Climate and Climate Change; Plant and Animal Habitat and Populations; Geology and Minerals; Soils; Water Resources and Water Quality; Wastes, Hazardous or Solid; Transportation; Recreation; Noise; Cultural Resources/Paleontology; Native American Religious Concerns; Visual Resources and Scenic Quality; Public Health; Socioeconomics; and Environmental Justice.

3.1. Land Use

The Marietta Unit lies mostly within the Ohio Valley Lowlands Subsection of the Southern Unglaciated Allegheny Plateau Section. This subsection is characterized by steep, wooded lands with high-gradient, often ephemeral streams. Ongoing uses of the land in the WNF include timber harvest, recreation, and mineral development. Private lands in the area are primarily for agriculture, business, recreation, and residential uses.

Oil, gas, and coal have been produced in the Appalachian Basin, which includes the Wayne National Forest, for well over 100 years. As of June 2015, there are 1,275 active vertical wells on the Wayne National Forest. This total includes federal and private mineral operations. Since the implementation of the 2006 Forest Plan, 14 vertical wells have been produced. As of June 2012, approximately 38,858 acres of federally-owned minerals have been leased, leaving approximately 61,281 acres not leased (U.S. Forest Service, 2016f).

3.2. Air Resources

3.2.1. Air quality

Air quality is affected by various natural and anthropogenic factors. The primary sources of air pollution in the United States are dust from blowing wind on disturbed or exposed soil, exhaust emissions from motorized equipment, oil and gas development, agriculture, and industrial sources. To address national air quality the first comprehensive federal air pollution legislation, known as the Clean Air Act (CAA) was enacted in 1970. This law, as amended, required the United States Environmental Protection Agency (US EPA) to set National Ambient Air Quality Standards (NAAQS). The NAAQS (summarized in Table 3.1), are criteria pollutants that include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate

matter (PM_{10} & $PM_{2.5}$), sulfur dioxide (SO_2), and lead (Pb). USEPA calls these pollutants “criteria” air pollutants because it regulates them by developing human health-based and/or environmentally-based criteria (science-based guidelines) for setting permissible levels. The NAAQS set a primary and, in some cases, a secondary standard for each of the criteria pollutants. *Primary standards* provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. *Secondary standards* provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. A geographic area with air quality that is cleaner than the primary standard is called an "attainment" area; areas that do not meet the primary standard are called "nonattainment" areas.

Air pollution emissions are characterized as point, area, biogenic or mobile (USEPA, 2016a). *Point sources* are large, stationary facilities such as power plants and manufacturing facilities and are accounted for on a facility by facility basis. *Area sources* are smaller stationary sources and, due to their greater number, are accounted for by classes. Production emissions from an oil and gas well and dust from construction of a well pad would be considered area source emissions. *Biogenic sources* are stationary sources that produce associated CO_2 emissions from combustion of biological gases and materials such as municipal solid wastes, manure management processes, and landfill wastes. *Mobile sources* consist of non-stationary sources such as cars and trucks. Mobile emissions are further divided into on-road and off-road sources. Engine exhaust from truck traffic to and from oil and gas locations would be considered on-road mobile emissions. Engine exhaust from drilling operations would be considered off road mobile emissions.

Although the USEPA was given the authority for air quality protection, it had the provision to delegate this authority to each state as appropriate under federal law. In Ohio, most of the authority for air quality protection has been delegated to the Ohio Division of Air Pollution Control (DAPC), which monitors the NAAQS pollutants at a state level, while abiding by the federal standards.

Table 3.1. National Ambient Air Quality Standards

	Primary Standards		Secondary Standards		
Pollutant [final rule cited]	**Level**	**Averaging Time**	**Level**	**Averaging Time**	**Form**
Carbon Monoxide (CO) [76 FR 54294, 8/31/2011]	9 ppm (10 mg/m^3)	8 hours	None		Not to be exceeded more than once per year
	35 ppm (40 mg/m^3)	1 hour			
Lead (Pb) [73 FR 66964, 11/12/2008]	0.15 µg/m^3 (1)	Rolling 3-Month Average	Same as Primary		Not to be exceeded
Nitrogen Dioxide (NO_2) [75 FR 6474, 2/9/2010] [77 FR 20218, 4/3/2012]	53 ppb (2)	Annual (Arithmetic Average)	Same as Primary		Annual Mean
	100 ppb	1-hour	None		98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Primary Standards		**Secondary Standards**		
Pollutant [final rule cited]	**Level**	**Averaging Time**	**Level**	**Averaging Time**	**Form**
Particulate Matter (PM_{10}) [78 FR 3086, 12/14/2012]	150 µg/m^3	24-hour	Same as Primary		Not to be exceeded more than once per year on average of 3 years
Particulate Matter ($PM_{2.5}$) [78 FR 3086, 12/14/2012]	12.0 µg/m^3	Annual (Arithmetic Average)	15.0 µg/m^3	Annual (Arithmetic Average)	Annual mean, averaged over 3 years
	35 µg/m^3	24-hour	Same as Primary		98th percentile, averaged over 3 years
Ozone (O_3) [80 FR 65292, 11/26/2015]	0.070 ppm (3)	8-hour	Same as Primary		Annual fourth-highest daily maximum 8-hr average concentration, averaged over 3 years
Sulfur Dioxide (SO_2) [75 FR 35520, 6/22/2010] [77 FR 20218, 4/3/2012]	75 ppb (4)	1-hour			99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
			0.5 ppm	3-hour	Not to be exceeded more than once per year

Source: (USEPA, 2016e)

(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m3 as a calendar quarter average) also remain in effect.

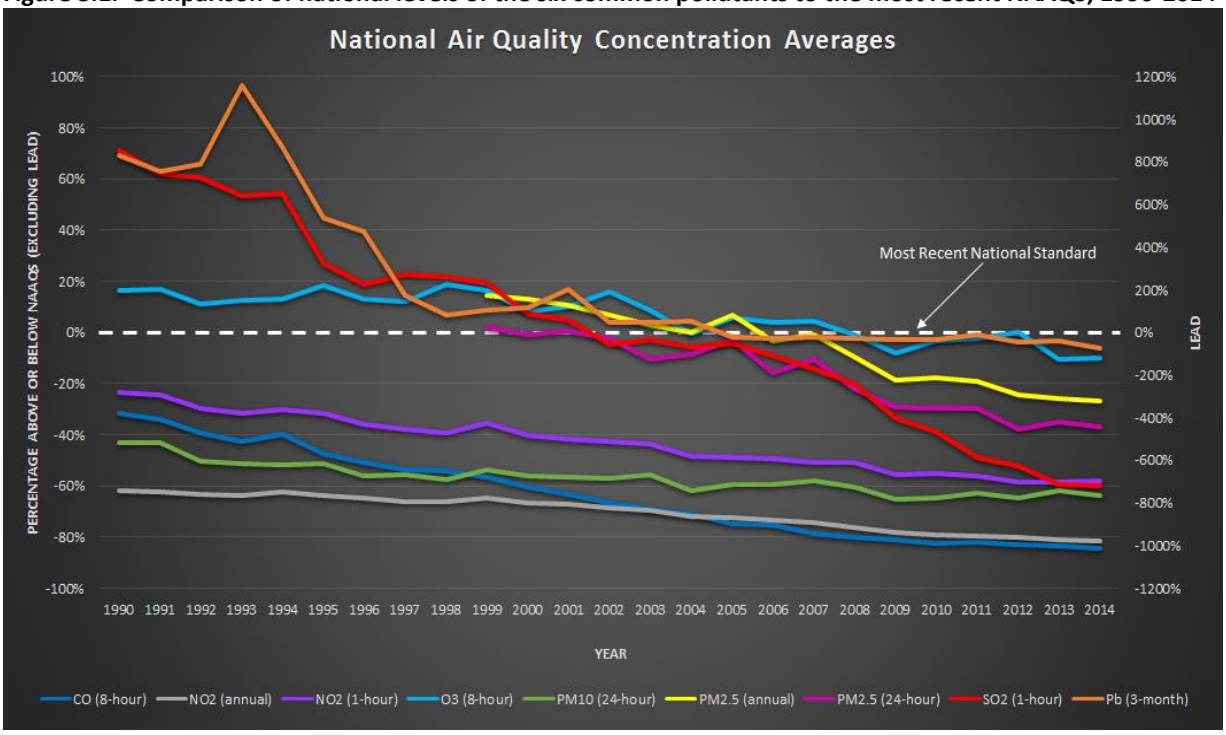
(2) The level of the annual NO_2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O_3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

(4) The previous SO_2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which implementation plans providing for attainment of the current (2010) standard have not been submitted and approved and which is designated nonattainment under the previous SO2 standards or is not meeting the requirements of a SIP call under the previous SO2 standards (40 CFR 50.4(3)), A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the require NAAQS.

According to the USEPA (2016b), nationwide air quality has improved for all common NAAQS air pollutants since 1990 (Figure 3.1). Nationally, air pollution emissions were lower in 2014 than in 1990 for: Carbon Monoxide (CO), by 62%, Nitrogen Oxides (NO_x), by 51%, Lead (Pb), by 80%, Volatile Organic Compounds (VOC), by 38%, Direct PM_{10}, by 19%, Direct $PM_{2.5}$, by 25% and Sulfur Dioxide (SO_2), by 79%.

Figure 3.1. Comparison of national levels of the six common pollutants to the most recent NAAQS, 1990-2014



*National levels are averages across all monitors with complete data for the time period.
**Note: Air quality data for $PM_{2.5}$ starts in 1999. Source: (USEPA, 2016b)

Nationally, annual $PM_{2.5}$ concentrations were 24% lower in 2014 compared to 1999 and 24-hour $PM_{2.5}$ concentrations were 38% lower in 2014 compared to 1999. Ozone levels did not improve in much of the East until 2002, after which there was a significant decline. Eight-hour ozone concentrations were 20% lower in 2014 than in 2002. This decline is largely due to reductions in nitrogen oxides (NO_x) emissions required by EPA rules, including the NO_x State Implementation Plan (SIP) call, preliminary implementation of the Clean Air Interstate Rule (CAIR), and Tier 2 Light Duty Vehicle Emissions Standards (USEPA, 2016b). In January 2015, the Cross-State Air Pollution Rule (CSAPR) replaced the CAIR and went into effect in Ohio and in 27 other eastern states, with the goal of significantly improving air quality by reducing power plant emissions that contribute to ozone and/or fine particle pollution in other states (USEPA, 2016c).

Hazardous Air Pollutants

Under the CAA, the USEPA is required to regulate emissions of hazardous air pollutants (HAPs). HAPs are substances that are known or suspected to cause cancer or other serious health effects. These include reproductive effects or birth defects, or adverse environmental impacts. The USEPA classified 187 air pollutants as HAPs (USEPA, 2015a). Examples of listed HAPs associated with the oil and gas industry include formaldehyde, benzene, toluene, ethylbenzene, isomers of xylene (BTEX) compounds, and normalhexane (n-hexane).

The USEPA has developed a list of source categories that must meet control technology requirements for these toxic air pollutants. Section 112(d) of the CAA (USEPA, 2016g) requires the USEPA to develop regulations that establish national emission standards for hazardous air pollutants (NESHAP) for each category or subcategory of major sources and area sources of HAPs, being industries that manage oil and gas production, transmission or storage no exception. Furthermore, the USEPA estimates that these promulgated NESHAP will reduce national HAP emissions from major sources in the oil and natural gas production source category by 77% and from major sources in the natural gas transmission and storage source category by 95.0% (USEPA, 1999). The standards require the maximum degree of emission reduction that the USEPA determines to be achievable by each particular source category, and such reduction is only possible by using the maximum achievable control technology (MACT).

3.2.2. Visibility

Visibility, also referred to as visual range, is a subjective measure of the distance that light or an object can clearly be seen by an observer. Light extinction is used as a measure of visibility and is calculated from the monitored components of fine particle mass (aerosols) and relative humidity. It is expressed in terms of deciviews, a measure for describing perceived changes in visibility. One deciview is defined as a change in visibility that is just perceptible to an average person, which is approximately a 10% change in light extinction. Visibility can also be defined by standard visual range (SVR) measured in miles, which is the farthest distance at which an observer can see a black object viewed against the sky above the horizon. In other words, a larger SVR equals cleaner air. To estimate potential visibility impairment, monitored aerosol concentrations are used to reconstruct visibility conditions for each day monitored including: ammonium sulfate, ammonium nitrate, organic mass, elemental carbon, soil elements, and coarse mass (Malm et al., 2013). The daily values are then ranked from clearest to haziest and divided into three categories; the mean visibility for all days (average), the 20% of days with the clearest visibility (20% clearest), and the 20% of days with the worst visibility (20% haziest).

A wide variety of pollutants can impact visibility, including particulate matter, nitrogen dioxide, nitrates (compounds containing NO_3), and sulfates (compounds containing SO_4). In addition, fine particles suspended in the atmosphere can decrease visibility by blocking, reflecting, or absorbing light. In addition, two types of visibility impairment can be caused by emission sources: plume impairment and regional haze. Plume impairment occurs when a section of the atmosphere becomes visible due to the contrast or color difference between a discrete pollutant plume and a viewed background, such as a landscape feature. Haze, on the other hand, is caused when sunlight encounters tiny pollution particles

in the air, which reduce, particularly during humid conditions, the clarity and color of what we see. Regional haze occurs when pollutants from widespread emission sources become mixed with the atmosphere and travel long distances (Malm, 1999).

There are three visibility classifications for areas that attain NAAQS, Class I; Class II; and Class III (Figure 3.2.). These classifications were established by Congress to facilitate implementation of the prevention of significant deterioration (PSD) of the air quality provisions of the Clean Air Act. Congress established certain national parks and wilderness areas as mandatory Class I, or areas where only a small amount of air quality degradation is allowed. Since 1980, the Interagency Monitoring of Protected Visual Environments (IMPROVE) network has measured visibility in Class I areas. These areas are managed as high visual quality under the federal visual resource management (VRM) program. The 1977 Clean Air Act Amendments (CAAA), Section 169A declared "as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I federal areas which impairment results from manmade air pollution" (42 U.S.C. § 7491(a)(1)). All other areas of the U.S. are designated as Class II, which allow a moderate amount of air quality degradation, and no areas of the U.S. have been designated Class III, which would allow more air quality degradation. The CAA gives federal managers the affirmative responsibility, but no regulatory authority, to protect air quality-related values, including visibility, from degradation.

Figure 3.2. Mandatory Class I Visibility Areas, United States

Source: (USEPA, 2016j)

PSD increments limit air quality degradation and ensure that areas with clean air continue to meet NAAQS, even during economic development. The PSD program goal is to maintain pristine air quality required to protect public health and welfare from air pollution effects and "to preserve, protect and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic or historic value" (USEPA, 2015b).

Furthermore, PSD increments have been established for NO_2, SO_2, and PM_{10}. Comparisons of potential PM_{10}, NO_2, and SO_2 concentrations with PSD increments are intended only to evaluate a threshold of concern. The allowable PSD increment depends on an area's classification. Class I areas have lower increments, due to their protected status as pristine areas.

3.2.3. Atmospheric deposition

Atmospheric deposition refers to processes in which air pollutants are removed from the atmosphere and deposited into terrestrial and aquatic ecosystems. Air pollutants can be deposited by precipitation (rain and snow) or the gravitational settling of gaseous pollutants on soil, water, and vegetation. Much of the concern about deposition is due to secondary formation of acids and other compounds from emitted nitrogen or sulfur species, such as NO_x and SO_2, which can contribute to the acidification of lakes, streams, and soils, which may in turn affect other ecosystem characteristics, including nutrient cycling and biological diversity.

Substances deposited include:

- Acids, such as sulfuric (H_2SO_4) and nitric (HNO_3), sometimes referred to as acid rain;
- Air toxics, such as pesticides, herbicides, and volatile organic compounds (VOC);
- Heavy metals, such as mercury; and
- Nutrients, such as nitrates (NO_3) and ammonium (NH4+).

The accurate measurement of atmospheric deposition is complicated because of contributions to deposition by several different components including but not limited to rain, snow, cloud water, particle settling, and gaseous pollutants. Deposition varies with precipitation and other meteorological variables (e.g., temperature, humidity, winds, and atmospheric stability), which in turn, vary with elevation and time. The U.S. Forest Service and the National Park Service have established guidelines for Levels of Concern (LOC) for total deposition of nitrogen and sulfur compounds in Class I Wilderness Areas. Total nitrogen deposition of up to 1.5 kilograms (kg) per hectare (ha) per year is considered unlikely to harm terrestrial or aquatic ecosystems and for total sulfur deposition, the LOC is 5 $^{kg}/_{ha\text{-}yr}$. The USFS is also considering sulfur LOC of 1.5 $^{kg}/_{ha\text{-}yr.}$ (U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service, 2010). There are no Class I Wilderness Areas located near the Marietta Unit.

3.2.4. Air quality in Ohio

The Marietta Unit in the WNF contains no Class I or sensitive Class II areas. Monroe and Noble Counties are currently in attainment for NAAQS pollutants; however, Washington County is currently in

nonattainment for Sulfur Dioxide (Table 3.2) (USEPA, 2016f). The 2006 Forest Plan Final EIS previously showed Washington County in nonattainment for eight-hour ozone and particulate matter (these designations were revoked in 2006 and 2012, respectively).

Table 3.2. Attainment Status for Washington County, Ohio

County	Pollutant	Area Name	Nonattainment in Year	Redesignation to Maintenance	Classification	City NA
Washington	8-Hr Ozone (1997) - NAAQS revoked	Parkersburg-Marietta, WV-OH	2004-2006	6/15/2007	Former Subpart 1	Whole
Washington	PM-2.5 (1997)	Parkersburg-Marietta, WV-OH	2005-2012	8/29/2013	Former Subpart 1	Whole
Washington	Sulfur Dioxide (1971)	Waterford Township (Washington County), OH	1992-1993	10/21/1994		Part
Washington	Sulfur Dioxide (2010)	Muskingum River, OH	2013-2015	Currently in Nonattainment		Part

Source: (USEPA, 2016f)

In Table 3.2, the nonattainment area identified as Muskingum River, Ohio is located in Waterford Township in Washington County. Ohio Environmental Protection Agency (Ohio EPA) submitted a Request for Redesignation letter to the USEPA on April 3, 2015 proposing to shutter the Muskingum River Power Plant to return the area to attainment status (Ohio EPA, 2015).

3.2.5. Greenhouse Gases Emissions

"Climate change" refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. "Global warming" refers to the recent and ongoing rise in global average temperature near Earth's surface. It is caused mostly by increasing concentrations of greenhouse gases in the atmosphere. Global warming is causing climate patterns to change. However, global warming itself represents only one aspect of climate change. Climate is both a driving force and limiting factor for ecological, biological, and hydrological processes, and has great potential to influence resource management.

As explained in CEQ's recent guidance on the consideration of GHG emissions and climate change in NEPA review, climate change science continues to expand and refine our understanding of the impacts of anthropogenic GHG emissions (CEQ, 2016). CEQ's first Annual Report in 1970 referenced climate

change, indicating that "[m]an may be changing his weather." It is now well established that rising global atmospheric GHG emission concentrations are significantly affecting the Earth's climate. These conclusions are built upon a scientific record that has been created with substantial contributions from the United States Global Change Research Program (USGCRP).[1] Studies have projected the effects of increasing GHGs on many resources normally discussed in the NEPA process, including water availability, ocean acidity, sea-level rise, ecosystem functions, energy production, agriculture and food security, air quality and human health.

Based primarily on the scientific assessments of the USGCRP, the National Research Council, and the Intergovernmental Panel on Climate Change, in 2009 the Environmental Protection Agency (EPA) issued a finding that the changes in our climate caused by elevated concentrations of greenhouse gases in the atmosphere are reasonably anticipated to endanger the public health and public welfare of current and future generations. In 2015, EPA acknowledged more recent scientific assessments that "highlight the urgency of addressing the rising concentration of CO2 in the atmosphere," finding that certain groups are especially vulnerable to climate-related effects. Broadly stated, the effects of climate change observed to date and projected to occur in the future include more frequent and intense heat waves, longer fire seasons and more severe wildfires, degraded air quality, more heavy downpours and flooding, increased drought, greater sea-level rise, more intense storms, harm to water resources, harm to agriculture, ocean acidification, and harm to wildlife and ecosystems.

Consistent with CEQ's guidance, this EA includes a qualitative and quantitative analysis of possible greenhouse gas emissions that could occur as a result of reasonably foreseeable oil and gas development associated with the parcels being offered for lease. Additional information about detailed potential emissions would also be available and calculated as part of subsequent at a site -specific reviews level of analysis such as those that occur at the APD stage.

It is accepted within the scientific community that global temperatures have risen at an increased rate and the likely cause is gases that trap heat in the atmosphere, referred to as greenhouse gases (GHG). GHGs are composed mostly of carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), water vapor, and ozone. The greenhouse gas effect is the process in which the radiation from the sun that heats the surface of Earth gets blocked by GHG molecules in Earth's atmosphere. Since GHGs are composed of molecules that absorb and emit infrared electromagnetic radiation (heat), they form an intrinsic part of the greenhouse effect.

Greenhouse gases are often presented using the unit of Metric Tons of CO_2 equivalent (MT CO_2e) or Million Metric Tons (MMT CO_2e), a metric to express the impact of each different greenhouse gas in terms of the amount of CO_2 making it possible to express greenhouse gases as a single number. For example, 1 ton of methane would be equal to 25 tons of CO_2 equivalent, because it has a global warming potential (GWP) 25 times that of CO_2 (The Guardian, 2011).

[1] See Global Change Research Act of 1990, Pub. L. 101–606, Sec. 103 (November 16, 1990). For additional information on the United States Global Change Research Program [hereinafter "USGCRP"], visit http://www.globalchange.gov.

As defined by USEPA, the GWP provides "ratio of the time-integrated radiative forcing from the instantaneous release of one kilogram of a trace substance relative to that of one kilogram of CO_2." The GWP of greenhouse gas is used to compare global impacts of different gases and used specifically to measure how much energy the emissions of one ton of gas will absorb over a given period of time (e.g. 100 years), relative to the emissions of one ton of CO_2. The GWP accounts for the intensity of each GHG's heat trapping effect and its longevity in the atmosphere. The GWP provides a method to quantify the cumulative effects of multiple GHGs released into the atmosphere by calculating carbon dioxide equivalent for the GHGs.

- Carbon dioxide (CO_2), by definition, has a GWP of 1 regardless of the time period used because it is the gas being used as the reference. CO_2 remains in the climate system for a very long time; CO_2 emissions cause increases in the atmospheric concentrations of CO_2 that will last thousands of years (USEPA, 2016h).
- Methane (CH_4) is estimated to have a GWP of 28-36 times that of CO_2 over 100 years. CH_4 emitted today lasts about a decade on average, which is much less time than CO_2. But CH_4 also absorbs much more energy than CO_2. The net effect of the shorter lifetime and higher energy absorption is reflected in the GWP. The methane GWP also accounts for some indirect effects, such as the fact that methane is a precursor to ozone, and ozone is in itself a greenhouse gas (USEPA, 2016h).
- Nitrous Oxide (N_2O) has a GWP of 265-298 times that of CO_2 for a 100-year timescale. N_2O emitted today remains in the atmosphere for more than 100 years, on average (USEPA, 2016h). Table 3.3. contains GHGs regulated by USEPA and global warming potentials.

Table. 3.3. GHG Regulated by USEPA and Global Warming Potentials

Air Pollutant	Chemical Symbol/ Acronym	Global Warming Potential
Carbon Dioxide	CO_2	1
Methane	CH_4	25
Nitrous Oxide	N_2O	298
Hydrofluorocarbons	HFCs	Varies
Perfluorocarbons	PFCs	Varies
Sulfur hexafluoride	SF_6	22,800

Source: (USEPA, 2016h)

The IPCC (2007) concluded that "warming of the climate system is unequivocal" and "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations." Extensive research and development efforts

are underway in the field of carbon capture and sequestration (CCS) technology, which could help direct management strategies in the future. The IPCC has identified a target worldwide "carbon budget" to estimate the amount of CO_2 the world can emit while still having a likely chance of limiting global temperature rise to 2°C above pre-industrial levels. The international community estimates this budget to be 1 trillion tonnes of carbon (IPCC, 2016).

Because GHGs circulate freely throughout Earth's atmosphere, climate change is a global issue. The largest component of global anthropogenic GHG emissions is CO_2. Global anthropogenic carbon emissions reached about 7,000,000,000 MT per year in 2000 and an estimated 9,170,000,000 MT per year in 2010 (Boden, Marland, & Andres, 2013). Oil and gas production contributes to GHGs such as CO_2 and methane. Natural gas systems were the largest anthropogenic source category of CH_4 emissions in the United States in 2014 with 176.1 MMT CO_2 e of CH_4 emitted into the atmosphere. Those emissions have decreased by 30.6 MMT CO_2 e (14.8 percent) since 1990 (USEPA, 2016i).

Global mean surface temperatures have increased nearly 1.0°C (1.8°F) from 1890 to 2006 (National Aeronautics and Space Administration Goddard Institute for Space Studies, 2007). In 2001, the IPCC (2007) indicated that by the year 2100, global average surface temperatures would increase 1.4 to 5.8°C (2.5 to 10.4°F) above 1990 levels. The National Academy of Sciences (Hansen et al., 2006) has confirmed these findings, but also indicated that there are uncertainties regarding how climate change may affect different regions. Observations and predictive models indicate that average temperature changes are likely to be greater in the Northern Hemisphere. Data indicate that northern latitudes (above 24° N) have exhibited temperature increases of nearly 1.2°C (2.1°F) since 1900, with nearly a 1.0°C (1.8°F) increase since 1970 alone. It also shows temperature and precipitation trends for the conterminous United States. For both parameters we see varying rates of change, but overall increases in both temperature and precipitation.

3.2.6. Ohio Climate

Climate is the composite of generally prevailing weather conditions of a particular region throughout the year, averaged over at least 30 years, and Ohio has a geographically variable climate. Ohio is exposed equally to cool air from the arctic or Canada and warmer air from the tropics. Northern Ohio has a variety of lake related weather patterns from Lake Erie, while southern and eastern Ohio may experience varied local conditions due to extreme topography. Ohio experiences a wide range of temperature and climatic conditions, including cold winters and warm, humid summers. Hot, dry air can occasionally envelop the state (high temp 113˚ 1934), but also cold, dry polar air masses during both winter and summer (low temp -39˚ 1994). Ohio is often affected by mid-latitude storms, often originating in Canada, Colorado, or the Gulf of Mexico. These can increase precipitation in any season (Rogers, n.d.). From February 2011 to January 2016, Ohio has had a 0.7 degree departure from the 20th Century average of 10.2 degrees. The freeze free periods (growing seasons) vary from 160-180 days in South Ohio, to 125-155 in Northern Ohio. In coastal areas on Lake Erie, the growing season can extend up to 200 days. High humidity and dew points can also cause heavy fog, and Ohio experiences high levels of fog and cloudiness in the winter. Ohio also has abundant precipitation, especially during mid-latitude wave cyclones and storms (heaviest from October-March). Ohio has also had a 635 millimeter

(mm) departure in precipitation from the 20th century average of 5,493.77mm (3rd wettest 60 Month period) (National Oceanic and Atmospheric Administration, 2016). Also of note, El Niño and La Niña events have had increasing effects on Ohio's, and the regional, climate. In addition, during the last century, Ohio has experienced rising temperatures, increased precipitation, more extreme weather events, and decreased water availability. While the most recent climate modeling predicts warmer temperatures and lower water levels for much of Ohio, these changes will be more pronounced if global emissions of greenhouse gases are not reduced (NCSL, 2008).

In 2010, the U.S. Energy Information Administration (EIA) ranked Ohio fourth in the United States for carbon dioxide emissions from fossil fuel consumption (2016). Ohio University and Ohio State University collaborated on a GHG emissions inventory for the state of Ohio in 2011. The inventory used standard approaches consistent with other state and USEPA reporting inventory standards. The inventory also used guidelines from the Intergovernmental Panel on Climate Change (IPCC) report (2006) which provides conversion factors for CO_2 equivalency for common GHGs. The inventory found that 93% of CO_2e (carbon dioxide equivalent) emissions were related to energy production, and the bulk of CO_2 emissions were the results of coal-fired power plants. Methane emissions were primarily from enteric fermentation in agriculture and solid waste landfills. Nitrous oxide emissions were mostly from manure management and manufacturing (Ohio University and The Ohio State University, 2011). Fugitive emissions from fuels of oil and gas were quantified as 1.67 MMT CO_2e, and energy production accounted for 117.63 MMT (mostly attributed to coal production) (Ohio University and The Ohio State University, 2011). Monroe County contributed very little to the overall Ohio GHG emissions, but Washington County was the second largest contributor in the southeast region of the state. Washington County emissions were mostly attributed to energy production, likely from the two coal combustion facilities (Muskingum River Power Plant and R.H. Gorsuch Station).

3.3. Plant and Animal Habitat and Populations

3.3.1. Introduction

The description of plant and animal habitat and population information is derived from the 2006 Forest Plan and EIS and incorporates by reference the supplemental information provided in the 2012 SIR, for which both the USFWS and the FS concurred that the conclusions of the 2006 Plan were still well founded. The BLM also made observations of habitat and wildlife during a site visit conducted in 2015.

For the purpose of management, the WNF is divided into 14 separate, non-contiguous management areas, which are defined by their history, geography, suitability for various types of use, and other factors. The Marietta Unit contains seven of these management areas, listed below by acreage in descending order and shown on Map 4 (see Chapter 6 of this EA):

1. **Diverse Continuous Forest**: Comprises more than half of the Marietta Unit, or more than 114,000 acres. It is characterized by large blocks of mature forest with a variety of species and ages providing diverse wildlife habitat types. Openings and patches of early-successional habitat are present generally around the edges of otherwise continuous blocks of mature forest. While wildland fire is used to promote oak and hickory stand types, many stands are becoming

increasingly dominated by maple and other fire-intolerant species. Oil and gas development is permitted on NFS lands within this management area. This management area in the Marietta Unit contains 160 acres of managed wildlife openings, which are small breaks in forest canopy that are under special management for the benefit of targeted wildlife species or habitat types.

2. **Forest and Shrubland Mosaic**: Comprises around 68,000 acres in the Marietta Unit and contains forests with a higher proportion of early- and mid-successional components than the Diverse Continuous Forest. There are permanent herbaceous openings dispersed throughout the forests, and prescribed fire and even-aged timber harvests are used to ensure the desired amount of young habitat types. Oil and gas development is permitted on NFS lands within this management area. This management area in the Marietta Unit contains 49 acres of managed wildlife openings.
3. **River Corridors**: Comprises about 35,000 acres in the Marietta Unit and follows the Little Muskingum and Ohio Rivers. The primary emphasis of this management area is on habitats that comprise a healthy riparian area, such as floodplain forests, open wetlands, and properly functioning stream channels. Oil and gas activities are permitted but are subject to a controlled surface use stipulation. This management area in the Marietta Unit contains 112 acres of managed wildlife openings.
4. **Future Old Forest with Mineral Activity**: Comprises about 17,000 acres and is present only on the Marietta Unit, due to the abundance of existing oil and gas wells, pads, and access roads. This area contains a largely uneven-aged forest that is managed very non-intensively. Over time, the area is expected to become dominated by maples and other fire-intolerant, shade-tolerant species, while occasional, natural disturbances will maintain a small component of early-successional habitat. This management area is closed to timber production and open for oil and gas activities.
5. **Special Areas**. These areas are managed to preserve and study unique natural areas. There are seven Special Areas in the Marietta Unit, totaling about 2,600 acres, mostly in the eastern half of the Unit. No surface occupancy (NSO) is allowed on new federal leases here.
6. **Developed Recreation**. Two areas totaling 366 acres make up the federally-owned component of this area within the Marietta Unit. This management area emphasizes providing safe areas for recreational activity. NSO is allowed on new leases in this management area.
7. **Research Natural Area**. This management area consists of "nationally significant areas with unique ecosystems deemed worthy of preservation for scientific purposes" (2006 Forest Plan, p. 3-53). The Marietta Unit contains one such area, known as Reas Run Research Natural Area, a 78-acre mature Virginia pine stand. NSO is allowed in this management area.

The 2006 Forest Plan (and EIS) emphasizes that various habitat types and all major successional stages are necessary for the WNF to meet its mandate of sustaining a diverse population of native plants and animals. The 2006 Forest Plan (and EIS) uses several habitat indicators in an effort to summarize the impacts of management activities within the WNF:

- Amount and trends in oak-hickory forest;

- Amount and trends in pine forest and trends in pine warbler (*Setophaga pinus*) habitat and population;
- Amount and trends in early successional habitat and trends in yellow-breasted chat (*Icteria virens*) and ruffed grouse (*Bonasa umbellus*, an upland game bird) habitat and populations;
- Mature, interior forest – amount and trends cerulean warbler (*Setophaga cerulea*, a songbird) and worm-eating warbler (*Helmitheros vermivorum*), and pileated woodpecker (*Dryocopus pileatus*) habitat for and populations;
- Mature riparian forest and headwater streams – amount and trends in Louisiana waterthrush (*Parkesia motacilla*);
- Grassland habitat – amount and trends in Henslow's sparrow (*Ammodramus henslowii*) population and habitat;
- Species of viability concern – threatened and endangered species and Regional Forester Sensitive Species;
- Species of public interest, such as white-tailed deer and ginseng;
- Non-native, invasive species; and
- Amount of Forest Service land open for timber harvesting.

For this EA, the BLM analyzed all of these indicators except timber harvesting and prescribed fire, since they relate strictly to amounts of land allocated to certain land management practices that are not affected by oil and gas leasing. Specific design criteria and/or mitigation measures have been used to implement project work in and around existing oil and gas production infrastructure.

3.3.2. Oak-hickory forest

Oak-hickory and mixed oak communities dominate the WNF (2006 Forest Plan Final EIS, p. 3-40). The Southern Unglaciated Allegheny Plateau ecological section was dominated by oak-hickory and mixed oak-pine communities at the time of first European settlement. The primary changes to the vegetation since then have been the initial cutover of the primeval forest and the broad suppression of wildfire that accompanied widespread European settlement. This second factor has resulted in the invasion of maples, beech, and yellow poplar into the oak-dominated communities, to such an extent in many areas that shade-intolerant, mast-bearing species (oaks and hickories) are declining. The primary factor in maintaining oak-hickory forest is periodic disturbance, primarily harvest and fire, either wild or prescribed.

3.3.3. Pine forest

Pine-dominated communities made up 6%, and mixed-pine communities 5% of the WNF in 2006 (2006 Forest Plan Final EIS, p. 3-55). As farms failed in southeastern Ohio in the 1930s, the Civilian Conservation Corps planted pines widely as an erosion-control practice. Pines on the WNF include four native species: shortleaf pine (*Pinus echinata*), pitch pine (*P. rigida*), Virginia pine (*P. virginiana*), and, in the eastern portion of the Marietta unit, white pine (*P. strobus*). Red pine (*P. resinosa*) is not native to Ohio but is widely planted and in present on the WNF. Pines are propagated by disturbances, such as blowdown, fire, and timber harvest.

Pine warbler is identified by the Partners in Flights Northern American Landbird Conservation Plan as a Stewardship Species for the Eastern Avifaunal Biome. This species has increased throughout the region in the last half century. The 2006 Forest Plan Final EIS projects a decline in pine-dominated stands and pine warbler population.

3.3.4. Early successional habitat

As in the case of oak-dominated and pine communities, early successional habitat types depend on periodic disturbances. Disturbances such as fire and timber harvesting expose the ground to sunlight and permit the growth of shrubby communities that favor certain types of wildlife. Wildfire once provided periodic disturbance to a large portion of southern Ohio but has been widely suppressed over the past century. Abandoned farms created a large component of early successional habitat, but this component declined from 25% of the WNF in 1968 to the 2006 level of 5.4% (2006 Forest Plan Final EIS, p. 3-60). A large component of current early successional habitat is on reclaimed mine lands. Yellow-breasted chat and ruffed grouse are species of conservation concern on the WNF that require young stands with open canopies. These and many other early successional forest birds have experienced population declines as early successional habitat has given way to closed-canopy forests.

3.3.5. Mature interior forest

94% of the WNF and 80% of the surrounding landscape were forested in 2006 (2006 Forest Plan Final EIS, p. 3-70). Mature forests have been increasing throughout southern Ohio over the last half century. Most stands are even-aged or nearly so, since most stands originated following clearcuts or farm abandonment. Many wildlife species thrive in mature forest conditions, and there is a wide variety of types of structure in mature forests, such as semi-open canopies and tight canopies that provide dense shade. The most abundant management area on the Marietta Unit is Diverse Continuous Forest, which is managed to emphasize large blocks of unbroken forest.

Three bird species, cerulean warbler, worm-eating warbler, and pileated woodpecker, were selected as indicators of mature forest conditions because they represent a broad cross-section of the habitat needs of mature-forest-dependent wildlife. Cerulean warblers require uneven-aged forests with large trees for cavity-nesting. Worm-eating warblers nest on the ground and require well-developed understory with plenty of coarse, woody debris. Pileated woodpeckers favor old forests but will use less-mature habitats. All of these birds protect large territories and require large, unbroken tracts of mature forest.

3.3.6. Mature, riparian forest/headwater streams

Riparian areas are the zones of interaction between the terrestrial and aquatic ecosystems, including the floodplains and the land whose vegetation, microclimate, and wildlife are directly influenced by the presence of the aquatic ecosystem. The WNF provided a GIS file showing riparian areas within the Marietta Unit. There are almost 15,000 acres of riparian area within the Marietta Unit, and the Forest Service manages 15 percent of this area. Most of the federally-managed riparian areas are forested, and some of the lands in riparian areas are used for agriculture and roads.

Louisiana waterthrush is a bird species that lives in large riparian forests. The Louisiana waterthrush is considered a good indicator of riparian area health because it eats insects that live in various microhabitats that are present in a healthy riparian area. Louisiana waterthrush is listed as a Stewardship Species in the Partners in Flight North American Landbird Conservation Plan with a goal of maintaining its current population, and the species is considered stable on the WNF.

3.3.7. Grassland habitat

Much of the grassland habitat on the WNF was created by reclaimed mine lands. The Marietta Unit does not contain any of the major prairie areas of the WNF, and the Unit contains no land allocated to the Grassland Forest Mosaic management area.

Henslow's sparrow, a grassland-dependent species, has been declining in southeastern Ohio in recent decades but is not known to be present on the Marietta Unit.

3.3.8. Species of viability concern

3.3.8.1. Federally endangered or threatened species

Sensitive species managed by the Forest Service include federally listed endangered, threatened, and candidate species under the Endangered Species Act as well as Regional Forester Sensitive Species (see Section 3.3.8.2, Regional Forester Sensitive Species). The Forest Service, including both the WNF and Region 9, has previously consulted with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Endangered Species Act with respect to federally listed species. As part of this consultation, the USFWS issued a Biological Opinion (BO) on November 22, 2005. The BO provided a tiered approach to the Section 7 consultation. The programmatic BO (Tier I) covers all the activities described in the 2006 Forest Plan described in the 2006 Forest Plan and EIS at a programmatic, non-site-specific level. Because the BLM was a cooperating agency in the 2006 Forest Plan/EIS, the consultation conducted with respect to the 2006 Forest Plan and EIS applies to the Proposed Action analyzed in this EA.

As part of the 2012 SIR, the Forest Service reviewed new information related to hydraulic fracturing and whether there could be additional effects to threatened and endangered species that had not been previously analyzed in the 2006 Plan/EIS. The Forest Service and the USFWS concluded that no further analysis or consultation was needed and that the consultation conducted under the 2006 Plan/EIS was still valid

The information below summarizes the status of the threatened or endangered species that may be present in or near the Marietta Unit. Table 3.4 lists the species that were covered in the 2005 BO and additional species such as the northern long-eared bat, sheep nose, and snuffbox. A discussion of each species follows the table:

Table 3.4. Species addressed in the Tier I Biological Opinion and in the current analysis

Common name	Scientific name	Listing status	Determination, Tier I BO
Mammals			
Indiana bat	*Myotis sodalis*	endangered	LAA
Northern long-eared bat	*Myotis septentrionalis*	threatened	n/a
Insects			
American burying beetle	*Nicrophorus americanus*	endangered	NLAA
Birds			
Bald eagle	*Haliaeetus leucocephalus*	delisted, but still protected under Bald and Golden Eagle Protection Act	NLAA
Common name	**Scientific name**	**Listing status**	**Determination, Tier I BO**
Mussels			
Fanshell	*Cyprogenia stegaria*	endangered	NLAA
Pink mucket pearlymussel	*Lampsilis abrupta*	endangered	NLAA
Sheepnose	*Plethobasus cyphus*	endangered	n/a
Snuffbox	*Epioblasma triquetra*	endangered	n/a

Common name	Scientific name	Listing status	Determination, Tier I BO
Plants			
Northern monkshood	*Aconitum noveboracense*	threatened	NLAA
Running buffalo clover	*Trifolium stoloniferum*	endangered	LAA
Small whorled pogonia	*Isotria meleoloides*	threatened	NLAA
Virginia spirea	*Spirea virginiana*	threatened	NLAA

LAA - likely to adversely affect; NLAA - not likely to adversely affect; n/a - not included in the Tier I BO

The WNF previously considered in its analysis the entire Forest proclamation boundary and a one-mile buffer around the Forest, which fully encompasses the area being analyzed for potential oil and gas activities on the Marietta Unit.

3.3.8.1.1. Indiana bat

Indiana bat, which has similar habitat requirements to the northern long-eared bat, is well-documented on all units of the WNF and is present year-round. The WNF contains one documented hibernaculum, and it is not on the Marietta Unit (U.S. Fish and Wildlife Service (USFWS), 2011, p. 3). Likewise, lactating and post-lactating females and adult males have been captured within the WNF, which indicates that roost trees are most likely present on the WNF. While suitable summer habitat exists on all three units of the WNF, the Athens and Ironton Units most likely contain the most heavily concentrated populations of Indiana bat, based on thorough surveys conducted previously throughout the WNF by the USFWS (USFWS, 2011, p. 3).

3.3.8.1.2. Northern long-eared bat

Northern long-eared bats live in forested areas during the summer, where they forage on flying insects and roost in trees with exfoliating bark and other natural or artificial crevices. The Marietta Unit contains ample suitable foraging and roosting habitat for this species, based on the similarities between the habitat requirements of this species and the Indiana bat. The primary threat to this species is the highly contagious and widespread disease, white-nose syndrome. White-nose syndrome is caused by the fungus Pseudogymnoascus destructans and generally infects hibernating bats, resulting in up to 100 percent mortality in hibernacula. Because the primary threat to this species is a disease and not anthropogenic (originating in human) activities, the USFWS has instituted a rule, known as a 4(d) rule, which permits take of this species under certain circumstances. This species was listed as threatened in April 2015 and, as such, was not addressed in the 2006 Forest Plan and EIS or its related BO. However

the USFWS issued a new, programmatic BO in 2016 for all Federal agencies for the northern long-eared bat (USFWS, 2016) to account for this species.

3.3.8.1.3. American burying beetle

American burying beetles live in various types of habitats. They require dove- or chipmunk-sized carrion, which they bury and feed to their young until the larvae pupate. This species was released on state-owned lands near the WNF and on the WNF Athens Unit in 2009. These locations are all far enough from the Marietta Unit that it is unreasonable to think that the American burying beetle would have naturally migrated to, and established a population on, the Marietta Unit.

3.3.8.1.4. Freshwater mussels

Fanshell and pink mucket pearlymussel are not documented anywhere on the WNF (U.S. Forest Service, 2005, p. F1-116 and F1-129). The WNF contains suitable habitat for fanshell host fish species but not for fanshell or pink mucket pearlymussel. Sheepnose and snuffbox may be present on waterways within the WNF and were not included in the 2005 BO, but the USFWS concurred with the Forest Service that the 2012 SIR did not need any update regarding these species because neither of these species would be affected by oil and gas activities on the national forest (U.S. Forest Service, 2012, p. 58) and therefore the Section 7 consultation for the 2006 Plan was sufficient.

3.3.8.1.5. Northern monkshood, small whorled pogonia, and Virginia spirea

Northern monkshood lives in shaded to partially-shaded habitats cliffs, talus slopes, or other locations with cool air, soil, or groundwater. One of the three populations known to exist in Ohio is in Hocking County, which overlaps the Athens Unit, but is not on federal land. The WNF contains no known potential reintroduction sites (U.S. Forest Service, 2006).

One population of small whorled pogonia is near the Athens Unit, and the Ironton District contains abundant suitable habitat. However, this species has not been identified on the Marietta Unit.

Also, Virginia spirea has not been identified on the WNF. The nearest known population is located near the Ironton District, outside of the WNF.

3.3.8.1.6. Running buffalo clover

This species is known to occur on the Ironton District (Historic Forest with Off-Highway Vehicles Management Area) on lands that are not protected, but where stipulations limit minerals development. This species was recently discovered on the Athens Unit in 2013; however, to date there are no known occurrences on the Marietta Unit.

3.3.8.2. Regional forester sensitive species

Regional Forester Sensitive Species include candidate species under the Endangered Species Act, species that have been federally delisted within the past five years, and species documented within the proclamation boundary with a global, trinomial, or national rank of G1-G3, T1-T3, or N1-N3. The Biological Evaluation (BE) that was drafted for the 2006 Forest Plan addressed 14 animal species and

nine plant species, and several have been added and/or removed from the list since then, as detailed in Tables 3.5 and 3.6.

Table 3.5. RFSS animal species

Common name	Scientific name	2006	2016	Occurrence/Habitat
Mammals				
Bobcat	*Lynx rufus*	X		Forest-wide
Black bear	*Ursus americanus*	X	X	Forest-wide
Little brown bat	*Myotis lucifugus*		X	Forest-wide
Tri-colored bat	*Perimyotis subflavus*		X	Forest-wide
Birds				
Bald eagle	*Haliaeetus leucocephalus*		X	Forest-wide but no documented nests
Cerulean warbler	*Dendroica cerulea*	X	X	Forest-wide
Henslow's sparrow	*Ammodramus henslowii*	X	X	Athens Unit and Ironton Ranger District
Reptiles				
Timber rattlesnake	*Crotalus horridus*	X	X	Athens Unit and Ironton Ranger District
Amphibians				
Eastern hellbender	*Cryptobranchus alleganiensis*	X	X	Marietta Unit (Little Muskingum River)
Four-toed salamander	*Hemidactylium scutatum*		X	Ironton Ranger District
Green salamander	*Aneides aeneus*		X	Ironton Ranger District
Mud salamander	*Pseudotriton montanus*		X	Ironton Ranger District
Fishes				
Ohio lamprey	*Ichthyomyzon bdellium*	X	X	Marietta Unit (Little Muskingum River)

Common name	Scientific name	2006	2016	Occurrence/Habitat
Fishes				
Western lake chubsucker	*Erimyzon sucetta*	X	X	Ironton Ranger District
Eastern sand darter	*Etheostoma pellucidum*	X		
Redside dace	*Clinostomus elongatus*		X	Witten Fork and Ohio River tributaries
Mollusks				
Round hickorynut	*Obovaria subrotunda*	X		
Lilliput	*Toxolasma parvus*	X		
Little spectaclecase	*Villosa lienosa*	X	X	Ironton Ranger District (Symmes Ck.)
Salamander mussel	*Simpsonaias ambigua*	X	X	Marietta Unit (Little Muskimgum R.), Ironton RD (Symmes Creek)
Insects				
Grizzled skipper	*Pyrgus wyandot*	X	X	Athens Unit (Dorr Run area)
Northern metalmark	*Calephelis borealis*		X	Athens and Ironton Units
Green-faced clubtail	*Gomphus viridifrons*		X	Marietta Unit (Little Muskingum R. watershed)
Rapids clubtail	*Gomphus quadricolor*		X	Marietta Unit (Little Muskingum R. watershed)

Table 3.6. RFSS plant species.

Common name	Scientific name	2006 Forest Plan	Current	Habitat
Juniper sedge	*Carex juniperorum*	X	X	Open woodland, fire-adapted
Yellowish gentian	*Gentiana alba*	X	X	Open woodland, fire-adapted
Striped gentian	*Gentiana villosa*	X	X	Semi-open woodland
Butternut	*Juglans cinerea*	X	X	Semi-open woodland
Umbrella magnolia	*Magnolia tripetala*	X	X	Mature woodland
Blue scorpionweed	*Phacelea ranunculacea*	X	X	Semi-open woodland; Ironton Ranger District
Yellow-fringed orchid	*Platanthera ciliaris*	X	X	Open woodland, fire-adapted
Rock skullcap	*Scutellaria saxatilis*	X	X	Mature woodland
Pigeon grape	*Vitis cinerea*	X		Riparian
Dwarf iris	*Iris verna*		X	Semi-open woodland
Sparse-lobed grape fern	*Botrychium biternatum*		X	Mature woodland
Lined sedge	*Carex striatula*		X	Mature woodland
Pinxter flower	*Rhododendron nudiflorum*		X	Semi-open woodland
Carolina thistle	*Cirsium carolinianum*		X	Open woodland, fire-adapted
Hirsute sedge	*Carex complanata*		X	Open woodland, fire-adapted
Slender blazingstar	*Liatris cylindracea*		X	Open woodland, fire-adapted
Wild pea	*Lythyrus venosus*		X	Open woodland, fire-adapted
Fern-leaf false foxglove	*Aureolaria pedicularia*		X	Open woodland, fire-adapted
Yellow crownsbeard	*Verbesina occidentalis*		X	Open habitat
Featherbells	*Stenanthium gramineum*		X	Open habitat

Common name	Scientific name	2006 Forest Plan	Current	Habitat
Bushy broom-sedge	*Adropogon glomeratus*		X	Open habitat
Small white snakeroot	*Ageratina aromatica*		X	Open habitat
Large sedge	*Carex gigantea*		X	Riparian
Louisiana sedge	*Carex louisianica*		X	Riparian

3.3.9. Species of public interest

Species of public interest are defined as meeting one or more of the following criteria:

- Fish, wildlife, and plant species commonly enjoyed and used by the public for hunting, fishing, trapping, gathering, observing, or sustenance;
- Conditions and trends in the 2006 Forest Plan area are associated with these species; and
- The use and enjoyment of these species contributes to social and economic sustainability.

Species of interest considered in this EA are Whitetail deer and Wild American ginseng, discussed below.

3.3.9.1. Whitetail deer

The southeastern third of Ohio has the state's highest population densities of whitetail deer. The ODNR attempts to manage the deer herd throughout the state through harvest management. The objectives are to maintain a healthy deer population and hunting opportunities while mitigating damage to crops. Most of the federal land throughout the WNF is open for hunting. Table 3.7 contains deer harvest data for Monroe, Washington, and Noble Counties combined, gleaned from the ODNR website (Ohio Department of Natural Resources, 2016b).

Table 3.7. Deer harvested in Monroe, Washington, and Noble Counties

Year	Harvest	Year	Harvest
2006-07	15,018	2011-12	11,886
2007-08	13,020	2012-13	11,024
2008-09	15,156	2013-14	9,012
2009-10	15,289	2014-15	7,535
2010-11	12,808	2015-16	9,006

Source: ODNR, 2016b

3.3.9.2. Wild American ginseng

Wild ginseng is a medicinal herb that may be harvested by permit in most of the Marietta Unit. Management areas in the Marietta Unit where harvest is prohibited include special areas and future old forest with minerals. Overharvesting poses the greatest threat to populations on the WNF (2006 Forest Plan Final EIS, p. 3-150).

3.3.10. Non-native, invasive species

Non-native, invasive species include non-native plants, animals, and plant diseases that aggressively displace native species and alternative plant communities and ecosystems. Roughly one-third of the WNF is infested with one or more non-native, invasive species. Most of the documented non-native, invasive species in Ohio and on the WNF are plants, and the 2006 Forest Plan lists 47 non-native, invasive plant species known to occur on the WNF. Staff from the BLM observed garlic mustard, Japanese stilt grass, and multiflora rose on multiple locations on the Marietta Unit during site visits conducted in 2015 as part of this EA effort.

Non-native, invasive diseases include several fungal pathogens that attack particular tree species, such as butternut canker and Dutch elm disease.

Invasive insects include Gypsy moth and emerald ash borer. Gypsy moth feeds on hundreds of plant species, but its most common hosts are oaks and aspen, which are abundant on the WNF. The Ohio Department of Agriculture conducts treatments to suppress Gypsy moth populations in cooperation with willing landowners.

Emerald ash borer, an insect that kills all species of ash (genus *Fraxinus*), is widespread in Ohio and has been identified on the Athens Unit of the WNF. It may be present on the Marietta Unit as well (Ohio Department of Agriculture, 2016).

3.4. Geology and Minerals

Bedrock outcrops on the WNF are composed of clay, shale, siltstone, sandstone, conglomerate, and limestone, mostly from Pennsylvanian and Permian systems. Some Mississippian rocks also occur on the surface. Coal seams are found interbedded in the Pennsylvanian and Permian formations. These rock units – as well as the thick sequence of sedimentary rocks of Devonian, Silurian, Ordovician and Cambrian Ages – overlie an igneous and metamorphic Pre-Cambrian complex.

Formations in the vicinity of the WNF generally strike in a northeast-southwest direction and dip gently to the southeast, averaging less than five degrees.

The correlation between the Appalachian Plateau and a subsurface feature called the Appalachian Basin accounts for the southeasterly dip of rock formations underlying the WNF. This basin was likely formed by slow subsidence during the Paleozoic era. The subsidence is believed to have been most rapid towards the center of the basin, which lies southeast of the Forest. Sedimentation into the basin kept up with the subsidence during most of the basin's formation, consequently, sedimentary rock units thicken as they dip towards the basin's center, resulting in an increased dip of older (deeper) rock units.

This dip represents the only known major structural feature within the Athens Ranger District, Athens Unit and Ironton Ranger District, Ironton Unit. However, within the Marietta Unit the major structural feature is the north-south trending Burning Springs Anticline, which has smaller features on its flanks. No large faulting is known in the area, although small faults do occur.

Additionally, there are as many as 15 discontinuous coal beds within the Pennsylvanian Conemaugh and Allegheny Groups.

Given the nature of the sedimentary formations outcropping or close to the surface, mineral materials (sand and gravel, dolomite, limestone, clay, etc.) are abundant within the WNF.

There are several fossiliferous marine members of the Pennsylvanian system. The marine fossils within these members consist of gastropods, corals, cephalopods, fusulinid protozoans, clams, brachiopods, bryozoans, and trilobites. These are all fairly common invertebrate fossils. A few formations have yielded fish fossils and scales. Plant fossils in the form of plant fragments, fern fronds, trunks, pyritized logs, stumps, spores, and roots, can be found in a variety of deposits including coal, clay, shale, sandstone, and limestone. Some formations have an abundance of plant fossils. Others only have traces, while the majority has none (2006 Forest Plan Final EIS, pp. 3-253 – 3-255).

Ohio ranks 28th amongst the 50 states in seismic activity with 8 earthquakes (3.5 or above) between 1974 and 2003. Geologic mapping and 2-D and 3-D seismic data can locate faults within the area but current science may not be able to differentiate a “natural” earthquake from an earthquake induced by fluid injection.

Wells that undergo HF may be drilled vertically, horizontally, or directionally and the resultant fracture induced by HF can be vertical, or horizontal, or both. Wells may extend to depths greater than 20,000 feet or less than 1,000 feet, and horizontal sections of a well may extend several thousand feet from the production pad on the surface.

To ensure that oil and gas exploration and development is conducted in a safe and environmentally sound manner, the BLM approves and regulates all drilling and completion operations, and related surface disturbance on federal public lands. Prior to approving a Notice of Intent for Geophysical Exploration (NOI) or APD, the BLM identifies all potential subsurface formations that may be penetrated by the wellbore. This includes all groundwater aquifers and any geologic ones that would present potential safety or health risks that may need special protection during drilling. Once the geologic analysis is completed, the BLM reviews the proposed casing and cementing programs to ensure the well construction design is adequate to protect the surface and subsurface environment, including the potential risks identified by the geologist and all known or anticipated zones with potential risks.

3.4.1. Minerals

Ohio has a long history of oil and gas exploration and production. The location of the first discovery of oil was from a drilled well in Noble County in 1814 and Ohio’s first commercial oil well began production in 1860 in Washington County (Ohio Oil and Gas Energy Education Program, 2016). Beginning in the late

1800's oil and gas exploration and production focused on the Devonian Ohio -Bedford shales and the Berea sandstone, and earlier Ordovician Trenton limestone. During the 1960s the Cambrian Trempealeau, Rose Run, and Beekmantown reservoirs became targets for drilling and continue to be active drilling targets. The Clinton sandstone was extensively drilled in the 1970's and 1980's and remains a major petroleum reservoir (Ohio Oil and Gas Energy Education Program, 2016). In eastern Ohio the major hydrocarbon source rock groups can be divided into six general units:

- Pennsylvanian Pottsville, Allegheny, Conemaugh, and Monongahela Groups;
- Upper Devonian Olentangy, Ohio, and Bedford Shales;
- Middle Devonian Marcellus Shale;
- Silurian Rochester Shale;
- Upper Ordovician Utica and Queenston Shales; and
- Middle Ordovician Point Pleasant Formation.

Hydrocarbon source rocks and adjacent porous rock formations constitute a petroleum reservoir from which oil and gas are produced. Major oil and gas producing zones in eastern Ohio include:

- Devonian Ohio, Bedford, and Marcellus Shales, and Berea Sandstone;
- Ordovician Trenton and Lexington limestones, Point Pleasant and Utica shales, and the Clinton Sandstone; and
- Cambrian Knox Dolomite including the Trempealeau Dolomite, Rose Run Sandstone, and Beekmantown Dolomite.

Since the early 2000s, the focus of petroleum exploration and production has moved to the Marcellus, Utica, and Point Pleasant Shales (see Chapter 9, Appendix B, for map). Previously oil shales were not considered good hydrocarbon producers due to their low permeability but advances in horizontal drilling and hydraulic fracturing methods have enabled the production of oil, natural gas, and gas liquids possible from these reservoirs in paying quantities.

The Marcellus Shale is a large natural gas reservoir of black, organic-rich shale of middle Devonian age. It extends an estimated 95,000 sq. miles under large portions of New York, Pennsylvania, West Virginia, and Ohio (Pickett, 2011). In eastern Ohio the Marcellus Shale lies approximately 5,000 to 6,000 feet below the surface. Due to the thinness of the Marcellus Shale in eastern Ohio there has been relatively little drilling compared to locations further east.

Below the Marcellus Shale, some 2,000 – 3,000 feet, is a thicker and more extensive hydrocarbon reservoir known as the Utica Shale. This Ordovician-aged formation consists of a dark-gray to black, calcareous, organic-rich shale that contains light oil and natural gas. In contrast to the Marcellus Shale, the thickness of the Utica in Ohio increases from east to west (Pickett, 2011).

The deepest and oldest of the shale formations is the Point Pleasant. Resting on top of the Trenton Limestone and immediately below the Utica Shale, the Point Pleasant Shale is found 6,000 to 10,000 feet deep in eastern Ohio. As the Trenton Limestone trends westward it gradually thins into the inter-

bedded limestone and organic-rich shale of the Point Pleasant formation (Wickstrom, Riley, Erenpreiss, & Perry, 2012). This interlayered formation is thicker and higher in total carbon content than the Utica (Pickett, 2011) suggesting a larger reservoir than the Utica. In the eastern Ohio counties of Washington and Monroe, the Point Pleasant formation is rich in oil and natural gas liquids, also known as wet gas.

3.4.2. Mineral development

Since 2010, Ohio has seen an increase in the drilling and production of oil and gas. The ODNR reported that 15,707,339 barrels of oil and 651,193,106 million cubic feet (Mcf) of gas were produced from Ohio's horizontal shale wells in the first nine months of 2015. This exceeds the 15,062,912 barrels of oil and 512,964,465 Mcf of gas produced by all wells in Ohio for the entire year of 2014. Approximately 715 new wells were drilled in Ohio with Monroe and Washington counties ranking fourth and tenth respectively in the number of new wells drilled (Stucker, 2015). The majority of exploration and production in 2014 occurred in the Ohio - Marcellus, Utica/Point Pleasant, and Trempealeau producing zones.

Mineral ownership on the WNF is complicated and consists of a mix of Forest Service and private surface ownership along with federal and private mineral ownership. Table 3.8 details the ownership within the Marietta unit of the WNF. Approximately 59% of the WNF surface ownership is underlain by private minerals. The remaining approximately 41% of surface ownership is underlain by federal minerals (U.S. Forest Service, 2012). When federal minerals are leased by BLM, all surface and downhole activities must comply with federal regulations.

Table 3.8. Wayne National Forest surface/mineral ownership

Ownership			Marietta Unit (acres)	Athens Unit (acres)	Ironton District (acres)	Forest Totals (acres)
Federal Surface	Federal Minerals	100% minerals Unencumbered	8,507	10,382	43,491	62,380
		100% minerals with deed lease[1]	8,760	8,069	17,037	33,866
		Total Federal Minerals	**17,267**	**18,451**	**60,528**	**96,246**
	Private Minerals[2]	Reserved Minerals	4,384	5,663	9,182	19,229
		Outstanding Minerals	7,622	12,468	11,000	31,090
		Combination[3]	34,725	36,565	21,642	92,932
		Total Private Minerals	**46,731**	**54,696**	**41,824**	**143,251**
Total Federal Surface			**63,998**	**73,147**	**102,352**	**239,497**
Private Surface	**Federal Minerals**		7	116	708	831
	Private Minerals		204,053	195,682	214,273	614,008
Total Private Surface			**204,060**	**195,798**	**214,981**	**614,839**
Total Acres within the WNF			**268,058**	**268,945**	**317,333**	**854,336**

Source: (2006 Forest Plan Final EIS, Table 3-62)

[1] Most of these leases appear to be inactive and/or may have expired, but their legal status is currently unknown.

[2] Reserved, Outstanding, and Combination minerals may not all be 100% private minerals. Partial Federal interests may exist as well.

[3] Combination indicates a parcel with two or more outstanding, reserved or deed lease rights.

Currently, there are 493 active federal wells on the Wayne National Forest in the following counties:

- Washington County: 285 Wells;
- Monroe County: 117 Wells;
- Perry County: 30 Wells;
- Athens County : 25 Wells;
- Hocking County: 31 Wells; and
- Lawrence County: 5 Wells.

3.5. Soils

The 2006 Forest Plan Final EIS states that the forest is located in Ohio's Hill Country, consisting of a long series of narrow ridges and U-shaped valleys. The slopes tend to be benched or segmented with alternating sections of steep and moderately sloped gradients due to the resistance of different strata to erosion. Due to the steep gradients and soil textures (surface texture = silt loam, loam, or sandy loam; subsoil texture = sandy loam to clay) erosion is probable if the duff layer is disturbed.

Soil loss within the Marietta Unit proclamation boundary ranges from up to one-half ton per acre per year on undisturbed forested lands and to up to seven tons per acre per year on croplands. Soil mass movement is possible on the steepest areas of the forest, with nearly all valleys containing evidence of slide areas. Serious erosion is usually limited to road use during excessively wet periods where roads are poorly located or not engineered for proper drainage or flow, which is usually most likely on unauthorized roads and trails. Intermingled farms and rural roads, rather than forested land, are the major sources of soil erosion.

For more detailed information refer to the Soils section of the 2006 Forest Plan Final EIS, pages 3-21.

3.6. Water Resources and Water Quality

3.6.1. Surface water

3.6.1.1. Overview

On average the state of Ohio sees approximately 133 days with rain each year with an annual average of 56.11 inches (U.S. Climate Data, 2016). However, this average annual precipitation can vary by 15 inches. Levels of precipitation are lowest in the northwestern part of the state and highest in the south/southwest of Ohio. The inconsistent quantities of evapotranspiration combined with a consistent level of precipitation throughout the year increases the average monthly streamflow; therefore, there are higher flow rates in winter and early spring and lower flow rates in the summer and fall months (Schiefer, 2002).

The Marietta Unit is entirely contained within the Little Muskingum Middle Island Hydraulic Unit Code (HUC)-8 sub-basin (also known as a level-4 watershed). The Marietta Unit overlays five HUC-10 (level-5) watersheds, as shown in Map 5 (see Chapter 6 of this EA) and Table 3.9 below. This analysis omits the small portions of the Seneca Fork-Wills Creek and Sunfish Creek watersheds, since there are no federal lands associated with the Marietta Unit in those watersheds. The Ohio River forms the southern edge of

the Marietta Unit, and all of the watersheds in the Marietta Unit drain to the Ohio River. The Marietta Unit contains over 1,250 miles of streams.

Table 3.9. HUC-10 (Level-5) Watersheds in the Marietta Unit

Watershed	Area in Marietta Unit (acres)	Federally owned area (acres)
West Fork Duck Creek	2,523	164
East Fork of Duck Creek	15,001	1,484
Clear Fork Little Muskingum River-Little Muskingum River	100,597	28,421
Headwaters Little Muskingum River	92,956	15,009
French Creek- Ohio River	53,686	19,560
Total	**264,763**	**64,638 (24%)**

Furthermore, the Marietta Unit contains over 1,250 miles of streams. However, the streams within the proclamation boundary are low-order (small size) or ephemeral (flow only during and immediately after precipitation) streams, both being headwaters for the Little Muskingum River or Ohio River. Low order streams do not have many tributaries contributing to their flow, and about two-thirds of that length is intermittent.

3.6.1.2. Surface water quality

According to the Clean Water Act (CWA) each state is required to identify a prioritized list of their Section 303 (d) impaired waters. Each state submits their Total Maximum Daily Loads (TMDL) to the EPA and the TMDLs are either approved or denied. TMDLs are determined by taking into account the loading capacity of the water body as it relates to different pollutants and what actions would need to occur in order to control them. TMDLs are significant because they are the link between causes of impairment and the actions needed to meet water quality standards. Once the causes of point and non-point pollution or impairment are identified TMDLs for each pollutant are determined. The probable causes for impairments in the Marietta Unit are non-irrigated crop production, pasture land, and acid mine drainage (AMD).

In 1996 the Forest Service assessed 200 miles of impaired streams within the WNF finding that 11% of the streams met Ohio's water quality standards, 48% were impaired, and 41% had not been assessed yet by the Ohio EPA or Forest Service. The causes of impairment are generally attributed to abandoned mines and agriculture. In the Marietta Unit, impairment is attributed to nutrients, siltation, pasture land run-off, agricultural run-off, and on-site wastewater systems (2006 Forest Plan EIS, 3-11).

In 2010, the USEPA conducted an assessment analyzing stream impairment on the Little Muskingum-Middle Island Watershed (HUC-12 Watersheds). Of the 36 watersheds (1555 miles of streams) in the Little Muskingum-Middle Island Watershed, 25 (1245.7 miles) were impaired and the remaining 9 (309.3 miles) were not assessed. Of the streams that were analyzed in the Little Muskingum-Middle Island Watershed, 19 are within the Marietta Unit. In the Marietta Unit, 17 of the streams were impaired and the remaining 2 were not analyzed. The causes of impairment include: flow alterations (FA), sedimentation or siltation (S), total suspended solids (TSS), total toxics (TT) or unknown toxicity, organic enrichment/ low dissolved oxygen/ Oxygen Depletion (O), polychlorinated biphenyls (PCBs), Pesticides/DDT (P), nutrients (N), metals (M), habitat alterations (HA), or other toxicity levels exceeding Total Maximum Daily Load (TMDL) standards. The reasons for impairment are listed in Table 3.10 as they correspond with the risks they pose on aquatic life, human health, recreation, or public drinking (USEPA, 2016d).

Table 3.10. Impairment of Little Muskingum- Middle Island Watershed streams within Marietta Unit

Waterbody Name	Waterbody ID	Waterbody Type	Size (miles)	Status	Aquatic Life	Human Health	Public Drinking	Recreation
Archers Fork	OH050302010702	Stream	28.6	Impaired	impaired: FA, N, S	not assessed (na)	na	na
Clear Fork Little Muskingum River	OH050302010701	Stream	73.2	Impaired	impaired: FA, N, S	na	na	na
Cranenest Fork	OH050302010602	Stream	43.6	Impaired	impaired: S	na	na	na
Eightmile Creek-Little Muskingum River	OH050302010705	Stream	64.2	Impaired	impaired: FA, N, S	na	na	na
Fifteen Mile Creek	OH050302010704	Stream	28.7	Impaired	impaired: FA, N, S	na	na	na
Haynes Run-Ohio River	OH050302011004	Stream	27.9	Not Assessed	na	na	na	na
Leith Run-Ohio River	OH050302011007	Stream	38.1	Not Assessed	na	na	na	na
Lower East Fork Duck Creek	OH050302010805	Stream	26.1	Impaired	impaired: HA, FA, M, O, S, TSS, TT	na	na	na
Middle East Fork Duck Creek	OH050302010803	Stream	60.9	Impaired	impaired: HA, FA, M, O, S, TSS, TT	na	na	na
Middle Sunfish Creek	OH050302010103	Stream	35.5	Impaired	impaired: unknown	na	na	na

Waterbody Name	Waterbody ID	Waterbody Type	Size (miles)	Status	Aquatic Life	Human Health	Public Drinking	Recreation
New Years Creek-Duck Creek	OH050302010903	Stream	44.6	Impaired	impaired: FA, O, S, TT	impaired: unkown	na	na
Paw Paw Creek	OH050302010804	Stream	43.9	Impaired	impaired:HA, FA, M, O, S, TSS, TT	na	na	na
Rich Fork	OH050302010601	Stream	38.3	Impaired	impaired: S	na	na	na
Straight Fork-Little Muskingum River	OH050302010605	Stream	53.1	Impaired	impaired: Sedimentation	na	na	na
Sugar Creek-Duck Creek	OH050302010904	Stream	26.4	Impaired	impaired: FA, O, S, TT	impaired: P, PCBS	na	na
Upper East Fork Duck Creek	OH050302010801	Stream	54	Impaired	impaired: HA, FA, M, O, S, TSS, TT	na	na	na
Wingett Run-Little Muskingum River	OH050302010703	Stream	55.4	Impaired	impaired: FA, N, S	na	na	na
Witten Fork	OH050302010604	Stream	71.6	Impaired	impaired: S	na	na	na
Wolfpen Run-Little Muskingum River	OH050302010603	Stream	37.5	Impaired	impaired: S	na	na	na
Total			**851.6**					

Impaired HUC-12 watershed within Marietta Unit from 2010 EPA report, the causes of impairment include: flow alternations (FA), sedimentation or siltation (S), total suspended solids (TSS), total toxics (TT) or unknown toxicity, organic enrichment/ low dissolved oxygen/ Oxygen Depletion (O), polychlorinated biphenyls (PCBs), Pesticides/DDT (P), nutrients (N), metals (M), habitat alterations (HA) and Ohio Integrated Water Quality Monitoring and Assessment Report from 2014 (Ohio Department of Natural Resources, 2016).

The most recent *Ohio Integrated Water Quality Monitoring and Assessment Report* was conducted in 2014, and is also known as the Integrated Report. The Integrated Report satisfies the CWA requirements for both Section 305 (b) for biennial reports on the state's waters conditions and Section 303 (d) for prioritized list of impaired waters. Overall it indicates that larger rivers in Ohio are more likely to be in attainment than smaller streams; that is where most of the nonattainment waterways are found. There are four major components to the Integrated Report; human health use, recreation use, aquatic life use, and public drinking water use. Human health evaluation occurs by comparing contaminated fish tissue to determine fish consumption advisories. Recreation evaluation methodology is a bacterial water assessment. Aquatic life is evaluated through the use of a biological assessment and a biocriteria program which measured by using two indices, the Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb) for fish and Invertebrate Community Index (ICI) for aquatic macroinvertebrates. Public drinking water conditions are determined by the level of algae and associated cyanotoxins. Also, the populations of certain micro or macro invertebrates can be indicators of poor or good stream health.

The human health analysis found that one-third of the Watershed Assessment Units (AUs) or HUC-12 watersheds and more than half of the lakes in Ohio were unimpaired for this use. Most of the impairments for human health were attributed to polychlorinated biphenyl (PCB) contamination. Recreation use assessment found that beaches located near population centers had a higher frequency of swimming advisories because of elevated bacteria levels. The only areas that were identified as impaired or put on a watch list for public drinking water use are located in the northwestern part of Ohio and parts of central Ohio.

Acid Mine Drainage

Southeastern Ohio has several abandoned mine sites and these point sources of pollution have been known to impact watershed health and alter the flow of groundwater. During the 19th and 20th centuries, significant damage was done to riparian areas. In some cases, streams were overloaded with sediment polluted by AMD that may have collapsed the limestone cap over underground mines causing freshwater to be captured and contaminated in abandoned mines. Gob piles (accumulated spoil piles) contaminated the water and surrounding areas, and the natural landscape was altered by strip-mining (2006 Forest Plan Final EIS, pp. 3-6 & 3-7). In 1972, Ohio statutes began to require restoration of desirable environment that had been disturbed by mining. Prior to these reclamation standards, Ohio was left with 1,300 miles of AMD-polluted streams, 500 miles of streams affected by sediment deposition, and polluted domestic water supplies. In March 1995, the ODNR established the Acid Mine Drainage Abatement and Treatment (AMDAT) fund to aid in long-term cleanup of AMD problems. This program addresses source control and then treatment which can be active or passive (Ohio Department of Natural Resources, 2015a). The way AMD is addressed is continuously evolving. An example of active treatment would be using chemical treatment systems and an example of passive treatment would be allowing natural occurring chemical or biological processes to aid in AMD treatment. In 1977, the federal government passed the Surface Mining Control Reclamation Act in recognition of all the abandoned mines, and then created the federal Abandoned Mine Land (AML) Program. The results of this program up until 2014 include a total of more than 10,000 acres of reclaimed lands in Ohio that were impacted by the 200 years of coal mining in Ohio. Through 2014, the AML Program has also replaced 339 supplies of polluted residential water supplies, completing 94.7% of the completed current inventory (Ohio Department of Natural Resources, 2016a).

3.6.2. Groundwater

3.6.2.1. Groundwater quantity

Nearly all rural populations in Ohio obtain drinking water from groundwater sources (USGS). There are 888 drinking water wells within the Marietta Unit proclamation boundary (Ohio Department of Natural Resources, 2015b and 2015c). Their static water levels range from zero feet below surface to 183 feet below surface with a mean of 32 feet. The mean depth of drinking water wells in the Marietta Unit is 86 feet, with a maximum depth of 475 feet. Most of these wells have a yield of less than ten gallons per minute. The higher-yielding wells are located in the floodplains of the Ohio River and Little Muskingum River. According to the SIR, HVHF operations require anywhere from 3.5 – 4 million gallons of water per well, whereas conventional hydraulic fracturing operations use approximately 44,000-85,000 gallons of

water (SIR, 2012, Table 1, p. 2). Because of the low production rates of groundwater, it is not likely that a proposal would ever be made to utilize groundwater from the WNF for HVHF. Nevertheless, a Forest-wide guideline directs the WNF to control the withdrawal of water.

However, there is no agency (federal or state) that regulates water withdrawals from streams and rivers in the State of Ohio. ORC section 1521.16 requires that the owner/operator of any facility that is capable of withdrawing 100,000 gallons/day or more must register with ODNR Division of Soil and Water Resources. Amended Substitute Senate Bill 315 was signed into law by the Governor on June 11, 2012. This bill amends Ohio Revised Code to provide for the disclosure on a permit application of the sources of ground and surface water to be used in the development of the well. Applicants must disclose if the water is from the Lake Erie or Ohio River watershed and must provide the estimated rate and volume of withdrawal (Amended ORC 1509.06(A)(8)(a)).

3.6.2.2. Groundwater quality

Groundwater under the Marietta Unit flows largely through fractures in bedrock (Thompson, 2012). These fractures are most abundant near the surface, and at depths of a few hundred feet. The relative absence of fractures inhibits groundwater flow keeping it in contact with the bedrock for an extended time, which allows it to dissolve minerals from the bedrock, producing brackish water.

The potable groundwater under the Marietta Unit is largely free of contaminants at levels above human health standards (Ohio EPA, 2012). There are sites in Washington County with elevated nitrates, and Washington County has two sanitary landfills that are sources of groundwater contamination. Groundwater pollution potential is highest in the riparian areas, most likely because of the short depth to groundwater in those areas (Ohio Department of Natural Resources, 2002).

3.6.3. Riparian areas

Riparian areas connect terrestrial habitat to aquatic habitat creating an essential and dynamic ecosystem for a variety of species. Riparian areas can also be defined as wetlands, floodplains, or shoreline that can occasionally be submerged in water. The Marietta Unit contains about 15,000 acres of riparian areas, as detailed in Table 3.11. Mining practices, the impoundment of water, and early settlements near and in the WNF have affected riparian areas. In the Marietta Unit, the creation of the Ohio River Lock and Dam system allowed water to back up into embayments and the barges created waves that caused erosion of riverbanks and additional adverse impacts on riparian areas (U.S. Forest Service, 2006).

Table 3.11. Riparian areas in the Marietta Unit

Watershed	Total riparian area (acres)	Federally owned riparian area (acres)
West Fork Duck Creek	556	5
East Fork Duck Creek	2,285	53
Clear Fork Little Muskingum R.-Little Muskingum R.	5,182	1,046
Headwaters Little Muskingum River	4,515	777
French Creek-Ohio River	2,459	387
Total	**14,997**	**2,266**

3.7. Wastes, Hazardous or Solid

The Resource Conservation and Recovery Act (RCRA) of 1976 established a comprehensive program for managing hazardous wastes from the time they are produced until their disposal. The USEPA regulations define solid wastes as any "discarded materials" subject to a number of exclusions. On January 6, 1988, USEPA determined that oil and gas exploration, development and production wastes would not be regulated as hazardous wastes under the RCRA. The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980, deals with the release (spillage, leaking dumping, accumulation, etc.), or threat of a release of hazardous substances into the environment. Therefore, despite many oil and gas constituent wastes being exempt from hazardous waste regulations under RCRA, certain exempt contaminants could be subject to regulations as a hazardous substance under CERCLA.

Results reviewed from a search of the EPA's Envirofacts web page on September 22, 2016 (a map is included as Appendix D) showed no known hazardous waste sites within the WNF boundary. The Envirofacts Multisystem Search integrates information from a variety of databases and includes latitude and longitude information. Each of these databases contains information about facilities that are required to report activity to a state or federal system. Information retrieved from the system includes hazardous waste (including the Biennial Report), toxic and air releases, Superfund sites, and water discharge permits. More information on the Envirofacts Multisystem search can be found at https://www.epa.gov/enviro/envirofacts-overview.

In discussions with Region 9 Forest Service personnel, it was noted that the only known sites being cleaned up and/or monitored on the WNF are related to old/abandoned coal mines. None of the sites known by the Forest Service are related to oil and gas development and were not identified through the Envirofacts Multisystem Search. Most public lands, however, are victim to illegal trash/waste dumping typically related to private landowners in the area or the illegal production of drugs, both of which can include hazardous waste products regulated under RCRA.

3.8. Public Health and Safety

NEPA requires federal agencies to evaluate whether a proposed action is significant based on the "degree to which the proposed action affects public health or safety" (40 CFR 1508.27). Public health and safety is often considered within the context of other resources, such as air quality, water quality and/or quantity, environmental justice, or transportation, among others, and is typically assessed in terms of what the expected risk is to the human environment as a result of the Proposed Action. For this EA, public health and safety issues are generally considered within the proclamation boundary of the Marietta Unit; although some issues related to public health and safety, such as air quality, requires consideration of a larger affected environment due to the potential dispersion of air emissions.

A fundamental agency value of BLM and the Forest Service is to operate in a safe manner and to provide a safe environment for the public. As specified in the 2012 SIR, it is intrinsic to all projects introduced and implemented on the WNF that safety be the most important factor. This safety outlook applies to all types of projects within the WNF, including mineral development. If something cannot be completed in a safe manner, then it may not be permitted to move forward into implementation, no matter the ownership status of the minerals. That is, regardless if the minerals are federal or private, the WNF has a responsibility along with state and local authorities to implement the appropriate measures, when needed to provide for public safety.

The 2006 Forest Plan/EIS identifies standards for mineral development that the WNF implements to provide a healthy and safe environment for people and wildlife. Some examples are:

- **SFW-MIN-2:** Require that all proposed surface-disturbing mineral activities have an approved operation and reclamation plan before the activity begins;
- **SFW-MIN-3:** Require that operators conduct activities and maintain equipment to prevent the discharge of oil or brine onto the ground or into surface waters;
- **SFW-MIN-4:** Upon discovery or notification of an accidental spill of crude oil or brine that discharges, or threatens to discharge, into surface waters, notify the Ohio Environmental Protection Agency Emergency Response and Special Investigations unit in Columbus; and
- ***SFW-SAFE-19:*** Any wastewater that originates from oil and gas operations would be considered non-federal and so disposal would not be allowed on Wayne National Forest lands (including the roads under jurisdiction of the WNF). In addition, the Ohio Revised Code only allows for four different disposal methods of fluids associated with oil and gas operations: injection, surface application (on roads only, and only when permitted by the authority with jurisdiction over the road), enhanced recovery (reuse of the fluids in other wells) or other methods to test new technologies and methodologies (ORC 1509.22(C)(1)).

Furthermore, the law specifically states that no one is allowed to place fluids associated with oil and gas operations in surface or groundwater or in or on the land in amounts that cause or could cause pollution of water used for human or domestic animal consumption or damage/injury to public health and safety or the environment (ORC 1509.22).

Other provisions for employees and the public that provide for safety within the WNF include:

- **SFW-SAFE-17:** Post warnings of dangerous conditions and threats of immediate concern for the safety of Forest employees and the public; and
- **SFW-SAFE-18:** Issue closure orders to protect the public when clear and present dangers cannot be mitigated in a timely manner.

The Division of Oil and Gas Resources Management (DOGRM) within Ohio's Department of Natural Resources (DNR) maintains an electronic database with information needed in the case of an emergency situation that poses a threat to public health, safety or the environment. Minimum information required is that which is also required for the Emergency Planning and Community Right-To-Know Act regulations (ORC 1509.23(B)). Amended Substitute Senate Bill 315 was signed into law by the Governor on June 11, 2012. This bill amends Ohio Revised Code to require the owner of a well to provide emergency responders with the exact chemical composition of all fluids used in the drilling and stimulating of a well. Exact composition of each proprietary component is made available upon request from emergency responders (Amended ORC 1509.10(H)).

In addition, Onshore Oil and Gas Orders are a way in which BLM implements and supplements the oil and gas regulations found at 43 CFR 3160 for conducting oil and gas operations on federal lands, particularly at the APD stage. These Onshore Orders are listed below:

- **Order No. 1** - Approval of Operations: This Order provides procedures for submitting an Application for Permit to Drill and all required approvals of subsequent well operations and other lease operations;
- **Order No. 2 –** Drilling: This Order provides requirements and standards for drilling and abandonment;
- **Order No. 3 -** Site Security: This Order provides requirements and standards for site security;
- **Order No. 4 -** Measurement of Oil: This Order provides requirements and standards for measurement of oil;
- **Order No. 5 -** Measurement of Gas: This Order provides the requirements and standards for the measurement of gas;
- **Order No. 6 -** Hydrogen Sulfide Operations: This Order provides the requirements and standards for conducting oil and gas operations in an environment known to or expected to contain hydrogen sulfide (H2S) gas; and
- **Order No. 7 -** Disposal of Produced Waters: This Order provides the methods and approvals necessary to dispose of produced water associated with oil and gas operations.

3.9. Transportation

The WNF is within a few hours' drive of several major metropolitan areas in Ohio including Columbus, Toledo, Cleveland, and Cincinnati, as well as Huntington, West Virginia. Principal access routes running near or through the WNF include U.S. Highways 23, 33, 35, 50, and 52 and State Highways 7, 26, 32, and

93. Compared with many National Forests, the WNF has an extensive road network maintained by local governments and the State of Ohio. Townships and counties maintain hundreds of miles of roads within the WNF proclamation boundary. Many of the county roads are paved. In contrast, many of the township roads are single-lane, aggregate surfaced, low-standard roads (U.S. Forest Service, 2006 [Appendix I]). The WNF also maintains several miles of Forest Service roads.

A Forest Scale Roads Analysis was completed in 2002 for the 2006 Forest Plan/EIS, which reviewed the condition of the existing road system on the WNF. The study found that approximately 18% of the roads on the WNF are Forest Service system roads and approximately 82% are comprised of county right-of-ways, state right-of-ways, private right-of-ways, non-system roads, and other Federal jurisdiction roads that are all maintained by others (U.S. Forest Service, 2002). The vast majority of the local roads under Forest Service jurisdiction are dead-end roads, terminating on NFS land and gated or otherwise closed to public motorized vehicles. As with the rest of the WNF, the Marietta Unit contains an extensive road network (see Marietta Unit Motor Vehicle Use Map located at http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm9_005758.pdf)

Regarding the use of existing roads for mineral development, the WNF may implement road use agreements with oil and gas operators to reclaim expenses associated with use of Forest Development Roads for access to oil and gas wells. The agreement would allow the Forest Service to reclaim expenses associated with the use of the roads by the operator's heavy equipment through surface replacement dollars where applicable. The counties have local frost laws which restrict use of the roads by heavy vehicles when the roads would be most easily damaged during days of freeze and thaw. Vehicle operators are also subject to county road use and bridge weight requirements (U.S. Forest Service, 2002, p. 22). Further, all State of Ohio and local regulations related to transportation apply on roads that are not within the jurisdiction of the WNF.

3.10. Recreation

The WNF is a popular location for both dispersed and developed recreation activities and is located within a one day drive of several urban areas including Akron, Columbus, Cleveland, Cincinnati, Toledo, Huntington, West Virginia, and Pittsburgh. It is also the "second largest supplier of public recreation lands" in Ohio after the State Park system (U.S. Forest Service, 2006). Hiking, fishing, hunting, boating, canoeing wildlife viewing, off-highway vehicle trails, camping, and visiting historic site are all popular activities on the Marietta Unit. There are several access points to the Ohio River for watercraft and fishing, and the Little Muskingum River is a popular site for canoeing. The WNF is also a popular area for off-highway vehicle (OHV) use and contains several OHV trails; however none of the OHV trails are located on the Marietta Unit.

As listed below in Table 3.12, the WNF manages 17 developed or designated recreation sites on the Marietta Unit including trailheads, campgrounds, and boat launches. Unless otherwise noted, the open season for all recreation sites is April 15 to December 15. An in-depth review of recreational activities and sites can be found in the 2006 Forest Plan Final EIS.

Table 3.12. Developed Recreation Sites, Marietta Unit

Name	Notes
Frontier Boat Launch	Access to the Ohio River. Includes 70 parking spaces for truck/trailers and cars. Open year round, weather river flood stage permitting.
Haught Run Campground	Closed in spring 2014 due to erosion and safety issues. Normally contains 4 campsites and access to Little Muskingum River and local trails.
Hune Bridge Campground	Three developed campsites which provide access to the Little Muskingum River and the North Country Trail. Five-mile trail to Haught Run Campground. Site also includes interpretive panels discussing the history of the Hune Bridge and local oil and gas industry.
Lamping Homestead	Developed recreation complex with six walk-in campsites, eight picnic sites, a picnic shelter, five miles of hiking trails, and a 2-acre fishing pond. Includes a small cemetery and several structures related to the Lamping Homestead, which dates to the late-1800s.
Lane Farm Campground	Four developed campsites along Little Muskingum River.
Rinard Covered Bridge	Interpretive site with discussing the history of the Rinard Bridge, originally built in 1875. The Bridge is open to pedestrian traffic only.
Ring Mill House	Remains of grist mill, saw mill, and renovated house.
Leith Run Recreation Area	Developed campground with 21 campsites, RV dump station, picnic areas, horseshoe pit, and volleyball court, and showers. Site provides access to the Ohio River with a canoe launch and various piers for fishing. Also serves as trailhead for the Scenic River Trail.

Source: (U.S. Forest Service (2016d)

In addition to the developed recreation sites, the WNF also manages approximately 300 miles of designated trails for hiking, horse riding, mountain biking, and OHVs (however no OHV trails on the Marietta Unit). Unless otherwise noted, trails are open year round for foot travel and from April 15 to December 15 for mountain biking. Distances listed in Table 3.13 below are for trails located on WNF land, unless otherwise noted.

Table 3.13. Trails and scenic roads on the Marietta Unit

Name	Description
Archers Fork Trail	9.5-mile loop trail which visits several areas of natural interest including Irish Run Natural Bridge and a rock shelter.
Covered Bridge Trail	5-mile trail between Haught Run and Hune Bridge Campground along the Little Muskingum River.
Covered Bridge Scenic Byway	35 miles of SR26 between Marietta and Woodsfield, paralleling the Little Muskingum River. Provides access to four covered bridges located in the decision area and numerous other historic era sites (see Cultural Resources section for more information).
Davis Spur Run	3.9 miles, hiking and horse trail, offshoot of the Kinderhook Trail.
Green Wood Trail	6.5-mile linear trail connecting North Country Trail and Scenic River Trail. Hiking and mountain biking. Open year round.
North Country National Scenic Trail/Buckeye Trail	Trails are co-located. Consist of approximately 53 miles of trail which travels through the Marietta Unit, approximately 39 of which are WNF managed land.
Ohio River Scenic Byway	750-mile National Scenic Highway which travels along the Ohio River from Indiana to the Ohio/West Virginia border. Approximately 30 miles of the Byway travels through the Marietta Unit on CR7.
Lamping Homestead Trails	Two loop trails of 3.5 and 1.5 miles. Provides access to the Lamping Homestead area.
Kinderhook Trail	12.3-mile trail open to hiking, horses, and mountain biking.
Ohio River Scenic Byway	Covers approximately 35 miles of SR7 along the Ohio River.
Ohio View Trail	7-mile trail which follows the Ohio River between SR7 and SR260. Connects to the North Country Trail. Open year round.
Scenic River Trail	9.5-mile linear trail which connects to the North Country Trail at CR9 and ends at Leith Run Recreation Area. Open year round.
Shay Ridge Trail	3-mile trail connecting Archers Fork and Covered Bridge trails.

Source: (U.S. Forest Service (2016d)

Vehicles can contribute to noise along roadways and trails. The forest also permits logging activities and prescribed fire to treat and manage lands. All of these approved activities contribute to the current levels of noise in the forest that could affect recreational and wildlife utilization (for more information see Noise section).

3.11. Noise

Noise may be defined as unwanted sound, and noise is usually objectionable because it causes disturbance or annoyance to the noise receptors, however this depends on the susceptibility of the receptors. Typically, levels of noise are measured in units called decibels (dB). The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. A number of factors affect how the human ear perceives sound: the actual level of noise, frequency, period of exposure, and fluctuations in noise levels during exposure. Because the human ear cannot perceive all pitches or frequencies equally well, noise measurements are adjusted or weighted to compensate for the human lack of sensitivity to low-pitched and high-pitched sounds. The A-weighting scale closely resembles the frequency response of the human ear and, therefore, the adjusted unit of measurement, the A-weighted decibel, or dBA, is used to characterize noise, and to quantify the impact of noise, produced by transportation (e.g., vehicle traffic) and construction activities.

Construction equipment generates between 70 and 115 decibels (dB) (Bureau of Land Management, 1998). Typical noise associated with oil and gas activities include the actual drilling, the pumps (that extract the oil), the engines, the compressor and the vehicle traffic to and from the site. However, the forest has a natural damping effect and a forest may damp noise by 5 to 20 dB per 100 feet. This effect is highest in summer and winter (when leaves and snow cover are present). As a result of this natural damping, the area of potential disturbance surrounding a construction site can range from approximately 1.6 acres and 160 acres per point source of the described construction noise. Noise associated with oil and gas development typically continues non-stop for 30 days for each well that is constructed, but after this initial development period the noise is expected to subdue.

Ohio's primary oil and gas law (Ohio Revised Code Chapter 1509) explicitly provides the Ohio Department of Natural Resources ("ODNR") with the authority to adopt regulations regarding noise mitigation with respect to (1) wells and production facilities in urbanized areas and (2) horizontal wells and associated production facilities. ODNR promulgated a rule in 2005 with respect to urbanized areas providing that "drilling, well servicing and well site maintenance operations in urbanized areas shall be conducted in a manner to mitigate noise, including the reasonable use of screening and appropriate mufflers on drilling and servicing equipment." "Urbanized areas" are defined to include any municipality with a population of more than 5,000 residents according to the most recent federal census. ODNR has yet to promulgate noise control rules with respect to horizontal wells (the language in ORC 1509 authorizing the promulgation of noise control rules for horizontal wells was not added until 2012). Thus, under Ohio's regime, the state requires all oil and gas operators with wells and production facilities in municipalities of more than 5,000 residents to mitigate noise, including the "reasonable use" of screening and "appropriate" mufflers. Ohio's oil and gas law and regulations also establish minimum setback requirements (typically 100–200 feet) from occupied dwellings and property lines.

3.12. Cultural Resources/Paleontology

A cultural resource is a location of human activity, occupation, or use identifiable through field inventory, historical documentation, or oral evidence. Cultural resources include both historic and prehistoric archaeological sites, structures, places of architectural significance, locations with important public and scientific uses, and may include traditional cultural properties, which are definite locations of traditional and or cultural importance to specific social and or cultural groups. Cultural resources include but are not limited to the following types: prehistoric archaeological resource, ethnographic resource, and historic-period archaeological and built environment resources. Cultural resources may be, but are not necessarily eligible, for the National Register of Historic Places (NRHP).

The Ohio River Valley is known for its history dating to the early European exploration and settlement in the 1600s. During the 1700s and early 1800s, southeastern Ohio saw the most intensive settlement in what was then called the Northwest Territory because of its proximity to Pennsylvania and Virginia, with Marietta becoming the first major town in the region (Arbogast, 2004). The majority of the land in the Marietta Unit was subjected to farming and logging. The Forest Service began to acquire such land in 1935 with official boundaries being determined in 1951. Until 1993, the WNF was managed as a section of the Wayne-Hoosier National Forest until official separation in 1993 (Arbogast, 2004).

The majority of the Marietta Unit has not been surveyed for cultural resources and there is little known about its prehistoric component (A. Cramer, personal communication, October 29, 2015). As part of the consultation process required by the National Historic Preservation Act Section 106, the BLM sent a consultation letter to the Ohio State Historic Preservation Office (SHPO) on November 16, 2015, requesting information on archeological sites in the Marietta Unit. The Ohio SHPO has not responded to date, indicating that they have not found any adverse effects related to the proposed action. Further consultation will take place on a site by site basis at the APD phase, prior to ground disturbance.

Most of the known historic era resources in the Marietta Unit consist of covered bridges and the remains of homesteads and farms. Most of the land of the Covered Bridge Scenic Byway allows access to four covered bridges and several historic locations located along the Little Muskingum River in the decision area. Several of these sites are listed in the National Register of Historic Places (NRHP), including the Rinard Bridge, originally built in 1879 (Buonopane, Ebright, & Smith, 2012). The Hills Covered Bridge, built in 1878, contains an interpretive display discussing the history of the bridge and its Howe Truss design (U.S. Forest Service, 2015). Hune Bridge, built in 1877 and listed in the NRHP, is the only covered bridge on the byway still open to traffic and allows access to the Hune Campground. The campground contains interpretive panels discussing the history of the bridge and the local oil and gas industry; part of this display includes an active tank which collects oil from nearby wells and an interpretive panel discussing the process and history of the oil and gas industry in the region (U.S. Forest Service, 2016a). The Walter Ring House, originally constructed in the 1850s and also listed in the NRHP, includes interpretative panels discussing its prior use as a grist mill and sawmill (U.S. Forest Service, 2016e).

Other sites accessed by the Covered Bridge Scenic Byway include the Lamping Homestead. The Lamping Homestead contains the remains of several buildings constructed by the Lamping family during the 1800s as well as the family cemetery (Reed, 2014). The Lane Farm Campground is located at the former site of the Lane Family Farm, of which there are little remnants except a walnut plantation (U.S. Forest Service, 2016b).

Paleontology

Paleontology refers to the branch of science related to fossils. There are no known paleontology localities within the Marietta Unit.

3.13. Native American Religious Concerns

The BLM sent letters to seven Federally Recognized Tribes who have a known connection to the area on November 6, 2015, asking to identify any concerns which would need special consideration with respect to the Proposed Action (see Section 1.7.2 for list of Tribes). The BLM has received no responses to these letters, to date.

3.14. Visual Resources and Scenic Quality

Visitors to the WNF are not only attracted to the area for the many recreational opportunities it offers, but also to enjoy the natural scenic beauty of its landscape. Most of the land that became the WNF consisted of land cleared for timber, agricultural use, or mined for coal and other minerals. During the Great Depression in the 1930s, much of the land was abandoned and reverted back to the federal government. The landscape is highly dissected by rolling hills, striking rock bluffs and shelters, and caves of sandstone and shale. There are areas of unique natural beauty and cultural history.

The natural appearing landscape is composed predominantly of oak-hickory forest with scattered pines and is interspersed with private farms and pastureland. The character of the landscape includes such cultural features as historic barns, log structures, iron furnaces, covered bridges and minerals development. Also contributing to the scenic quality are the temporary openings created by timber harvests, mineral development and natural events (i.e. ice storms, fire, or insect infestations). These openings can seem visually out of place; however, they do contribute to the spatial diversity and opportunities for viewing the progression of successional vegetative stages. The deep valley bottoms consist of a network of streams and rivers.

The scenic resources of the WNF are currently managed in accordance with the 2006 Forest Plan, which lays out how the scenic resources will be managed under the Visual Quality Objectives (VQO) determined by the Visual Management System (VMS). The VQS defines acceptable levels of alteration of scenic resources with the WNF. In the 2006 Forest Plan Final EIS, the VMS language was updated to the newer Scenery Management System (SMS) utilizing Scenic Integrity Objectives (SIO) that were developed for each management area. The SMS responds to the deficiencies of, builds on, and validates the original VMS inventories.

Table 3.14. Cross-walk of VMS and SMS Objectives

Visual Quality Objective (VQO)	**Appearance to Casual Observer**	**Scenic Integrity Objective (SIO)**
Preservation (P)	Unaltered	Very High (VH)
Retention (R)	Appears Unaltered	High (H)
Visual Quality Objective (VQO)	**Appearance to Casual Observer**	**Scenic Integrity Objective (SIO)**
Partial Retention (PR)	Slightly Altered	Moderate (M)
Modification (M)	Moderately Altered	Low (L)
Maximum Modification (MM)	Heavily Altered	Very Low (VL)

Source: (U.S. Forest Service, 1995)

For more information on scenic quality and scenic integrity objectives refer to the 2006 Forest Plan Final EIS (pp. 3-231 - 3-241) and Map 6 (see Chapter 6 of this EA).

3.15. Socioeconomics and Environmental Justice

3.15.1. Socioeconomics

Socioeconomics can be defined as the basic attributes and resources associated with the human environment, particularly population and economic activity. Economic activity typically encompasses employment, personal income, and economic growth. The socioeconomic analysis for this EA focuses on the counties that are in or directly adjacent to the Marietta Unit: Monroe, Noble, and Washington Counties in Ohio and Pleasants and Tyler Counties in West Virginia.

Population

Southeastern Ohio and the adjacent portion of West Virginia are largely rural, with the largest city being Marietta. Based on U.S. Census Bureau projections between 1990 and 2015, the population in Ohio increased by 7.1% and the population in West Virginia increased by 2.8% (see Table 3.15). Of the five counties considered in this analysis, Noble County experienced the greatest population increase (26.4%) and Tyler County experienced the greatest population decrease (-8.4%).

Table 3.15. Population

Nationwide	1990	2000	2010	2015 (estimate)	Difference in Population as a Percentage 1990-2016
United States	248,709,873	281,421,906	308,745,538	321,418,820	29.2%
States	**1990**	**2000**	**2010**	**2015 (estimate)**	**Difference in Population as a Percentage 1990-2016**
Ohio	10,847,115	11,353,140	11,536,504	11,613,423	7.1%
West Virginia	1,793,477	1,808,344	1,852,994	1,844,128	2.8%
Counties	**1990**	**2000**	**2010**	**2015 (estimate)**	**Difference in Population as a Percentage 1990-2016**
Monroe County	15,497	15,180	14,642	14,409	-7.0%
Noble County	11,336	14,058	14,645	14,326	26.4%
Washington County	62,254	63,251	61,778	61,112	-1.8%
Pleasants County	7,546	7,514	7,605	7,674	1.7%
Tyler County	9,796	9,592	9,208	8,975	-8.4%

Source: U.S. Census Bureau, 2010. Annual Estimates of the Resident Population by Sex, Race, and Hispanic Origin for the United States, States, and Counties

Race and Ethnicity

Evaluating the ethnic characteristics of an area can help determine whether a minority population is present. The CEQ defines minorities as individuals in the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. A minority population is identified where "(a) the minority population of the affected area exceeds 50% or (b) the minority population percentage of the affected area is meaningfully greater…" (CEQ, 1997). Additionally, "[a] minority population also exists if there is more than one minority group present and the minority percentage, as calculated by aggregating all minority persons, meets one of the above-stated thresholds" (CEQ, 1997).

As shown in Table 3.15 below, all of the counties considered in the socioeconomic analysis for this EA are predominantly White (over 95%), which is higher than the average for Ohio (approximately 83%), West Virginia (approximately 91%), and the United States overall (72.4%). The counties overall have a lower percentage of minority populations (ranging from 1.0% to 3.9%) than Ohio (17%), West Virginia (6%), and the United States (27.6%). Of all the counties, Noble County has the largest percentage of a single minority population at 2.51%, Black or African American.

Table 3.16. Distribution of Races

COUNTIES	Different Races							Totals	
	White	**Black or African American**	**Asian**	**American Indian and Alaska Native**	**Native Hawaiian / other Pacific Islander**	**Other**	**Two or More Races**	**Total Minority Population (%)**	**Total Population**
Monroe (OH)	98.06%	0.42%	0.11%	0.12%	0.01%	0.11%	1.17%	1.9%	14,642
COUNTIES	**Different Races**							**Totals**	
	White	**Black or African American**	**Asian**	**American Indian and Alaska Native**	**Native Hawaiian / other Pacific Islander**	**Other**	**Two or More Races**	**Total Minority Population (%)**	**Total Population**
Noble (OH)	96.09%	2.51%	0.14%	0.29%	0.02%	0.17%	0.79%	3.9%	14,645
Washington (OH)	96.47%	1.07%	0.55%	0.22%	0.02%	0.20%	1.46%	3.5%	61,778

	Different Races							Totals	
COUNTIES	**White**	**Black or African American**	**Asian**	**American Indian and Alaska Native**	**Native Hawaiian / other Pacific Islander**	**Other**	**Two or More Races**	**Total Minority Population (%)**	**Total Population**
Tyler (WV)	98.96%	0.15%	0.13%	0.20%	0.00%	0.03%	0.53%	1.0%	9,208
COUNTIES	**White**	**Black or African American**	**Asian**	**American Indian and Alaska Native**	**Native Hawaiian / other Pacific Islander**	**Other**	**Two or More Races**	**Total Minority Population (%)**	**Total Population**
Pleasants (WV)	97.32%	1.31%	0.11%	0.16%	0.00%	0.14%	0.96%	2.7%	7,605
	Different Races							**Totals**	
STATES	**White**	**Black or African American**	**Asian**	**American Indian and Alaska Native**	**Native Hawaiian /other Pacific Islander**	**Other**	**Two or More Races**	**Total Minority Population (%)**	**Total Population**
Ohio (OH)	82.69%	12.20%	1.67%	0.22%	0.04%	1.13%	2.06%	17.0%	11,536,504
West Virginia (WV)	93.90%	3.41%	0.67%	0.20%	0.02%	0.33%	1.46%	6.0%	1,852,994

Nationwide	Different Races							Totals	
	White	Black or African American	Asian	American Indian and Alaska Native	Native Hawaiian /other Pacific Islander	Other	Two or More Races	Total Minority Population (%)	Total Population
United States	72.4%	12.6%	4.8%	0.9%	0.02%	6.38%	2.9%	27.6%	308,758,105

Source: U.S. Census Bureau, 2010. Annual Estimates of the Resident Population by Sex, Race, and Hispanic Origin for the United States, States, and Counties

Employment and Income

This EA uses several data sources to assess the economic characteristics near the WNF; these sources include studies conducted by the WNF, Appalachian Regional Commission, and data from the U.S. Census Bureau.

WNF compiled an economic assessment in 2004 (Arbogast, 2004). This report states that the counties that comprise the WNF generally have lower per capita incomes, higher unemployment rates, and lower rates of college graduation than the rest of Ohio. They also had a higher degree of economic diversification, which is an index of the spread of economic activity across economic sectors.

The Appalachian Regional Commission (ARC), a regional economic development agency that seeks to build community capacity and strengthen economic growth in the 420 counties in the 13 Appalachian states. The counties considered in this EA analysis are within the purview of the ARC. The ARC ranks the Appalachian counties on a continuum ranging from *distressed* to *attainment*, using unemployment, per capita income, and poverty data. These rankings are defined as follows:

- Attainment - ranking among the nation's top 10%;
- Competitive - ranking in the top quartile but not in the top 10%;
- Transitional - ranking in the middle two quartiles;
- At-Risk - ranking in the bottom quartile but not in the bottom 10%; and
- Distressed - ranking in the bottom 10%.

Aggregate economic data take time to collect, process, and vet, and the rankings provided by the ARC are typically based on data that are three or more years old. Table 3.13 lists the rankings of the counties in or adjacent to the Marietta Unit since 2002 (Appalachian Regional Commission, 2016). As shown in the table, the counties are currently ranked as "at-risk" (Noble, Monroe, and Tyler counties) and "transitional" (Washington and Pleasants counties).

Table 3.17. Economic status as ranked by the Appalachian Regional Commission

Fiscal Year	Noble	Monroe	Washington	Pleasants	Tyler
2002	transitional	distressed	transitional	transitional	transitional
2003	transitional	distressed	transitional	transitional	transitional
2004	transitional	transitional	transitional	transitional	transitional
2005	transitional	transitional	transitional	transitional	transitional
2006	transitional	transitional	transitional	at-risk	transitional
2007	at-risk	at-risk	transitional	transitional	at-risk
2008	at-risk	at-risk	transitional	transitional	at-risk
2009	at-risk	distressed	transitional	transitional	at-risk
2010	at-risk	distressed	transitional	transitional	at-risk
2011	at-risk	at-risk	transitional	transitional	at-risk
2012	distressed	at-risk	transitional	transitional	at-risk
2013	distressed	at-risk	transitional	transitional	at-risk
2014	distressed	at-risk	transitional	at-risk	at-risk
2015	at-risk	transitional	transitional	transitional	at-risk
2016	at-risk	at-risk	transitional	transitional	at-risk

Source: (Appalachian Regional Commission, 2016)

According to recent data obtained from the U.S. Census Bureau, the median household income for the five counties within and adjacent to the WNF ranged from $40,646 (Monroe County) to $45,048 (Washington County) and poverty levels ranged from 15.7% (Monroe and Washington counties) to 16.5% (Tyler County), as shown below in Table 3.18 and Table 3.19. As shown in Table 3.18, the five counties had a lower median household income than the U.S. average. Poverty levels for the counties in Ohio were comparable to the state average of 15.8%. Poverty levels for the counties in WV were slightly below the state average of 18.3%. All of the counties had a slightly higher poverty level than the U.S. average.

Table 3.18. Median Household Income

Name	Median Household Income
United States (USA)	$53,657
Ohio (OH)	$49,349
West Virginia (WV)	$41,030
Monroe County (OH)	$40,646
Noble County (OH)	$43,953
Washington County (OH)	$45,048
Pleasants County (WV)	$44,801
Tyler County (WV)	$41,019

Source: U.S. Census Bureau, Small Area Income and Poverty Estimates (SAIPE) Program

Table 3.19. Poverty Levels

Counties	Poverty Percent
Monroe (OH)	15.7%
Noble (OH)	16.3%
Washington (OH)	15.7%
Tyler (WV)	16.5%
Pleasants (WV)	15.8%
States	**Poverty Percent**
Ohio (OH)	15.8%
West Virginia (WV)	18.3%
Nationwide	**Poverty Percent**
United States (USA)	14.8%

Source: U.S. Census Bureau, Small Area Income and Poverty Estimates (SAIPE) Program

3.15.2. Environmental Justice

Executive Order 12898, *"Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,"* formally requires Federal agencies to incorporate environmental justice as part of their missions. Specifically, it directs Federal agencies to address, as appropriate, any disproportionately high and adverse human health or environmental effects of their actions, programs, or policies on minority or low-income populations.

Per CEQ – *Environmental Justice Guidance under the National Environmental Policy Act (1997),* minorities can be defined as individuals in the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. A minority population is identified where "(a) the minority population of the affected area exceeds 50% or (b) the minority population percentage of the affected area is *meaningfully greater*…" (CEQ, 1997). The term "meaningfully greater" varies by agency, but a reasonable threshold is typically 10%. Additionally, "[a] minority population also exists if there is more than one minority group present and the minority percentage, as calculated by aggregating all minority persons, meets one of the above-stated thresholds" (CEQ, 1997).

Also per the CEQ guidance, while there is no specific criteria defining a "low income population," Federal agencies are directed to identify low-income populations using Census data poverty thresholds (CEQ, 1997). If a community as a whole has an average income at or below the poverty level, that community is considered a low income community. Therefore for the purpose of determining whether a low income population is present, comparisons are made between the poverty levels of the project area and the states of Ohio, West Virginia, and the U.S. overall. Neither the CEQ nor other federal guidelines call for a "meaningfully greater" analysis for low income populations comparable to that conducted for minority populations.

Based on a review of socioeconomic data for the five counties within and directly adjacent to the WNF, the potential for low-income environmental justice populations residing near the Marietta Unit does exist. Median household incomes for the five counties is lower than the state and national average and the overall poverty level is slightly higher (see Table 3.19). Compared to state and national averages, however, the percent of minorities is much lower. Therefore, minority environmental justice populations within the project area are not likely present.

4. ENVIRONMENTAL IMPACTS

This chapter assesses the anticipated environmental consequences associated with direct, indirect, and cumulative effects of the Proposed Action and No Action Alternative. The Proposed Action of leasing parcels would, by itself, have no direct impact on any resources in the lease area since it does not propose authorizing any surface-disturbing activities. All anticipated resource impacts would be associated with the potential impacts of future oil and gas development on both the Forest Service lands and on adjacent private lands within the Marietta Unit.

For the purpose of this EA, a RFDS is used to assess the potential impacts from reasonably foreseeable, but yet uncertain, future oil and gas development as a result of leasing federal minerals in the Marietta Unit. Short-term impacts from potential development are considered those that would be stabilized or mitigated within five years and long-term impacts are those that would substantially remain for more than five years. Cumulative impacts include the combined effect of past projects, specific planned projects and other reasonably foreseeable future actions such as infill wells (wells drilled between producing wells for the purpose of more efficient recovery of petroleum from the reservoir) being located within these leases. Cumulative impacts are addressed at the end of this Chapter. Possible best management practices, standard operating procedures, and mitigation measures that could be implemented are also discussed within the context of each resource section below. What is important to note is that additional site-specific NEPA analysis will be conducted at the APD stage, if actual mineral development on a lease parcel(s) is proposed.

4.1. Land Use

While the act of leasing would produce no changes to existing land use since a lease would not authorize any surface-disturbing activities, potential future mineral development would result in short and longer term changes in land use due to conversion of undeveloped areas to those used for oil and gas activities. In particular, future mineral development would lead to construction of well pads, roads, and other supporting infrastructure. These potential land use changes on federal land would need to be in conformance with desired management objectives (such as vegetation and species) identified in the 2006 Forest Plan, and land use changes on private land would need to be in conformance with local planning and zoning requirements. Affected areas would be reclaimed at the end of their use as well pads or construction areas. Potential mineral development is consistent with activities identified in the 2006 Forest Plan and would not be a new activity introduced to the forest; therefore potential future oil and gas activities would be consistent with ongoing uses of the forest.

4.2. Air Resources

4.2.1. Air Quality

Leasing the subject parcels would have no direct impacts on air quality. Any potential effects on air quality would occur if and when the leases are developed for oil and gas activities. For the purpose of NEPA analysis, this EA includes both a qualitative and quantitative discussion of air emissions that could result from reasonably foreseeable oil and gas development in the Marietta Unit. The following sections discuss the type of air emissions that could be expected from future oil and gas development including quantified estimates of potential GHG emissions and the possible relationship to climate change (see Section 4.2.3). Section 4.16 includes a discussion of potential cumulative effects on air quality.

It is important to note that at the leasing stage, there is a degree of speculation and uncertainty with regard to the amount of air emissions (and GHGs) that could occur since specific design details are not yet known. Therefore, the BLM would conduct additional analysis on air quality at the APD stage if development is proposed in the future. However, for the purpose this EA, the BLM used assumptions to

quantify potential emissions associated with the pre-production and post-production phases of development in order to identify an order of magnitude estimate of potential future emissions. The methodology used is described in Section 4.2.3.

Vehicle and equipment make, model, engine size, etc. and trip length, project acreage, and construction schedule are among several variables required to generate meaningful emissions estimates. Combined, these factors determine the intensity, duration, and characteristics of associated pollutants.

Specifically, information needed to reasonably quantify emissions associated with well exploration and production activities include:

- The number, type, and duration of equipment needed to construct/reclaim, drill and complete (e.g., belly scrapers, rig, completions, supply trucks, compressor, and production facilities);
- The technologies which may be employed by a given company for drilling any new wells to reduce emissions (e.g. Selective Catalytic Reduction [SCR] on diesel powered drill rigs, natural gas fired drill rig engines, the use of "green" completion technology, and multi-stage flare stacks);
- Area of disturbance for each type of activity (e.g. roads, pads, pipelines, electrical lines, and compressor station);
- Compression per well (sales and field booster), or average horsepower for each type of compressor, if needed; and
- The number and type of facilities utilized for production operations.

The American Petroleum Institute (API) categorizes sources of emissions from all oil and gas operations into the classifications listed below. The degree of impact would vary according to the characteristics of the geological formations from which production occurs but emissions associated with oil and gas operations would likely incrementally contribute to increases in air quality emissions into the atmosphere no matter the degree of future impact.

Direct Emissions from Future Development

- Combustion Sources – includes stationary devices (boilers, heaters, internal combustion engines, flares, burners) and mobile devices (barges, railcars, and trucks for material transport; vehicles for personnel transport; forklifts, construction equipment, etc.).
- Process Emissions and Vented Sources - includes process emissions from glycol dehydrators, stacks, vents, ducts; maintenance/turnaround; and non-routine activities such as pressure relief valves, emergency shutdown devices, etc.
- Fugitive Sources - includes fugitive emissions from valves, flanges, pumps, connectors, etc.; and other non-point sources from wastewater treatment.

Indirect Emissions from Future Development

Emissions associated with company operations, such as off-site generation of electricity, hot water or steam, and compression for on-site power, heat and cooling. Direct and indirect air emissions may occur from various sources during each phase of exploration and development. During exploration and development, emissions are generated from well pad and access road construction, rigging up/down, drilling, well completion, and testing phases. Air emissions for these phases are mainly CO_2 emissions from fuel in internal combustion engines of diesel trucks, equipment, and rigs.
Specifically, the primary sources of emissions anticipated during future oil and gas exploration or development include the following:

- Combustion engines (i.e. fossil fuel fired internal combustion engines used to supply electrical or hydraulic power for hydraulic fracturing to drive the pumps and rigs used to drill the well, drill out the hydraulic stage plugs and run the production tubing in the well);
- Electric generators to power drill rig engines, pumps, and other equipment;
- Compressors used to increase the pressure of the oil or gas for transport and use;
- Tailpipe emissions from vehicles transporting equipment to the site;
- Venting (i.e. fuel storage tanks vents and pressure control equipment);
- Mobile emissions (i.e. vehicles bringing equipment, personnel, or supplies to the location); and
- Fugitive sources (i.e. pneumatic valves, pipelines, tank leaks, and dust).

These sources have the potential to produce and release a number of pollutants associated with combustion of fossil fuels: CO, NO_x, SO_2, Pb, PM, CO_2, CH_4, and N_2O. Venting may release VOC/HAP, H_2S, and CH_4. Mobile source emissions are likely to include fugitive particulate matter from dust and NO_x associated with vehicle engine combustion, traffic and/or construction activities. In addition, during the completion phase, the most significant emissions of criteria pollutants emitted by oil and gas operations in general are VOCs, particulate matter and NO_2. The primary sources of GHGs associated with oil and gas exploration and production are CO_2, CH_4, and N_2O.

VOCs and NO_x contribute to the formation of ozone and aid in prolonging the life of methane in the atmosphere. The EPA's Natural Gas STAR Program (2014) is a voluntary program that identifies sources of fugitive methane sources and seeks to minimize fugitive CH_4 through careful tuning of existing equipment and technology upgrades. Data provided by STAR show that some of the largest air emissions in the natural gas industry occur as natural gas wells are fractured and are being prepared for production. During well completion, flowback, fracturing fluids, water, and reservoir gas come to the surface at high velocity and volume. This mixture includes a high volume of VOCs and CH_4, along with air toxins such as benzene, ethylbenzene, and n-hexane. The typical flowback process lasts from three to ten days. Additional emissions from other processes and equipment during production and transportation of the oil and gas from the well to a processing facility may occur.

Degradation of air quality may damage ecosystem resources. For example, ozone can damage vegetation, adversely impacting the growth of plants and trees. These impacts can reduce the ability of plants to uptake CO_2 from the atmosphere and can then indirectly affect the larger ecosystems.

Although air emissions are expected from future oil and gas development in the Marietta Unit, activities (and therefore air emissions) would be staggered over time therefore decreasing the overall intensity of potential impacts. Section 4.2.3 includes additional discussion of air emissions (specifically GHGs) that could occur from reasonably foreseeable mineral development in the Marietta Unit.

A discussion of potential public health and safety impacts associated with air emissions is located in Section 4.8 of this EA. All proposed activities including, but not limited to, exploratory drilling activities would be subject to applicable local, State, and Federal air quality laws and regulations.

4.2.2. Visibility

Section 169A of the CAA requires the examination of certain categories of air pollution sources on atmospheric clarity in downwind National Park or wilderness areas (Implemented in 64 FR 35714 and 70 FR 39104) using Guidelines for Best Available Retrofit Technology (BART). An air pollution source meeting the specific criteria are considered BART-eligible. The Ohio EPA published a report on BART-eligible sources and impacts in 2011, which were all in adjacent states (Ohio Environmental Protection Agency, 2011). Twelve facilities were found to need more analysis for potential impacts to 17 total Class 1 Areas. Impacts for all but one coal combustion facility fell well below the eight days/year exceedance levels for Sulfur Dioxide, Nitrous Oxide, and particulate matter. Sulfur Dioxide was the only contributing factor to two Class 1 areas after a zero out test, and the facility was put on a five-year reduction permit to eliminate 90% of the emissions. Taking the Ohio EPA report into account, potential reasonably foreseeable oil and gas activities would only contribute negligible amounts to local visibility, and would not impact any Class 1 or Sensitive Class 2 areas in adjacent states.

4.2.3. Greenhouse Gases Emissions

As explained in Section 3.2.5 and the recent CEQ guidance, the effects of climate change observed to date and projected to occur in the future include more frequent and intense heat waves, longer fire seasons and more severe wildfires, degraded air quality, more heavy downpours and flooding, increased drought, greater sea-level rise, more intense storms, harm to water resources, harm to agriculture, ocean acidification, and harm to wildlife and ecosystems.

There would be no GHG emissions as a direct result of the Proposed Action, which is administrative in nature – i.e., issuance of leases for Federal mineral resources. Nevertheless, the BLM recognizes that GHG emissions are a potential effect of the subsequent fluid mineral exploration and/or development of any leases that are issued. Oil and gas activities may lead to the installation and production of new wells, which may consequently produce an increase in GHG emissions. The primary sources of GHG emissions include the following:

- Fossil fuel combustion for construction and operation of oil and gas facilities – vehicles driving to and from production sites, engines that drive drill rigs, etc. These produce CO_2 in quantities that vary depending on the age, types, and conditions of the equipment as well as the targeted

formation, locations of wells with respect to processing facilities and pipelines, and other site-specific factors;

- Fugitive CH_4 – CH_4 that escapes from wells (both gas and oil), oil storage, and various types of processing equipment. This is a major source of global CH_4 emissions. These emissions have been estimated for various aspects of the energy sector, and starting in 2011, producers are required under 40 CFR 98, to estimate and report their CH_4 emissions to the USEPA; and
- Combustion of produced oil and gas – it is expected that future operations would produce marketable quantities of oil and/or gas. Combustion of the oil and/or gas would release CO_2 into the atmosphere. Fossil fuel combustion is the largest source of global CO_2.

In recent years, many states, tribes, and other organizations have initiated GHG inventories, tallying GHG emissions by economic sector. The U.S. EPA provides links to statewide GHG emissions inventories (USEPA, 2015c). Guidelines for estimating project-specific GHG emissions are available (URS Corporation, 2010), but some additional data, including the projected volume of oil or natural gas produced for an average well, number of wells (as well as other factors described in Section 4.2.1. Air Quality) were used to provide GHG estimates.

Rule of Reason

CEQ advises that agencies should be guided by a "rule of reason" in ensuring that the level of effort expended in analyzing GHG emissions or climate change effects is reasonably proportionate to the importance of climate change related considerations to the agency action being evaluated. This statement is grounded in the purpose of NEPA to concentrate on matters that that are truly significant to the proposed action (40 CFR §§ 1500.4(b), 1500.4(g), 1501.7.). CEQ guidance cautions against using a comparison of global GHG emissions to project-specific GHG emissions as a stand-alone reason for no detailed analysis (CEQ 2016). In light of the difficulties in attributing specific climate impacts to individual projects, CEQ recommends agencies use the projected GHG emissions as a proxy for assessing a Proposed Action's potential climate change impacts (CEQ, 2016).

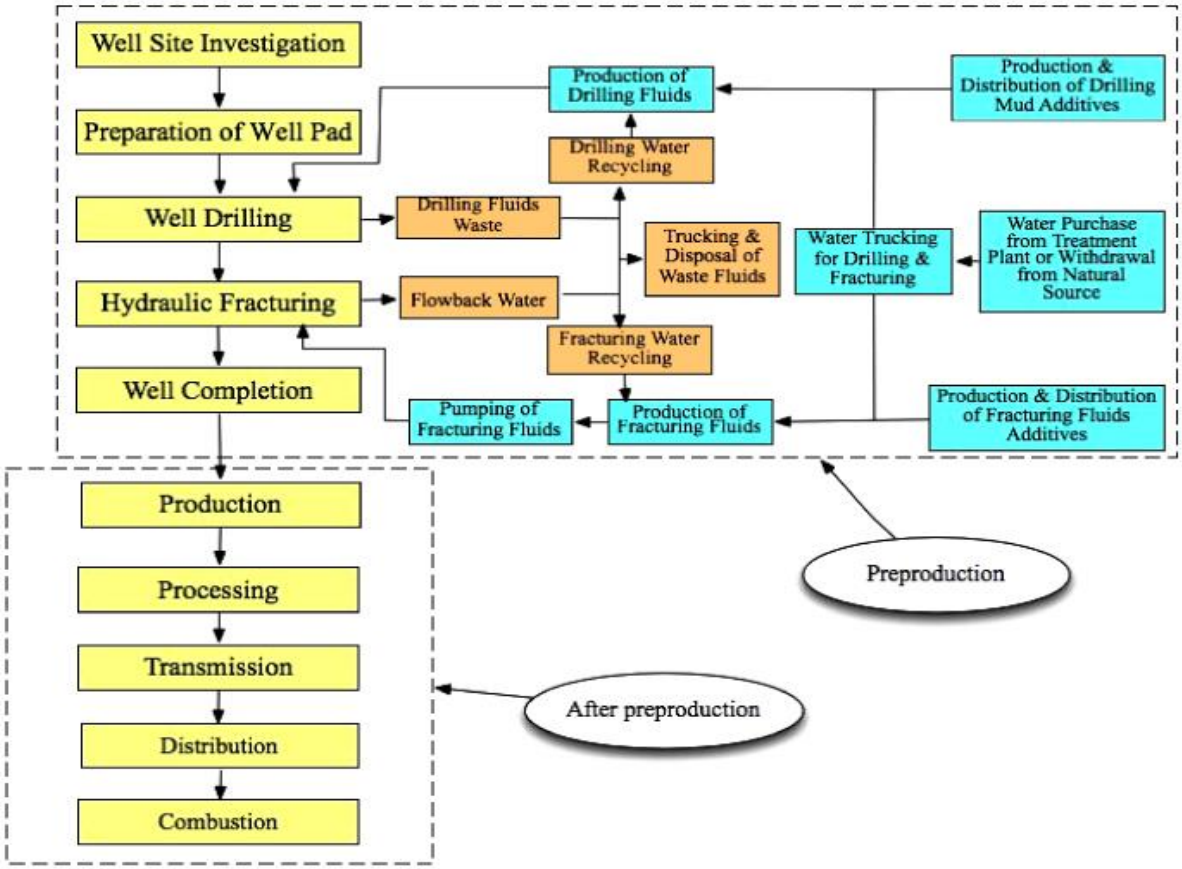
Greenhouse Gas Analysis and Calculations

As previously stated, this EA analysis includes quantified estimates of potential GHGs associated with reasonably foreseeable oil and gas development in the Marietta Unit. Although this EA analysis assumes that both oil and gas may be produced in the future within the Marietta Unit, natural gas is more likely to be produced and is therefore used in the assumptions for the GHG analysis. Even though this GHG analysis assumes that natural gas would be the primary product, potential GHGs that would also be expected from oil development would be similar or lower than those projected for natural gas.

The analysis of GHG emissions focused on the preproduction and postproduction phases. The preproduction phase includes well site investigation, preparation of well pads including grading and construction of well pads and access roads, well drilling, hydraulic fracturing, and well completion. After this preproduction phase is completed, the well becomes operational and starts producing. Production

can require additional processing to remove water, CO_2, and/or liquids before it enters the natural gas transmission and distribution system, which delivers it to final end users. Figure 4.1 shows the various components associated with each phase. Preproduction is considered "upstream" or direct emissions and may be calculated more effectively at the APD stage, when specific construction details are known. "Downstream" or indirect emissions are associated with the postproduction phase. The BLM used readily available scientific information and reasonable assumptions to estimate potential GHGs for upstream and downstream emissions.

Figure 4.1. Preproduction and After Preproduction Phases



Source: (Jiang et. al., 2011)

Preproduction Phase

Summary of Preproduction GHG Emissions

The scientific paper, *Life cycle greenhouse gas emissions of Marcellus shale gas* (and associated supplementary data) (Jiang et al., 2011) was used as the basis for estimating GHG emissions from the preproduction phase of potential oil and gas development in the Marietta Unit. Jian, M. et al, estimated GHGs for the complete life cycle of an average producing well using horizontal drilling and hydraulic fracturing to reach Marcellus Shale. Some of the key assumptions in the paper with regard to oil and gas

development included the following (see Jiang et al., 2011, Table 2, p. 4 for the complete list of parameters and assumptions):

- Disturbance for wellpad – approximately 5 acres
- Approximately 6 wells per wellpad (per the 2006 RFDS)
- Approximately 25 years for the lifetime of a well
- Use of horizontal drilling and hydraulic fracturing

Based on the location of the proposed lease, geological formations, and similar construction techniques that would be used if future production was to occur in the Marietta Unit, the preproduction data gleaned from Jiang et al., 2011, is applicable to possible foreseeable mineral development within the Wayne National Forest.

Carbon Loss Due to Vegetative Clearing

Carbon loss resulting from the land and vegetative disruption for horizontal wells was estimated based on the value of CO_2 sequestration, which can range from 24g per sq. ft. to 30g per sq. ft. per year (Tillman, Hill, & Lehman, 2006). Thus, approximately 31 MT CO_2e (0.000031 MMT CO_2e) on average, are released per well (Table 4.1).

Table 4.1. Emissions from Carbon Loss due to Vegetative Disruption (MT CO_2e)

	Minimum	Maximum
CO_2 Sequestration (g/square foot/year)	24	30
Well Pad Area (square feet/well pad)	96,000	260,000
Carbon Loss (MT CO_2e/well)	11	43
Average Carbon Loss (MT CO_2e/well)	**31**	

Source: (Jiang et al., 2011)

Stages of Preproduction

The lifecycle of Marcellus shale natural gas begins with a 'preproduction phase' which includes the well site investigation, preparation of the well pad including grading and construction of the well pad and access roads, drilling, hydraulic fracturing, and well completion (Soeder & Kappel, 2009). At the moment that this phase is complete the well becomes operational and starts producing natural gas. This natural gas may then require additional processing to remove water, natural gas liquids and/or CO_2 before it enters transmission and distribution systems, which delivers it to final end users (Jiang et al.,

2011). The following stages such as processing, transmission, distribution, and finally combustion are considered downstream end uses. Methodology and assumptions for calculating GHG emissions for the preproduction phase are available within the supplementary data provided in Jiang et al., 2011.

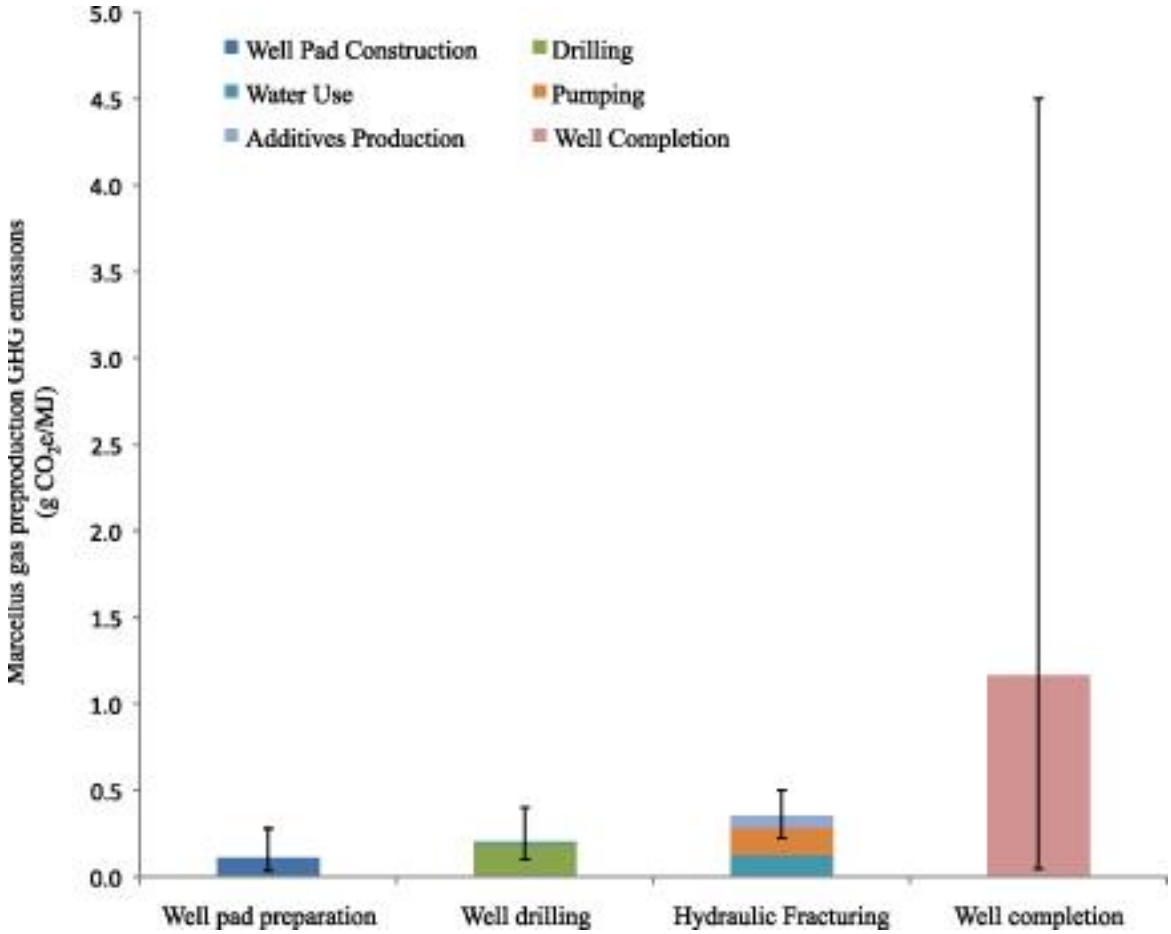
Table 4.2. Total GHG Emissions from Preproduction (MT CO_2e/well)

Stage		MT CO_2e/well	g CO_2e/ MJ Natural Gas
Well Pad Preparation (assuming a 6-well pad)		**370**	0.12
Well Drilling	Drilling	600	0.20
	Mud Production	1	~0
	Water Use	6.5	~0
	Sum	610	0.20
Hydraulic Fracturing	Pumping	460	0.15
	Fluid Additives Production	200	0.07
	Water Consumption	370	0.12
	Sum	1,000	0.35
Well Completion	With Pipeline in Place	270	0.09
	Without Pipeline in Place	3,400	1.15
	Range	270 – 3,400	0.09 – 1.15
	Total	**1,900 – 5,000**	0.64 – 1.70

Source: (Jiang et al., 2011)

Based on the study, a total average of GHG emissions expected from the preproduction phase is approximately 5,500 MT (0.0055MMT) CO_2e/per well. Figure 4.2 provides the same information regarding preproduction emissions in grams of CO_2e/ Megajoules. As seen in the figure, the completion stage has the largest projected GHG emissions, which result from flaring and/or venting. The figure also depicts the limits of the 90% confidence interval of the emissions from each stage based on the uncertainty analysis conducted by Jiang. et. al.

Figure 4.2. GHG Preproduction Emissions in grams of CO_2 e/ Megajoules



Source: (Jiang et al., 2011)

<u>Post-Production Phase</u>

Summary of Post-production GHG Emissions

While preproduction GHG emissions were based on an existing scientific study, emissions associated with the post-production phase of development were calculated based on reasonable assumptions and standard emissions factors. Mean emission factors used in this EA for production of natural gas, processing, transmission and storage, distribution, and combustion were provided by Venkatesh et. al. (2011) within the scientific study. Below are the emission factors used for post-production GHG calculations.

Table. 4.3. Emission Factors (EF) for Post-production Processes for Natural Gas in g CO_2/MJ

Greenhouse Gas Emission Factors for Post-production Processes	
Production	9.7 g CO2e/MJ
Processing	4.3 g CO2e MJ
Transmission and storage	1.4 g CO2e/MJ
Distribution	0.8 g CO2e/MJ
Combustion	50 g CO2e/MJ

Source: (Venkatesh et. al. 2011)

Carbon dioxide equivalent (CO_2e) emissions can be calculated in several ways. A common methodology for calculating GHG includes using high and low estimates for production, multiplying by each emission of carbon dioxide, methane, and nitrous oxide, then converting the GHG emissions to carbon dioxide equivalents according to the global warming potential (GWP) factors reported by the U.S. EPA or IPCC.

An example calculation of CO_2e for combustion emissions of CO_2, CH_4, and N_2O is provided below. This calculation could be expanded to include additional GHGs. The units of CO_2e are the same as the units used to represent the quantity of CO_2, CH_4, and N_2O emissions. Please refer to Appendix E of this EA for U.S. EPA emission factors for greenhouse gas inventories.

CO_2 emissions= [(Production Amount x CO_2 emission factor)]
CH_4 emissions= [(Production Amount x CH_4 emission factor)]
N_2O emissions= [(Production Amount x N_2O emission factor)]
CO_2e= [(CO_2 emissions x GWP] + [CH_4 emissions x GWP] + [N_2O emissions x GWP]

Ohio's Natural Gas and Crude Oil Exploration and Production Industry and Emerging Utica Gas Formation Economic Impact Study estimated that the average amount of natural gas per the life of a natural gas well is 5 billion cubic feet (bcf) (Kleinhenz & Associates 2011). This figure is based on a range of 3.7 bcf to 9.9 bcf with an expectation that 40% of the 5 bcf would occur within the first 5 years. Using emission factors provided by Venketesh. et. al (2011), calculations were obtained for total post-production of GHGs per natural gas horizontal well/per year. The methodology used for the calculations is presented below. Conversion factors include the following: 1 bcf= 1,000,000,000 cubic feet (cf), 1 Million (MM) Cubic Feet= 1,000,000 cf, 1 Thousand (M)cf= 1,000 cf, 1 cf= 1.0551 Megajoules. Conversion factors were obtained from kylesconverter.com. The summary of results for estimated GHG emission for post-production is provided in Table 4.4.

Methods of Calculating Average production of well per year:

- (Average Production Amount for Life of Well (cf) X Percentage of Expected Production (%)) / 5 Years (Yrs)= Average production of well per year (cf/year)
- Average production per well per year converted to Megajoules (MJ/year)

Methods of Calculating GHG:

- [Average production per year (MJ/per year) X (EF of Natural Gas Post-production Phase) (gCO_2 e/MJ))] = gCO_2e /MJ
- Convert gCO_2e to MT CO_2e (MMT CO_2e)

Actual Calculation for Average production of natural gas well per year:

- (5,000,000,000 cf) X 0.40 / 5 Years= 400,000, 000 cf/per year (400,000 Mcf)
- 400,000,000 cf X 1.0551 (MJ/cf) = **422,040,000 MJ/per well per year**

Actual GHG Calculation for Production:

- 422,040,000 MJ/per year
- 422,040,000 MJ X 9.7 CO_2e (g/MJ) = 4,093,788,000 gCO_2e
- 4,093,788,000 (gCO_2e) X 1E-6 Metric Tons(MT) = **4,093.799 MT CO_2e (0.004094 MMT CO_2e) of GHG per well/year.**

Actual GHG Calculations for Processing:

- 422,040,000 MJ/per year
- 422,040,000 MJ X 4.3 CO_2e (g/MJ) = 1,814,772,000 gCO_2e
- 1,814,772,000 (gCO_2e) X 1E-6 Metric Tons(MT) = **1,814.772 MT CO_2e (0.00181 MMT CO_2e) of GHG per well/year.**

Actual GHG Calculations for Transmission and Storage:

- 422,040,000 MJ/per year
- 422,040,000 MJ X 1.4 CO_2e (g/MJ) = 590,856,000 gCO_2e

  590,856,000 (gCO_2e) X 1E-6 Metric Tons(MT) = **590.856 MT CO_2e (0.000591 MMT CO_2e) of GHG per well/year.**

Actual GHG Calculations for Distribution:

- 422,040,000 MJ/per year
- 422,040,000 MJ X 0.8 CO_2e (g/MJ) = 337,632,000 gCO_2e

  337,632,000 (gCO_2e) X 1E-6 Metric Tons(MT) = **337.632 MT CO_2e (0.000338 MMT CO_2e) of GHG per well/year.**

Actual GHG Calculations for Combustion:

- 422,040,000 MJ/per year
- 422,040,000 MJ X 50 CO_2e (g/MJ) = 21,102,000,000 gCO_2e

  21,102,000,000 (gCO_2e) X 1E-6 Metric Tons(MT) = **21,102 MT CO_2e (0.021102 MMT CO_2e)**

  Production of GHG per well/year

Table. 4.4. Total GHG emissions from Post-production (MT CO2e/well)

Stage	MT CO_2e/well	MMT CO_2e
Production	4,0934	0.004094
Processing	1,815	0.00181
Transmission	591	0.000591
Distribution	338	0.000338
Combustion	21,102	0.021102
Total	**64,780**	**0.027935**

Table 4.5. Total Result amount of GHG per Horizontal Well/Year

Source	GHG Emissions in Metric Tons (Per well/Yr)	GHG Emissions per well pad (6 wells per pad)	Projections using RFD estimates of 10 Horizontal well pads
Preproduction Phase (well pad preparation, carbon loss due to vegetative disruption, well drilling, hydraulic fracturing, well completion) (Table 4.2)	5,500 MT CO_2e (0.0055 MMT)	33,000 MT CO_2e (0.033 MMT)	330,000 MT CO_2e (0.3300 MMT)
Post-production (production, processing, transmission and storage, distribution, and combustion)	64, 790 MT CO_2e (0.06479 MMT)	388,740 MT CO_2e (0.38874 MMT)	3,887,400 MT CO_2e (3.8874 MMT)
Total	**70,290 MT CO_2e (0.70290 MT)**	**421,740 MT CO_2e (0.421740 MMT)**	**4,217,400 MT CO_2e (4.21740 MMT)**

<u>Uncertainties of GHG Calculations</u>

Although this EA presents a quantified estimate of potential GHG emissions associated with reasonably foreseeable oil and gas development in the Marietta Unit, there is significant uncertainty in GHG emission estimates due to uncertainties with regard to eventual production volumes and variability in flaring, construction, and transportation.

End Uses

The estimates above provide a complete GHG lifecycle of a well from site inspection to possible indirect emissions through combustion. A rough estimate was possible using publicly available information and using estimates from future production for reasonably foreseeable development. With respect to the rough estimates of indirect CO_2 emissions, it should be noted that it is a difficult to discern with certainty what end uses for the fuels extracted from a particular leasehold might be reasonably foreseeable. For instance, some end uses of fossil fuels extracted from Federal leases include: combustion of transportation fuels, fuel oils for heating and electricity generation, as well as production of asphalt and road oil, and the feedstocks used to make chemicals, plastics, and synthetic materials. Since natural gas is the most likely product that would be obtained within the Marietta Unit, it was used in the assumptions for GHG analysis; however, oil could also be developed. At this time, there is some uncertainty with regard to the actual development that may occur.

Estimates for combustion may vary depending on the calculation used as well as the uncertainty associated with what products would be combusted. For this particular EA, a combustion emission factor was provided by Venkatesh et. al (2011) and was used to estimate GHG emissions from combustion. Alternatively, the formula CO_2e= [(CO_2 emissions x GWP] + [CH_4 emissions x GWP] + [N_2O emissions x GWP] can also be used to calculate GHG emissions. Using this formula and U.S. EPA combustion emission factors for natural gas (see Appendix E) allowed BLM to compare combustion emissions to those calculated for this EA (see above, Table 4.4). Calculations using the alternate formula show that GHG estimates for combustion would be approximately 21,798 MT CO_2 e. This estimate is comparatively close to the estimates provided in Table 4.4 above (21,102 MT CO_2 e).

It is important to note that the BLM does not exercise control over the specific end use of the oil and gas produced from any individual federal lease. The BLM has no authority to direct or regulate the end use of the produced oil and/or gas. As a result, the BLM can only provide an estimate of potential GHG emissions using national approximations of where or how the end use may occur because oil, condensate, and natural gas could be used for combustion of transportation fuels, fuel oils for heating and electricity generation, as well as production of asphalt and road oil, and the feedstocks used to make chemicals, plastics, and synthetic materials.

Availability of Input Data

In light of the difficulties in attributing specific climate impacts to individual projects, CEQ recommends agencies use the projected GHG emissions as a proxy for assessing a Proposed Action's potential climate change impacts. Estimates were made based on readily available data and reasonable assumptions about potential future development in the Marietta Unit. There are many factors that affect the potential for GHG emissions estimates at the leasing stage: a lease may not be purchased, so no GHG emissions would be expected; a lease may be purchased but never explored, so again there would be no GHG emissions; a lease may be purchased and an exploratory well drilled that showed no development potential, so minimal GHG emissions would occur; or a lease may be purchased, explored, and

developed. If developed there are notable differences in the potential for emissions related to a wide variety of variables, including the production potential of the well, economic considerations, regulatory considerations, and operator dynamics, to name a few. Further NEPA analysis would be conducted at the APD stage, when specific development details with which to analyze potential GHG emissions are likely to be known.

Monetizing Costs and Benefits: Social Cost of Greenhouse Gases

The 2016 CEQ guidance states that "NEPA does not require monetizing costs and benefits" and allows for agency discretion in including monetized assessment of the impacts of GHGs in NEPA documents (CEQ, 2016). The BLM finds that including monetary estimates of the social cost of GHGs (SC GHG) in its NEPA analysis for this Proposed Action would not be useful. Since the BLM is not doing a cost-benefit analysis in this NEPA document, we do not believe monetizing only SC GHG would be instructive.

4.2.4. Possible Future Best Management Practices, Standard Operating Procedures, and/or Mitigation Measures

The BLM holds regulatory jurisdiction over portions of natural gas and petroleum systems, identified in the USEPA *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (USEPA, 2016i). Exercise of this regulatory jurisdiction has led to development of Best Management Practices (BMPs), which are state-of-the-art mitigation measures applied to oil and natural gas drilling and production to help ensure that energy development is conducted in an environmentally responsible manner. The BLM encourages industry to incorporate and implement BMPs to reduce impacts to air quality through reduction of emissions, surface disturbances, and dust from field production and operations. Typical measures are mentioned below.

- Open burning of garbage or refuse would not occur at well sites or other facilities;
- Drill rigs would be equipped with Tier II or better diesel engines;
- Vent emissions from stock tanks and natural gas TEG dehydrators would be controlled by routing the emissions to a flare or similar control device which would reduce emissions by 95% or greater;
- All internal combustion equipment would be kept in good working order;
- Flared hydrocarbon gases at high temperatures in order to reduce emissions of incomplete combustion through the use of multi-chamber combustors;
- Watering dirt roads during periods of high use to reduce fugitive dust emissions;
- Co-location wells and production facilities to reduce new surface disturbances;
- Use of natural gas fired or electric drill rig engines;
- The use of selective catalytic reducers and low-sulfur fuel for diesel-fired drill rig engines;
- Adherence to BLM's Notice to Lessees' (NTL) 4a concerning the venting and flaring of gas on Federal leases for natural gas emissions that cannot be economically recovered;
- Protecting frac sand from wind erosion;

- Implementation of directional drilling and horizontal completion technologies whereby one well provides access to petroleum resources that would normally require the drilling of several vertical wellbores;
- Requiring that vapor recovery systems be maintained and functional in areas where petroleum liquids are stored; and
- Performing interim reclamation to reclaim areas of the pad not required for production facilities and to reduce the amount of dust from the pads.

Additionally, the BLM encourages oil and natural gas companies to adopt proven, cost-effective technologies and practices that improve operational efficiency and reduce natural gas emissions. In October 2012, USEPA promulgated air quality regulations for completion of hydraulically fractured gas wells (USEPA, 2015b). These rules required air pollution mitigation measures that reduced the emissions of volatile organic compounds during gas well completions. Mitigation included utilizing a process known as a "green" completion in which natural gas brought up during flowback is captured in tanks rather than in open fluid pits. Among other measures to reduce emissions include the USEPA's Natural Gas STAR program. The USEPA U.S. inventory data shows that industry's implementation of BMPs proposed by the program has reduced emissions from oil and gas exploration and development (USEPA, 2016i).

4.3. Plant and Animal Habitat and Populations

4.3.1. Introduction

The analysis in this section is based on findings from the 2012 SIR, which notes that the anticipated environmental impacts of high-volume, horizontal fracturing technology are within the range of impacts analyzed and disclosed in the 2006 Forest Plan Final EIS. The amount of surface disturbance projected on the WNF with the use of high-volume, horizontal fracturing technology is within the amount of surface disturbance analyzed in the 2006 Forest Plan Final EIS (2012 SIR, p. 45, 47, 49). Second, the regulations enforced by the BLM and ODNR and measures prescribed by the 2006 Forest Plan reduce impacts from land clearing and other activities that may impact wildlife habitat and populations (2012 SIR, p. 45).

The Proposed Action would have no direct impacts on plant and animal habitat and populations, since a lease would not authorize any surface-disturbing activities. This section describes potential effects that may result from reasonably foreseeable future development of lease parcels. The primary effect to plants and animals from oil and gas development would be habitat modification from land clearing, grading, and reclamation. While contamination of water, soil, and air may affect wildlife, those effects are not discussed in detail in these sections, since they are covered in those relevant sections.

The effects from future-proposed development may occur on federal or non-federal (primarily private) lands. Given the highly fragmented nature of land ownership in the Marietta Unit, a well pad on one parcel, federal or private, may be serviced by roads, pipelines, tank batteries, and other infrastructure on other parcels in other ownerships. Second, an operator may use directional drilling to locate a pad

on a parcel not directly above the bottom hole location for various reasons, thus enabling federal minerals to be accessed from outside the federal surface.

The vegetative cover types on the federal lands are well delineated and easily accessible to the BLM in the form of a geographic database. Likewise, the Forest Service's goals for vegetative cover in each delineated zone are detailed in the Forest Plan. This information enables the BLM to state where development may have different types of impact and where development would be restricted in order to protect plant and animal habitat and populations. This is not true for the private lands. Some analysis of the private lands may be done through aerial photo analysis and on-the-ground observation, but a complete assessment of vegetative cover on the private lands would be prohibitively expensive. Each separate private landowner would be responsible for setting the terms for land clearing and reclamation. The discussions that follow focus primarily on the federal lands, where sufficient information is available, and makes generalizations, where applicable, regarding differences in expected impacts on private lands.

The Forest Service seeks to maintain a particular range of open habitat for each management area, and these ranges are as follows:

- Diverse Continuous Forest - 2-4%;
- Forest and Shrubland Mosaic - 3-6%;
- Future Old Forest with Mineral Activity - 0-1%; and
- River Corridors - 3-6%.

While some proposed lease stipulations (see Chapter 5 of this EA) target particular species, other measures would be taken to protect wildlife and habitats in general at the APD stage. For example, as described in the 2012 SIR, the Forest Service would require operators to use closed-loop systems (i.e., tanks) for containing wastewater (2012 SIR, p. 45). The only fluids that may be contained in open pits would be fresh water and drill cuttings, and pits would be backfilled promptly after they are used. The Forest Service would also require operators to promptly drill all the planned wells on a pad or partially reclaim portions of the pad while drilling is not occurring on the pad (2012 SIR, p. 63). These measures would help minimize the effects from well pad construction, should development occur in the future.

Land clearing associated with potential future mineral development could result in *fragmentation* and *edge effects*. These two terms refer to effects to portions of forested habitat that are adjacent to open habitat. Fragmentation is the division of a large block of one type of habitat – in this case, forest – into smaller blocks. Certain species require large blocks of unbroken forest, and the removal of a few acres of forest canopy for a road through the forest may render the entire forest block unsuitable for that species. Edge effects to wildlife are similar; they occur from the loss of suitable habitat due to proximity to another, unsuitable habitat type. This can be due to predation from predators (such as hawks) that forage or hunt near a forested edge.

Fragmentation and edge effects pose more of a risk to habitat types and management areas that emphasize large, unbroken forests. For example, construction of a temporary road would present a

larger impact in a Diverse Continuous Forest management area, which emphasizes habitat for forest interior species, than it would in the Forest and Shrubland Mosaic management area, which emphasizes abundant, small openings and breaks in the forest canopy. Any proposed oil and gas activity in a managed wildlife opening would be subject to additional conditions of approval (at the APD stage) by the Forest Service in order to protect the particular management objectives of the managed opening.

Following is a discussion of potential effects from reasonably foreseeable mineral development to the habitat indicator types identified in Section 3.3.1 of this EA.

4.3.2. Oak-hickory forest

In general, potential future mineral development could result in some loss of oak-hickory forest. Development in a forested area such as oak-hickory forest would result in longer-term impacts than development in an area dominated by herbaceous vegetation. This is because forest vegetation takes longer to replace than grasses and wildflowers during reclamation. However, periodic disturbance is necessary for the propagation of oaks. For this reason, any future construction that results in clearing a portion of oak-hickory forest would not necessarily result in a negative impact to the forest as a whole. The 2006 Forest Plan goal for herbaceous or shrubby habitat in the Diverse Continuous Forest Management Area is 2 to 4%; an APD may not be approved that threatens to create open habitat in excess of that goal. Likewise, the Forest and Shrubland Mosaic management area in the Marietta Unit is intended to contain openings in the forest canopy for diverse wildlife and to ensure the long-term health of the oak-hickory ecosystem. Therefore, vegetation loss associated with potential future oil and gas development would not be expected to adversely affect the sustainability of oak-hickory forest areas in the Marietta Unit overall.

4.3.3. Pine forest

Impacts to pine forests would be similar to the impacts described above for oak-hickory forests. In locations where the Forest Service has determined that openings are beneficial for wildlife populations, clearing for development may enhance habitat and species diversity or benefit a particular target wildlife species. In areas where more permanent openings are not a goal of the Forest Service, the impact from clearing would not last as long as it would in a hardwood community. This is because pines are relatively fast-growing, enabling pines to reinvade openings where desired by land managers.

4.3.4. Early-successional habitat

Land cleared for future oil and gas development would result in an increased amount of early-successional habitat. If early-successional habitat is cleared for roads or well pads, then the vegetation and plant structure that were removed would take less time to recover upon reclamation than would forest habitat, since the vegetation in early-successional habitat consists of grasses, forbs, and young shrubs and trees. The private lands in the Marietta Unit contain more early-successional habitat, although each individual landowner may have different goals for that habitat and may impose different restrictions on an oil and gas operator regarding land clearing and reclamation.

4.3.5. Mature interior forest

Some future oil and gas development would likely occur within mature interior forest areas, including the Diverse Continuous Forest management area and a smaller block of Future Old Forest with Mineral Development. This management area does have a target proportion of open habitat and contains 160 acres of managed openings. Development in this area may create new openings and/or hold existing openings longer in an open condition. Since the desired outcome for this management area is some component of oaks, which require disturbances such as timber removal, some clearing in this management area may be desirable. Even if all the projected future mineral development were to occur on the Marietta Unit within this management area, the total area of disturbance would not exceed the WNF management goal for this area.

Cerulean warbler, the indicator species for this habitat type, is a Regional Forester Sensitive Species and, as such, is protected by a controlled-surface-use stipulation.

The amount of land that these projects would alter is very small in relation to the total acreage of the WNF. Therefore, these projects would not have a major effect on efforts to restore and maintain an oak ecosystem on the Forest. As described above, fragmentation and edge effects have greater implications in a mature interior forest than in oak-hickory forests or early-successional habitat, which depend on periodic disturbance. In a mature interior forest, the loss of a few acres of canopy can result in the loss of suitability of hundreds of acres of habitat for a wildlife species, such as Cerulean warbler, that depends on the presence of large blocks of unbroken forest.

4.3.6. Mature, riparian forest/headwater streams

As discussed in the 2006 Forest Plan, riparian areas and floodplains are protected in the 2006 Forest Plan by a controlled-surface-use stipulation, which enables the Forest Service to protect certain critical elements of those areas. Stipulations #15 and #16 allow the Forest Service to set additional conditions of approval on proposed development in riparian areas and floodplains. These stipulations are expected to protect the habitat of the Louisiana waterthrush. Other potential impacts to this species, which may be due to water quality impacts, are addressed in the relevant sections. Development on private lands in floodplains and adjacent to streams would be subject to State and federal laws protecting wetlands and floodplains.

4.3.7. Grassland habitat

Development in a grassland area would have less durable impact on vegetative structure than would development in a forest, since grassland vegetation can be restored to preconstruction conditions more quickly than woody vegetation. Since the Marietta Unit contains less abundant grassland habitat than the rest of the forest, and since most management areas are managed to include some component of open habitat, it is possible that the Forest Service may choose to have a cleared area restored with grassland species even if it is originally woodland, which would assist in the Forest Service in obtaining its desired component of open habitat. Stipulation #14 enables the Forest Service to protect managed openings.

4.3.8. Species of viability concern

4.3.8.1. Federally endangered or threatened species

The Forest Service consulted with the USFWS under Section 7 of the Endangered Species Act for the 2006 Forest Plan, and the BLM was a cooperating agency in developing the 2006 Forest Plan and EIS. As part of this consultation, the USFWS issued a Biological Opinion (BO) on November 22, 2005. The BO provided a tiered approach to the Section 7 consultation. The programmatic BO (Tier I) covers all the activities described in the 2006 Forest Plan described in the 2006 Forest Plan and EIS at a programmatic, non-site-specific level. Because the BLM was a cooperating agency in the 2006 Forest Plan and EIS, the consultation conducted with respect to the 2006 Forest Plan and EIS applies to the Proposed Action analyzed in this EA.

Also, as part of the 2012 SIR, the Forest Service reviewed new information related to hydraulic fracturing and whether there could be additional effects to threatened and endangered species that had not been previously analyzed in the 2006 Forest Plan and EIS. The Forest Service and the USFWS concluded that no further analysis or consultation was needed and that the consultation conducted under the 2006 Forest Plan and EIS was still valid.

However, the northern long-eared bat was not listed at the time of the 2006 Forest Plan's development; therefore the 2016 USFWS BO for the northern long-eared bat was used. The Forest Service activities fall under the 4(d) rule that exempts incidental take of northern long-eared bat, provided those activities adhere to certain, basic conservation measures to protect hibernacula and roost trees (U.S. Fish and Wildlife Service, 2016).

Following is a discussion of potential impacts to federally listed species. As noted throughout this EA, leasing is an administrative action and would not result in impacts to species; however, there may be impacts associated with potential future mineral development. Should the leases be issued and a specific plan of development proposed, additional site-specific NEPA analysis would be conducted including required ESA Section 7 consultation and/or surveys. Any new information pertaining to threatened or endangered species that arises before an APD is submitted would be considered at the APD stage, as specified in Notification #3 in Chapter 5 of this EA. The Forest Service would require the use of closed-loop systems (i.e., tanks instead of open pits) for containing drilling and completion fluids, which would remove the risk of animals ingesting toxic fluids or becoming entangled in nets over open pits (2012 SIR, p. 47).

4.3.8.1.1. Indiana bat

The Forest Service determined that oil and gas activities are likely to adversely affect Indiana bat (2006 Forest Plan Final EIS, p. F1-58). However, the USFWS determined that the 2006 Forest Plan's activities are ***not likely to jeopardize the Indiana bat's continued existence*** (BO, p. 75), and potential negative impacts to individual bats are not expected to have measurable negative impacts on colonies or discrete populations. Based on this finding, the USFWS issued an incidental take permit that applies to activities conducted pursuant to the 2006 Forest Plan, including oil and gas activities.

4.3.8.1.2. Northern long-eared bat

It is possible that tree removal may result in impacts to individual northern long-eared bats. This risk is minimized by the application of lease stipulations designed to protect Indiana bat. The stipulations that pertain to oil and gas leasing on the Wayne National Forest are more restrictive than the requirements provided in the Fish and Wildlife Service's 4(d) rule for northern long-eared bat, and any incidental take of northern long-eared bat would comply with the exemption provided by the 2016 4(d) rule. The 4(d) rule exempts take from tree-removal activities that take place more than one-quarter mile from a known hibernaculum, and it exempts tree removal outside of the pup season (June 1 - July 31). There are no known bat hibernacula on the Marietta Unit.

4.3.8.1.3. American burying beetle

Potential future oil and gas activities on the Marietta Unit would have no effect on burying beetle because the species is most likely not present on the Marietta Unit. Stipulations requiring pre-construction habitat surveys, minimal disturbance, and prompt reclamation would further reduce the potential for suitable habitat to be degraded.

4.3.8.1.4. Freshwater mussels

The U.S. Fish and Wildlife Service concurred with the Forest Service on November 22, 2005, that forest activities proposed in the 2006 Forest Plan are ***not likely to adversely affect*** fanshell and pink mucket pearly mussel (BO, p. 6). On April 12, 2012, USFWS concurred with the Forest Service determination that forest activities would have ***no effect*** on sheepnose and snuffbox (2012 SIR, Appendix G), and therefore the 2006 Plan was sufficient to account for the possible affected species.

4.3.8.1.5. Northern monkshood, small whorled pogonia, and Virginia spirea

The U.S. Fish and Wildlife Service agreed with the Forest Service on November 22, 2005, that forest activities proposed in the 2006 Forest Plan are ***not likely to adversely affect*** Northern monkshood, small whorled pogonia, and Virginia spirea (BO, p. 8).

4.3.8.1.6. Running buffalo clover

The only known populations of running buffalo clover are located outside of the Marietta Unit in Lawrence and Vinton Counties. The Proposed Action would have no effect on this species.

4.3.8.2. Regional forester sensitive species

The BE for the 2006 Forest Plan details that oil and gas activities have the potential to impact water quality, which may therefore impact aquatic species (mussels, aquatic insects, amphibians, and fishes). Water quality impacts may affect also bats and other mammals that drink from contaminated water sources or bald eagles that hunt from them. Such impacts to bald eagles are unlikely, since eagles in the area likely hunt from large waterways, where the volume of water would quickly dilute minor spills that may occur from potential future oil and gas activities. Water quality impacts in general are mitigated by no-surface-occupancy stipulations pertaining to steep slopes, controlled-surface-use stipulations pertaining to riparian areas and floodplains, and berms around stored fluids. Oil and gas activities may impact terrestrial species through conversion of habitat to more open conditions, in the case of species

that require closed canopies. Stipulation #13 in Chapter 5 of this EA enables the Forest Service to protect known locations of Regional Forester Sensitive Species.

The BE concluded that the alternatives considered in the 2006 Forest Plan and EIS would potentially impact individuals of the species considered but would not negatively impact them to the point of reducing their viability or moving their populations in the direction of needing protection under the Endangered Species Act. The BE extended this conclusion to the species that had not yet been designated as Regional Forester Sensitive Species, since those species had been proposed for listing and were analyzed in the BE.

4.3.9. Species of public interest

4.3.9.1. Whitetail deer

The 2006 Forest Plan identifies the long-term management of oak-dominated stands, which provide abundant food for deer, and management for early-successional habitat types, which provide cover. Oil and gas activities may affect local deer populations for the duration of construction by scaring deer away. Habitat modifications would likely have little effect on deer populations overall, since deer are highly adaptable to human presence on the landscape.

4.3.9.2. Wild American ginseng

Ginseng harvests across Ohio declined significantly in the decade leading up to the 2006 Forest Plan, and overharvesting is considered the greatest threat to the species. The WNF requires collectors to obtain an annual permit, which allows the collection of up to one pound, dry weight, of ginseng. Future construction from oil and gas development in wooded areas may destroy American ginseng plants or convert shady habitats to open habitats, but population effects are expected to be minimal.

4.3.10. Non-native, invasive species

Construction of roads, well pads, pipelines, and other structures associated with potential future oil and gas development can spread invasive species and/or noxious weeds in two general ways. First, increased vehicle traffic may carry seeds, plant parts, or other live organisms that may become established within the proposed lease area. This could introduce new species from outside the proposed lease area, and could result in them spreading from one area to another. The risk of such propagation may be estimated in terms of the area disturbed, the volume of vehicle traffic, and the presence of invasive species in locations along the routes that traffic uses on the way to and within the Marietta Unit. While it would be unreasonable to attempt to quantify the last two variables without site-specific analysis, this analysis considers various scenarios of infestation. Areas that are disturbed by well pads or other development would be susceptible to direct infestation by non-native, invasive plant species that thrive in disturbed conditions. However, many of these species are able to propagate into undisturbed areas, and large areas of otherwise intact habitat could be infested by plants that are introduced into the Marietta Unit on equipment and vehicles. Therefore, it is possible that far more than the directly-disturbed area of land could be infested by non-native, invasive plant species as a result of the initial disturbance.

The second way that oil and gas development may result in the propagation of invasive species is by creating open corridors and forest edges that are highly susceptible to edge-loving species. Where the forest canopy is broken, invasive species that thrive in sunny conditions may be introduced into the newly cleared area and quickly populate areas of disturbed soil.

4.3.10.1. Possible Future Best Management Practices, Standard Operating Procedures, and/or Mitigation Measures

The Forest Service and the BLM will require operators to reclaim disturbed areas as soon as they are no longer necessary, which will reduce the area of disturbed soil remaining after construction, and the BLM requires an operator using private land to have a land use agreement with the private owner, which may detail minimum reclamation requirements. Likewise, operators will be required to submit a drilling and operations plan before an APD is approved, and these plans will be used to ensure that areas that are highly prone to invasion by non-native, invasive species are avoided to the extent practicable. Finally, the stipulations that restrict development on steep slopes will minimize soil erosion, thereby minimizing the area of disturbed soil and the consequent vulnerability to invasion that disturbed soils present.

4.4. Geology and Minerals

4.4.1. Geology

There would be no direct geologic effects from issuing new oil and gas leases because leasing does not directly authorize oil and gas exploration and development activities. However, potential geologic hazards may result from future development and production operations. Induced seismic activity, seismic events attributable to human activities, may include landslides or earthquakes. Landslides involve the mass movement of earth materials down slopes and can include debris flows, soil creep and slumping of large blocks of material. Earthquakes occur when energy is released due to blocks of the earth's crust moving along areas of weakness of faults.

A study conducted by the National Academy of Sciences examined the issue of induced seismic activity from energy development. As a result of the study, they found that: (1) the process of hydraulic fracturing a well as presently implemented for shale gas recovery does not pose a high risk for inducing felt seismic events; and (2) injection for disposal of wastewater derived from energy technologies into the subsurface does pose some risk for induced seismicity, but very few events have been documented over the past several decades relative to the large number of disposal wells in operation (National Academy of Sciences, 2012).

On April 11, 2012, the Deputy Secretary of the United States Department of the Interior, David Hayes, stated that scientists have been investigating the recent increase in the number of earthquakes in the United States to determine whether there is scientific evidence of a link between unconventional oil and gas production and seismic activity. The preliminary findings did not suggest that HF caused the increased rate of earthquakes. Instead, "at some locations the increase in seismicity coincides[d] with the injection of wastewater in deep disposal wells" (Hayes, D. J., 2012).

4.4.2. Minerals

There would be no direct impacts to minerals from the Proposed Action, since there would be no surface disturbing activities at this stage; however, subsequent exploration and oil and gas development could impact the production horizons and reservoir pressures. If production wells are established, the resources allotted to the wells would eventually be depleted. There could also be impacts to other mineral resources as a result of exploration/development through the loss of available surface or subsurface area needed to develop or access the other mineral resource overlapping the subject lease parcel. The extent of the impacts to mineral resources, if any, would be further determined once site-specific development information is available at the APD stage.

4.4.3. Possible Future Best Management Practices, Standard Operating Procedures, and/or Mitigation Measures

The ODNR now requires operators drilling within three miles of a known fault or area of seismic activity greater than 2.0 to install seismometers. If seismic activity above 1.0 is detected, work must pause while the seismic activity is investigated, and work must stop if the investigation reveals a probable connection to the drilling operation. This regulation would affect drilling primarily in the southern half of the Marietta Unit, since the known and inferred faults and seismic areas are generally in Washington County or near the Washington-Monroe County line (Ohio Department of Natural Resources, 2014).

Before HF takes place, all casings from the surface to the bottom of the well bore are cemented and the mechanical integrity of the well is tested. The cemented well is pressure tested to ensure there are no leaks and a cement bond log is run to ensure the cement has bonded to the casing and the formation. If the fracturing of the well is considered to be a “non-routine” fracture for the area, the BLM would be onsite during those operations as well as when abnormal conditions develop during the drilling or completion of a well.

4.5. Soils

While the act of leasing federal minerals would not affect soils, subsequent exploration/development may produce short and long term impacts by physically disturbing the topsoil and exposing the substratum soil on subsequent Marietta Units. Direct impacts resulting from reasonably foreseeable oil and gas construction of well pads, access roads, and reserve pits include removal of vegetation, exposure of the soil, mixing of horizons, compaction, loss of top soil productivity and susceptibility to wind and water erosion where construction of these facilities are necessary.

Indirect impacts from reasonably foreseeable development such as runoff, erosion and off-site sedimentation could result from construction and operation of well sites, access roads, gas pipelines and facilities. Contamination of soil from drilling/completion and production wastes mixed into soil or spilled on the soil surfaces could cause a long-term reduction in site productivity if not adequately identified and addressed. Contaminated soil could also potentially affect nearby surface waters if not properly contained. Some of these impacts can be reduced or avoided through proper design, construction and maintenance, and implementation of best management practices. Additionally,

reclamation would restore soil conditions where they had previously been disturbed, thus lessening some of the potential longer term effects.

4.5.1. Possible Future Best Management Practices, Standard Operating Procedures, and/or Mitigation Measures

The 2006 Forest Plan and EIS directly addresses soil concerns and mitigations in many different sections including Watershed, Aquatic and Riparian Resources, Scenic Management, Minerals and Geology and Transportation. A notification and three stipulations notify potential lessees at the leasing stage to the presence of slopes and/or unstable soils that may result in limited surface occupancy on the lease parcels.

All State of Ohio regulations related to mitigating soil impacts would also apply at the site-specific level for horizontal drilling and fracturing operations. Many of the stipulations are in the Ohio Revised Code, as well as the ODNR manual of "Best Management Practices for Oil and Gas Well Site Construction". Provisions in the manual are incorporated into a state-issued permit as terms and conditions of the permit.

4.6. Water Resources and Water Quality

4.6.1. Surface water

4.6.1.1. Surface water quality

While the act of leasing federal minerals would produce no impacts to surface water quality, subsequent exploration and development of the lease parcels have the potential to produce impacts. The potential effects to surface water from reasonably foreseeable mineral development include sediment loading of stream channels due to the erosion associated with site development or operational transport and introduction of pollutants, toxic chemicals, sediment or debris, via spills and releases to surface water from oil/produced water treatment, storage tanks, handling and sanitary facilities or oil/produced water transportation mediums (trucks or pipelines). The magnitude of these impacts to surface water quality would depend on the proximity of the disturbance to the drainage channel, slope aspect and gradient, degree and area of soil disturbance, soil character, duration and time within which construction activity would occur, and the timely implementation of mitigation measures.

Risks to surface water quality would be reduced by requiring contaminated water to be stored in tanks rather than in open pits, which would reduce the likelihood of a spill and contain the maximum likely volume of a spill to a single tank's capacity. Per SFW-MIN-3, the Forest Service requires operators to "conduct activities and maintain equipment to prevent the discharge of oil or brine onto the ground or into surface waters." Stipulations restricting oil and gas development on steep slopes (U.S. Forest Service, 2012, pp. 6 and 8) and restricting oil and gas development in floodplains or riparian areas (U.S. Forest Service, 2012, pp. 7-8) would further reduce the likelihood of a spill reaching surface waters.

4.6.1.2. Surface water quantity

Drilling and completion operations use anywhere from 4,000,000-8,000,000 gallons per well. Because HF technology is continuously evolving it is difficult to isolate an exact quantity of water that would be needed. There is likely not enough surface water in the Marietta Unit for water to be withdrawn and used so HF water would either need to be brought into the area or potentially withdrawn from the Ohio River, although a local waterway may be used if it is determined to be an appropriate water source. Water withdrawals of an average of more than two million gallons per day in any thirty-day period have to be registered with the Ohio Department of Natural Resources, Division of Water Resources (Ohio Department of Natural Resources, 2016). The BLM and Forest Service would not approve water withdrawals that would draw down a surface waterbody to the extent that aquatic life would be measurably adversely impacted, for example, by dewatering a stream enough to entrap fish or expose mussels to dry conditions in a stream that would normally have perennial flow.

4.6.2. Groundwater

4.6.2.1. Groundwater quantity

Local aquifers (within the Marietta Unit) do not yield sufficient water to support industrial activities within the Marietta Unit. Therefore, the likelihood that the proposed leasing action and potential future mineral development would affect groundwater quantity is negligible.

4.6.2.2. Groundwater quality

Future mineral development activities would pose some risk of accidental spills of drilling fluids, produced water, and other chemicals (see also Section 4.7, Wastes, Hazardous or Solid). This risk would be minimized by the requirement, described in the 2012 SIR, for operators to use tanks, instead of open pits, to hold all fluids other than fresh water. Since tanks are smaller than typical open pits, a spill from a tank would produce less of a hazard than an accidental discharge from a pit.

The only areas where a spill would pose an unacceptable risk to groundwater quality are designated wellhead protection areas or certain locations within the Ohio River and Little Muskingum River floodplains (Thompson, 2012). Other locations throughout the Marietta Unit tend to have low groundwater pollution potential due to low hydraulic conductivity and depths of groundwater (around 200 feet or less from the surface).

Drilling to a production zone that is below a potable water-bearing formation poses the risk of allowing brine and other chemicals to migrate up into a potable water zone. This risk is mitigated in federal wells by casing and cementing requirements in Onshore Oil and Gas Order Number 2. The Ohio DNR, Division of Oil and Gas Resources Management (DOGRM) also requires cementing and casing in all wells as well as sampling of all water wells within 1,500 of a proposed horizontal well prior to a permit being issued. Also, preexisting orphaned wells could be in the area. However, the DOGRM addresses these types of situations in the permitting process, and federal lessees are liable to plug and abandon orphan wells on their leases.

The potential for fluids to migrate from the hydraulic fracture zone is considered very low, because of the thousands of feet separating the likely production formations, which mainly consist of rocks of very low permeability, such as shale. As noted in the 2012 SIR, BLM and DOGRM are required to be notified in advance of drilling and, in most cases, to have inspectors onsite at the time of drilling. Operators are required to submit cementing logs. Further, if the DOGRM suspects that the cementing is insufficient, the inspector may require the operator to conduct cement tests, and well stimulation is not permitted to take place until cementing passes inspection testing.

The Ohio Department of Natural Resources permits the construction of new underground injection wells or conversion of existing wells to injection wells. The risk of groundwater contamination through this method of disposal is minimized by the regulations pertaining to underground injection wells. The ODNR defines an *area for review*, the area to be analyzed before the permit is approved, typically as the area within a one-quarter mile or one-half mile radius of the well, depending on the volume to be injected, per Ohio Administrative Code 1501:9-3-06.

4.6.2.3. Riparian areas

As detailed in the **Plant and Animal Habitat and Populations** section previously, stipulations #15 and #16 establish protections for riparian area and floodplain function. These same stipulations are designed to protect the functions of riparian areas and floodplains in regulating water flows, capturing sediment, and recharging aquifers. Therefore, adverse impacts to riparian areas are not anticipated as a result of reasonably foreseeable mineral development activities.

4.7. Wastes, Hazardous or Solid

Though the Proposed Action of leasing would not create or produce wastes, subsequent reasonably foreseeable actions related to oil and gas exploration and development would typically generate the following wastes, (1) discharge of drilling fluids and cuttings into the tanks on location; (2) wastes generated from used lubrication oils, hydraulic fluids, and other fluids used during production of oil and gas, some of which may be characteristic or listed hazardous waste; and (3) service company wastes from exploration and production activities as well as containment of some general trash. Generation of wastes could result in the need for additional landfill space, disposal sites, and injection wells. Certain wastes unique to the exploration, development, and production of crude oil and natural gas have been exempted from Federal Regulations as hazardous waste under Subtitle C of the RCRA of 1976. The exempt waste must be intrinsic to exploration, development or production activities and cannot be generated as part of a transportation or manufacturing operation. The drilling fluids, drill cuttings, and produced waters are classified as a RCRA exempt waste, and potential drilling that could occur would not introduce hazardous substances into the environment if they are managed and disposed of properly under federal, state, and local waste management regulations and guidelines. Properly used, stored, and disposed of hazardous and non-hazardous substances greatly decreases the potential for any impact on any environmental resources. One way operators and the BLM ensure hazardous and non-hazardous substances are properly managed is through the preparation of a Spill Prevention, Control, and Countermeasure (SPCC) plan.

After the fracturing procedure is complete, 15% to 80% of the fluid returns to the surface as waste water (Throupe, Simons, & Mao, 2013). In hydraulic fracturing, chemical substances other than water make up a small percentage of the fluid composition; however, the very large volumes used require correspondingly large volumes of a variety of compounds. These substances range from the relatively benign to the highly toxic at certain concentrations. In addition to these added chemicals, naturally occurring toxicants such as heavy metals, volatile organics, and radioactive compounds are mobilized during extraction and return to the surface with the produced water. Although the risk is low, the potential exists for unplanned releases that could have effects on human health and environment. A number of chemical additives are used that could be hazardous, but are safe when handled properly through adherence to chemical safety procedures and long-standing industry practices. In addition, many of these additives are common chemicals which people regularly encounter in everyday life (Ground Water Protection Council & ALL Consulting, 2009).

Surface spills of drilling mud and additives, hydraulic fracturing fluids and additives, flowback water, and other produced water can happen at a variety of points in the development and production phases. Spills that occur can span a range of different spill sizes and causes of failure at any point in the process. For example, small spills often happen as the result of poor pipe connections or leaks; large spills sometimes occur as the result of a major well blowout, but such blowouts rarely occur. Additionally, spills from some parts of the phases may be the result of human error (i.e. vehicle collisions, improper handling, improper equipment operation or installation, etc.), while others could stem from equipment failure (i.e. broken pipes, torn pit liners, leading tanks, etc.) or acts of nature. The most common cause of spills comes from equipment failure and corrosion (Wenzel, 2012).

The cause of the spill, the spill size, the hazard rating of the spilled material, response time to clean up the spill and the effectiveness of the cleanup, all play a critical role in determining the overall impact on the environment. The volume of a spill can significantly vary with spill types. Pipe spills are not expected to release more than 1,000 gallons into the environment, truck spills are not expected to release more than 10,000 gallons of fluid, and blowouts are expected to cause the largest spills, with the potential to release tens of thousands of gallons into the environment. Small spills occur with greater frequency than large spills. Secondary containment or recovery for small spills would likely minimize, if not eliminate, any potential release into the environment. However, for spills on the order of several thousands of gallons of fluid, it is expected that less than half the fluid may be captured by secondary containment or recovery. The vast majority of operations do not incur reportable spills (5 gallons or more), indicating that the fluid management process can be, and usually is, managed safely and effectively (Fletcher, 2012).

4.7.1. Possible Future Best Management Practices, Standard Operating Procedures, and/or Mitigation Measures

If federal minerals are proposed for development in the future, an APD would be required and the BLM would conduct additional site-specific analysis of potential impacts from wastes. Specific mitigation is deferred to the APD process. The following measures to reduce adverse impacts from wastes are common to most projects: all trash would be placed in a portable trash cage and hauled to an approved

landfill, with no burial or burning of trash permitted; chemical toilets would be provided for human waste; fresh water zones encountered during drilling operations would be isolated by using casing and cementing procedures; a berm or dike would enclose all production facilities if a well is productive; and wastes from all waste streams on site would be removed to an approved disposal site. Future mineral development activities would be regulated under the RCRA, Subtitle C regulations. Additionally, waste management requirements are included in the 12 point surface use plan and the 9 point drilling plan required for all APDs. Leaseholders proposing development would be required to have approved SPCC plans, if the applicable requirements of 40 CFR §112 are met, and comply with all requirements for reporting of undesirable events. Lease bonds would not be released until all facilities have been removed, wells are plugged, and satisfactory reclamation has occurred.

The BLM would apply Conditions of Approval (COAs) in conjunction with the Forest Service at the APD stage regarding handling and disposing of wastes based on what the operator proposes at that time.

4.8. Public Health and Safety

There would be no direct impacts to public health and safety from leasing, since leasing is an administrative action. Public health and safety considerations associated with potential future oil and gas development include effects from air emissions, potential exposure to contamination, and increased truck traffic. BLM acknowledges that if the leasing area was to be developed in the future, environmental hazards of exploration, production or extraction of oil and gas may produce some effects to public health or safety if not properly managed. For an environmental hazard to pose a risk to public health, a vulnerable human population must first come into contact or be exposed to the hazard. Therefore communities or workforce residing or working near the potential development sites may be at higher risk for accidental spills, fugitive emissions or releases of gas from a future well bore. The level of effect would depend on the product released or spilled, level of activity, density of development, technological and safety controls/regulations in place, and the receptors' susceptibility to risk.

As of 2014, most studies addressing the public health implications of oil and gas development have been either predictive and/or descriptive hypothesis generating. The few analytic studies are preliminary and do not provide enough evidence to conclusively determine if oil and gas operations directly result in health effects in nearby populations. Existing studies have provided evidence that hazards are inherently present in and around oil and gas operations and populations can be exposed to these hazards if safety measures are not implemented. People living near oil and gas operations have reported that oil and gas operations affect their health and quality of life, particularly through traffic accidents, air and water pollution, and social disruption expressed as psychosocial stress (University of Colorado at Boulder, 2015). Some short term health effects reported by people living near oil and gas operations include irritation of the eyes, nose, throat, lungs or skin, or other symptoms like headache, dizziness or nausea and vomiting. Some also report sleep disturbance or anxiety associated with noise or light effects from mineral development activities. There is very little information about long term health effects in people living near oil and gas operations. The amount of scientific literature

connections between oil and gas related exposures and a health effect is currently limited but is growing (Colorado Department of Public Health and Environment (CDPHE), 2016).

One of the primary ways in which the public could be exposed to pollutants associated with potential future oil and gas operations is through the air. There is also the possibility of exposure through surface water, groundwater or soil, but this is much less likely under normal operating conditions due to the numerous safety protocols implemented by oil and gas operations (CDPHE, 2016). Numerous scientific studies have linked air pollution to a variety of health problems including: (1) respiratory and cardiovascular disease, (2) decreased lung function, (3) increased frequency and severity of respiratory symptoms such as difficulty breathing and coughing, (4) increased susceptibility to respiratory infections, (5) effects on the nervous system, including the brain, such as IQ loss and impacts on learning, memory, and behavior, (6) cancer, and (7) premature death. Sensitive individuals or those at high risk appear to be at even greater risk for air pollution-related health effects, for example, those with pre-existing heart and lung diseases (e.g., heart failure/ischemic heart disease, asthma, emphysema, and chronic bronchitis), diabetics, older adults, and children. Future mineral development operations within the Marietta Unit that would violate a state and/or federal air quality standard would not be approved.

As discussed in Section 4.9 Transportation, Section 4.11 Noise, and Section 4.2.2 Visibility, future mineral development within the Marietta Unit would likely result in an increase in truck traffic, noise, and potential visual and light pollution effects. These sections of the EA discuss potential effects as well as best management practices, standard operating procedures, and potential mitigations for future oil and gas development activities.

Through the NEPA process and adherence to federal, state, and local regulations, laws, permits and policy, as well as numerous safety standards and protocols, the BLM and Forest Service ensures that future oil and gas leasing operations would not compromise public health and safety. Additional site-specific analysis on public health and safety will be conducted at the APD stage.

4.9. Transportation

Leasing minerals within the WNF would not result in any direct impacts to the existing transportation network due to the administrative nature of the action; however, potential impacts to existing roads and traffic may occur from future mineral development. As discussed in Chapter 2 of this EA, the RFDS projects some additional roads may be needed to support future oil and gas development. Adequate access to a well can be provided by:

- Using existing roads, some of which may need upgrading;
- Constructing a new road; or/and
- A combination of both.

As previously discussed in Chapter 3, the WNF (including the Marietta Unit) already contains an established road network. Therefore, while some new roads would be needed, it is likely that new road

construction to support potential future mineral development would not be extensive. The location of existing roads primarily dictates the need for additional construction for access to the drill pad. The closer the pad is to an existing road, the shorter the distance of the new construction. Existing roads may need to be improved to support heavy equipment associated with oil and gas development. Additional maintenance on existing roads may also be needed, as heavy equipment causes greater damage to a road compared to passenger vehicles or light trucks. The American Association of State Highway and Transportation Officials (AASHTO) estimate that up to 91% of road damage is due to heavy over-the-road equipment. This is a concern on Forest Service roads and seasonal closures to this type of activity may be needed in some areas.

The effects to existing roads would differ between hot-mixed paved highways and gravel or other rock based material roads. Heavy vehicles may cause paved roads to crack, or deteriorate, especially along the edges of the narrower roadways. Gravel and dirt roads may be subject to the formation of ruts, potholes, and washboard effects. The level of impact is dependent upon the amount of activity, weather conditions during the activity and the level of road maintenance. The greatest effects would likely occur during the drilling and plugging phases of future oil and gas operations which usually require the use of heavy vehicles and equipment.

Future mineral development within the Marietta Unit would likely result in increased truck traffic to the area and potential collisions with wildlife crossing the roads, such as the whitetail deer. Effects to traffic patterns on the road system within the Forest may vary depending on the location(s) of the future well(s) and the time of day the roads are used. Increases in vehicle traffic associated with potential future mineral development could result in longer drive times for recreational visitors to the WNF or nearby residents. An increase in truck traffic may also increase the risk of potential traffic-related accidents. Such traffic may create dust on dirt roads, hampering wildlife viewing and degrading scenic views, while possibly disrupting normal activity patterns, such as hiking. The length and duration of disruption would depend on the amount of future exploration and drilling. After exploration and drilling, the vehicle traffic would decline but would still be subject to the occasional need for vehicle access to the well sites.

4.9.1. Possible Future Best Management Practices, Standard Operating Procedures, and/or Mitigation Measures

Although future mineral development would result in some impacts to the existing transportation network, adhering to required federal, state, and local laws and regulations (such as speed limits and safety standards for operating heavy vehicles) would minimize potential roadway and traffic impacts in the Marietta Unit. The Forest Service also addresses infrastructure activities and mitigations relating to traffic and roads from the oil and gas development in the 2006 Forest Plan and EIS and 2012 SIR (see page 77 in U.S. Forest Service, 2012).

4.10. Recreation

There would be no direct impacts from leasing, since there would be no ground disturbance at this stage. Subsequent mineral development, such as well construction, operation, and, eventually, abandonment would create noise and change views in ways that could make the area less attractive to people who desire solitude and natural surroundings.

Reasonably foreseeable mineral development activities would also indirectly affect developed recreation sites and possibly increase travel time to such sites because of increased vehicle traffic during drilling. The noise from construction may drive away game animals.

Developed recreation areas and trails would be declared NSO and would not be affected by any ground disturbing activities; however, truck traffic, noise, and visual impacts can be expected. Vehicle traffic would increase during initial exploration activities, possibly resulting in longer drive times for forest visitors. Recreation sites within 0.28 miles of drilling activities would be temporarily affected by the noise. However, because of the dense forest in the general area, visual impacts from drilling are expected to be minimal. Most of the recreation sites within the Marietta Unit are either closed from December 15 through the winter or receive little visitation, meaning that the majority of effects to recreation would be limited primarily to late spring through early winter.

Future exploration activities would also result in visual effects on recreational users. Vehicle traffic during this period would create dust on dirt roads, hampering wildlife viewing and degrading scenic views. The length and duration of disruption would depend on the amount of exploration and drilling. After exploration and drilling, the vehicle traffic would decline but would still be subject to the occasional support vehicle for the wells.

Recreation on the WNF is expected to increase over the next few years. This is projected because of the increased retirement of the "Baby Boomer" generation and their increased leisure time, and because the population of southeastern Ohio has been increasing at a larger rate than the rest of the state (Arbogast, 2004). Recreation contributes to the local economy in the form of gas being bought by recreationists, lodging, camping fees, restaurants, outfitters, outdoor stores, OHV suppliers and other retail and service centers which cater to outdoor recreation. Vendors in the 12 counties of southeastern Ohio also purchase a disproportionately high number of nonresident hunting licenses (Arbogast, 2004).

According to a socioeconomic review created by the Forest Service in 2004 in preparation for the 2006 Forest Plan (Arbogast, 2004), after hunting, OHV use and mountain biking tend to be the recreational uses which contribute most to the local economy. However, day use such as sightseeing or nature watching, hiking, boating, and fishing tend to be the most common recreational activities on the WNF. Noise and visual effects caused by future exploration are expected to have temporary effects on all of these activities, and it can be expected that money contributed to the local economy through recreation would decline during the initial exploration and drilling phase, but how much, and the duration, would depend on the amount of time and the amount of exploration being conducted. However, long term

impacts to recreation and tourist dollars should be nonexistent to minimal since future construction associated with mineral development would be located outside of developed recreation areas.

This analysis does not consider the recreational values of private lands that may be located within the boundary of the WNF. Private lands indeed provide recreational opportunities, and sometimes these opportunities may be available to the public, since some state-sponsored land management programs require participants to permit public use of their lands. Recreational values of private lands would be considered in future NEPA analysis evaluating an APD, since it would be more reasonable to assess such values on a site-specific basis.

4.10.1. Possible Future Best Management Practices, Standard Operating Procedures, and/or Mitigation Measures

If future development occurs, the BLM, in consultation with the Ohio DNR, WNF, operators, and other parties, would seek to minimize auditory or visual impacts on recreational resources through simple, reasonable measures, such as restricting construction to certain times of year or requiring the preservation of plants that provide visual screening.

4.11. Noise

There would be no direct noise impacts from leasing, since there would be no ground disturbance at this stage. However, subsequent mineral development activities could generate noise in a way that could make some areas less attractive to people who desire solitude and natural surroundings. Noise impacts on wildlife may also occur as a result of reasonably foreseeable mineral development activities such as construction and increased truck traffic. Noise may cause wildlife to relocate and may displace migratory birds or other species residing or passing through the area. The BLM will conduct additional detailed analysis on potential noise impacts once specific development details are known at the APD stage.

Noise management continues to be an ongoing challenge for the shale oil and gas sector. While many of the noise impacts associated with shale play surface operations are relatively temporary in nature, neighbors, communities, and recreational users who have been accustomed to the quietude of the rural landscape may be intolerant of even temporary intrusions. Noise that is generated by construction or operation, however, is naturally damped as it travels through the environment. The nature of the environment through which noise travels, such as open air, buildings, or forest, determines the rate at which noise is damped.

Noise impacts on certain user groups would likely vary throughout the year. For example, most of the recreation sites within the Marietta Unit are either closed from December 15 through the winter or receive little visitation, meaning that the majority of effects to recreation, due to noise, could be limited primarily to late spring through early winter. Hunters would also likely be affected only during certain times of the year due to specific hunting seasons for certain game animals. This is why the time of year

of construction and the length and duration of the operations could have a critical effect on the magnitude of the potential disruption.

Horizontal drilling operations may cause more noise impacts than conventional drilling. When describing drilling operations the 2006 Forest Plan EIS states: "Since drilling is a continuous operation until the total depth of the well is reached, the engine noise from the rig are evident throughout the day and night. It takes a rotary rig about 3 to 5 days to drill a typical well on the WNF" (2006 Forest Plan EIS Appendix G, p G-6). One study conducted found that many bird types were significantly less dense in noisy areas vs. non-noisy areas, and that removing this excessive sound could help conserve high-quality habitat for birds in the region (Bayne, et al., 2008). Other studies on periodic but intense noise disturbances have concurred with this assessment, finding that animals tend to abandon areas where anthropogenic noise is occurring and return only after the noise is dissipated (Bayne, et al., 2008). This implies that noise generated by fracking processes could have the capacity to influence habitat quality in surrounding ecosystems, which could adversely affect the rest of the ecosystem (Bayne et al., 2008).

4.11.1. Possible Future Best Management Practices, Standard Operating Procedures, and/or Mitigation Measures

There are various measures that can be used to minimize the potential impacts of noise, such as using mufflers on equipment, taking advantage of topography when siting roads and other facilities, and using sound barriers. In addition, various notifications and stipulations may apply for noise control, for example, to coincide with periods when impacts to wildlife species would be the lowest, or to utilize specific noise dampening technologies. Also, the WNF can include measures related to muffling of noise if the well site is located in close proximity to private homes and/or populated areas or to or their habitat. Furthermore, the WNF can strive to schedule mechanized activities along travel ways, use areas, and water bodies to occur during low-use periods to alleviate noise and visual impacts.

4.12. Cultural Resources/Paleontology

There would be no direct impacts to cultural resources/paleontology as a result of leasing as there would be no surface disturbance at this stage. Direct and indirect impacts from reasonably foreseeable future oil and gas development may occur to cultural resources if there is ground disturbance. Any known archeological sites within the leasing area, however, would be avoided and declared NSO to the extent possible in accordance with BLM and Forest Service policy. If development is proposed, the Forest Service, as the surface land manager, would conduct site-specific Section 106 compliance measures including surveys, records search, and the appropriate Tribal and SHPO consultation prior to any ground disturbing activities.

The BLM initiated consultation with the Ohio SHPO under Section 106 of the NHPA, by letter dated November 16, 2015; to date, the SHPO has not responded to the letter, indicating that they have found no adverse effects on historic properties within the scope of the Proposed Action. Further consultation will take place at the APD phase prior to ground disturbing activities.

4.13. Native American Religious Concerns

There would be no direct impacts to Native American Religious interests as a result of leasing as there would be no surface disturbance at this stage. On November 6, 2015, the BLM sent certified letters to seven federally recognized tribes who have a known connection to the area notifying them of the Proposed Action and asking to identify any concerns with respect to the Proposed Action. The BLM received no responses to these letters; therefore, no concerns were identified.

As discussed above under Section 4.8, the Forest Service, as surface land manager, would conduct the appropriate consultations and site-specific surveys, as needed, prior to any ground disturbing activities.

4.14. Visual Resources/Scenic Quality

There would be no direct impacts on visual resources or scenic quality as a result of leasing as there would be no surface disturbance at this stage; however, subsequent mineral development could result in impacts. Should a lease result from this action a lessee would have to submit an APD and any pertinent rights-of-way (ROW) requests and receive approval. Should mineral development occur, land may be cleared for roads, pipelines, lightened areas and well pads that could create visual impacts to surrounding private land owners, passersby, recreational, and cultural/historic users. Upon receiving an APD/ROW, more site-specific NEPA would be required to analyze the impacts of the scenic quality in accordance with the most recent version of the 2006 Forest Plan. This analysis would determine any site-specific mitigation measures to be placed on the application which could include moving the proposed location, low profile tanks, paint color, 3D modeling or various other measures to meet the SIO objectives where development is allowed. Upon completion of drilling and completion operations the well pad, pipeline and any areas not necessary for production would be placed into interim reclamation further reducing the footprint and visual impacts of the location. While there may be some long-term residual effects to visual resources/scenic quality even after reclamation, those impacts would be considered negligible or minor. See Chapter 5 of this EA for a more detailed list of potential stipulations that would be applied upon receipt of an EOI.

4.14.1. Possible Future Best Management Practices, Standard Operating Procedures, and/or Mitigation Measures

As discussed above, further site-specific NEPA analysis would be conducted at the APD stage, if development is proposed. The Forest Service will evaluate each parcel proposed and apply the appropriate lease stipulations depending on the SIO rating and resources, including the viewshed, of the area. More site-specific mitigation measures, if needed, will be developed at the APD level.

4.15. Socioeconomics

4.15.1. Economic stimulation from potential future construction and drilling activity

The direct effect of leasing would be the payments received, if any, from the leasing of the proposed parcels in the WNF. There would also be various effects from potential future mineral development

activities. This analysis draws from studies on economic stimulus from development of the Utica Shale because most current drilling activity is in the Utica Shale and because economic studies on shale development are readily available. Impacts to economic activity from future mineral development may be divided into the following three principal types of impact (Thomas, et al., 2012):

1. Additional drilling stimulates oil and gas businesses to do more business, including hiring additional people and contractors and purchasing more equipment. This is a *direct* effect.
2. Additional contractors hire suppliers, and heightened business activity may stimulate new entrants into an industry or new companies moving into a local market from another area. This is an *indirect* effect.
3. Laborers who have moved into a community demand housing, food, haircuts, entertainment, etc., and laborers who have just gotten a promotion or a new job have additional income on hand to spend on all of these things. This effect is a kind of indirect effect that economists call *induced* effects.

These effects can be quantified by measuring additional business revenues and profits, numbers of jobs created, workers' incomes, and taxes collected (Thomas et al., 2012). All of these effects and variables are difficult to collect, process, and interpret over a complex regional economy. For example, if the number of jobs created by oil and gas activities were known, it cannot be assumed that all of those jobs were truly added to the economy because some of those employees likely transferred into those jobs from others, while some of the laborers are likely transient employees who will leave the area at the end of the project.

The total value added to Ohio's economy, in terms of the effects and variables described, of oil and gas development in Ohio through 2014 was estimated at $162 million for 2011 and projected to be $4.8 billion in 2014. Thirty-three horizontal wells were drilled in Ohio in 2011, and the report projected 1,075 wells being drilled in 2014. A comparable study that makes similar projections into the next decade or beyond was not available for inclusion in this EA.

A workforce analysis has been completed to project the numbers, types, and incomes of the jobs that oil and gas development will demand in Ohio (Lendel, Thomas, Townley, Murphy, & Kalynchuk, 2015). One important difference in labor demand between horizontal drilling and vertical drilling is that the need for labor declines precipitously after one well has been drilled on a pad. The next well to be drilled on the same pad does not require pad, roadway, or pipeline construction that was required for the first well.

The authors of the workforce analysis described above predict that it will take several years for the industry to provide many jobs that can employ local laborers. The pre-drilling phase of oil and gas development primarily requires highly technical professions, such as geologists, GIS specialists, attorneys, and engineers. In the early phase of an oil and gas play, these professionals are usually brought in by the companies. As a play matures, companies may open local offices, providing local employment opportunities, and local people may complete education and training that would qualify

them to work in those types of jobs. One-third of all jobs generated by projected Utica Formation development and 58% of those in the pre-drilling phase require post-secondary education, certification, or specialized experience, which will limit the number of jobs that are available to local residents. In time, as area universities and technical schools implement or augment training programs targeted at the growing industry's needs, more workers from Ohio may be hired for jobs in Utica shale development.

The workforce analysis predicts that Utica shale development will generate 7,558 jobs in Ohio in 2015 and 10,505 in 2019. In all of Ohio, 700 wells were drilled in the Utica formation in 2015, and 879 wells are predicted to be drilled in 2019. The RFDS for the WNF projects the drilling of 110 wells on the Marietta Unit over a period of 10 years. If we assume a linear year-to-year increase through 2019 and that drilling on the Marietta Unit follows the same pattern, then the number of wells drilled per year on the Marietta Unit is about 3.5% of the statewide development. This percentage of the projected number of jobs is about 320 jobs. Only a small proportion of these jobs would go toward reducing unemployment in the five counties for the reasons discussed above, notably the abundant use of transient workers and the lack of technical qualifications among the workforce in southeastern Ohio and northwestern West Virginia.

4.15.2. Payments from the federal government

Federal lands are exempt from property taxes, and the federal government compensates communities for lost property taxes in several ways (Arbogast, 2004). The federal government supports counties with federal land through reimbursements for highway construction, law enforcement, and fire protection and through rural development grants, but the three primary sources of compensation to the states and counties are the 25 Percent Fund, payments in lieu of taxes (PILT), and mineral royalties.

Through the 25 Percent Fund, the federal government pays to the states 25% of the fees collected from timber harvests, camping, grazing, and special use permits. These funds are transferred to the counties based on their proportions of federal land ownership. These payments peaked in the mid-1980s and declined precipitously after that due to a nationwide decline in timber harvesting and a litigation-related stop to timber harvests on the WNF. Payments in lieu of taxes are made by the federal government to counties based on each county's proportion of federal lands that were acquired from private owners and several other indicators. The method for calculating PILT payments has changed through the years, and counties have had options for how they collect the funds, making simple statements of PILT payments less meaningful than they would be if the calculations were simple and consistent. These payments increased in the mid-1990s due to legislation that changed the method for calculating PILT. Finally, mineral royalties have been paid at the rate of 25%. These funds were, until 1992, paid through the 25 Percent Fund and earmarked for schools and roads. Since then royalty payments have been shifted into a separate fund for counties. Each county receives a proportion of mineral royalties based on its proportion of federal lands, regardless of which county's federal lands generated the royalties. That is to say, a county that had no mineral extraction in a given year could receive a share of royalties, and a county that had high mineral extraction could have a disproportionately low share of royalties.

Federal oil and gas leases generate revenue through initial bids as well as annual rents. The minimum competitive lease bid is $2.00 per acre. Lease rental costs $1.50 per acre per year for the first five years and $2.00 per acre per year thereafter. Oil and gas leases expire after 10 years unless they are producing, under which circumstance they last for the duration of production. Annual lease rents continue until production begins, at which point rents are replaced by royalties, which are set at 12.5% of production revenue. The average expected production of a Utica well is 3.5 billion cubic feet (Lendel et al., 2015), but natural gas prices have fluctuated too wildly for a meaningful price projection.

There have been many changes through the years to the payment programs described above, and a major increase in Forest Service ownership in the WNF in the late 1990s reduced the average per-acre payments to counties. From the mid-1980s through the late-1990s, average per-acre payments to counties declined by 64%. Table 4.5, below, summarizes payments made by the federal government to Noble, Monroe, and Washington Counties (U.S. Forest Service, 2016c). *These figures are not adjusted for inflation and are not directly comparable across years.*

Table 4.5. Federal government payments to counties.

	Monroe, total	Monroe, royalties	Noble, total	Noble, royalties	Washington, total	Washington, royalties
2001	$28,441	$2,432	$998	$63	$72,924	$3,895
2002	$31,750	$1,142	$1,048	$33	$73,695	$1,828
2003	$48,525	$1,565	$1,038	$44	$62,668	$2,486
2004	$50,171	$4,581	$1,142	$126	$70,091	$7,123
2005	$41,276	$4,411	$1,148	$125	$70,368	$7,113
2006	$45,370	$7,262	$1,208	$207	$74,344	$11,772
2007	$41,588	$3,620	$1,176	$177	$69,210	$6,417
2008	$97,154	$9,690	$3,882	$277	$131,624	$15,706
2009	$92,083	$4,693	$3,766	$134	$127,651	$7,606
2010	$58,214	$9,423	$2,602	$269	$81,482	$15,273
2011	$49,203	$5,912	$2,322	$169	$83,347	$9,583

2012	$51,149	$6,812	$2,289	$195	$86,103	$11,041
2013	$58,581	$5,336	$2,107	$152	$92,598	$8,649
2014	$61,356	$6,265	$1,665	$179	$95,673	$10,155

Source: U.S. Forest Service (2016c)

4.15.3. Environmental Justice

Per Executive Order 12898, an environmental justice concern arises if a Federal agency action results in disproportionate high and adverse human health or environmental effects on minority or low-income populations. The CEQ (1997) provides the following criteria for assessing disproportionately high and adverse environmental effects:

> "(a) Whether there is or will be an impact on the natural or physical environment ***that significantly*** (as employed by NEPA) ***and adversely affects*** a minority population, low-income population, or Indian tribe. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment; and
> (b) Whether environmental effects are significant (as employed by NEPA) and are or may be having an adverse impact on minority populations, low-income populations, or Indian tribes ***that appreciably exceeds or is likely to appreciably exceed those on the general population*** or other appropriate comparison group; and
> (c) Whether the environmental effects occur or would occur in a minority population, low-income population, or Indian tribe ***affected by cumulative or multiple adverse exposures*** from environmental hazards."

While the act of leasing Federal minerals would have no direct effects, subsequent oil and gas development within the Marietta Unit may result in impacts to people living near potential development sites, including potential low income populations. As noted in Chapter 3 of this EA, minority environmental justice populations, as defined by CEQ criteria, are not expected. Future exploration, drilling or production could create an inconvenience to people living adjacent to development areas due to increased traffic and traffic delays, as well as light, noise and visual impacts. These impacts would be particularly noticeable in areas where oil and gas development has not occurred previously. The level of inconvenience would depend on the activity affected, traffic patterns within the area, noise levels, the length of time and season in which these activities occurred, and other factors. Creation of new access roads would potentially allow increased public access and exposure of private property to vandalism. For leases in which the surface is privately owned and the mineral estate is federally owned, surface owner agreements, standard lease stipulations, and BMPs would potentially address many of the concerns of private surface owners. Although there is potential for future mineral development within the Marietta Unit to affect low income populations in the area, the level of affect is not expected to be

disproportionate and high as defined by CEQ criteria. Therefore, the proposed action would not be expected to result in environmental justice concerns.

Should future development be proposed and specific oil and gas development plans be identified, the BLM would conduct additional site-specific analysis to further assess potential environmental justice issues associated with oil and gas development in the Marietta Unit.

4.16. Cumulative Effects

CEQ regulations direct action proponents to consider the potential environmental impacts resulting from "the incremental impacts of the action when added to past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions" (40 CFR 1508.7). CEQ guidance in considering cumulative effects (1997) involves defining the scope of the other actions and their interrelationship with the Proposed Action. The scope must consider geographical and temporal overlaps among the Proposed Actions and other actions. It must also evaluate the nature of interactions among these actions.

Cumulative effects are most likely to arise when a relationship or synergism exists between the Proposed Action and other actions expected to occur in a similar location or during a similar time period. Actions overlapping with or in proximity to the Proposed Action would be expected to have more potential for a relationship than those more geographically separated.

To identify cumulative effects, three fundamental questions need to be addressed:

- Does a relationship exist such that affected resource areas of the Proposed Action might interact with the affected resource areas of past, present, or reasonably foreseeable actions;
- If one or more of the affected resource areas of the Proposed Action and another action could be expected to interact, would the Proposed Action affect or be affected by impacts of the other action; and
- If such a relationship exists, then does an assessment reveal any potentially significant impacts not identified when the Proposed Action is considered alone?

The scope of the cumulative effects analysis involves both the geographic extent of the effects and the time frame in which the effects could be expected to occur.

4.16.1. Context for Cumulative Effects Analysis

For this EA, the affected area for the cumulative effects analysis includes the Marietta Unit and surrounding vicinity. The timeframe considered is ten years and beyond (oil and gas leases are issued for a 10-year period and continue for as long as oil or gas is produced in paying quantities; the life of a well may extend to 25 years). Aside from air quality and climate change, the cumulative effects analysis does not consider potential leasing in other areas of the WNF, such as the Athens Unit or Ironton District. This is because any impacts associated with leasing in these areas would be separated sufficiently in time and location from the Proposed Action such that cumulative impacts would not be expected.

The analysis of potential cumulative effects incorporates information from both the 2006 Forest Plan and EIS and 2012 SIR as well as new information. For example there are several specific, planned and completed projects on the Marietta Unit with the potential to contribute to cumulative effects in combination with the Proposed Action, as listed below. These projects are authorized under the 2006 Forest Plan and EIS and are listed on the WNF website: (http://www.fs.usda.gov/wps/portal/fsinternet/projects/wayne/landmanagement/projects?archive=1&sortby=1)

- Approval of an electric line that crosses 600 feet of NFS lands, 2009;
- Habitat improvement for yellow-fringed orchid on 38.5 acres using a variety of mechanical and chemical treatments and minor construction activities, 2010;
- Approval of three oil and gas wells, 2010;
- Renewal of two miles of electric pipeline permits, ranging in width from 15 to 80 feet, 2010
- Renewal of 61 acres of hay and row-crop cultivation and 114 acres of grazing, most of which is in river corridor management area, 2010;
- Renewal of permits for 3,300 feet of road access, 2010;
- Approval of laying approximately 2,500 feet of 1½-inch plastic pipeline on surface;
- Mechanical treatments on managed openings, 2011;
- Habitat management, including 564 acres of early successional habitat creation, 432 acres of all-aged stands using single-tree and group selection, and 870 acres of prescribed burning, 2011;
- Approval of an Application for Permit to drill a vertical oil and gas well on a 0.74-acre pad with a 250-foot access road, 2013;
- Plugging and abandonment of six orphaned wells, 2014;
- 4.4-mile expansion of Kinderhook equestrian trail, 2015; and
- Approval of a 150-foot-by-10-foot ATV trail to serve an oil and gas well, 2015.

In addition to the discrete projects listed above, the cumulative effects analysis also considers recent past, ongoing, and reasonably foreseeable mineral development (private and federal) within the Marietta Unit. As of 2015, there were 285 federal wells in Washington County, 117 federal wells in Monroe County, and none in Noble County. There were a total of 790 active wells on private lands in the Wayne National Forest. Leasing federal minerals within the Marietta Unit may lead to additional future mineral development on private land and private minerals within the area. Although federal oversight of mineral development on federal land/federal minerals is more stringent than on private land/private minerals, there are numerous state laws and regulations in place. Appendix C of this EA summarizes the laws and regulations that govern mineral development activities on private land in Ohio.

The ability to accurately assess potential cumulative impacts in this EA is limited due to the lack of site-specific information for potential future oil and gas development activities. Therefore at this stage, the RFDS can be used to generalize the types of cumulative impacts that could occur associated with the proposed leasing action; however, it is important to note that leasing is an administrative action and no ground disturbance would occur at this time. Therefore, there are technically no cumulative effects associated with the action of leasing since it is purely administrative. However, for the purpose of NEPA

analysis, the BLM has considered potential cumulative effects based on what is reasonably foreseeable at this time. Upon receipt of an APD, which would identify specific parcel(s) for development, a site-specific analysis would be conducted along with additional cumulative effects analysis. The following sections discuss potential cumulative effects from the Proposed Action.

4.16.2. Cumulative Effects Analysis

4.16.2.1. Cumulative Effects on Air Resources

Even though the Proposed Action of leasing would not contribute to cumulative effects on air resources, future foreseeable development could contribute to cumulative GHG emissions. The primary sources of emissions include the following:

- Fossil fuel combustion for construction and operation of oil and gas facilities – vehicles driving to and from production sites, engines that drive drill rigs, etc. These produce CO_2 in quantities that vary depending on the age, types, and conditions of the equipment as well as the targeted formation, locations of wells with respect to processing facilities and pipelines, and other site-specific factors.
- Fugitive CH_4 – CH_4 that escapes from wells (both gas and oil), oil storage, and various types of processing equipment. This is a major source of global CH_4 emissions. These emissions have been estimated for various aspects of the energy sector, and starting in 2011, producers are required under 40 C.F.R. §98, to estimate and report their CH_4 emissions to the EPA.
- Combustion of produced oil and gas – it is expected that operations will produce marketable quantities of oil and/or gas. Combustion of the oil and/or gas would release CO_2 into the atmosphere. Fossil fuel combustion is the largest source of global CO_2.

<u>Cumulative Effects of Greenhouse Gas Emissions</u>

When considering the cumulative effects of GHGs, existing oil and gas activity in the area must be considered. Since climate change and global warming are global phenomena, for purposes of this NEPA analysis, the analysis presented above about the direct and indirect effects of GHG emissions from the proposed actions is also an analysis of the cumulative effects of the proposed actions. Consistent with CEQ guidance, the BLM has determined that this analysis "adequately addresses the cumulative impacts for climate change from the proposed action and its alternatives, and therefore a separate cumulative effects analysis for GHG emissions is not needed.

That said, to provide addition context, the BLM has also analyzed the existing development with the Wayne National Forest. As of June 2015, there are approximately 1,275 active vertical wells on the Wayne National Forest. This includes both private and federal. Of these there are 493 active federal wells, as shown in Table 4.6.

Table. 4.6. Total Federal Active Wells by County

Wayne National Forest Counties	Active Federal Wells
Washington County	285
Monroe County	117
Perry County	30
Athens County	25
Hocking County	31
Lawrence County	5
Noble	0

(Source: U.S. Forest Service, 2015)

The 2012 RFDS for this EA projected 10 Horizontal well pads in the Marietta Unit. A well pad might have as few as 1 well per pad (single well pad) and as many as 16 horizontal wells per pad, but more typically 6-8 horizontal wells per pad (IFC International, 2009; NYSDEC, 2009; Currie & Stelle, 2010). The estimated GHGs associated with the preproduction and postproduction phases of reasonably foreseeable oil and gas development in the Marietta Unit would be approximately 70,290 MT CO_2e (0.70290 MMT CO_2e) per horizontal well/year. This represents a GHG contribution of approximately 0.00102% per horizontal well per year when compared to the total GHG emissions of the United States (approximately 6,870,000,000 MT CO_2e (6,870 MMT CO_2e) in 2014 [USEPA, 2016]). This total is the cumulative amount of GHG from preproduction (5,500 MT CO_2e) and postproduction processes (64,790 MT CO_2e). Combustion is the primary source of indirect GHG emissions and make up close to a third of postproduction GHG emissions.

Comparatively, if all 10 projected horizontal well pads were constructed with an average of 6 wells per pad and were actively producing as well as combusted in a single year, the total GHG emissions would be approximately 4,217,400 MT CO_2e (4.22 MMT CO_2 equivalent) in 2014 (USEPA, 2016), the estimated emissions at most would contribute a 0.06% contribution to nationwide greenhouse gas emissions.

There is much uncertainty, though, in terms of whether all 10 well pads would be constructed or whether all of the wells would result in actual production of oil or gas. Furthermore, this would have to constitute that the entire source of natural gas production would also be used for combustion which is not always the case in regards to oil and gas. Assumptions could be made that 50% would be for plastic the other 50% could be propane/butane mix. It should be noted that it is difficult to discern with certainty what end uses for the fuels extracted from particular leasehold might be reasonably foreseeable.

Oil and gas activity would be staggered over time and therefore, the overall intensity of potential impacts would also be staggered. The RFDS states that for the past ten years, oil and gas drilling on federally owned surface has been lagging behind the average drilling pace on Forest Service surface of the previous twenty years (USDA, 2012). Surface disturbance projected in the RFDS projects 10 horizontal wells resulting in approximately 55 acres disturbance; substantially less than the 135 acres that was initially projected under the 2006 RFDS. Approximately 10 acres have already been disturbed to date from oil and gas development in the Marietta Unit. The lifespan of a producing well is approximately 15-30 years. Although this EA analysis assumes that both oil and gas may be produced in the future within the Marietta Unit, natural gas is more likely to be produced. Horizontal drilling to natural gas would result in higher amounts of GHGs than that of vertical drilling; however there would be more surface disturbance required for vertical drilling. Further analysis would be conducted at the APD stage to assess the potential for cumulative effects to air resources, once specific design details are known.

4.16.2.2. Cumulative Effects on Plant and Animal Habitat and Populations

The most important actions contributing to cumulative effects in the Marietta Unit are the intensive resource extraction – especially timber removal – that dominated much of the Twentieth Century, which greatly simplified vegetative structure and wildlife habitat, as well as the development of the Wayne National Forest, which has restored healthy forests throughout the Marietta Unit. Timber extraction focused on clearcutting, removing whole stands and leaving denuded areas to regenerate as single-aged stands of just a few, shade-intolerant species. A related effect of intensive settlement of the area was the suppression of wildfire, which is a natural force that is important to the propagation of oak forests.

The development of the WNF has resulted in the active reforestation of cleared sites and the development of long-term goals, objectives, and targeted management areas. This long-term process has coincided with the passive and active reforestation of tens of thousands of additional acres throughout the Marietta Unit, as farming has declined as a land use and less-destructive methods for mineral extraction have been employed over the last several decades.

The broader actions that are described in the 2006 Forest Plan/EIS are expected, over the coming decades, to result in a decline in oak-dominated stands, which depend on periodic disturbance, and to produce an increase in acres forested in shade-tolerant, fire-intolerant species like maples. The Forest Service will continue to promote early-successional habitats and will use site-specific stipulations and guidelines to manage known locations and suitable habitats for threatened and endangered species. The Ohio DNR's hunting regulations are the primary tool for managing the state's deer herd at a level that ensures recreational hunting opportunities while mitigating crop damage, and the WNF restrictions on ginseng harvesting are expected to ensure the viability of that species for collection.

Although the Proposed Action would not result in any changes to plant and animal populations or their habitats from leasing, potential reasonably foreseeable mineral development could affect these resources and would contribute incrementally to effects on biological resources. As stated previously, leasing of federal minerals in the Marietta Unit may lead to additional mineral development on adjacent

private lands. Increased mineral development activities in the Marietta Unit would affect native plant communities and priority vegetation species. Surface disturbing activities are also likely to increase the potential for invasive plant species to spread within a site and for new species to be introduced. Increases in mineral development would collectively result in direct loss of habitat, displacement of fish and wildlife, and habitat degradation and fragmentation. Wildlife may be temporarily affected by fugitive dust emissions from construction of facilities. Additional habitat could be degraded in the vicinity of oil and gas wells and facilities through accidental spills or leaks. There would likely be an increase in habitat fragmentation and creation of edge habitat, particularly in areas where potential oil and gas development may be more concentrated. Aquatic species could be affected by water withdrawals needed to support hydraulic fracturing operations, although the Forest Service would not approve any water withdrawals on federal land that would result in adverse effects to aquatic species.

Despite the potential for cumulative effects to fish and wildlife and their habitats, reclamation and other stipulations and best management practices, as described earlier in this EA, would help to minimize the potential for significant adverse cumulative effects. Additionally, conducting required consultation under the ESA ensures that potential impacts to federally listed species are identified and managed in accordance with the law. Additional protections may be applied at the APD stage. Appendix C of this EA summarizes the laws and regulations that would apply to mineral development activities on private land with regard to federally listed species.

4.16.2.3. Cumulative Effects on Water Resources and Water Quality

Potential cumulative effects to water resources and water quality in the Marietta Unit must be evaluated within the context of several decades of activities that have affected water resources within the WNF overall. Intensive mining, timber extraction, and farming through much of the Twentieth Century had broad impacts on surface water resources in the WNF. Surface mining activities included rerouting waterways, and acid mine drainage polluted many waterways and extirpated much of the aquatic life in them. Timber extraction left many steep slopes denuded of vegetation and cleared vegetation from riparian areas, leading to mass wasting and severe soil erosion into waterways. Riparian areas serve a critical role in watershed and local hydrology health and any disturbance to its function could be harmful to habitat in surrounding areas (U.S. Department of Agriculture, 1996).

The formation of the WNF has initiated and continued the restoration and management of the watersheds in the Marietta Unit. The Forest Service has conducted many acid mine drainage and abandoned mine lands restoration projects, reducing sedimentation and acidification in many waterways. By reestablishing vegetation and managing healthy forests, especially on steep slopes and other erosion-prone areas, the Forest Service has reduced sediment loads in streams. At the same time, forests on private lands throughout the Marietta Unit have been reforested in recent decades, further reducing erosion and improving surface water quality.

Although the Proposed Action of leasing the parcels would not result in any changes to water resources, potential reasonably foreseeable mineral development could affect this resource and could contribute detrimentally to it in the future. As stated previously, leasing of federal minerals in the Marietta Unit

may lead to additional mineral development on adjacent private lands. Increased mineral development in the area would collectively result in the removal of vegetation, long-term reduction in overall vegetation cover, and disturbance of soils. This would increase overland flow, result in accelerated soil erosion, and decrease the stability of watersheds to buffer high flows and filter water, sediment, and nutrients. Soil mobilized by wind and water erosion would be transported downslope and to nearby water bodies, which would increase sediment and nutrient loads to surface waters and thereby degrade water quality. Increases in overland flow also would directly increase the amount of water transported to streams and rivers, which could lead to increased downcutting, widening, and overall degradation of stream channels.

Cumulative impacts on groundwater resources from future oil and gas development could also occur. Oil and gas wells would have the potential to affect groundwater quality and quantity through withdrawal, injection, and unintentional leakage and spills. Proper well design, construction, drilling, and completion methods would reduce these impacts but would not entirely eliminate them. Hydraulic fracturing is used to enhance recovery by enlarging fractures through which oil and gas can be drawn to a wellbore and brought to the surface. After fluids are injected at high pressures to expand fractures, injected fracture fluids and some formation water flows back to the surface and is removed to allow gas and/or oil to flow into the wellbore. In recent years there has been an elevated public concern about the possibility of subsurface hydraulic fracturing operations creating fractures that extend well beyond the target formation to water aquifers, allowing methane, contaminants naturally occurring in formation water, and fracturing fluids to migrate from the target formation into drinking water supplies. For completion or formation fluids to escape the wellbore and affect the usable quality water or contaminate or cross contaminate aquifers, the fluid would have to breech several layers of steel casing and cement. Failure of the cement or casing surrounding the wellbore is a possible risk to water supplies. If the annulus is improperly sealed, natural gas, fracturing fluids, and formation water containing high concentrations of dissolved solids may be transferred directly along the outside of the wellbore among the target formation, drinking water aquifers, and layers of rock in between. Complying with BLM and state regulations regarding casing and cementing, implementing best management practices, testing casings and cement prior to continuing to drill or introducing additional fluids and continual monitoring during drilling and hydraulic fracturing, allow producers and regulators to check the integrity of casing and cement jobs and greatly reduce the chance of aquifer contamination.

Casing specifications are designed and submitted to the BLM. The BLM independently verifies the casing program, and the installation of the casing and cementing operations are witnessed by a Petroleum Engineer. Petroleum products and other chemicals used in the drilling and/or completion process could result in groundwater contamination through a variety of operational sources including but not limited to pipeline and well casing failure, well (gas and water) construction, and spills.

Produced and flowback water from oil and gas operations would be managed in accordance with the Onshore Orders, best management practices, and numerous state regulations. The preferred method of disposal would be underground injection into a suitable geologic formation isolated from freshwater

aquifers. Injection would require a permit as would surface disposal from oil and gas operations. Accidental leakage of drill fluids, hazardous waste spills, or leakage from tanks could be introduced into the groundwater as well. Accidental leakage of drill fluids, hazardous waste spills, or leakage from reserve pits on private lands, if they are used, could be introduced into the groundwater as well. Although potential impacts on groundwater from accidental leaks would be reduced through the implementation of federal, state, and local regulations that require site characterization and corrective action for hazardous waste and spills, such impacts would not be eliminated.

Despite the potential for cumulative effects to water resources, reclamation and other stipulations and best management practices, as described earlier in this EA, would help to minimize the potential for significant adverse cumulative effects. Additional protections may be applied at the APD stage. Appendix C of this EA summarizes the laws and regulations that would apply to mineral development activities on private land.

4.16.2.4. Cumulative Effects on Soils

There would be no cumulative impacts to soils from the administrative action of leasing, but increases in mineral development, construction activities, and the conversion of land to developed landscapes collectively could result in the removal of vegetation, long-term reduction in vegetation cover, and disturbance of soils. This would expose soils to the erosive forces of wind and water, destabilize soils, and increase overland flow, which in turn could result in accelerated erosion. Accelerated erosion could mobilize soils and remove nutrient-rich topsoil, and thereby reduce soil productivity and vegetation growth rates. Accidental spills or leaks could result in soil contamination. Depending on the size and type of spill, the impact to soils would primarily consist of the loss of soil productivity. Typically, contaminated soils would be removed and disposed of in a permitted facility or would be bio remediated in place using techniques such as excavating and mulching to increase biotic activities that would break down petrochemicals into inert and/or common organic compounds. The use of best management practices such as those discussed in Section 4.5 would minimize cumulative effects on soils.

Although the Proposed Action of leasing the parcels would not result in any changes to soil, potential reasonably foreseeable mineral development could affect this resource and could contribute incrementally to it in the future. Reclamation and other stipulations and best management practices, as described earlier in this EA, would help to minimize the potential for significant adverse cumulative effects. Additional protections may be applied at the APD stage.

4.16.2.5. Cumulative Effects on Geology and Mineral Resources

There would be no cumulative impacts to minerals from the administrative action of leasing, but the potential reasonably foreseeable development projected under the RFDS in combination with other mineral development activities in the Marietta Unit would result in a minor incremental effect from development on BLM federal mineral estate. As stated previously, leasing of federal minerals in the Marietta Unit may also lead to additional mineral development on adjacent private lands. At this stage it is uncertain how productive the wells accessing the federal or private mineral estate would be, should

development occur in the future. If developed, the mineral resources would be drained and depleted over time.

As described in Section 4.4 of this EA, studies have shown that while the likelihood is low, there is some potential for seismic events associated with injection wells. The Ohio Department of Natural Resources requires companies to install seismometers when drilling within three miles of known faults or near an area that recently experienced earthquakes. Drilling is halted if an earthquake occurs. These measures would minimize the potential for adverse cumulative effects from seismic events due to increased mineral development.

Along with existing oil and gas operations, there is the potential for orphaned wells to be present. The BLM's Northeastern States District Orphan Wells Program identifies and oversees plugging operations for abandoned wells in their jurisdiction. Additional site-specific analysis would be conducted at the APD stage and measures would be implemented to minimize interwell communications resulting in adverse cumulative effects.

4.16.2.6. Cumulative Effects from Wastes

As noted in the Proposed Action description, impacts from waste storage, handling, and disposal would be minimized through the use of BMPs, SOPs, and COAs at the APD stage, should federal minerals be proposed for development. Other mineral development, agriculture, and timber management activities in the area would need to comply with all required laws and regulations with regard to wastes. Although the Proposed Action of leasing the parcels would not result in any changes to wastes, potential reasonably foreseeable mineral development could affect waste generation, storage, handling and disposal and could contribute incrementally to it in the future. Additional mineral development on federal and private land may lead to an increase in waste storage and disposal facilities which may occur on or off site. However, adherence to required laws and regulations, SOPs, and best management practices, as described earlier in this EA (see Section 4.7), would help to minimize the potential for significant adverse cumulative effects. Appendix C of this EA summarizes the laws and regulations that would apply to mineral development activities on private land.

4.16.2.7. Cumulative Effects on Public Health and Safety

Although lacking in definitive proof of cause and effect, self-reporting health surveys and environmental testing have suggested possible adverse health outcomes from oil and gas development. However, the administrative act of leasing would have no cumulative effects on public health and safety in the Marietta Unit. Should development occur on leased parcels, there could be cumulative effects based on the dispersion of potential pollutants. This could occur if fracturing fluids come into contact with humans by leaks, releases from holding tanks, spills and accidents during transportation of fluids, flowback or produced water to and from the well pad, and run-off during blowouts, storms, and flooding events. Further, the mixing of these compounds with compounds from other wells or under conditions of high pressure—and often high heat—may synergistically create additional potentially toxic compounds (Shonkoff, 2014). Compounds found in these mixtures may pose risks to public health through numerous environmental pathways, including water, air, and soil. However, potential risks

would be mitigated with BMPs, stipulations, and adherence to federal, state, and local regulations, laws or policies that address the risk of emissions or accidents during all phases of oil and gas development activities. Operators would prepare a Spill Prevention, Control, and Countermeasure (SPCC) plan to ensure hazardous and non-hazardous substances are properly managed.

Although the Proposed Action of leasing the parcels would not result in any changes to public health and safety, potential reasonably foreseeable mineral development could affect the overall population, especially sensitive or high risk individuals, contributing incrementally to it in the future. However, reclamation and other stipulations and best management practices, as described earlier in this EA, would help to minimize the potential for significant adverse cumulative effects. Appendix C of this EA summarizes the laws and regulations for development of oil and gas resources on private lands, which are designed to minimize adverse effects on resources such as public health and safety.

4.16.2.8. Cumulative Effects on Transportation

There would be no cumulative impacts to transportation from the administrative action of leasing; however, should development occur on leased parcels, there could be cumulative effects based on the increase in truck traffic and other heavy equipment in the area. Reasonably foreseeable development of minerals and related construction activities would require large trucks and other machinery to travel to and from drilling sites with expanded use of state, local and forest roads in the WNF. The estimated emissions generated from the truck traffic and use of heavy equipment in oil and gas development activities is described in Section 3.2. Traffic would increase in areas of mineral development that could lead to an increased risk of vehicle accidents. While some new roads would be needed, it is likely that new road construction to support potential future mineral development would not be extensive.

To mitigate road degradation effects, as described in Section 3.9, the WNF may implement road use agreements with oil and gas operators to reclaim expenses associated with use of Forest Development Roads for access to oil and gas wells. These agreements would allow the Forest Service to reclaim expenses associated with the use of the roads by the operator's heavy equipment through surface replacement dollars where applicable. Reclamation and other stipulations and best management practices, as described earlier in this EA, would help to minimize the potential for significant adverse cumulative effects.

4.16.2.9. Cumulative Effects on Recreation and Land Use

There would be no cumulative impacts to recreation and land use as a result of leasing; however, there would be potential effects to both if future mineral development activities occur on or near the leased parcels. As discussed in Section 4.11 of this EA, noise caused by mineral development activities would result in wildlife temporarily vacating the area, reducing hunting and wildlife viewing opportunities for that time. Reasonably foreseeable development of minerals would also affect other recreational activities, particularly those located at developed recreation sites, and noise may cause forest visitors to look for recreational activities elsewhere until exploration is complete.

Although the Proposed Action of leasing the parcels would not result in any changes to recreation and land use, potential reasonably foreseeable mineral development could affect these resources, contributing incrementally to them in the future. Increased mineral development on federal and private land could result in long-term changes to the landscape in some areas of the Marietta Unit; however, this change would likely occur over many years. Also due to the small amount of surface disturbance projected by the RFDS in comparison to the total acreage in the Marietta Unit, it is unlikely that the Marietta Unit would experience widespread land use changes or that the landscape characteristics of the forest would be significantly altered overall. While some recreation areas may be affected, particularly those where activities such as hunting, wildlife viewing, and trail use occur, overall recreation within the Marietta Unit would not be expected to change. There are many acres in the forest where recreation would still occur uninterrupted. The Forest Service would ensure oil and gas activities are conducted in a manner that does not interfere with desired management objectives for public recreation in the Marietta Unit and other areas of the WNF. Reclamation and other stipulations and best management practices, as described earlier in this EA, would help to minimize the potential for significant adverse cumulative effects to land use and recreation.

4.16.2.10. Cumulative Effects on Noise

There would be no cumulative impacts regarding noise from the administrative action of leasing, but increases in mineral development, and initial construction activities could result in the generation of noise. The majority of the noise produced would subside after the initial development period, in which the drilling would stop. Parallel constructions may increase the sound within the area but these situations are not likely to occur extensively. In addition, the circulation of vehicles going to different pre-existing well sites could potentially create a combined increase in traffic noise; however this could be mitigated by well-established schedules and routes identified during the APD stage.

Although the Proposed Action of leasing the parcels would not result in any changes to noise, potential reasonably foreseeable mineral development could affect noise generation or incrementation, contributing incrementally to it in the future. However, reclamation and other stipulations and best management practices, such as equipment baffling, as described earlier in this EA, would help to minimize the potential for significant adverse cumulative effects.

4.16.2.11. Cumulative Effects on Cultural Resources and Native American Concerns

There would be no cumulative impacts to cultural resources as a result of leasing; however, potential cumulative effects to cultural resources could occur if future development activities on or near the lease parcels are conducted without proper surveys and consultations under the NHPA or state requirements. Cumulative effects from repetitious illegal activity, primarily archaeological vandalism, may occur on certain sites or site types unless perpetrators are apprehended and prosecuted. The degree of cumulative effects to known properties from BLM activities, however, should be slight as inventory, assessment, protection, and mitigation measures would be implemented at the APD stage if federal minerals are accessed. Under the No Action Alternative, operators in the vicinity would be required to

comply with all required laws and regulations with regard to protection of cultural resources and Native American Concerns.

Although the Proposed Action of leasing the parcels would not result in any changes to cultural resources or Native American concerns, potential reasonably foreseeable mineral development could affect this issue, incrementally contributing to it in the future. However, reclamation and other stipulations and best management practices, as described earlier in this EA, would help to minimize the potential for significant adverse cumulative effects.

4.16.2.12. Cumulative Effects on Visual Resources and Scenic Quality

The act of leasing would have no cumulative effects on visual resources and/or scenic quality of the Marietta Unit. Should development occur on leased parcels, there could be cumulative effects based on the number of well pads, roads and any other associated development which could include pipelines and power. Upon receipt of an APD, further site-specific analysis would be completed and cumulative effects on visual resources and scenic quality analyzed in relation to other projects or potential projects.

Although the Proposed Action of leasing the parcels would not result in any changes to visual resources or scenic quality, potential reasonably foreseeable mineral development could affect this resource and value, incrementally contributing to it in the future. Individuals residing near or recreating near oil and gas development would be affected more than others. As discussed under land use, due to the small amount of surface disturbance projected by the RFDS in comparison to the total acreage in the Marietta Unit, it is unlikely that the Marietta Unit would experience widespread land use changes (and therefore, changes to the visual resources) or that the landscape characteristics of the forest would be significantly altered overall. However, reclamation and other stipulations and best management practices, as described earlier in this EA, would help to minimize the potential for significant adverse cumulative effects.

4.16.2.13. Cumulative Effects on Socioeconomics

The economic conditions of southeastern Ohio have been changing over the past years and decades as a result of many factors and decisions. As described above, timber production was once a much larger generator of wages and downstream economic activity than it is at present. Mineral production, including coal, limestone, dolomite, sand, and gravel, decreased in economic value of production as well as in employment between 1970 and 2000. More recently, oil and gas production in the region has caused an increase in wages, employment, and downstream economic activity.

One of the primary actions that affect economic conditions in southeastern Ohio is the ownership of the Wayne National Forest. The Forest Service's Social and Economic Assessment (Arbogast, 2004) states that federal ownership of lands comprising the WNF is beneficial to local, rural economies for several reasons. First, the federal government supports the counties through various types of payments and cost-share programs. Second, the federal government maintains the roads and other infrastructure on NFS lands. Finally, the presence of the National Forest stimulates local economies as visitors to the national forest contribute money that they spend for outdoor gear, lodging, food, and other expenses.

Although the Proposed Action of leasing the parcels would not result in any changes to socioeconomics, potential reasonably foreseeable mineral development could affect the eventual economic activity, incrementally contributing to it in the future. However, reclamation and other stipulations and best management practices, as described earlier in this EA, would help to minimize the potential for significant adverse cumulative effects.

4.17. Irreversible and Irretrievable Commitments of Resources

NEPA Section 102(2)C requires a discussion of any irreversible or irretrievable commitments of resources that would be involved in the proposal should it be implemented. An irreversible commitment of a resource is one that cannot be reversed (e.g., the extinction of a species or disturbance to protected cultural resources). An irretrievable commitment of a resource is one in which the resource or its use is lost for a period of time (e.g., extraction of any solid mineral ore or fluid mineral).

Reasonably foreseeable future oil and gas development associated with the Proposed Action would result in surface disturbing activities that would result in irreversible or irretrievable commitments of resources. These surface disturbing activities would result in alterations to soil, removal of vegetation cover and wildlife habitat, and possible damage to cultural resources if proper surveys and consultations are not conducted under the NHPA. Increases in sediment and nonpoint source pollution that result from these activities could result in degradation of water quality within the watershed and habitat for aquatic-dependent species, although no major surface waters are located adjacent to the parcel. Use of BMPs, SOPs, COAs and stipulations as described in the EA are designed to reduce the magnitude of these impacts by preventing habitat degradation.

Development of oil and gas resources would represent an irretrievable commitment of nonrenewable fossil fuels.

4.18. Relationship between Local Short-term Uses and Long-term Productivity

NEPA requires an analysis of the relationship between a project's short-term impacts on the environment and of the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This refers to the possibility that choosing one development option reduces future flexibility in pursuing other options, or that giving over a parcel of land or other resource to a certain use eliminates the possibility of other uses being performed at the site.

The Proposed Action would take place within a national forest. While vegetation loss from future development would occur, no unique habitat or ecosystems would be lost due to this action. Implementation of the Proposed Action or No Action Alternative may result in future oil and gas development, which results in surface-disturbing and other disruptive activities that remove vegetation, increase soil erosion and compaction, create visual intrusions and landscape alterations, increase noise,

and degrade wildlife habitat. Although management actions, BMPs, surface use restrictions, and lease stipulations are intended to minimize the effect of short-term uses, some impact on long-term productivity of resources could occur.

4.19. No action alternative for all resources

The no action alternative would preclude leasing of federal minerals under the Marietta Unit of the WNF. The direct and indirect effects described above would, for the most part, not occur. If the BLM does not sell mineral leases, then the revenues that would be produced by leasing and, potentially, by mineral production may not be made available to the counties. Without a lease, operators would not be authorized to access federal minerals at the time of development but could develop adjacent privately owned minerals, potentially resulting in drainage of federal minerals without benefit to the government.

5. LEASE-SPECIFIC OIL AND GAS NOTIFICATIONS AND STIPULATIONS

5.1. Introduction

The text of this section is taken directly from Appendix H to the Forest Plan.

The following notifications and stipulations implement the standards and guidelines of the Wayne National Forest's 2006 Land and Resource Management Plan (Forest Plan). These are in addition to the standard lease terms for oil and gas leases (BLM Form 3100-11). Not all of these notifications and stipulations are applied to every lease, rather, only those that are relevant based on site conditions. These notifications and stipulations are necessary to protect specific resource values on the lease area. They may be made less restrictive or modified for site-specific situations if such change is found to be in the public interest. These notifications and stipulations may be made less restrictive or modified only after a formal analysis has been completed and specifically approved in writing by a Forest Service line officer.

5.2. Notifications

Special Notification #1

Operations under this lease will be consistent with all the standards and guidelines found in the Wayne National Forest's 2006 Land and Resource Management Plan and are hereby incorporated into this lease in its entirety. Forest Plan standards and guidelines may restrict location, timing, and methodology of oil and gas lease operations. Special surveys for protection of National Forest System land and resources will be required. A copy of the WNF's 2006 Land and Resource Management Plan is available from the following website http://www.fs.fed.us/r9/wayne/ or by writing to:

Forest Supervisor
Wayne National Forest
13700 US HWY 33
Nelsonville, OH 45764

Notification #1 - Cultural Resources
The Forest Service is responsible for assuring the area to be disturbed is examined for cultural resources prior to allowing surface disturbing activities on lands covered by this lease. Important cultural resource values may be present on portions of a lease. Surface disturbing activities must avoid these areas unless the authorized officer agrees to the mitigation measures. The lessee/operators may, at their discretion and cost, conduct the examination on the lands to be disturbed. This examination must be done by or under the supervision of a qualified resource specialist approved by the Forest Service. An acceptable report must be provided to the Forest Service identifying the anticipated effects of the Proposed Action on cultural resource values. If items of substantial archaeological or paleontological values are discovered during operations, or a known deposit of such items is disturbed, the lessee (or operator) will cease work in the affected area. The lessee (or operator) will then notify the Forest Service and will not resume excavation until the Forest Supervisor gives written approval.

Notification #2 - Floodplains
Any activities proposed in, or likely to affect a floodplain will be subject to:

• Analysis and identification of alternate sites
• Public notification and comment period
• Provisions of any other federal, State or local laws and regulations as required under presidential Executive Order 11988, Protection of Floodplains.

Notification #3 - Protection of Federally Listed Endangered and Threatened and Regional Sensitive Species and their Habitats
The Forest Service is responsible for assuring that the area to be disturbed is examined prior to allowing any surface disturbing activities on lands covered by this lease. The examination is to determine effects upon any plant or animal species listed, or proposed for listing, as federally endangered or threatened, regional sensitive, and their habitats. If the findings of this examination determine that the operation(s) may have a detrimental effect on a species covered by the federal Endangered Species Act, the operator's plans may be denied or restrictions added. The presence of regional sensitive species may also require some restrictions of the operation(s).

The Forest Service has the responsibility to conduct the required examination. In cases where the Forest Service time frames cannot meet the needs of the lessee/operator, the lessee/operator may, at his discretion and cost, conduct the examination on the lands to be disturbed. This examination must be done by or under the supervision of a qualified resource specialist approved by the Forest Service. An acceptable report must be provided to the Forest Service identifying the anticipated effects of the Proposed Action on federal endangered or threatened species, regional sensitive species, or their habitats.

Notification #4 - Compliance with Public Laws and Federal Regulations
Operators are required to comply with all public laws and federal regulations that apply to National Forest System lands and the Wayne National Forest's 2006 Land and Resource Management Plan.

Notification #5 - Steep Slopes and/or Unstable Soils
The area of this lease contains a considerable amount of land with steep slopes and/or unstable soils. Accordingly, the opportunity to locate access roads, drilling sites, pipelines, storage tanks and other improvements may be extremely limited.

5.3. Management Areas Requiring Special Stipulations

Stipulation #1 - No Surface Occupancy - Future Old Forest
No surface occupancy allowed on the entire lease or on designated areas of the lease (see lease map) for the protection of the Future Old Forest resources.

On National Forest System land in Future Old Forest Management Areas, the Forest Service will issue leases for federal oil and gas only with a No Surface Occupancy (NSO) stipulation. In the case of federal leases issued pursuant to the Comprehensive National Energy Policy Act of 1992, the Forest Service will recommend to the Bureau of Land Management that operations be allowed to continue provided that all activities comply with Forest guidance. When the existing well (or wells) is depleted, all facilities must be removed and the site rehabilitated to Forest Service standards. No new wells will be allowed, nor will existing wells be allowed to be drilled to deeper formations. The NSO stipulation does not apply to reserved or outstanding mineral rights.

Stipulation #2 - No Surface Occupancy - Research Natural Areas
No surface occupancy within designated areas of the lease (see lease map) for the protection of natural processes or research, historical, or educational values.

On National Forest System land in Research Natural Area Management Areas, the Forest Service will issue leases for federal oil and gas only with a No Surface Occupancy (NSO) stipulation. In the case of federal leases issued pursuant to the Comprehensive National Energy Policy Act of 1992, the Forest Service will recommend to the Bureau of Land Management that operations be allowed to continue provided that all activities comply with Forest guidance. When the existing well (or wells) is depleted, all facilities must be removed and the site rehabilitated to Forest Service standards. No new wells will be allowed, nor will existing wells be allowed to be drilled to deeper formations. The NSO stipulation does not apply to reserved or outstanding mineral rights.

Stipulation #3 - No Surface Occupancy - Special Areas
No surface occupancy within designated areas of the lease (see lease map) to protect natural processes or research, historical or educational values.

On National Forest System land in Special Interest Management Areas, the Forest Service will issue federal oil and gas leases only with a No Surface Occupancy (NSO) stipulation. In the case of federal leases issued pursuant to the Comprehensive National Energy Policy Act of 1992, the Forest Service will recommend to Bureau of Land Management that operations be allowed to continue provided that all activities comply with Forest guidance. When the existing well (or wells) is depleted, all facilities must be removed and the site rehabilitated to Forest Service standards. No new wells will be allowed, nor will

existing wells be allowed to be drilled to deeper formations. The NSO stipulation does not apply to reserved or outstanding mineral rights.

Stipulation #4 - No Surface Occupancy - Candidate Areas
No surface occupancy within designated areas of the lease (see lease map) for the protection of natural processes or research, historical or educational values.

On National Forest System lands in Candidate Research Natural Management Areas, the Forest Service will only issue federal oil and gas leases that have a No Surface Occupancy (NSO) stipulation. In the case of federal leases issued pursuant to the Comprehensive National Energy Policy Act of 1992, the Forest Service will recommend to Bureau of Land Management that operations be allowed to continue provided that all activities comply with Forest guidance. When the existing well (or wells) is depleted, all facilities must be removed and the site rehabilitated to Forest Service standards. No new wells will be allowed, nor will existing wells be allowed to be drilled to deeper formations. The NSO stipulation does not apply to reserved or outstanding mineral rights.

Stipulation #5 - No Surface Occupancy - Administrative Sites, Developed Recreation Areas, Trails, and Associated Trailheads
No surface occupancy within designated areas of the lease (see lease map) to protect special management units such as developed recreation areas, trails and associated trailheads, water supply facilities, administrative site, etc.

On National Forest System land within administrative sites, developed recreation areas, trails and associated trailheads, the Forest Service will issue leases for federal oil and gas only with a No Surface Occupancy (NSO) stipulation. The NSO designation will include a buffer zone, which will be determined in accordance with the Implementation Guide for Scenery Management. In the case of federal leases issued pursuant to the Comprehensive National Energy Policy Act of 1992, the Forest Service will recommend to the Bureau of Land Management that operations be allowed to continue provided that all activities comply with Forest guidance. When the existing well (or wells) is depleted, all facilities must be removed and the site rehabilitated to Forest Service standards. No new wells will be allowed, nor will existing wells be allowed to be drilled to deeper formations. The NSO stipulation does not apply to reserved or outstanding mineral rights.

5.4. Resources Requiring Special Stipulations

Stipulation #7 - No Surface Occupancy - Cultural Resources of Known Significance
No surface occupancy is allowed within archaeological or historical sites of known significance (see lease map). At the time of any new proposed lease developments, a Forest Service archaeologist shall determine the need for any setbacks or restrictions for the protection of objects of historic or scientific interest.

Stipulation #8 - No Surface Occupancy - Slopes in Excess of 55 Percent
No surface occupancy is allowed on slopes in excess of 55 percent (see lease map) to protect soil and water from erosion and mass failure hazards because of steep slopes.

Stipulation #9 - No Surface Occupancy - Areas of Mass Instability
No surface occupancy is allowed for the exploration and development of energy minerals on areas with mass soil instability, as defined by the USDA County Soil Surveys (see lease map).

Stipulation #10 - No Surface Occupancy - Hibernacula
No surface occupancy within ¼ mile of all known Indiana bat hibernacula.

Stipulation #11 - Controlled Surface Use - Areas of Land with a Scenic Integrity Objective of 'High' or 'Moderate'
At the time of any new proposed lease developments, the responsible line officer shall determine the need for any visual quality mitigation. Some examples of mitigation may include special design and reclamation measures, transplanting trees and shrubs, fertilization, mulching, special erosion control structures, irrigation, site recontouring to match the original land contour, low profile equipment and painting to minimize contrast. Surface occupancy may also be limited or denied in sensitive areas, such as unique geologic features and rock formations, visually prominent areas such as designated trails and developed recreation sites.

Stipulation #12 - Controlled Surface Use - Known Locations of Federally Listed Species
No cutting of snags (trees with less than 10% live canopy), shagbark or shellbark hickories, or trees that are hollow and/or have major splits or broken tops, except during the bat hibernation season (September 15 through April 15). If such trees are a safety hazard, they may be cut anytime they pose an imminent threat to human safety, but if cut in the nonhibernation season the Forest Service biologist must be notified in advance. This stipulation applies only to trees over six inches in diameter.

Protect all supercanopy trees or other identified congregation roost trees for bald eagles along major river corridors and lakes. Protect known nests and roosts as described in the Bald Eagle Recovery Plan, or as directed by the U.S. Fish and Wildlife Service.

Prior to any surface disturbing activities a Forest Service biologist will conduct an assessment for potential American burying beetle habitat and occurrence. Occupancy restrictions will be determined at the time of the evaluation.

Stipulation #13 - Controlled Surface Use - Known Locations of Regional Forester Sensitive Species
Controlled surface use may include setbacks or restrictions from portions of the lease to ensure protection of habitat for regional sensitive species. At the time of any new proposed lease developments, the responsible line officer shall determine the need for any setbacks or restrictions, or the need for timing-related stipulation in accordance with the aquatic and terrestrial wildlife and botanical resources standards and guidelines.

The leaseholder and Forest Service inspector shall work together to identify locations for development and production facilities in order to protect the structural integrity of large old trees found on a portion of the tract.

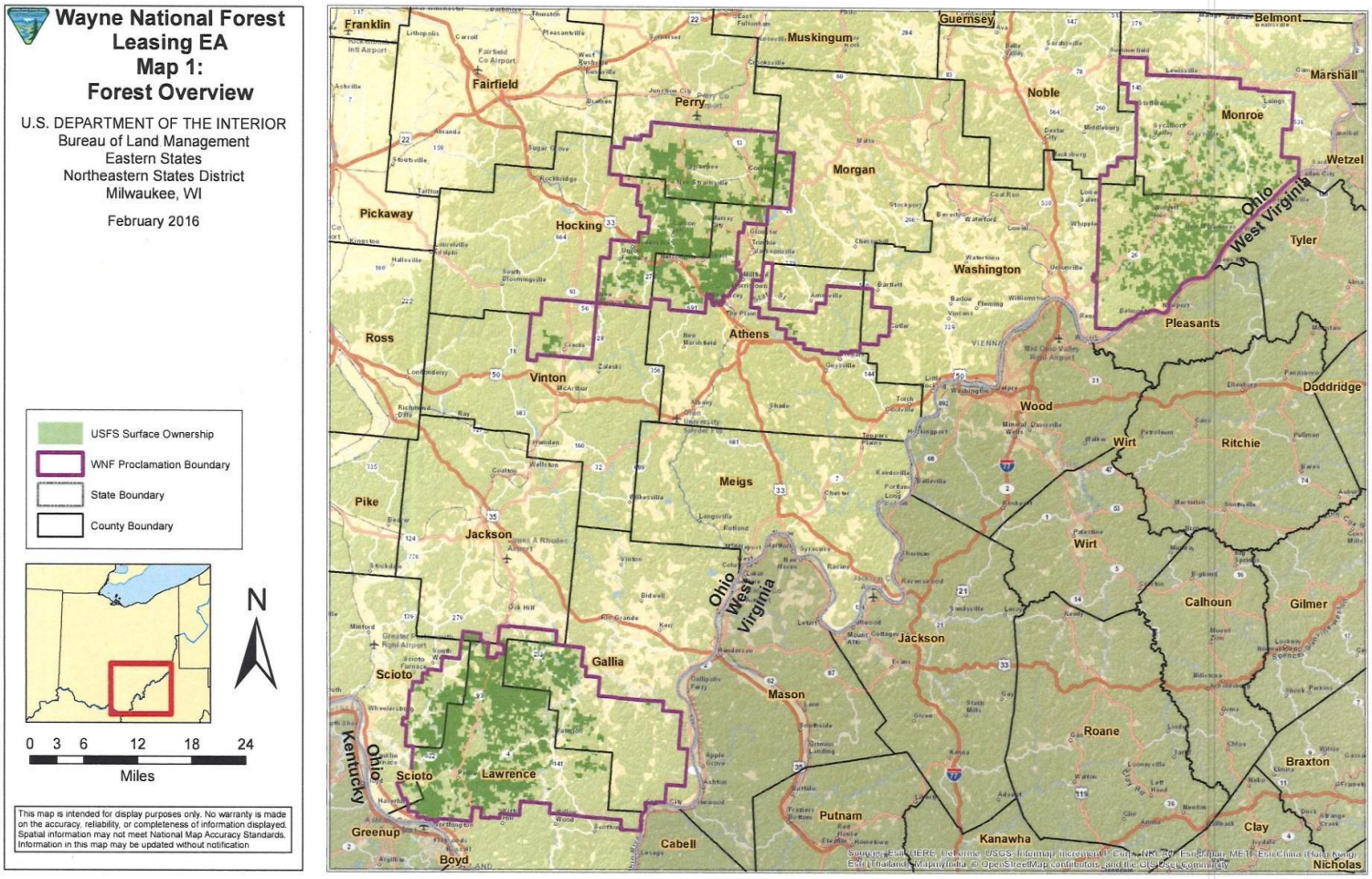
Stipulation #14 - Controlled Surface Use - Managed Wildlife Openings
At the time of any new proposed lease developments, the responsible line officer shall determine the extent of the surface use restrictions necessary to maintain habitat integrity for plant and animal species dependent on such habitats.

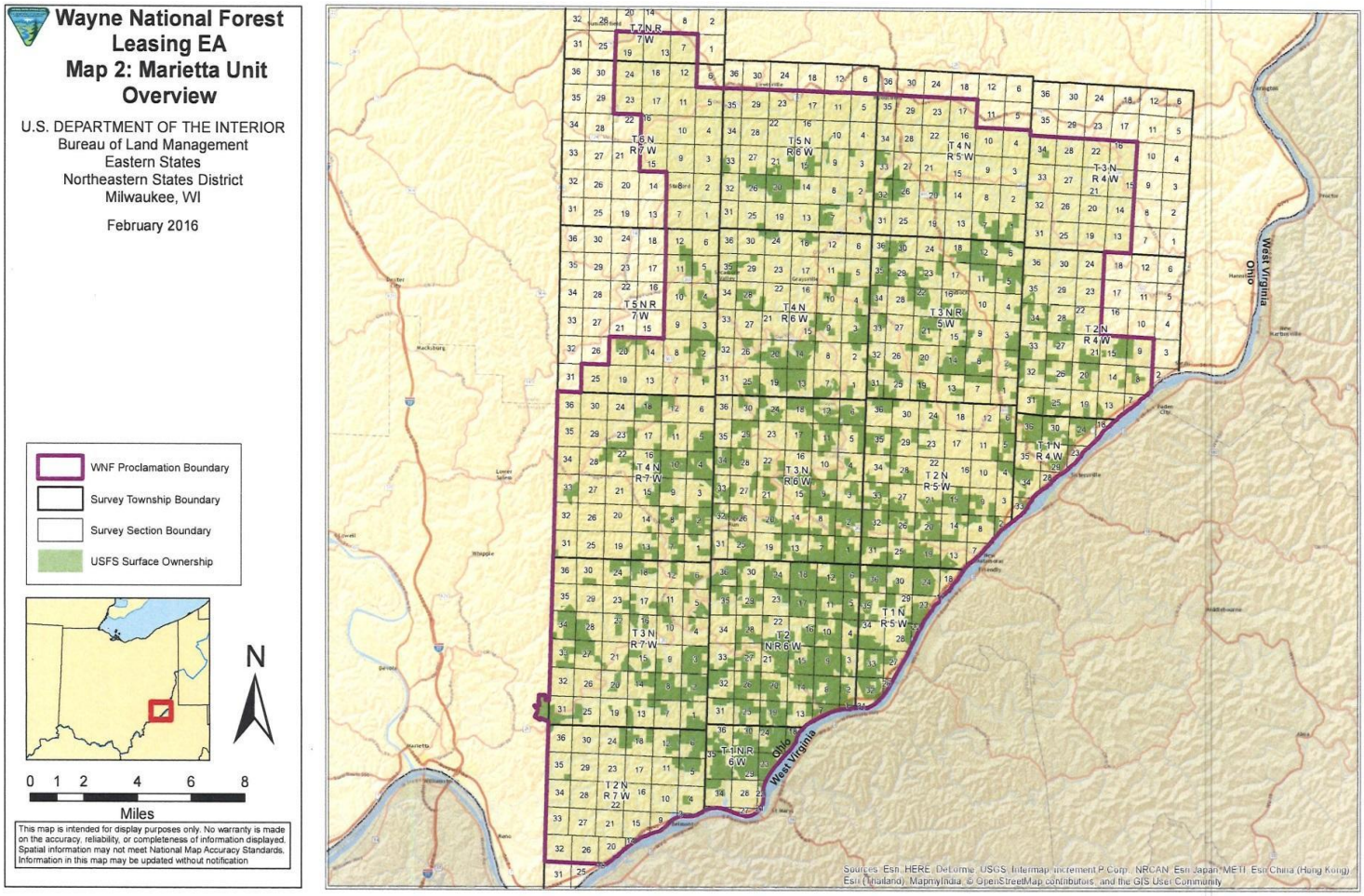
Stipulation #15 - Controlled Surface Use - Riparian Areas
At the time of any new proposed lease developments, the responsible line officer shall determine the appropriate surface use restrictions necessary to maintain the structural and ecological integrity of riparian areas, and aquatic and riparian-dependent species viability.

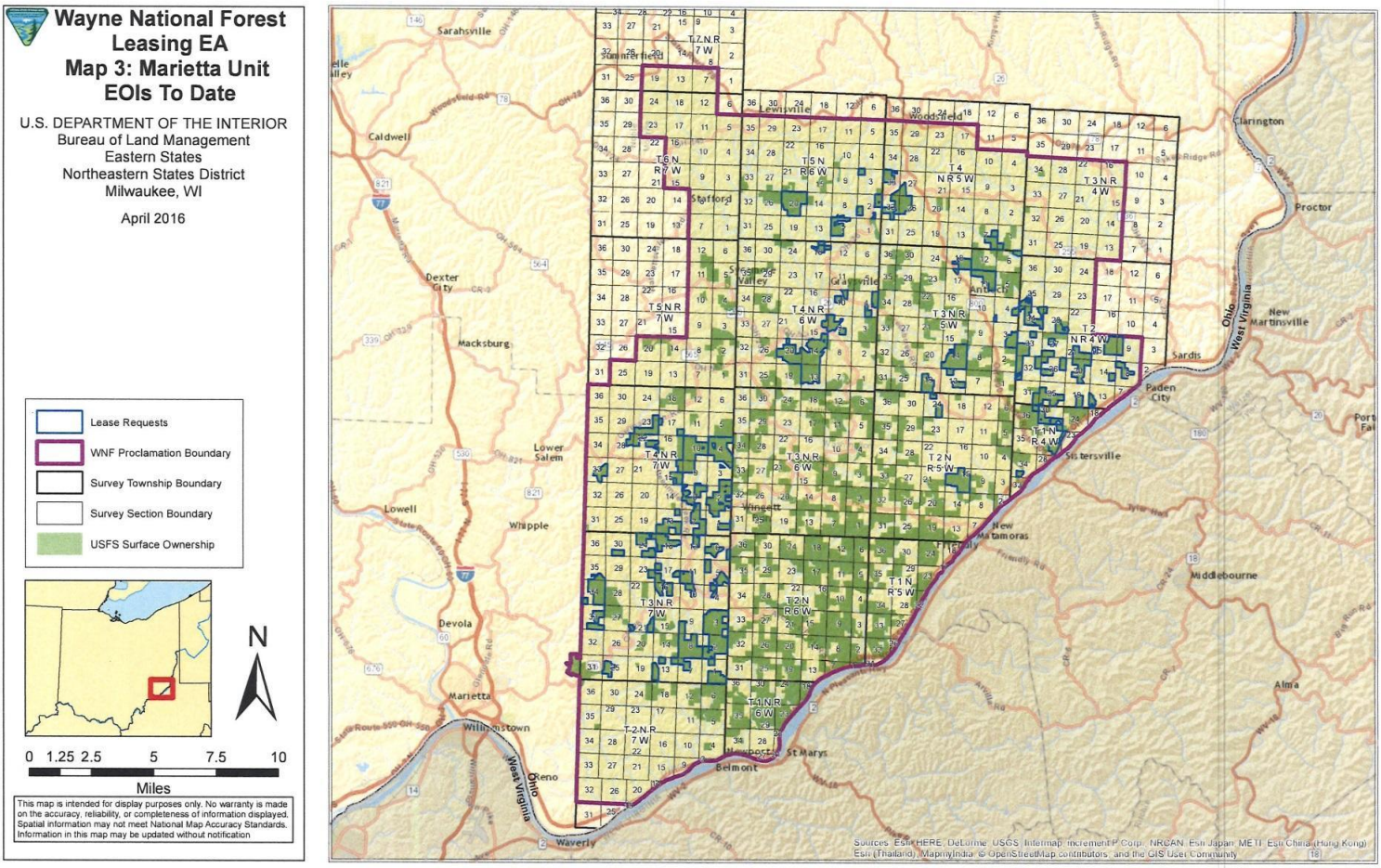
Stipulation #16 - Controlled Surface Use - Portions of Floodplains Outside Riparian Areas
Oil and gas activities may be allowed within that portion of a floodplain outside riparian areas. Mineral activities will be evaluated on a case-by-case basis, and appropriate mitigation measures will be applied. The leaseholder and Forest Service inspector shall work together to identify locations for roads, pipelines, well pads and production facilities.

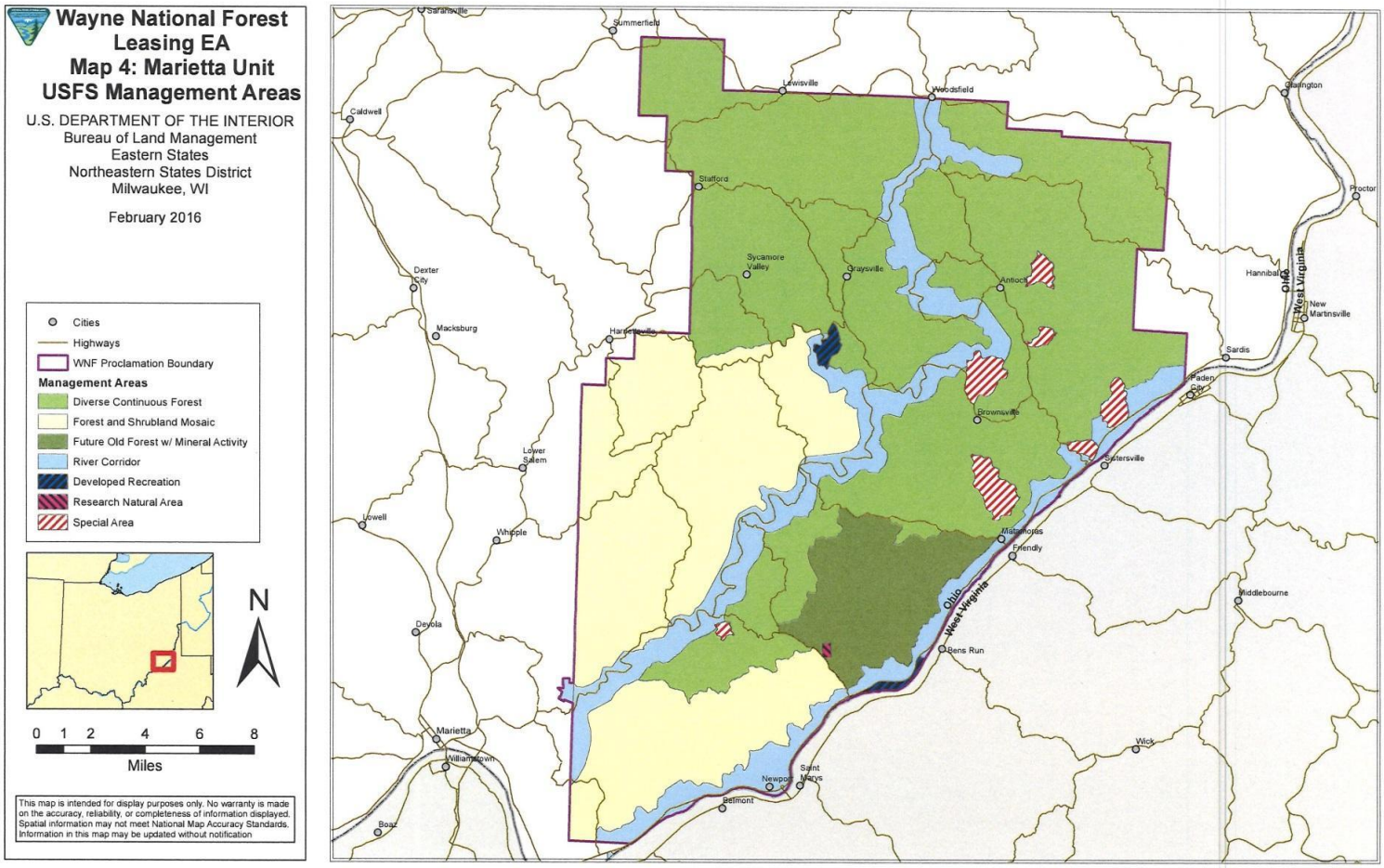
Stipulation #17 - Controlled Surface Use - Slopes Between 35 and 55 Percent
Oil and gas activities will be allowed on slopes from 35 to 55 percent on a case-by-case basis with appropriate mitigation. New road construction and maintenance shall be planned to disturb the least amount of ground. The leaseholder and Forest Service inspector shall work together to identify locations for roads, pipelines, well pads, and production facilities.

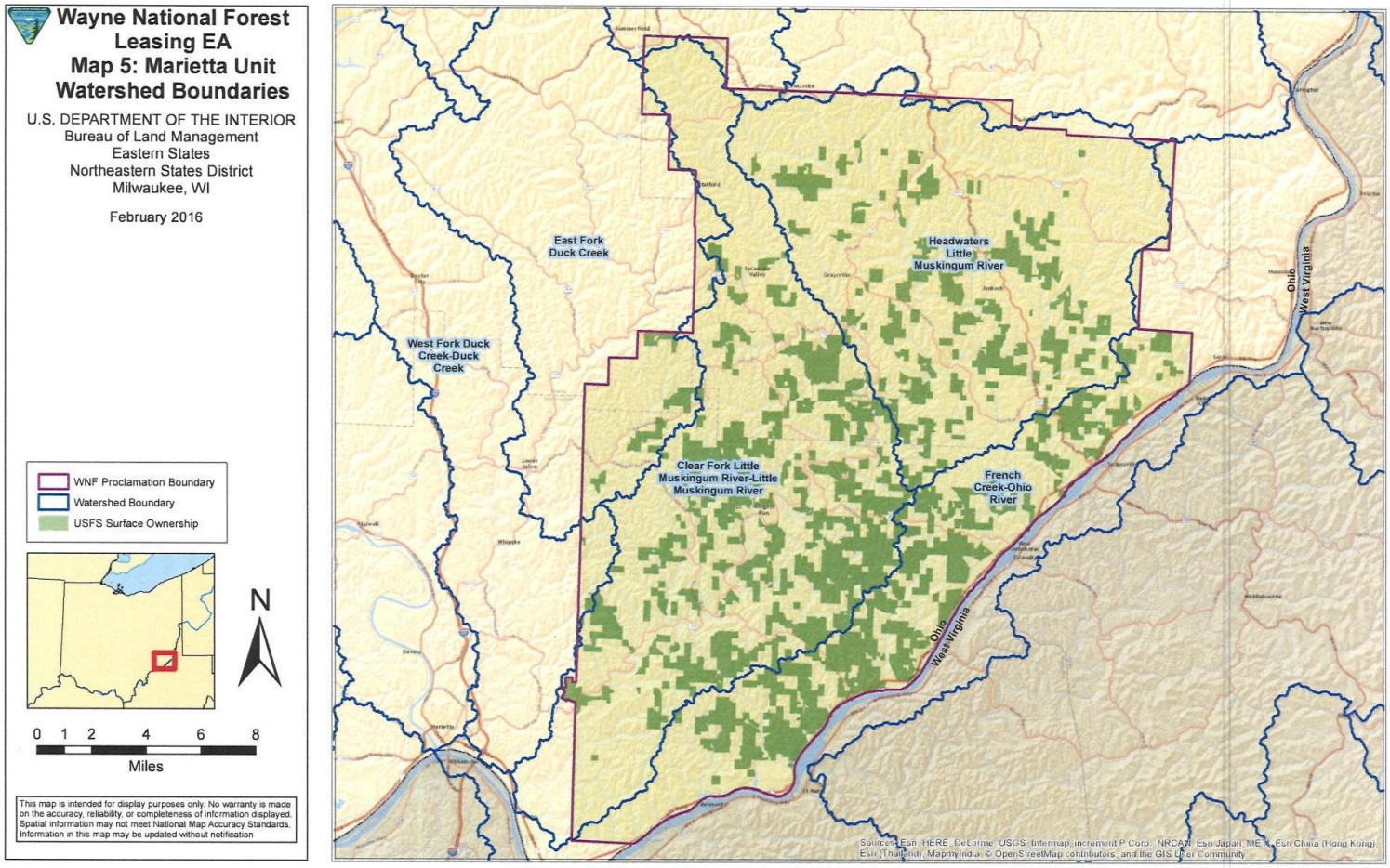
6. MAPS

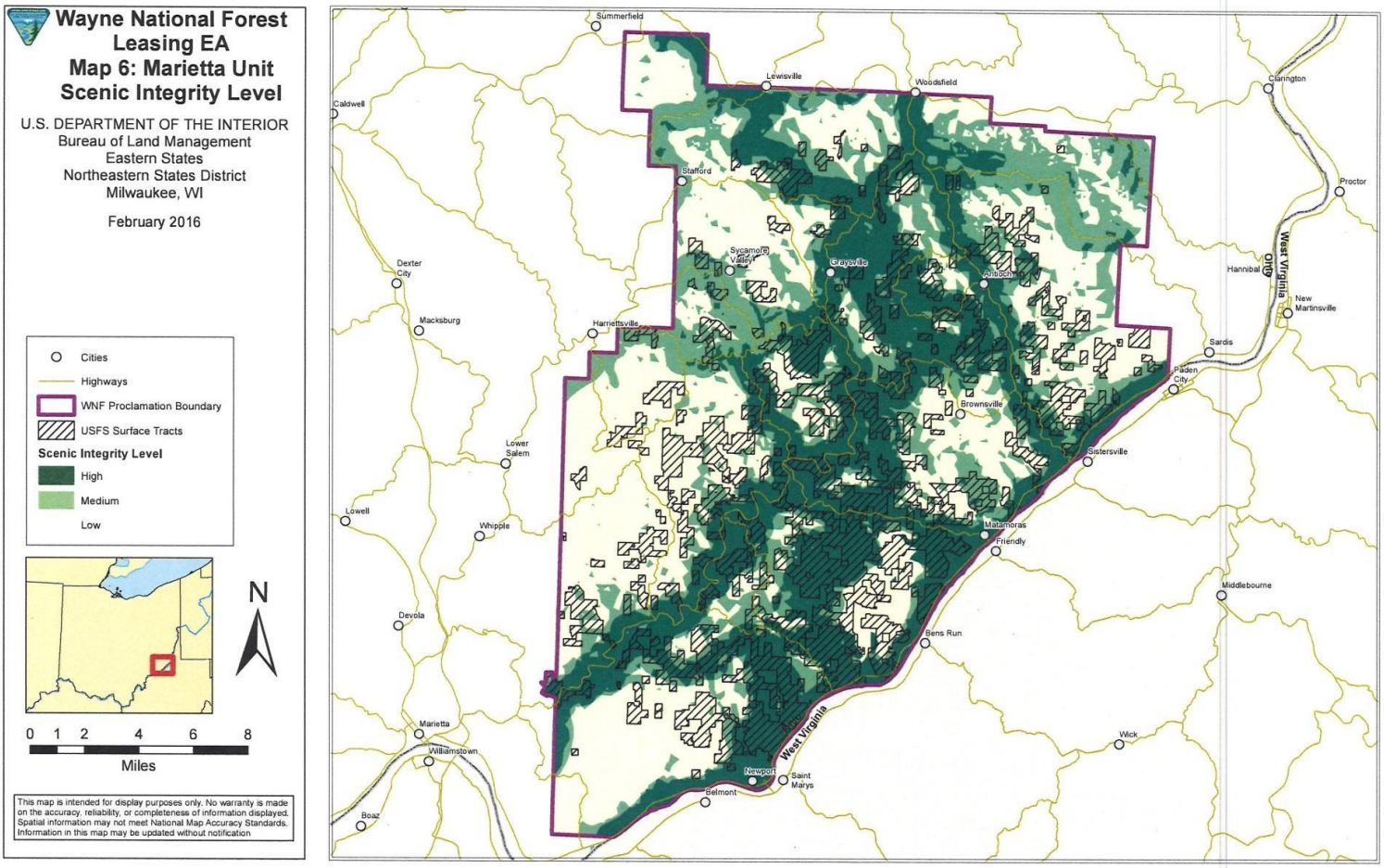

Wayne National Forest
Leasing EA
Map 1:
Forest Overview
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
Eastern States
Northeastern States District
Milwaukee, WI
February 2016
USFS Surface Ownership
WNF Proclamation Boundary
State Boundary
County Boundary
N
0 3 6 12 18 24
Miles
This map is intended for display purposes only. No warranty is made on the accuracy, reliability, or completeness of information displayed. Spatial information may not meet National Map Accuracy Standards. Information in this map may be updated without notification.
Franklin
Fairfield
Muskingum
Guernsey
Belmont
Marshall
Noble
Monroe
Wetzel
Perry
Morgan
Pickaway
Hocking
Washington
Tyler
Ohio
West Virginia
Athens
Pleasants
Ross
Vinton
Wood
Doddridge
Wirt
Ritchie
Meigs
Pike
Jackson
Calhoun
Gilmer
Gallia
Scioto
Mason
Roane
Braxton
Kentucky
Lawrence
Putnam
Kanawha
Clay
Greenup
Cabell
Boyd
Nicholas


Wayne National Forest
Leasing EA
Map 2: Marietta Unit
Overview
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
Eastern States
Northeastern States District
Milwaukee, WI
February 2016
WNF Proclamation Boundary
Survey Township Boundary
Survey Section Boundary
USFS Surface Ownership
N
0 1 2 4 6 8
Miles
This map is intended for display purposes only. No warranty is made on the accuracy, reliability, or completeness of information displayed. Spatial information may not meet National Map Accuracy Standards. Information in this map may be updated without notification
T 7 N R 7 W
T 6 N R 7 W
T 5 N R 6 W
T 4 N R 5 W
T 3 N R 4 W
T 5 N R 7 W
T 4 N R 6 W
T 3 N R 5 W
T 2 N R 4 W
T 4 N R 7 W
T 3 N R 6 W
T 2 N R 5 W
T 1 N R 4 W
T 3 N R 7 W
T 2 N R 6 W
T 1 N R 5 W
T 2 N R 7 W
T 1 N R 6 W
Ohio
West Virginia
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

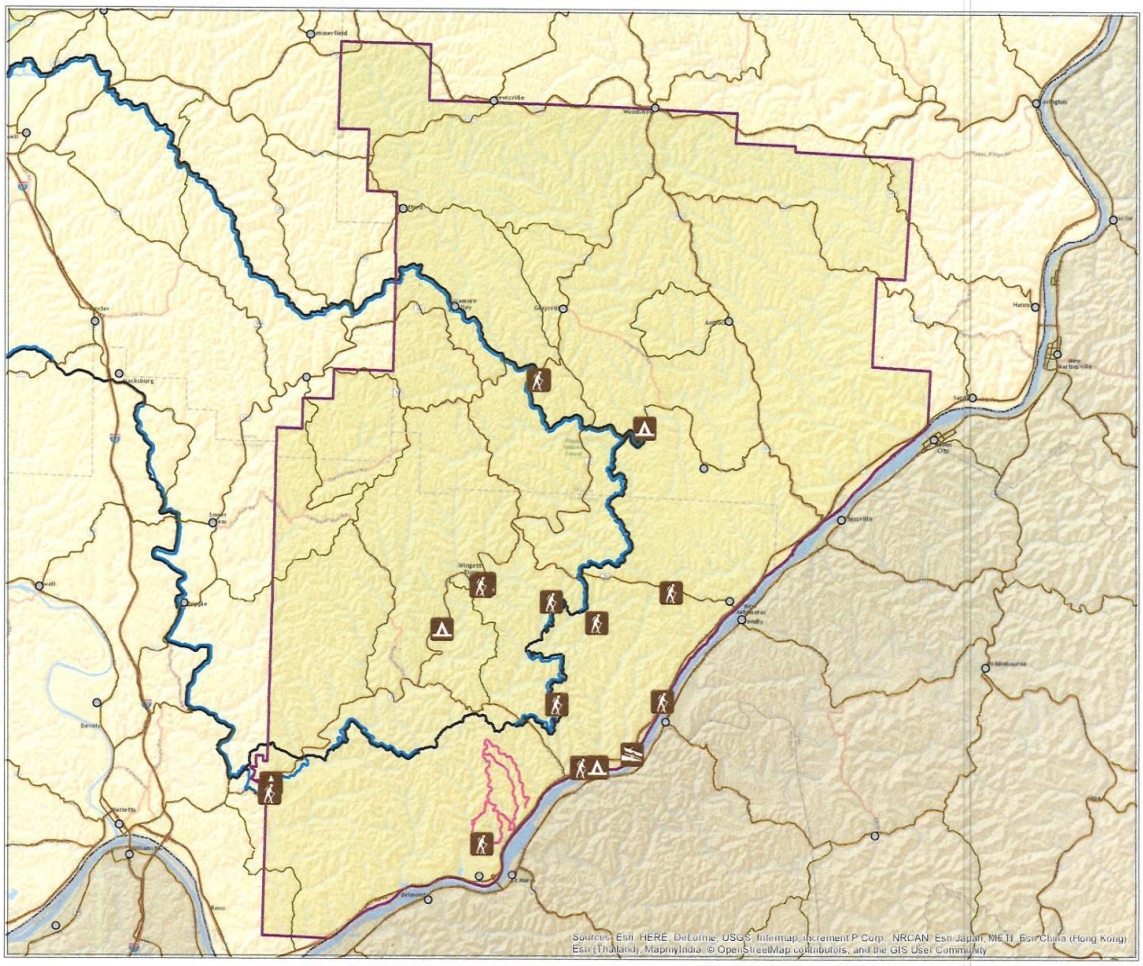

Wayne National Forest
Leasing EA
Map 3: Marietta Unit
EOIs To Date
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
Eastern States
Northeastern States District
Milwaukee, WI
April 2016
Lease Requests
WNF Proclamation Boundary
Survey Township Boundary
Survey Section Boundary
USFS Surface Ownership
N
0 1.25 2.5 5 7.5 10
Miles
This map is intended for display purposes only. No warranty is made on the accuracy, reliability, or completeness of information displayed. Spatial information may not meet National Map Accuracy Standards. Information in this map may be updated without notification
Sarahsville
Caldwell
Dexter City
Macksburg
Lower Salem
Lowell
Whipple
Devola
Marietta
Williamstown
Belmont
St Marys
Waverly
Stafford
Lewisville
Woodfield
Clarington
Proctor
New Martinsville
Sardis
Paden City
Sistersville
New Matamoras
Middlebourne
Alma
Ohio
West Virginia


Wayne National Forest
Leasing EA
Map 4: Marietta Unit
USFS Management Areas
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
Eastern States
Northeastern States District
Milwaukee, WI
February 2016
Cities
Highways
WNF Proclamation Boundary
Management Areas
Diverse Continuous Forest
Forest and Shrubland Mosaic
Future Old Forest w/ Mineral Activity
River Corridor
Developed Recreation
Research Natural Area
Special Area
N
0 1 2 4 6 8
Miles
This map is intended for display purposes only. No warranty is made on the accuracy, reliability, or completeness of information displayed. Spatial information may not meet National Map Accuracy Standards. Information in this map may be updated without notification.
Summerfield
Lewisville
Woodsfield
Caldwell
Stafford
Sycamore Valley
Graysville
Antioch
Dexter City
Macksburg
Hannibal
Ohio
West Virginia
New Martinsville
Sardis
Paden City
Brownsville
Lower Salem
Sistersville
Lowell
Whipple
Matamoras
Friendly
Middlebourne
Devola
Bens Run
Marietta
Williamstown
Wick
Newport
Saint Marys
Belmont
Boaz


Wayne National Forest
Leasing EA
Map 5: Marietta Unit
Watershed Boundaries
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
Eastern States
Northeastern States District
Milwaukee, WI
February 2016
WNF Proclamation Boundary
Watershed Boundary
USFS Surface Ownership
N
0 1 2 4 6 8
Miles
This map is intended for display purposes only. No warranty is made on the accuracy, reliability, or completeness of information displayed. Spatial information may not meet National Map Accuracy Standards. Information in this map may be updated without notification
East Fork Duck Creek
West Fork Duck Creek-Duck Creek
Headwaters Little Muskingum River
Clear Fork Little Muskingum River-Little Muskingum River
French Creek-Ohio River
Ohio
West Virginia
Ohio
West Virginia
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community


Wayne National Forest
Leasing EA
Map 6: Marietta Unit
Scenic Integrity Level
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
Eastern States
Northeastern States District
Milwaukee, WI
February 2016
Cities
Highways
WNF Proclamation Boundary
USFS Surface Tracts
Scenic Integrity Level
High
Medium
Low
N
0 1 2 4 6 8
Miles
This map is intended for display purposes only. No warranty is made on the accuracy, reliability, or completeness of information displayed. Spatial information may not meet National Map Accuracy Standards. Information in this map may be updated without notification
Summerfield
Lewisville
Woodsfield
Clarington
Caldwell
Stafford
Proctor
Sycamore Valley
Grayville
Albright
Hannibal
Ohio
West Virginia
New Martinsville
Dexter City
Macksburg
Harrietsville
Sardis
Paden City
Brownsville
Lower Salem
Sistersville
Lowell
Whipple
Matamoras
Friendly
Middlebourne
Devola
Bens Run
Marietta
Williamstown
Wick
Newport
Saint Marys
Belmont
Boaz

Wayne National Forest
Leasing EA
Map 7: Marietta Unit
Recreation Sites
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
Eastern States
Northeastern States District
Milwaukee, WI
February 2016
Boat Launch
Campground
Trailhead
Cities
Highways
WNF Proclamation Boundary
Buckeye Trail
North Country Trail
Horse Trails
N
0 1 2 4 6 8
Miles
This map is intended for display purposes only. No warranty is made on the accuracy, reliability, or completeness of information displayed. Spatial information may not meet National Map Accuracy Standards. Information in this map may be updated without notification


Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

7. PERSONS, GROUPS, AND AGENCIES CONSULTED

7.1. List of Persons, Agencies and Organizations Consulted

U.S. Forest Service, Wayne National Forest;
U.S. Forest Service, Eastern Region 9;
U.S. Fish and Wildlife Service;
Ohio State Historic Preservation Office;
The Delaware Tribe of Indians;
The Delaware Nation;
The Shawnee Tribe;
The Eastern Shawnee Tribe of Oklahoma;
The Absentee Shawnee Tribe of Indians;
The Wyandotte Nation; and
Peoria Tribe of Indians of Oklahoma.

7.2. List of Preparers

BLM Preparers

Name	Title	Contributor
Derek Strohl	Natural Resources Specialist	Soils; Plant and Animal Habitat and Populations; Environmental Justice; Socioeconomics; Air Resources (Reviewer)
Jarrod Kellogg	Archaeologist	Cultural Resources; Paleontology; Native American Religious Concerns; Recreation; Land Use; Noise
Katie Kassander	Natural Resources Specialist	Water Resources and Water Quality
Kurt Wadzinski	Planning and Environmental Coordinator	Reviewer; Editor
Carolyn Helm	Geologist	Geology and Minerals
Kyle Schumacher	Natural Resources Specialist	Wastes, Hazardous and Solid; Visual Resources and Scenic Quality
George Matzke	Petroleum Engineer	Geology and Minerals (Reviewer)

Name	Title	Contributor
Carol Zurawski	Planning and Environmental Coordinator	Cumulative Effects; Reviewer; Editor;
Justin Katusak	Planning and Environmental Coordinator/Litigation	Appendix C; Reviewer
Karlee Yurek	Branch Chief, Natural and Community Resources, ESO	Reviewer; Editor
Nicole Virella	Planning and Environmental Specialist	Reviewer; Editor
Kimberly Melendez-Rivera	Planning and Environmental Specialist, Southeastern States District	Air Resources (Climate Change, GHG Emissions)

8. REFERENCES

Arbogast, K. (2004). Social and Economic Assessment for the Wayne National Forest. Tomas M. Koontz, PhD (ed.). Nelsonville, OH: U.S. Department of Agriculture, Wayne National Forest.

Appalachian Regional Commission (ARC). (2016). *Maps by topic: Economic status. County economic status in Appalachia, FY 2016*. Retrieved from http://www.arc.gov/research/MapsofAppalachia.asp?F_CATEGORY_ID=1.

Bayne, E. M., Habib, L., & Boutin, S. (2008). Impacts of chronic anthropogenic noise from energy-sector activity on abundance of songbirds in the boreal forest. In *Conservation Biology, Vol. 22*(5), 1186-1193. doi: 10.1111/j.1523-1739.2008.00973.x

Boden, T. A., Marland, G., & Andres, R. J. (2013). *Global, regional, and national fossil-fuel CO2 emissions*. U.S. Department of Energy. Oak Ridge, TN: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory. doi:10.3334/CDIAC/00001_V2013

Buonopane, S., Ebright, S., & Smith, A. (2012). *Historic American Engineering Record, Rinard Bridge: HAER No. OH-130*. Washington, DC: National Park Service. Retrieved from http://www.loc.gov/pictures/item/oh1983/

Bureau of Land Management. (1998). *Mosquito Creek Lake draft planning analysis/Environmental assessment*. Milwaukee, WI: Milwaukee District Office.

Bureau of Land Management. (2007). *Split estate: Rights, responsibilities, and opportunities* (BLM Publication No. BLM/WO/GI-06/022+3161/REV 07). Retrieved from Bureau of Land Management website: http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/split_estate.html

Colorado Department of Public Health & Environment (CDPHE). (2016). *Frequently asked questions*. Retrieved from https://www.colorado.gov/cdphe/oghealth/faq

Council on Environmental Quality (CEQ). (1997). *Environmental justice: Guidance under the National Environmental Policy Act*. Retrieved from https://ceq.doe.gov/ceq_regulations/guidance.html

Council on Environmental Quality (CEQ). (2016). *Regulations for implementing the procedural provisions of the National Environmental Policy Act*. Retrieved from https://ceq.doe.gov/ceq_regulations/regulations.html

Currie, K., & Stelle, E. (2010). Pennsylvania's natural gas boom: Economic and environmental impacts. *Policy Brief from the Commonwealth Foundation*, *22*(05), 1-12. Harrisburg, PA: Commonwealth Foundation for Public Policy Alternatives. Retrieved from: www.commonwealthfoundation.org/doclib/20100607_MarcellusShaleDrilling.pdf

Fletcher, S. M. (2012). *Risk assessment of groundwater contamination from hydraulic fracturing fluid spills in Pennsylvania* (Thesis S.M. in Technology and Policy). Cambridge, MA: Massachusetts Institute of Technology, Engineering Systems Division, Technology and Policy Program. Retrieved from http://hdl.handle.net/1721.1/72885

Ground Water Protection Council & ALL Consulting. (2009). *Modern shale gas development in the United States: A primer*. Oklahoma City, OK. Retrieved from http://www.gwpc.org/resources/publications

Ground Water Protection Council & International Oil & Gas Compact Commission. (2016). *FracFocus chemical disclosure registry*. Retrieved from https://fracfocus.org/

Hansen J., Sato, M., Ruedy, R., Lo, K., Lea, D.W., & Medina-Elizade, M. (2006). Global temperature change. *Proceedings of the National Academy of Sciences 103*(39), 14288-14293. National Academy of Sciences of the United States. Retrieved from www.pnas.orgcgidoi10.1073pnas.0606291103

Hayes, D. J. (2012). Is the recent increase in felt earthquakes in the Central US natural or manmade? Retrieved from https://www.doi.gov/blog/Is-the-Recent-Increase-in-Felt-Earthquakes-in-the-Central-US-Natural-or-Manmade

ICF International. (2009). Technical Assistance for the Draft Supplemental Generic EIS: Oil and Gas and Solution Mining Regulatory Program. New York: New York State Energy Research and Development Authority (NYSERDA). Retrieved from: https://www.regulations.gov/document?D=EPA-HQ-ORD-2010-0674-1624

Intergovernmental Panel on Climate Change (IPCC). (2006). *2006 IPCC guidelines for national greenhouse gas inventories*. Task Force on National Greenhouse Gas Inventories. Retrieved from http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

Intergovernmental Panel on Climate Change (IPCC). (2007). *Climate change 2007: Mitigation, contribution of working group III to the fourth assessment report of the Intergovernmental Panel on Climate Change* [B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, L. A. Meyer (eds.)]. Cambridge, UK and New York, NY: Cambridge University Press. Retrieved from: http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg3_report_mitigation_of_climate_change.htm

Intergovernmental Panel on Climate Change(IPCC). (2016). Infographic: The Global Carbon Budget. http://www.wri.org/ipcc-infographics

Institute of Medicine (IOM) . (2014). Fracturing: Accessing shale and tight gas. David Cole, M.S. In C. Coussens and R. M. Martinez (eds.), *Health impact assessment of shale gas extraction: Workshop summary,* 17-22. Washington, DC: The National Academies Press. Retrieved from http://www.nap.edu/catalog/18376/health-impact-assessment-of-shale-gas-extraction-workshop-summary

Jiang, M., Griffin, W. M, Hendrickson, C., Jaramillo, P., VanBriesen, J., & Venkatesh, A. (2011). Life cycle greenhouse gas emissions of Marcellus shale gas. *Environmental Research Letters*, *6*(3), 1-10. Retrieved from: http://dx.doi.org/10.1088/1748-9326/6/3/034014
* Supplementary Data retrieved from http://iopscience.iop.org/1748-9326/6/3/034014/media/erl381437suppdata.pdf

Kleinheinz & Associates. (2011). *Ohio's natural gas and crude oil exploration and production industry and emerging Utica gas formation economic impact study*. Ohio: Ohio Oil and Gas Energy Education Program. Retrieved from https://energyindepth.org/wp-content/uploads/ohio/2011/09/Ohio-Natural-Gas-and-Crude-Oil-Industry-Economic-Impact-Study-September-2011.pdf

King, G. E. (2012). *Hydraulic fracturing 101: What every representative, environmentalist, regulator, reporter, investor, university researcher, neighbor and engineer should know about estimating frac risk and improving frac performance in unconventional gas and oil wells*. SPE 152596. The Woodlands, TX: SPE (Society for Petroleum Engineers) Hydraulic Fracturing Technology Conference, 6-8 February, 2012. Retrieved from https://www.bucknell.edu/script/environmentalcenter/marcellus/default.aspx?articleid=B6GAKZRAOQYKMB9YCSTFEFQ7Z

Lendel, I., Thomas, A. R., Townley, B., Murphy, T., & Kalynchuk, K. (2015). Economics of Utica shale in Ohio: Workforce analysis. *Urban Publications.* Paper 1330. Cleveland, OH: Cleveland State University. Retrieved from http://engagedscholarship.csuohio.edu/urban_facpub/1330/

Malm, W. C. (1999). *Introduction to visibility*. National Park Service Air Resources Division and Cooperative Institute for Research in the Atmosphere (CIRA). NPS Visibility Program. Under Cooperative Agreement CA2350-97-001: T097-04, T098-06. Fort Collins, CO: Colorado State University. Retrieved from https://www.epa.gov/visibility/introduction-visibility

Malm, W. C., Schichtel, B. A., Barna, M. G., Gebhart, K. A., Rodriguez, M. A., Collett, Jr., J. L.,…S. M., Kreidenweis. (2013). Aerosol species concentrations and source apportionment of ammonia at Rocky Mountain National Park. In *Journal of the Air & Waste Management Association*, *63*(11), 1245-1263. doi: 10.1080/10962247.2013.804466

National Aeronautics and Space Administration Goddard Institute for Space Studies (NASA). (2007). *GISS surface temperature analysis*. Retrieved from http://data.giss.nasa.gov/gistemp/2007/

National Oceanic and Atmospheric Administration (NOAA). (2016). *Climatological rankings*. Asheville, NC: National Centers for Environmental Information. Retrieved from http://www.ncdc.noaa.gov/temp-and-precip/climatological-rankings/index.php?periods%5B%5D=60&parameter=tavg&state=33&div=0&month=1&year=2016#ranks-form

National Conference of State Legislatures (NCSL). (2008). *Ohio, Assessing the costs of climate change*. Retrieved from http://cier.umd.edu/climateadaptation/Climate%20change--OHIO.pdf

New York State Department of Environmental Conservation (NYSDEC). (2009). *2009 Draft Supplemental Generic Environmental Impact Statement for Oil, Gas and Solution Mining.* New York: New York State of Environmental Conservation. Retrieved from http://www.dec.ny.gov/energy/75370.html

Ohio Department of Agriculture (ODA). (2016). *Plant Health Division - Emerald Ash Borer*. Reynoldsburg, OH: Ohio Department of Agriculture. Retrieved from http://www.agri.ohio.gov/divs/plant/eab/eab-index.aspx#tog

Ohio Department of Natural Resources (ODNR). (2002). *Groundwater pollution potential, Washington County, Ohio* (GIS data file). Columbus, OH: Ohio Department of Natural Resources. Retrieved from http://geospatial.ohiodnr.gov/data-metadata/search-by-category

Ohio Department of Natural Resources (ODNR). (2014). Recent Earthquake Epicenters in Ohio (map). Columbus, Ohio: Ohio Department of Natural Resources. Retrieved from http://oilandgas.ohiodnr.gov/shale#SEIS.

Ohio Department of Natural Resources (ODNR). (2015a). *Acid mine drainage abatement program*. Columbus, OH: Division of Mineral Resources. Retrieved from http://minerals.ohiodnr.gov/abandoned-mine-land-reclamation/acid-mine-drainage#AMD

Ohio Department of Natural Resources (ODNR). (2015b). *Water well locations in Monroe County, Ohio* (GIS data file). Columbus, OH: Ohio Department of Natural Resources. Retrieved from http://geospatial.ohiodnr.gov/data-metadata/search-by-category

Ohio Department of Natural Resources (ODNR). (2015c). *Water well locations in Washington County, Ohio* (GIS data file). Columbus, OH: Ohio Department of Natural Resources. Retrieved from http://geospatial.ohiodnr.gov/data-metadata/search-by-category

Ohio Department of Natural Resources (ODNR). (2016a). *Abandoned mine land and reclamation programs*. Columbus, OH: Division of Mineral Resources. Retrieved from http://minerals.ohiodnr.gov/abandoned-mine-land-reclamation/aml-reclamation-programs#BAC

Ohio Department of Natural Resources (ODNR). (2016b). *Deer harvest numbers*. Columbus, OH: Ohio Department of Natural Resources. Retrieved from http://wildlife.ohiodnr.gov/hunting-trapping-and-shooting-sports/hunting-resources-by-species/deer/deer-harvest-yearly-comparison

Ohio Department of Natural Resources (ODNR). (2016c). *Diversion & Withdrawal Regulation*. Columbus, OH: Ohio Department of Natural Resources. Retrieved from http://water.ohiodnr.gov/water-use-planning/diversion-withdrawal-regulation#WIT

Ohio Environmental Protection Agency. (2011). *Analysis of visibility impacts of BART-eligible sources on the regional scale*. Columbus, OH: Division of Air Pollution Control. Retrieved from http://www.epa.ohio.gov/portals/27/SIP/regional/D1-BART_TSD_edited_2011-clean.pd

Ohio Environmental Protection Agency. (2015). *State of Ohio nonattainment area state implementation plan and demonstration of attainment for 1-hour SO2 nonattainment areas.* Retrieved from http://epa.ohio.gov/portals/27/SIP/SO2/2010SO2_AttainDemo_Final.pdf

Ohio Environmental Protection Agency. (2016). *Ohio integrated water quality monitoring and assessment report*. Columbus, OH: Division of Surface Water. Retrieved from http://epa.ohio.gov/dsw/tmdl/OhioIntegratedReport.aspx#156069519-report

Ohio Oil and Gas Association (OOGA). (n.d.). *Ohio shale plays*. Retrieved from http://www.ooga.org/?page=OhioShalePlays

Ohio Oil and Gas Energy Education Program. (2016). *That was then … This is now!*. Retrieved from http://oogeep.org/teachers-students/history/

Ohio University and The Ohio State University. (2011). *Assuring Ohio's competitiveness in a carbon-constrained world*: *A collaboration between Ohio University and the Ohio State University*. Columbus, OH: Ohio Department of Development. Retrieved from http://ohioenergyresources.com/index.aspx

Pickett, A. (2011). *Vast Resource Potential Has Operators Gearing Up to Test Utica Shale Formation*. American Oil & Gas Reporter. Retrieved from http://www.aogr.com/magazine

Ramanathan, V., & Carmichael, G. (2008). Global and regional climate changes due to black carbon. In *Nature Geoscience, 1*, 221-227. doi:10.1038/ngeo156

Reed, M. (2014). *Hiking Ohio: A guide to the state's greatest hikes*. Guilford, CT: Globe Pequot Press.

Rogers, J. (n.d.). *Climate of Ohio*. Retrieved from http://www.geography.ohio-state.edu/faculty/rogers/OOC.pdf

Rubenstein, J. L., & Mahani, A. B. (2015). Myths and facts on wastewater injection, Hydraulic fracturing, Enhanced oil recovery, and induced seismicity. SRL Early Edition. *Seismological Research Letters 86*(4), 1-8. Retrieved from https://profile.usgs.gov/myscience/upload_folder/ci2015Jun1012005755600Induced_EQs_Review.pdf

Schiefer, M. C. (2002). *Basin descriptions and flow characteristics of Ohio streams*. Columbus, OH: Ohio Department of Natural Resources, Division of Water. Retrieved from https://water.ohiodnr.gov/portals/soilwater/pdf/stream/Bulletin47.pdf

Shonkoff, S. B. C., Hays, J., & Finkel, M. L. (2014). Environmental public health dimensions of shale and tight gas development. In *Environmental Health Perspectives, 122*(8), 787-795. doi:10.1289/ehp.1307866

Soeder, D. J., & Kappel, W. M. (2009). *Water resources and natural gas production from the Marcellus Shale*: *U.S. Geological Survey fact sheet 2009–3032*. U.S. Geological Survey: West Trenton Publishing Service Center. Retrieved from http://pubs.usgs.gov/fs/2009/3032/

Stucker, J.D., compiler. (2015). *2014 Report on Ohio mineral industries—An annual summary of the state's economic geology*. Columbus, OH: Department of Natural Resources, Division of Geological Survey. Retrieved from http://geosurvey.ohiodnr.gov/mineral-resources/minerals-home

The Guardian. (2011). *What are CO2e and global warming potential (GWP)?* Retrieved from: https://www.theguardian.com/environment/2011/apr/27/co2e-global-warming-potential

Thomas, A. R., Lendel, I., Hill, E. W., Southgate, D., & Chase, R. (2012). An analysis of the economic potential for shale formations in Ohio. *Urban Publications*. Paper 453. Cleveland, OH: Cleveland State University. Retrieved from http://engagedscholarship.csuohio.edu/urban_facpub/453/

Thompson, T. (2012). U.S. Forest Service white paper. A summary of the groundwater resources of the Wayne National Forest. *Supplemental information report - Horizontal drilling using high volume hydraulic fracturing - Appendix F.* Retrieved from http://www.fs.usda.gov/detail/wayne/landmanagement/planning/?cid=stelprdb5387922

Throupe, R., Simons, R. A., & Mao, X. (2013). A review of "Hydrofracking" and its potential effect on real estate. In *Journal of Real Estate Literature*, *21*(2), 205-232. Retrieved from https://energyindepth.org/wp-content/uploads/2014/09/A-review-of-hydrofracking-and-its-potential-effects-on-real-estate.pdf

Tillman, D., Hill, J., & Lehman, C. (2006). Carbon-negative biofuels from low-input high-diversity grassland biomass. *Science*, *314*(5805), 1598-1600. Retrieved from: https://dx.doi.org/10.1126/science.1133306

University of Colorado at Boulder. (2015). *Public health in oil and gas development*. Boulder, CO: Intermountain Oil and Gas BMP Project. Retrieved from http://www.oilandgasbmps.org/resources/public_health.php

URS Corporation. (2010). *Climate change supplementary information report, Montana, North Dakota and South Dakota Bureau of Land Management*. Denver, CO. Retrieved from http://www.blm.gov/mt/st/en/prog/energy/oil_and_gas/leasing/leasingEAs.html

U.S. Climate Data. (2016). *Climate Ohio-Columbus*. Retrieved from http://www.usclimatedata.com/climate/ohio/united-states/3205

U.S. Department of Agriculture (USDA). (1996). *Riparian areas environmental uniqueness, functions, and values*. Washington, DC: Natural Resources Conservation Service. Retrieved from http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/?cid=nrcs143_014199

U.S. Department of Agriculture, U.S. Department of Interior, & U.S. Environmental Protection Agency (USDA, USDOI, & USEPA). (2011). *Memorandum of Understanding among the U.S. Department of Agriculture, U.S. Department of Interior, & U.S. Environmental Protection Agency Regarding air quality analysis and mitigation for federal oil and gas decisions through the National*

Environmental Policy Act process. Retrieved from https://www.epa.gov/nepa/air-quality-guidance-national-environmental-policy-act-reviews

U.S. Energy Information Administration. (2016). *State carbon dioxide emissions*. Washington, DC: Department of Energy. Retrieved from http://www.eia.gov/environment/emissions/state/

U.S. Environmental Protection Agency (USEPA). (1999). 64 FR 32610 - National emissions standards for hazardous air pollutants: Oil and natural gas production and national emission standards for hazardous air pollutants: Natural gas transmission and storage. *Federal Register*, *64*(116), 32610-32664. Retrieved from https://www.gpo.gov/fdsys/search/pagedetails.action?granuleId=99-12894&packageId=FR-1999-06-17&acCode=FR&collectionCode=FR

U.S. Environmental Protection Agency (USEPA). (2002). *Exemption of oil and gas exploration and production wastes from federal hazardous waste regulations*. EPA530-K-01-004. October 2002. Washington, DC: Office of Solid Waste (5305W). Retrieved from http://www3.epa.gov/epawaste/nonhaz/industrial/special/oil/

U.S. Environmental Protection Agency (USEPA). (2012). *Report to Congress on black carbon*. *Department of the Interior, Environment, and Related Agencies Appropriations Act, 2010*. EPA-450/R-12-001. March 2012. Research Triangle, NC: Office of Air and Radiation and Office of Air Quality Planning and Standards. Retrieved from https://www3.epa.gov/blackcarbon/

U.S. Environmental Protection Agency (USEPA). (2013). *Greenhouse gas reporting program*. Retrieved from http://www.epa.gov/ghgreporting/reporters/subpart/w.html

U.S. Environmental Protection Agency (USEPA). (2015a). *Hazardous air pollutants*. Retrieved from http://www.epa.gov/haps

U.S. Environmental Protection Agency (USEPA). (2015b). *Prevention of Significant Deterioration (PSD) basic information.* Retrieved from http://www.epa.gov/nsr/prevention-significant-deterioration-basic-information

U.S. Environmental Protection Agency (USEPA). (2016a). *Air pollution emissions overview*. Retrieved from https://www3.epa.gov/airquality/emissns.html

U.S. Environmental Protection Agency (USEPA). (2016b). *Air quality trends*. Retrieved from https://www3.epa.gov/airtrends/aqtrends.html

U.S. Environmental Protection Agency (USEPA). (2016c). *Cross-State Air Pollution Rule (CSAPR)*. Retrieved from http://www.epa.gov/airtransport/CSAPR/

U.S. Environmental Protection Agency (USEPA). (2016d). *Little Muskingum-Middle Island watershed – 05030201*. Retrieved from https://cfpub.epa.gov/surf/huc.cfm?huc_code=05030201

U.S. Environmental Protection Agency (USEPA). (2016e). *NAAQS table.* Retrieved from https://www.epa.gov/criteria-air-pollutants/naaqs-table

U.S. Environmental Protection Agency (USEPA). (2016f). *Ohio nonattainment/maintenance status for each county by year for all criteria pollutants*. Retrieved from http://www3.epa.gov/airquality/greenbook/anayo_oh.html

U.S. Environmental Protection Agency (USEPA). (2016g). *Section 112(a)-Definitions*. Retrieved from https://www3.epa.gov/airtoxics/112a_def.html

U.S. Environmental Protection Agency (USEPA). (2016h). *Understanding global warming potentials*. Retrieved from https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

U.S. Environmental Protection Agency (USEPA). (2016i). *U.S. greenhouse gas inventory report, 1990-2014*. Retrieved from https://www.epa.gov/ghgemissions/us-greenhouse-gas-inventory-report-1990-2014

U.S. Environmental Protection Agency (USEPA). (2016j). *Visibility - Regional haze program*. Retrieved from https://www.epa.gov/visibility/visibility-regional-haze-program

U.S. Fish and Wildlife Service (USFWS). (2005). *Biological Opinion on the Wayne National Forest Land and Resource Management Plan for the Federally-Listed Endangered Indiana Bat (Myotis sodalis) and Running Buffalo Clover (Trifolium soloniferum)*. Retrieved from http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm9_005683.pdf.

U.S. Fish and Wildlife Service (USFWS). (2011). Letter from United States Department of the Interior, Fish and Wildlife Service to DeVela J. Clark, District Ranger, Wayne National Forest, Athens Ranger District. Re: Proposed Pleasant Bear Vegetation Management Project, Marietta Unit, Athens District, WNF. Retrieved from https://www.fws.gov/midwest/endangered/mammals/inba/inbaBOs.html

U.S. Fish and Wildlife Service (USFWS). (2016). *Programmatic biological opinion on final 4(d) rule for the Northern Long-eared Bat and activities excepted from take prohibitions*. Bloomington, MN: Ecological Services Midwest Region. Retrieved from http://www.fws.gov/midwest/endangered/mammals/nleb/

U.S. Forest Service (USFS). (1995). *Landscape aesthetics: A handbook for scenery management*. Agriculture Handbook Number 701. Retrieved from http://www.fs.usda.gov/detail/tonto/landmanagement/planning/?cid=stelprdb5412120

U.S. Forest Service (USFS). (2005). *Final Environmental Impact Statement for the Revised Land and Resource Management Plan, Wayne National Forest*. Milwaukee, WI: Eastern Region. Retrieved from http://www.fs.usda.gov/main/wayne/landmanagement/planning

U.S. Forest Service (USFS). (2006). *Final Revised Land and Resource Management Plan, Wayne National Forest*. Milwaukee, WI: Eastern Region. Retrieved from http://www.fs.usda.gov/main/wayne/landmanagement/planning

U.S. Forest Service (USFS). (2012). *Supplemental information report - Horizontal drilling using high volume hydraulic fracturing*. Nelsonville, OH: Wayne National Forest. Retrieved from http://www.fs.usda.gov/detail/wayne/landmanagement/planning/?cid=stelprdb5387922

U.S. Forest Service (USFS). (2014). *Marietta unit - Motor vehicle use map*. Nelsonville, OH: Wayne National Forest. Retrieved from http://www.fs.usda.gov/main/wayne/maps-pubs

U.S. Forest Service (USFS). (2015). *Covered Bridge Scenic Byway* (brochure). Nelsonville, OH: Wayne National Forest.

U.S. Forest Service (USFS). (2016a). *Hune Bridge Campground*. Nelsonville, OH: Wayne National Forest. Retrieved from http://www.fs.usda.gov/recarea/wayne/recarea/?recid=6218

U.S. Forest Service (USFS). (2016b). *Lane Farm Campground*. Nelsonville, OH: Wayne National Forest. Retrieved from http://www.fs.usda.gov/recarea/wayne/recreation/wateractivities/recarea/?recid=6217&actid=79

U.S. Forest Service (USFS). (2016c). *Payments to counties*. Nelsonville, OH: Wayne National Forest. Retrieved from: http://www.fs.usda.gov/detailfull/wayne/landmanagement/resourcemanagement/?cid=fsm9_005978&width=full

U.S. Forest Service (USFS). (2016d). *Recreation*. Nelsonville, OH: Wayne National Forest. Retrieved from http://www.fs.usda.gov/recmain/wayne/recreation

U.S. Forest Service (USFS). (2016e). *Walter Ring House*. Nelsonville, OH: Wayne National Forest. Retrieved from http://www.fs.usda.gov/detailfull/wayne/specialplaces/?cid=fsm9_006037&width=full

U.S. Forest Service (USFS). (2016f). *Administration of oil and natural gas activities*. Nelsonville, OH: Wayne National Forest. Retrieved from http://www.fs.usda.gov/detail/wayne/home/?cid=stelprdb5376502

U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service. (USFS & USFWS) (2010). Federal land managers' air quality related values work group (FLAG): phase I report—revised (2010). Natural Resource Report NPS/NRPC/NRR—2010/232. Denver, CO: National Park Service. Retrieved from http://www.nature.nps.gov/air/Permits/flag/

Wenzel, C. (2012). *A case study—Hydraulic fracturing geography: The case of the Eagle Ford Shale, TX, USA* (Thesis M.S.). San Marcos, TX: Texas State University-San Marcos, Department of Geography. Retrieved from https://digital.library.txstate.edu/handle/10877/4247

Wickstrom, L. H., Riley, R. A., Erenpreiss, M. S., & Perry, C. J. (2012). *Geologic overview and activity update for the Utica-Point Pleasant shale play in Ohio*. Search and Discovery Article #10409, American Association of Petroleum Geologist Data Pages, 25 June 2012. Columbus, OH: Ohio Department of Natural Resources, Division of Geological Survey. Retrieved from http://www.searchanddiscovery.com/pdfz/documents/2012/10409wickstrom/ndx_wickstrom.pdf.html

9. APPENDICES

Appendix A: Public Comment Matrix

Issue/ Condensed Comment	Response
Air/ Climate Change/ GHGs	
BLM has failed to take a hard look at potential impacts to air quality. The Draft EA does not adequately assess all of the potential sources of air emissions, nor does it fully evaluate the impacts on air quality from future oil and gas operations. For example, the EA failed to adequately discuss: ● volatile organic compounds (VOCs) emissions from vehicles, diesel emissions from trucks (approximately 1,800 heavy truckloads, on average, which are delivered to/from the wellhead of every typical fracking well) ● Methane gas ● Fugitive emissions from tanks, pipelines ● Emissions from hydraulic fracturing (for example: mixing of chemicals; use of silica or sand as a proppant; and the storage of frack fluid) ● Emissions from Evaporation pits The EA also does not include adequate enforceable mitigation measures to ensure there would be no significant impacts to air resources.	Sections 3.2 and 4.2 in the Final EA discuss the potential sources of air emissions associated with reasonably foreseeable future oil and gas development in the Marietta Unit as well as the potential effects of those emissions. For example, Section 4.2.1 of the EA discloses that there are various sources of air emissions from potential mineral development, including VOCs, methane, fugitive emissions, and emissions associated with hydraulic fracturing. As stated in Section 4.3.8.1 (Federally endangered or threatened species), the Forest Service would require the use of closed-loop systems (i.e., tanks instead of open pits); however, evaporation pits may be used on private land in compliance with Ohio regulations. The air quality analysis in the Final EA has been updated to include quantified estimates of potential air emissions from the production and pre-production phase of potential oil and gas development. The climate change sections of the EA (Sections 3.2.5 and 4.2.3) have also been updated to include a quantification of potential greenhouse gas emissions associated with potential future mineral development and how it relates to climate change. Section 4.2.4 of the EA includes a list of best management practices, standard operating procedures, and mitigations for minimizing air emissions. Operators are required to ensure their actions do not violate any federal or state air quality standards. As the Interior Board of Land Appeals (IBLA) determined in Powder River Basin Resource Council, 183 IBLA 83, 95 (December 21, 2012), "BLM properly may rely on the state, which is subject to oversight by the USEPA, to ensure permitted activities do not exceed or violate any State or Federal air quality standard under the Clean Air Act (CAA)." Section 3.2.1 of the Final EA explains the various Ohio laws implementing the CAA. The BLM has taken the requisite "hard look" at air quality in compliance with NEPA, utilizing data that is available at the leasing stage. Further detailed NEPA analysis,

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	including air quality analysis, would be conducted at the Application for Permit to Drill (APD) stage when specific design details are known.
Oil & gas activities are exempted from major source pollution rules and are not monitored or regulated in Ohio.	Operators are required to ensure their actions do not violate any federal or state air quality standards. Appendix C, a new appendix added to the Final EA, summarizes Ohio's oversight over emissions from oil and gas operations (page 155). The Ohio Environmental Protection Agency (EPA) air pollution regulations are located in the Ohio Administrative Code (OAC) in Chapters 3745-14 to 3745-26, 3745-31, 3745-71 to 3745-80, 3745-100 to 3745-105, 3745-108, 3745-109, and 3745-112 to 3745-114.
The Draft EA should be informed by air modeling to show where the air pollution will flow.	Sections 3.2 and 4.2 in the Final EA discuss the potential sources of air emissions associated with reasonably foreseeable future oil and gas development in the Marietta Unit as well as the potential effects of those emissions. The BLM has revised the EA to include a quantified estimate of potential greenhouse gas emissions, but has elected not to conduct air modeling. Air modeling at the leasing stage would not provide meaningful information since specific development plans are not yet known. The output of a model is determined by the quality of the input data, and the BLM believes that air modeling at this time would be too speculative. Furthermore, the results of air modeling would not likely change the overall conclusion regarding the anticipated magnitude of effects of the Proposed Action. Further detailed NEPA analysis, including air quality analysis, would be conducted at the Application for Permit to Drill (APD) stage. At that time, the BLM will reassess whether air modeling is appropriate or necessary to make an informed decision.
The BLM cannot defer detailed analysis of air quality until the APD stage.	Sections 3.2 and 4.2 in the Final EA discuss the potential sources of air emissions associated with reasonably foreseeable future oil and gas development in the Marietta Unit as well as the potential effects of those emissions. The BLM has revised the EA to include a quantified estimate of potential greenhouse gas emissions, but has elected not to conduct air modeling. Air modeling at the leasing stage would not provide

Issue/ Condensed Comment	Response
	meaningful information since specific development plans are not yet known. The output of a model is determined by the quality of the input data, and the BLM believes that air modeling at this time would be too speculative. Furthermore, the results of air modeling would not likely change the overall conclusion regarding the anticipated magnitude of effects of the Proposed Action. Further detailed NEPA analysis, including air quality analysis, would be conducted at the Application for Permit to Drill (APD) stage. At that time, the BLM will reassess whether air modeling is appropriate or necessary to make an informed decision.
The Draft EA did not adequately assess potential impacts to climate change from future oil and gas operations. ● The Draft EA should have included a quantified analysis of greenhouse gas emissions (GHGs) from oil and gas development and combustion. BLM has the information available to make an attempt to quantify GHGs (ex: Ohio production data, USEPA tools) ● Impacts from oil and gas development and the relationship to climate change must be evaluated Forest-wide ● BLM deliberately minimizes potential GHG impacts by comparing to the global volume of GHGs ● Any GHG emissions, no matter how small, are potentially significant. ● The BLM violates NEPA by not incorporating mitigation measures to reduce the GHG effects. The EA for a recent lease sale in Utah undercuts BLM's assertion that GHGs	The BLM has revised both the air quality and climate change sections of the EA (see Sections 3.2 and 4.2), which includes quantified estimates of greenhouse gas emissions as well as qualitative discussions on the types of emissions that could occur as a result of reasonably foreseeable mineral development. Emissions that are considered "downstream" emissions, including the end uses of oil and gas (i.e., combustion), were not calculated within this EA due to the high degree of uncertainty associated with possible end use. Direct links to climate change are uncertain. The inconsistency in results of scientific models used to predict climate change at the global scale coupled with the lack of scientific models designed to predict climate change on regional or local scales, limits the ability to directly associate potential mineral development in the Marietta Unit with measureable changes in climate. The BLM has reviewed the Council on Environmental Quality (CEQ) 2016 final guidance on greenhouse gas emissions and climate change and believes the Final EA is consistent with these documents in terms of the approach taken to assess potential impacts from greenhouse gas emissions and on climate change.

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cannot be quantified at the leasing stage for the Wayne National Forest. CEQ and the courts have cautioned federal agencies that they cannot ignore climate change generally, or the combustion impacts of fossil fuel extraction.	
The Draft EA did not include more up to date research on climate change in Ohio.	Section 3.2.6 (Ohio Climate) of the Final EA has been updated.
The Draft EA contains no data on air contamination (associated with hydraulic fracturing) in Ohio.	The BLM has revised both the air quality and climate change sections of the EA (see Sections 3.2 and 4.2), which includes quantified estimates of greenhouse gas emissions as well as qualitative discussions on the types of emissions that could occur as a result of reasonably foreseeable mineral development. The new analysis in the Final EA accounts for potential emissions associated with hydraulic fracturing.
Editorial: Table 3.2 only addresses Washington County	Washington County is the only one of the three counties (where the Proposed Action would take place) that is currently in non-attainment for any of the criteria air pollutants (Sulfur Dioxide).
The Draft EA does not discuss policies which are not market-driven, and there is no integration of BLM oil and gas leasing with the U.S. international treaty commitments respecting reductions in fossil fuel usage and emission reduction targets.	Agencies continue to have substantial discretion in how they tailor their NEPA processes to accommodate emissions targets, consistent with the CEQ Regulations and their respective implementing regulation and policies, so long as they provide the public and decision makers with explanations of the basis for their determinations.
The Draft EA does not incorporate the U.S. EPA latest inventory of U.S. Greenhouse Gas Emissions and Sinks. This report indicates that methane gas from the natural gas industry has decreased since 1990.	The Final EA was edited in Section 3.2.5.1 to include data and a reference to this report.
Water	
The Draft EA contains no data on water consumption and pollution (associated with hydraulic fracturing).	The 2006 Forest Plan/EIS and 2012 SIR have detailed analysis on all water resources and the impact of development on the resources. The Final EA references the SIR on the average water withdrawal/consumption associated with hydraulic fracturing in Section 3.6.1.2.

Issue/ Condensed Comment	Response
	The EA includes a table (Table 3.9) portraying water quality within the Marietta Unit. As described in Section 4.6.1 of the Final EA, there could be effects to surface water quality from reasonable foreseeable oil and gas development but effects would be minimized through Forest Service protections, best management practices, and lease stipulations. Further analysis will be conducted at the APD stage.
The Draft EA does not fully and accurately evaluate the surface water and groundwater resource impacts of potential oil and gas operations.	The Final EA discusses the potential effects to surface water and groundwater, as well as potential cumulative effects (see Sections 3.6, 4.6, and 4.16.2.3). Before hydraulic fracturing takes place, all surface casing and some deeper, intermediate zones are required to be cemented from the bottom of the cased hole to the surface in accordance to Onshore Oil and Gas Order No. 2. The cemented well is pressure tested to ensure there are no leaks and a cement bond log is run to ensure the cement has bonded to the casing and the formation. The Ohio Department of Natural Resources (ODNR) requires new and existing wells that will be stimulated by hydraulic fracturing must demonstrate suitable and safe mechanical configuration for the stimulation treatment proposed. This would ensure that no groundwater gets contaminated.
The Draft EA does not adequately describe Forest Service policies for water protection.	Sections 4.6.1 and 4.6.2 of the Final EA refer the reader to the Safety Measures and Guidelines that the Forest Service incorporated in their 2006 Plan/EIS and 2012 SIR.
The EA does not address the long term impacts of hydraulic fracturing on the region (including the Athens and Ironton Units), including: ● water withdrawals – aquifers, aquatic life, water quantity ● waste production and disposal ● potential contamination to water resources (accidental spills, unmapped aquifers, contamination from drilling mud) ● impacts on ecosystems and watersheds and how these impacts could affect wildlife and threatened and endangered	The Final EA provides a comprehensive discussion of potential impacts associated with hydraulic fracturing in the Marietta Unit (see Sections 4.4, 4.6, 4.7, and 4.16). The EA does not address potential impacts of leasing and potential future mineral development within the Athens and Ironton Units because these actions, if they occur, would occur independently from the Proposed Action and are not connected actions. Before hydraulic fracturing takes place, all surface casing and some deeper, intermediate zones are required to be cemented from the bottom of the cased hole to the surface in accordance to Onshore Oil and Gas Order No. 2. The cemented well is pressure tested to ensure there are no leaks and a cement bond log is run to ensure the cement has bonded to the casing and the formation. For

Issue/ Condensed Comment	Response
species.	wells on private surface accessing private minerals the ODNR requires that all wells, which will be stimulated by hydraulic fracturing, demonstrate suitable and safe mechanical configuration for the stimulation treatment proposed. This would ensure that no groundwater gets contaminated.
There is no Ohio legislation that regulates water withdrawals. It is unclear which agency will oversee the extraction of water for mineral development, particularly if it occurs on private land.	Appendix C, pages 149-150, addresses Ohio Department of Natural Resources (ODNR) oversight of water withdrawals. Appendix C is a new appendix that has been added to the Final EA.
The Draft EA (groundwater quality section) fails to acknowledge studies suggesting that frack wells – and injection wells – can contaminate groundwater sources for drinking water (USEPA's Draft Investigation of Groundwater Contamination near Pavilion, Wyoming). These results have been confirmed with follow up studies. Ohio does not require monitoring of groundwater quality near injection wells.	The EA does acknowledge the risk of groundwater contamination due to hydraulic fracturing wells but also states that that before hydraulic fracturing takes place, all surface casing and some deeper, intermediate zones are required to be cemented from the bottom of the cased hole to the surface in accordance with Onshore Oil and Gas Order No. 2, which would make contamination highly unlikely as stated in Section 2.2.1. The cemented well is pressure tested to ensure there are no leaks and a cement bond log is run to ensure the cement has bonded to the casing and the formation. All Federal and State regulations concerning water are discussed in the 2006 Forest Plan/EIS and 2012 SIR. Both Federal and State regulations require new and existing wells, which will be stimulated by hydraulic fracturing, demonstrate suitable and safe mechanical configuration for the stimulation treatment proposed.
The BLM should have studied the rates of well casing failures over time and evaluate the likelihood that well casing failures can lead to groundwater contamination.	The Society of Petroleum Engineers has conducted studies on well failure rates and found them to be extremely low. Well failures are extremely rare. A well is comprised of about seven layers of thick steel and cement, each of which has a specific role in protecting the groundwater. For a well to leak every layer would have to break and leak. In 2011 the Groundwater Protection Council study found that the failure rates for wells in Ohio was less than .03 percent.
The Draft EA fails to mention that water from precipitation and snowmelt can serve as an avenue through which contaminants travel from an operation site to sensitive areas, including	The Final EA discusses atmospheric deposition in Section 3.2.3 and potential impacts to surface water from runoff in Section 4.6.1.1.

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population centers. Contaminated water runoff may seep into residential areas, polluting streets, sidewalks, soil, and vegetation in urban areas, adversely affecting human health.	
The Draft EA incorrectly states that there would be no direct impacts since there is no ground disturbance at this time. Groundwater contamination can occur without surface disturbing activities.	The Final EA states that there would be no groundwater contamination as the direct result of leasing, which is an administrative action. The Final EA, Section 4.6, discusses the potential effects to groundwater from reasonably foreseeable oil and gas development.
The BLM has ignored the fact that the water sacrificed for fracking has limited reuse potential, but in the end, is irredeemable.	This fact was acknowledged within the Final EA in Section 2.2.1
The Draft EA should consider including reference to a recent University of Cincinnati study that found "no evidence for natural gas contamination from shale oil and gas mining in any of the sampled groundwater wells of our study."	In 2011 a Duke University study failed to show a connection between hydraulic fracturing and groundwater contamination. The University of Cincinnati study is a multi-year, ongoing study and the results were not published at the time the Final EA was written.
References to "cement bond logs" in the EA should be replaced with "cement evaluation tools" or "cement evaluation logs" to ensure clarity and eliminate potential conflicts with BLM regulations.	The terminology was not changed in the Final EA. A cement bond log documents the method of the evaluation used to insure the integrity of the cementing job done on a well.
Geology/Minerals/Soils	
The Draft EA did not assess the potentially significant impacts of horizontal hydraulic fracturing of the deep shale formations that lie beneath the WNF. The EA also does not include a discussion of the potential impacts of hydraulic fracturing on specific geological formations.	The methods and potential effects of hydraulic fracturing on geology are discussed in several places in the Final EA (see Sections 2.2.1, 3.4, 4.4). The impacts of hydraulic fracturing on deep shale formations have been evaluated in numerous studies, and based on the results of these studies; the BLM believes there would be no significant impacts associated with hydraulic fracturing for potential future oil and gas development in the Marietta Unit. Further analysis will be conducted at an APD stage in regards to geology and hydraulic fracturing.
The Draft EA does not fully and accurately evaluate the potential effects from contamination permeating the geologic formations under the WNF. For example, frack wells are known to lead	The Final EA includes a comprehensive discussion of potential effects of hydraulic fracturing (see Sections 4.4, 4.6, 4.7, and 4.16). Before hydraulic fracturing takes place, all surface casing and some deeper, intermediate zones are required to be cemented from the bottom of the

Issue/ Condensed Comment	Response
to migration of gas and frack chemicals up to miles from injection. Geology under WNF is highly fractured and permeable.	cased hole to the surface in accordance to Onshore Oil and Gas Order No.2. The cemented well is pressure tested to ensure there are no leaks and a cement bond log is run to ensure the cement has bonded to the casing and the formation. The Onshore Order No. 2 is discussed in Section 3.8 of the Final EA.
Draft EA does not fully and accurately evaluate the geologic/seismic risks (including locations of faults) of potential oil and gas operations. The Draft EA does not include: the background seismicity of oil- and gas-bearing lands including the history of earthquake size and frequency, fault structure, seismicity rates, failure mechanisms, and state of stress of faults, the geology of oil- and gas-bearing lands including pore pressure, formation permeability, and hydrological connectivity to deeper faults; the hazards to human communities and infrastructure from induced seismic activity; how the distance from a well to a fault affects seismic risk, how fluid injection and extraction volumes, rates, and pressures affect seismic risk; how the density of wells affects seismic risk, the time period following the initiation of injection or extraction activities over which earthquakes can be induced, extraction or injection activities affects induced seismicity, the largest earthquake that could be induced…in areas for lease; and whether active and abandoned wells are safe from damage from earthquake activity over the short and long-term	The Final EA includes additional information on seismicity (see Section 4.4)
Conservatively, over 80% of the peer-reviewed science on hydraulic fracturing has been composed since the 2006 Final EIS and the 2012 SIR. This new	More information has been added to the Geology and Minerals sections (Sections 3.4. & 4.4) of the Final EA.

Issue/ Condensed Comment	Response
information has not been included in the Draft EA.	
There never has been a comprehensive analysis of the impacts of fracking in the WNF that applies increased knowledge of the underlying geology and a practical grasp of the contemporary state of fracking technology to quantify the prospects and anticipated damage that would follow from large-scale fracking in the Wayne.	The Final EA analyzes potential impacts from developing oil and gas resources underlying the Marietta Unit based on the Reasonably Foreseeable Development Scenario (RFDS) created for the 2006 Forest Plan/EIS and reviewed for the 2012 SIR. Based on the review of new information including the potential for hydraulic fracturing in the Wayne National Forest, the RFDS was deemed to be adequate for the amount and type of development anticipated.
The Draft EA does not distinguish between 50 years of fracking of vertical, comparatively shallow, wells, which did not explicitly aim for subsurface radioactive shale, and the scant decade and a half of horizontal drilling into radioactive shale layers.	The 2012 SIR evaluated the impacts of horizontal drilling into the shale formations versus the vertical wells analyzed in the 2006 Forest Plan/EIS. The findings from the 2012 SIR are incorporated into the EA.
Produced waters from hydraulic fracturing operations can contain high levels of total dissolved solids, salts, metals, and radioactive materials. If spilled, soils can become contaminated. Radium contamination could remain in the soils for thousands of years.	Section 4.5 of the Final EA acknowledges the potential effects to soils from reasonably foreseeable oil and gas development.
The Draft EA contains no data on mineral productivity and hydraulic fracturing in Ohio.	Information is included in Section 3.4.1 of the Final EA.
Biological/ T&E	
The Draft EA does not adequately analyze the impacts to threatened and endangered (T&E) species; it only states what plant and animal populations exist in the forest. The Draft EA should have included analysis on: ● population-level impacts ● habitat fragmentation ● potential effects to wildlife/T&E and vegetation from spills (i.e. surface water and on the ground)	Section 4.3.8 of the EA contains an analysis on potential impacts to threatened and endangered species from potential future oil and gas development in the Marietta Unit. The U.S. Fish and Wildlife Service (USFWS) concurred that the consultation conducted for the 2006 Plan/EIS was sufficient to account for the possible affected species at the leasing stage (see Section 4.3.8.1.4). Additional consultations would be completed at the APD stage, as required. At that time, further analysis would be conducted on any potential population-level effects to federally listed species.
The Draft EA should have discussed potential impacts from water extraction	Sections 3.6 and 4.6 of the Final EA analyze water resources and potential impacts from reasonably

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such as lowering the water table, harming local ecosystems, and affecting biodiversity.	foreseeable oil and gas development. As stated in Section 4.6.1.2 of the Final EA, "The BLM and Forest Service would not approve water withdrawals that would draw down a surface waterbody to the extent that aquatic life would be measurably adversely impacted, for example, by dewatering a stream enough to entrap fish or expose mussels to dry conditions in a stream that would normally have perennial flow."
There could be adverse effects to Indiana Bat from the proposed action because Forest Service requirements (closed loop systems) are only required on federal surface.	As stated in Section 3.3.8.1.1 of the Final EA, the Indiana Bat is likely present in the Marietta Unit but the most heavily concentrated populations are most likely on the Athens and Ironton Units. As described in Section 4.3.8.1.1 of the Final EA, oil and gas activities may adversely affect the Indiana Bat and the USFWS issued an incidental take permit to the Forest Service. The BLM and Forest Service have completed all required Endangered Species Act consultations at this time. Further consultations, as required, would be conducted at the APD stage. Appendix C of this EA (a new appendix), discusses Endangered Species Act requirements for private surface.
The information presented in the T&E section of the Draft EA does not apply since it has not been re-evaluated or assessed since 2006.	As described in Section 1.7.2.2 of the Final EA, the information provided in the Final EA with regard to potential effects to federally listed species is accurate, and no further USFWS consultation is needed at this time. Additional consultations, as required, would be conducted at the APD stage.
The BLM should have consulted with the USFWS for this EA to account for any changes since the 2006 Forest Plan.	As stated in Section 1.7.2.2 of the Final EA, the Forest Service and the USFWS concluded that no further analysis or consultation under the Endangered Species Act is needed at this time. Additional consultations, as required, would be conducted at the APD stage.
The Draft EA assumes that the Athens and Ironton Units contain the most heavily concentrated Indiana Bat populations, when there is no data in the EA to support this statement	As stated in Section 3.3.8.1.1 of the Final EA, this statement is based on thorough surveys conducted previously throughout the Forest by the USFWS.
Invasive species may be introduced through a variety of pathways that would be increasingly common if oil and gas activity is allowed to expand.	This statement is acknowledged in Section 4.3.10. of the Final EA.
Section 3.3.10 of the Draft EA did not mention Phragmites Australis	This section is not intended to be an exhaustive list of invasive species that may occur in the Marietta Unit. Particular species will be identified more exhaustively at

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	the APD stage.
The Draft EA fails to address whether roost trees and other suitable habitat for the Northern Long-Eared bat (NLEB) are within the action area. The fact that there are not known hibernacula within the areas for lease does not mean that NLEB foraging or summer roost sites are absent from these areas.	Section 3.3.8.1.2 states that there is suitable habitat for roosting and foraging for this bat. Further consultations, as required, would be conducted at the APD stage.
It is unclear whether the agencies have consulted on the Northern Long-Eared bat under ESA section 7. The EA should clarify what steps BLM and the Forest Service have taken or plan to take to ensure that the NLEB is adequately protected in compliance with ESA	The consultation process has been clarified in Section 1.7.2.2 of the Final EA.
The EA does not address the Indiana Bat recovery plan and how it plans to comply with this plan.	The recovery plan is beyond the scope of this EA. Tier I Section 7 consultation for the Indiana Bat was completed by the Forest Service in development of the 2006 Forest Plan/EIS. Further consultation with the USFWS on Indiana Bat and other species would be completed at the APD stage. Also while suitable summer habitat exists on all three units of the Wayne National Forest, the Athens and Ironton Units most likely contain the most heavily concentrated populations of Indiana bat, based on thorough surveys conducted previously throughout the Forest by the USFWS as stated in Section 3.3.8.1.1 of the Final EA.
The tricolored bat & timber rattler were not discussed in the Draft EA.	These species were not considered at the time of the Tier I Section 7 consultation for the 2006 Forest Plan/EIS. Additional species, as appropriate, will be considered at the APD stage.
The Draft EA should acknowledge that Louisiana water thrushes have been documented to be affected by fracking.	The Final EA (Section 4.3.6) states that, "Stipulations #15 and #16 allow the Forest Service to set additional conditions of approval on proposed development in riparian areas and floodplains. These stipulations are expected to protect the habitat of the Louisiana waterthrush. Other potential impacts to this species, which may be due to water quality impacts, are addressed in the relevant sections. Development on private lands in floodplains and adjacent to streams would be subject to State and federal laws protecting wetlands and floodplains."

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Draft EA should have included a full assessment of the direct and indirect impacts of unconventional oil and gas development on wildlife and ecosystems through a suite of comprehensive studies on all species and ecosystems that could be affected. ● The studies should be detailed for federally and state listed species, federal and state candidates for listing, and state species of special concern. The studies should address: habitat loss, degradation, and fragmentation, including edge effects; water depletion; air and water contamination; introduction of invasive species; climate change impacts; health and behavioral effects such as increased stress and changes in life history behaviors; changes in demographic rates such as reproductive success and survival; and potential for Population-level impacts such as declines and extirpations, individually and cumulatively.	A suite of comprehensive studies on all species and ecosystems that could be affected would be beyond the scope of this EA, which serves as a broad overview of expected impacts from proposed mineral leasing. Site-specific impacts would be analyzed at the APD stage, which may include surveys if needed. The BLM and Forest Service have conducted the necessary Endangered Species Act consultations and additional consultations would be conducted at the APD stage, as required. The Final EA provides a sufficient level of analysis to warrant making an informed decision at the leasing stage.
NEPA/Alternatives/Public Involvement	
The 2006 Forest Plan did not address hydraulic fracturing; therefore, this EA cannot be in compliance with that Plan.	The 2012 SIR was completed to determine if the 2006 Forest Plan/EIS needed to be updated in light of new information regarding hydraulic fracturing. The Forest Service determined that the potential effects associated with hydraulic fracturing and horizontal drilling were not significantly different from those of vertical drilling and that the mitigation measures in place for vertical drilling would suffice for horizontal drilling/hydraulic fracturing.
The EA should specify the amount of acreage available for lease in the Marietta Unit at this time, not serve as a	The Final EA (Section 1.6) clearly states that the Proposed Action is to lease approximately 40,000 acres. The maps in Chapter 6 provide locations of the proposed areas for

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blanket EA for what might be added in the future. What is the specific location of the acreage (latitude/longitude).	lease.
The Draft EA did not adequately evaluate alternatives to the proposed action, particularly those that are not "market driven"	The Final EA analyzes those alternatives that met the purpose and need for the Proposed Action. The Final EA also discusses alternatives that were considered but eliminated because they did not meet the purpose and need. (See Section 2.4).
The EA should clarify that the "vertical drilling only" is fundamentally the same as the No Action Alternative with regard to tight formations, and both alternatives do not meet the purpose and need.	This is addressed in Section 2.4.2 of the Final EA.
BLM has not considered the no-leasing and no-fracking alternatives as part of any of its RMP planning processes nor a comprehensive review of its federal oil and gas leasing program. BLM should suspend new leasing until it properly considers this alternative in updated RMPs or a programmatic EIS for the entire leasing program.	The BLM planning process is outside the scope of this EA. The analysis presented in the Final EA is sufficient to inform the decisionmaker of the reasonably foreseeable impacts associated with leasing parcels in the Marietta Unit.
BLM should have prepared an Environmental Impact Statement. There are three connected actions (Marietta, Athens, and Ironton) and BLM must take a "hard look" at the potential surface impacts from oil and gas development. The BLM is minimizing potential impacts to less than significant by conducting separate EAs, in violation of NEPA.	Potential leasing in the Marietta, Athens, and Ironton Units would occur independently of one another and are not connected actions (40 CFR 1508.25). Additionally, impacts associated with potential leasing in the three units would be separated sufficiently in time and geographical location such that cumulative effects would not be expected. Therefore, the analysis presented in the Final EA is sufficient to inform the decisionmaker of the reasonably foreseeable impacts associated with leasing parcels in the Marietta Unit. Based on the anticipated effects associated with oil and gas leasing in the Marietta Unit, an Environmental Impact Statement is not needed.
BLM should have conducted a comprehensive programmatic analysis of the potential impacts from mineral leasing in the WNF, including a programmatic analysis of the potential impacts from hydraulic fracturing, on public health, and environmental justice. BLM should not have conducted	The 2012 SIR included a programmatic review of the impacts of hydraulic fracturing and evaluated new information on potential mineral development methods compared to the analysis done for the 2006 Forest Plan/EIS. The Final EA references information from this report and also includes analysis of potential impacts from hydraulic fracturing, on public health, and environmental justice. Because potential oil and gas development in the

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a "piecemeal" approach using an EA for individual lease sales.	three Forest units are not connected actions, a programmatic analysis of leasing in the entire Wayne National Forest was neither required nor prudent.
NEPA regulations require BLM to evaluate 10 significance criteria. Several of these factors are implicated in the proposed action: ● The degree to which the effects on the quality of the human environment are likely to be highly controversial (hydraulic fracturing is considered a highly controversial issue) ● The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks (for example, there is uncertainty about the degree and specific pathways through which potential harm from oil and gas development may occur) ● The degree to which the proposed action affects public health or safety ● The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the ESA Further data collection may have helped to resolve the potential controversy and uncertainty significance factor	These criteria are analyzed in the Finding of No Significant Impact (FONSI) document related to the Final EA. Based on the analysis presented in the EA; the BLM believes that the conclusions presented in the FONSI are accurate.
The proposed action violates the Federal Land Policy (FLPMA) and Management Act and the Mineral Leasing Act (MLA) ● emissions are an undue and unnecessary waste and degradation of public lands	It is the policy of the BLM to make mineral resources available for use and to encourage development of mineral resources to meet national, regional and local needs. This policy is based on law, including the Federal Land Policy and Management Act of 1976 (FLPMA), Sec. 102(12) "the public lands be managed in a manner which recognizes the Nation's need for domestic sources of

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● New leasing within WNF would worsen climate change and contradicts BLM's mandate to manage the public lands "without permanent impairment of the productivity of the land and the quality of the environment.	minerals…from the public lands" The Mineral Leasing Act of 1920 as amended- Subtitle B (FOOGLRA) states: "Lease sales shall be held for each State where eligible lands are available at least quarterly..." (MLA sec 226(b)(1)(A).
The Public Involvement section of the Draft EA does not discuss the fact that the November 2015 meeting in Athens ended early due to public outcry/opposition.	Public involvement is discussed in the Final EA in Section 1.7, including the meeting in Athens (see Section 1.7.3). Sections 1.7.4 and 1.7.5 summarize the primary issues of public interest/concern.
The public comment period should have been extended by at least 60 days.	A primary purpose of NEPA is to inform the public about the environmental implications of Federal agency actions before they are made. Therefore, it is BLM policy to offer a 30-day public comment period on Draft EAs for fluid mineral leasing actions. Given that the BLM also conducted scoping meetings in November 2015 and issued two press releases to inform the public about the Proposed Action, a 30-day comment period was sufficient and satisfies the requirements of NEPA.
The public involvement process was inadequate. The November 2015 meetings did not meet NEPA requirements because officials provided few and contradictory answers and the public was not given an opportunity to be heard. The public was expecting a presentation rather than a poster session. The meetings were poorly advertised.	Per CEQ regulations, scoping is required for the preparation of Environmental Impact Statements, and optional for Environmental Assessments. The meetings held in November 2015 were designed in an open house format to allow informal information exchange between BLM, the Forest Service, and the public. The agencies documented the feedback and noted the public issues of interest in the EA (see Section 1.7.4). The public has additional opportunities to be involved in the process when the Draft EA is posted for a 30-day review period and also during the 30-day protest period. The BLM has conducted its public involvement activities in accordance with NEPA requirements.
The Draft EA should include a definition of "substantive" public comments.	A substantive comment for BLM is one that provides new information about the Proposed Action, an alternative or the analysis; identifies a different way to meet the need; points out a specific flaw in the analysis; suggests alternate methodologies and the reason(s) why they should be used; makes factual corrections, or identifies a different source of credible research which, if used in the analysis, could result in different effects.

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The 2006 FEIS and 2012 Supplemental Information Report (SIR) were legally and substantively inadequate to comply with NEPA (insufficient analysis on hydraulic fracturing, surface impacts from hydraulic fracturing and drilling, noise and air pollution from compressor stations, socioeconomics, drinking water contamination, waste, water consumption, risk of explosions, cumulative effects). Also, an agency cannot use a re-evaluation as an attempt to remedy any gaps in the impact analysis that should have been addressed in the original NEPA document. Therefore it is inappropriate for BLM to refer to the analysis in these documents.	BLM was a cooperating agency on the 2006 Forest Plan/EIS and provided input for the 2012 Supplemental Information Report (SIR). The 2012 SIR was developed to review certain aspects of mineral operations such as horizontal drilling and potential surface impacts associated with such operations. The review of new information (RONI) noted that potential impacts associated with such activities were within the scope of analysis already included in the 2006 Forest Plan/EIS. Both the Forest Service and the USFWS concurred that no further analysis or consultation was needed. Therefore, a supplement to the Forest Plan/EIS was not needed. Both documents provide adequate information to be used as references in the BLM's Final EA for leasing in the Marietta Unit.
The 2006 FEIS and 2012 SIR need considerable supplementation, therefore the BLM should not tier to these documents.	Tiering is using the coverage of general matters in broader NEPA documents in subsequent, narrower NEPA documents (40 CFR 1508.28, 40 CFR 1502.20). This allows the tiered NEPA document to narrow the range of alternatives and concentrate solely on the issues not already addressed. BLM was a cooperating agency on the 2006 Forest Plan/EIS and provided input for the 2012 SIR. Both the Forest Service and the USFWS concurred that no further analysis or Endangered Species Act consultation was needed at this stage.
The Draft EA is relying on data a generation old to predict that there will be minimal surface disturbances on public lands, and insignificant effects from the proposed action. The Forest Service and BLM intend to allow surface disturbances on federal leaseholds but suggest only that there is room under the ceiling they projected in 2006.	The Forest Service determined in the 2012 SIR that the Reasonably Foreseeable Development Scenario (RFDS) developed for the 2006 Forest Plan/EIS was adequate for the type and amount of future minerals development anticipated. Should conditions change, the Forest Service and the BLM would reevaluate the RFDS and the existing NEPA analysis would be amended or revised, as appropriate.
The Draft EA is using outdated references in general, based on information incorporated from the 2006 Plan and SIR. It is unclear whether the	The Forest Service determined in the 2012 SIR that the Reasonably Foreseeable Development Scenario (RFDS) developed for the 2006 Forest Plan/EIS was adequate for the type and amount of future minerals development

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Forest Plan has undergone any reevaluations since 2006. The 2012 supplementation was added to suit the fracking industry.	anticipated. The review of new information noted that potential impacts associated with such activities were within the scope of analysis already included in the 2006 Forest Plan/EIS. Therefore, a supplement to the Forest Plan/EIS was not needed.
The Draft EA incorrectly uses and cites references. For example, Fletcher 2012 is an unpublished master's thesis with a different conclusion than what was used in the EA. Also the EA contains almost no peer reviewed documents that are actually cited in the EA, only listed as references in the bibliography.	The master's thesis is published by Massachusetts Institute of Technology (MIT) and has been used in other BLM leasing EAs. The BLM has used various sources of information to prepare the Final EA. References are cited and used throughout the EA, but the BLM uses expert opinion in some cases.
The 2012 supplemental information report (SIR) was not available for public review or comments so therefore it is not a legitimate NEPA document.	The 2012 SIR was prepared in accordance with the Forest Service Handbook (FSH) 1909.15 - NEPA Handbook Chapter 10, Section 18.1.) This states in part, *"If new information or changed circumstances relating to the environmental impacts of a proposed action come to the attention of the responsible official after a decision has been made and prior to completion of the approved program or project, the responsible official should review the information carefully to determine its importance. Consideration should be given to whether or not the new information or changed circumstances are within the scope and range of efforts considered in the original analysis."* The 2012 SIR was developed to review certain aspects of mineral operations such as horizontal drilling and potential surface impacts associated with such operations. The review of new information noted that potential impacts associated with such activities were within the scope of analysis already included in the 2006 Forest Plan. Therefore, a supplement to the Forest Plan/EIS was not needed. The Wayne National Forest published a news release for the Finding for the 2012 SIR on August 27, 2012. Section 1.7.3 of the Final EA has been revised to reflect this. As described on page 2 of the 2012 SIR and in accordance with (FSH) 1909.15 - NEPA Handbook Chapter 10, Section 18.1, "The SIR itself is not a NEPA analysis or approval, nor

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	is it a discrete or circumscribed agency action. It is interlocutory in nature and does not mark the consummation of a decision-making process or determine any legal rights. It simply is a review of available information, akin to a memorandum to file, documenting assessment of the significance of new information."
The BLM needs to indicate if any land has been acquired within the WNF since the 2006 Plan. If so, new properties are subject to NEPA and BLM must indicate if NEPA was completed.	The Forest Service completes NEPA documentation for any lands it acquires. Wayne National Forest Current and Recent Projects (and archived projects) with any associated NEPA documentation can be found at http://www.fs.usda.gov/projects/wayne/landmanagement/projects
RFDS predictions	
The BLM and FS rely on their 10 year old prediction as the outer boundary of surface disturbance, without any explanation as to why there should be confidence in figures presented in Table 2-1.	The 2012 SIR was prepared in accordance with the Forest Service Handbook (FSH) 1909.15 - NEPA Handbook Chapter 10, Section 18.1.) This states in part, *"If new information or changed circumstances relating to the environmental impacts of a proposed action come to the attention of the responsible official after a decision has been made and prior to completion of the approved program or project, the responsible official should review the information carefully to determine its importance. Consideration should be given to whether or not the new information or changed circumstances are within the scope and range of efforts considered in the original analysis."* The 2012 SIR was developed to review certain aspects of mineral operations such as horizontal drilling and potential surface impacts associated with such operations. The review of new information (RONI) noted that potential impacts associated with such activities were within the scope of analysis already included in the 2006 Forest Plan/EIS. Therefore, a supplement to the Forest Plan/EIS was not needed.
The Draft EA does not take into account that horizontal wells have double the surface impact (5.2 acres) of vertical wells (2 acres) and emit over 250 percent more air pollution, including toxic volatile organic compounds and	The 2012 SIR takes a hard look at the impact of horizontal wells in the Wayne National Forest versus conventional vertical wells. Based on information related to mineral operations and specifically, hydraulic fracturing, the potential impacts associated with such activities were within the scope of analysis already included in the 2006

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greenhouse gases. Horizontal wells also require 5-10 times more water—which leads to more hazardous material to dispose of.	Forest Plan/EIS. Section 2.2 of the Final EA discusses the total surface impact expected from horizontal well development versus vertical wells. The Final EA has been updated to include information on quantified estimates of air emissions associated with reasonably foreseeable mineral development in the Marietta Unit. The Final EA also discusses potential water usage associated with horizontal well development.
The Draft EA does not disclose the acreage that is potentially available for lease now and where it is located.	The Final EA discloses the acreage that is potentially available for lease and where it is located in Section 2.1. Also, see Chapter 6 (maps).
Draft EA indicates that a Reasonably Foreseeable Development Scenario (RFDS) was developed as part of the 2006 Forest Plan Final EIS and that this EIS was included in Appendix G. However, the appendices were not included.	Section 1.5 was updated in the Final EA by including the link in which additional documents (including the 2006 Forest Plan/EIS and 2012 SIR) can be found.
Draft EA does not fully account for all potential surface disturbance: gathering lines and facilities, mega-pipeline projects and associated compressor stations, as well as expanded fracking waste down-blending, landfilling, transmission lines, and injection wells. The proposed surface disturbance that is therefore incorporated from the Forest Plan and SIR are underestimated.	The anticipated surface disturbance associated with reasonably foreseeable mineral development in the Marietta Unit is discussed in Section 2.2 of the Final EA. Section 4.6, Cumulative Effects, also acknowledges there could be additional surface disturbance on private lands. Since exact design details are not known at the leasing stage, it is not possible to know exactly what supporting infrastructure would be needed if development occurs in the future, other than acknowledging that additional surface disturbance could occur (as identified in the EA). The RFDS was developed using industry standards and subject matter expertise to assess the potential surface disturbance that could occur as a result of leasing federal minerals in the Wayne National Forest. Further detailed NEPA analysis would be conducted at the Application for Permit to Drill (APD) stage.
The BLM letter (adopted in the SIR) estimates that horizontal well pad sites average 3-5 acres of disturbance during construction and prior to reclamation, and 0.68-1.38 acres during the production phase, after reclamation. It is unclear whether this includes the entire limits of disturbance (such as the clearing and earth moving impacts	Table 2 of the May 3, 2012 BLM letter in the SIR shows in detail the total estimated surface disturbance (which includes clearing and grading) associated with both vertical and horizontal wells.

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immediately adjacent to the pad itself).	
The 2004 RFDS suggests the possibility of collocation of horizontal and vertical wells, but the EA does not analyze this scenario.	The EA analyzes the impact of leasing assuming that future development would include horizontal drilling. The 2006 Forest Plan/EIS had evaluated the impacts of vertical wells. The surface impacts from horizontal wells are far less than that from horizontal therefore collocation of horizontal and vertical would fall below those in the Forest Plan/EIS.
The EA is unclear whether surface disturbance from vertical well development is still expected to occur.	The Final EA assumes that horizontal wells would be constructed as this is the most likely scenario for the Marcellus and Utica Shales development.
Commenter is concerned about the potential for blasting, given the many private inholdings within the WNF.	Any use of explosives on private land would need to be conducted in accordance with federal, state, and local safety laws, regulations, and policy.
Waste	
The Draft EA contains no data related to waste generation (associated with hydraulic fracturing) in Ohio.	The Final EA (Section 4.7) discusses the potential waste products associated with hydraulic fracturing. Appendix C of the Final EA (page 157) discusses ODNR's oversight of disposal of waste from oil and gas operations. Appendix C (page 158) also states that Ohio Department of Health is responsible for disposal of any potential radioactive waste.
The Draft EA does not discuss how often accidental spills can be expected to occur.	The Final EA acknowledges the possibility for accidental spills. Appendix C of the Final EA (page 158) discusses Ohio requirements to mitigate potential spills, and requirements for reporting if a spill does occur.
The Draft EA fails to acknowledge a recent West Virginia study that shows wastewater injection can impact areas downstream of an injection well site.	Any wastewater that originates from oil and gas operations would be considered non-federal and so disposal would not be allowed on Wayne National Forest lands (including the roads under jurisdiction of the WNF). In addition, the Ohio Revised Code only allows for four different disposal methods of fluids associated with oil and gas operations: injection, surface application (on roads only, and only when permitted by the authority with jurisdiction over the road), enhanced recovery (reuse of the fluids in other wells) or other methods to test new technologies and methodologies (ORC 1509.22(C)(1)), therefore no significant downstream contamination is expected. This is stated in Section 3.8 in the Final EA.
The Draft EA fails to discuss the deregulation policies that have been implemented which allow the so-called "beneficial use" of radioactive and	Discussion on the merits of regulation of the oil and gas industry is outside the scope of this EA. The analysis presented in the Final EA is sufficient to inform the decisionmaker of the reasonably foreseeable impacts

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chemically-toxic drilling wastes for such purposes as landfill cover, fill for industrial parks and agricultural fertilizer, and access roads to drilling pads. Disposal of radium-bearing water reclaimed from hydraulic fracturing operations through the municipal water treatment systems likely causes water pollution.	associated with leasing parcels in the Marietta Unit.
The Draft EA fails to account for all potential waste impacts, including: ● Induced effects from expanded waste facilities and disposal of fracking wastes in licensed landfills (permissible in Ohio) ● Effects of wastes in holding ponds, which can poison wildlife or leak ● Contaminated drill cuttings that are buried ● Spreading wastes over large areas of land ● Wastewater discharged from treatment facilities without advanced "total dissolved solids" removal processes or inadequate capacity to remove radioactive material ● Breaches in injection disposal wells Also it is not clear what is covered under RCRA or CERCLA with regard to wastes.	The Final EA takes a hard look at potential waste impacts. Numerous sections of the EA address potential waste impacts (See sections Geology and Minerals, Public Health and Safety, Soils, Water Resources and Water Quality, Waste, and Hazardous, or Solid, and their following cumulative effects sections (i.e. Cumulative Effects on Water Resources and Water Quality, etc.). Further analysis would be conducted at the APD stage to address potential impacts from waste.
Environmental Justice	
The Draft EA must include an analysis of potential impacts faced by environmental justice communities (such as impacts from hydraulic fracturing and air emissions)	The Environmental Justice sections have been revised in the Final EA (see Sections 3.15. and 4.15.3). The analysis conforms to the Council on Environmental Quality definitions for minority and low-income populations. Based on the analysis, there would be no disproportionate adverse effects to environmental justice populations from leasing in the Marietta Unit. Further NEPA analysis will be conducted at the APD (site-specific) stage, and environmental justice will be evaluated again at that time.

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The Environmental Justice section of the Draft EA is highly offensive as it implies that private citizens are incapable of managing mineral development on their property.	The BLM sincerely apologizes and did not intend to offend the public. This section has been revised accordingly in the Final EA.
Public Health	
The Draft EA should include information about Washington County; specifically that the county had an ambient air cancer risk > 10-4, or 1 in 10,000 people can get cancer from the ambient air.	The Final EA (Section 3.2.4) clearly states that Washington County is in non-attainment for Sulfur Dioxide only, in the Muskingum River area. The nonattainment area identified as Muskingum River, Ohio is located in Waterford Township in Washington County. Ohio EPA submitted a Request for Redesignation letter to the USEPA on April 3, 2015 proposing to shutter the Muskingum River Power Plant to return the area to attainment.
Draft EA does not adequately discuss public health effects from deep-shale drilling and high-volume hydraulic fracturing. In 2006, the FS assumed the preferred extraction method for oil and gas would continue to be vertical drilling because of economics. The BLM should have conducted a health impact assessment, or equivalent, of the aggregate impacts of hydraulic fracturing on human health and nearby communities.	The Final EA has been revised to include stand-alone sections on Public Health and Safety (see Sections 3.8 and 4.8). Public health and safety will also be further analyzed at the site-specific (APD) stage, should development be proposed in the future.
The Draft EA failed to conduct a literature review of and consider that fracking products contain at least 29 products that are known to be possible carcinogens, regulated for their human health risk, or listed as hazardous air pollutants. The public's exposure to these harmful pollutants alone would constitute a significant impact. The Draft EA should have also considered the potential public health risks from hydraulic fracturing flow back, which has the potential to be radioactive.	NEPA does not require a literature review to make an informed decision. The Final EA discusses potential effects associated with hydraulic fracturing in multiple sections and also includes stand alone sections on public health (see Sections 3.8 and 4.8). Substantial uncertainty exists at the time the BLM offers a lease for sale regarding crucial factors that will affect mitigating measures at a site-specific level, including: (1) well density; (2) geological conditions; (3) development type (vertical, directional, horizontal); (4) hydrocarbon characteristics; (5) equipment to be used during construction, drilling, production, and abandonment operations; and (6) potential regulatory changes pertaining to GHGs over the life of the 10-year primary lease terms.

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	If any future oil and gas development is proposed, the lessee or their operator will be required to submit a plan of operations and obtain approval from BLM to access the fluid minerals or the lease. At the time, a NEPA analysis will be conducted to determine the appropriate terms and conditions of approval for the development. BLM retains the authority to regulate the environmental aspects of the lessee's operations and include site-specific protection measures at the APD stage. Without a site-specific plan of operations it would be speculative to determine the effects of drilling beyond the analyses presented in this EA.
The Draft EA does not consider current literature related to environmental impacts on health and safety. For example, the EA does not incorporate findings of: ● New York Compendium of Risks and Harms of Fracking (October 2015) ● Fugitive emissions from Bakken Shale in Geophysical Research and Letters, April 2016	New sections on Public Health and Safety have been added to the Final EA (see Sections 3.8 and 4.8). The BLM has conducted a review of the applicable literature and discussed the potential public health and safety impacts associated with oil and gas development in the Final EA. Numerous standards, best management practices, lease stipulations, mitigations, and regulations are in place to ensure public health and safety is not compromised from potential oil and gas development within the Marietta Unit.
The authors list Bamberger and Oswald in the bibliography, which is extremely important research that documents the highly significant impacts of fracking to human and animal health. Yet the only reference in the text to Bamberger and Oswald is in reference to the EA's estimate of how much water returns to the surface, which was not the subject of Bamberger and Oswald but merely referenced in that study.	This reference was removed from the Final EA. Another reference regarding how much water returns to the surface is included in Section 4.7.
The Draft EA does not quantify the risks to human health and the environment associated with on-site chemical and wastewater storage, including risks from natural events and negligent operator practice.	The Final EA has been revised to include information regarding Public Health (See sections 3.8 & 4.8) and the level of detail is sufficient to make an informed decision about potential leasing in the Marietta Unit. Potential site specific effects to surrounding communities would be analyzed at the APD stage, including information regarding possible chemical or wastewater storage units.

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The Draft EA refers to Ohio DNR regulations; however, ODNR does not require or perform monitoring for contamination of drinking water, surface water, or groundwater around injection wells, which has public health implications. The EA must be supplemented to address the public health effects from the hydraulic fracturing waste stream.	The Final EA addresses hydraulic fracturing, associated wastes and potential public health implications. The analysis is in accordance with the U.S. EPA June 2015 report "Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources" which states 'From our assessment, we conclude there are above and below ground mechanisms by which hydraulic fracturing activities have the potential to impact drinking water resources. These mechanisms include water withdrawals in times of, or in areas with, low water availability; spill of hydraulic fracturing fluids and produced water; fracturing directly into underground drinking water resources; below ground migration of liquids and gases; and inadequate treatment and discharge of wastewater. We did not find evidence that these mechanisms have led to widespread, systemic impacts on drinking water resources in the United States. Of the potential mechanisms identified in this report, we found specific instances where one or more mechanisms led to impacts on drinking water resources, including contamination of drinking water wells. The number of identified cases, however, was small compared to the number of hydraulically fractured wells.' As described in the EA, there are numerous mechanisms in place to minimize potential adverse effects to surface water and groundwater. Additional analysis would be conducted at the APD stage with regard to hydraulic fracturing, impacts to water resources, and public health and safety associated with oil and gas development in the Marietta Unit.
The Draft EA did not discuss the relationship between air quality and Human Health.	A new section on Public Health and Safety has been added to the EA (see Sections 3.8 and 4.8). This section acknowledges the potential public health and safety issues that may occur due to air emissions, among other sources.
Climate change, driven primarily by the combustion of fossil fuels, poses a severe and immediate threat to the health. Welfare, ecosystems, and economy of the United States	The Climate Change sections (Sections 3.2.5 and 4.2.5) were updated in the Final EA.
The Draft EA fails to adequately study the human health and safety impacts of noise pollution, light pollution, and	The Final EA has been revised to include new sections on Noise (Sections 3.11 and 4.11), Transportation (Sections 3.9 and 4.9) and Public Health and Safety (Sections 3.8 and

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traffic accidents resulting from oil and gas development.	4.8).
The Draft EA did not acknowledge the potential risks to residents from earthquakes associated with injection wells.	The Final EA acknowledges the potential for seismic activity in Sections 4.4. Potential mitigating measures are discussed in Section 4.4.1
The Draft EA does not discuss potential significant public health effects from operational activities associated with oil and gas development.	A new section on Public Health and Safety has been added to the Final EA (see Sections 3.8 and 4.8).
Noise & Transportation	
The Draft EA does not adequately address noise (particularly compressor stations), including impacts to visitors and wildlife. BLM has not addressed the noise levels or the impacts to visitors or wildlife.	The Final EA has been revised to include new sections on Noise (Sections 3.11 and 4.11). These sections discuss potential impacts on visitors and wildlife. Further NEPA analysis will be conducted at the APD stage, should development be proposed in the future.
The Draft EA does not adequately address effects from increased truck traffic.	The Final EA has been revised to include new sections on Transportation (see Sections 3.9 and 4.9). These sections assess the potential impacts associated with increased truck traffic associated with reasonably foreseeable mineral development. Further NEPA analysis will be conducted at the APD stage, should development be proposed in the future.
Socioeconomics	
Draft EA did not conduct a Social Cost of Carbon analysis.	The 2016 CEQ guidance, *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews* states that "NEPA does not require monetizing costs and benefits" and allows for agency discretion in including monetized assessment of the impacts of greenhouse gases in NEPA documents. The Final EA has been revised to explain the rationale for not using the Social Cost of Carbon in the analysis (see Section 4.2.3).
The Draft EA did not use analytical tools to evaluate the cost of methane emissions. (Example: EPA's peer-reviewed tool)	The 2016 CEQ guidance, *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews* states that "NEPA does not require monetizing costs and benefits" and allows for agency discretion in including monetized assessment of the impacts of greenhouse gases in NEPA documents. The Final EA has been revised to explain the rationale for not

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	using the Social Cost of Carbon in the analysis (see Section 4.2.3).
The Draft EA should have included a cost-benefit analysis. The costs in GHG emissions and degradation to the forest, water, and air are greater than any benefit to the agency.	The 2016 CEQ guidance, *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews* states that "NEPA does not require monetizing costs and benefits" and allows for agency discretion in including monetized assessment of the impacts of greenhouse gases in NEPA documents. The Final EA has been revised to explain the rationale for not using the Social Cost of Carbon in the analysis (see Section 4.2.3). Based on a review of potential impacts to all relevant resources including biological resources, water resources, air quality, etc., the BLM concludes there would be no significant effects from the proposed action.
There is no net financial benefit to the public from leasing.	As shown in Section 4.15.2. (Table 4.3) of the Final EA, the public receives benefits of leasing through revenues paid to the counties.
Cultural Resources	
The Draft EA asserts that operators may need to access the Ohio River as a water source; however, there are a number of archaeological sites that may be damaged.	Further consultations and surveys, as required, would be conducted at the APD stage to address potential effects to cultural resources, including archaeological sites (see Section 4.12). Any connected action with ground disturbance regarding cultural resources at the APD stage will be reviewed in a subsequent NEPA document.
Regardless of a response received from Tribes, the BLM should incorporate existing historic accounts into the EA.	The Final EA discusses the historic context of the area in Section 3.12. Additional cultural studies or evaluations would be conducted on a site-specific basis for any future APDs.
Private Development	
The Draft EA is unclear in whether Forest Plan protections would be applied to private surface. In addition, it is unclear to what extent notifications and stipulations attached to a lease would apply to private surface activities overlying private minerals that have been pooled with federal minerals.	A new appendix (Appendix C) is incorporated into the Final EA, and discusses the regulations and permitting of oil and gas operations in Ohio, specifically how environmental concerns are addressed.

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The EA Draft claims that leasing in the forest will not impact the development of private minerals. This is untrue, due to Ohio's unitization laws.	The Final EA acknowledges the potential development of private minerals (see Section 4.16), and Appendix C (a new appendix added to the Final EA) addresses development on private lands in Ohio.
Cumulative Impacts	
The Draft EA should have included the Ironton Unit and Athens Unit in the cumulative effects discussion.	As described in Section 4.16.1 of the Final EA, the cumulative effects analysis (aside from air quality and climate change) focuses on the Marietta Unit and does not consider potential leasing in other areas of the Wayne National Forest. This is because any impacts associated with leasing in the Athens or Ironton Units would be separated sufficiently in time and location from the Proposed Action such that cumulative effects are not anticipated.
The Draft EA and the 2012 SIR that it relies on, ignore the potential for federal leasing to open up private minerals and private surface for development, rendering the Draft EA fundamentally flawed.	The Final EA acknowledges that future mineral development could occur on private surface and private minerals (see Section 4.16, Cumulative Effects). There are numerous laws and regulations in place that govern how mineral development activities are conducted on private land. A new Appendix (see Appendix C) has been added to the Final EA summarizing this information.
The Draft EA does not fully and accurately evaluate the climate change and Greenhouse Gases impacts from potential oil and gas operations. Cumulative effects from air emissions/greenhouse gases are potentially highly significant. The EA should include a discussion on carbon budgets, other GHG pollution sources in the area, and how GHG emissions can be minimized to reduce potential cumulative effects.	The Final EA has been updated with additional information on climate change and quantified estimates of greenhouse gas emissions associated with potential future oil and gas development in the Marietta Unit (see Sections 3.2 and 4.2). Based on the analysis, the BLM believes there would not be significant impacts from the anticipated emissions associated with potential future oil and gas development, including significant cumulative impacts. Further analysis of climate change and greenhouse gas emissions would be conducted at the APD stage.
The Draft EA does not adequately address cumulative impacts on the region to water resources from water withdrawals – particularly with regard to permanent removal from the hydrologic cycle. Vast quantities of water will be permanently contaminated and injected as a result of	The Final EA includes a discussion of potential cumulative effects to water resources (see Section 4.16.2.3). Additional information on potential cumulative effects to water has been incorporated into the Final EA.

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the proposed action.	
The Draft EA does not adequately discuss cumulative effects from waste/wastewater disposal.	The Final EA includes a discussion of potential cumulative effects from waste/wastewater disposal (see Section 4.16.2.6). Additional information on potential cumulative effects from waste/wastewater disposal has been incorporated into the Final EA.
The Draft EA does not adequately discuss potential cumulative effects to wildlife and sensitive species. The Draft EA should have quantified the potential cumulative loss of habitat, discussed fragmentation, air emission effects on wildlife, and displacement of wildlife. Additionally the Draft EA should have discussed potential cumulative effects to aquatic species from water depletion due to low stream flows (attributed to water use for mineral development).	The Final EA includes a discussion of potential cumulative effects to wildlife and sensitive species and their habitat (see Section 4.16.2.2). Additional information on potential cumulative effects to these resources (including aquatic species) has been incorporated into the Final EA.
The Draft EA should acknowledge potential cumulative land use changes due to increased industrial development that could result in the future because of the proposed action.	The Final EA includes a discussion of potential cumulative effects to land use (see Section 4.16.2.9). Additional information on potential cumulative effects to land use has been incorporated into the Final EA.
The Draft EA used speculation and uncertainty to evade discussions of future environmental effects and quantifications of such.	The Proposed Action of leasing is an administrative action that in and of itself, has no direct environmental effects with the exception of increased revenue associated with the lease. The EA uses the RFDS to identify potential effects associated with reasonably foreseeable mineral development; however, specific details are not confirmed until the APD stage. For example, substantial uncertainty exists at the time the BLM offers a lease for sale regarding crucial factors that affect mitigating measures at a site-specific level, including: (1) well density; (2) geological conditions; (3) development type (vertical, directional, horizontal); (4) hydrocarbon characteristics; (5) equipment to be used during construction, drilling, production, and abandonment operations; and (6) potential regulatory changes pertaining to lease operations over the life of the 10-year primary lease terms. Because of these uncertainties, the BLM must make reasonable assumptions about the type of impacts that

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	could occur in the future and therefore must utilize both qualitative and quantitative analyses. Based on public comments, the Final EA has been revised in numerous areas to provide more detailed analysis of potential impacts. The air quality analysis has been revised to include quantifications of estimated emissions associated with potential oil and gas development in the Marietta Unit. If any future oil and gas development is proposed, the lessee or their operator will be required to submit a plan of operations and obtain approval from BLM to access the fluid minerals or the lease. At the time, additional NEPA analysis will be conducted to determine the appropriate terms and conditions of approval for the development. BLM retains the authority to regulate the environmental aspects of the lessee's operations and include site-specific protection measures at the APD stage. Without a site-specific plan of operations the analysis of impacts at the leasing stage does have a degree of speculation and uncertainty that cannot be avoided.
The Draft EA must consider the cumulative impacts of oil and gas production using controversial unconventional method such as hydraulic fracturing. While the actual well pads may only occupy a small proportion of a particular area, their impact can be much greater when their aggregate impact is considered cumulatively. Therefore BLM should have conducted an EIS instead of an EA.	NEPA under 40 CFR 1508.9 requires the preparation of an Environmental Assessment (EA) to provide sufficient evidence and analysis determining whether to prepare an Environmental Impact Statement and to aid an agency's compliance with NEPA when an EIS is not necessary. Offering and subsequently issuing competitive oil and gas leases in the Marietta Unit is an implementation decision that can be satisfied with an EA (40 CFR 1501.3.b; and BLM Handbook, H-1601-1 Appendix C II H). The Final EA provides a cumulative impact analysis (see Section 4.16) that acknowledges the potential cumulative effects of reasonably foreseeable oil and gas development in the Marietta Unit. The analysis recognizes the aggregate impacts of well pads and ancillary infrastructure. Although cumulative effects are expected, the BLM, through its analysis, has determined that potential cumulative effects would not be significant.
The Draft EA does not provide information about orphaned wells, such as: have they been adequately surveyed, capped and/or maintained in the area to be affected by the proposed	The Final EA acknowledges that along with existing oil and gas operations in the Wayne NF and surrounding areas, orphan wells may be present. Along with the Northeastern States District Orphan Wells Program, which identifies and oversee plugging operations for abandoned

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drilling processes?	wells in their jurisdiction, analysis intended to prevent interwell communication would be conducted at the APD stage.
NEPA requires "reasonable forecasting," which includes the consideration of "reasonably foreseeable future actions…even if they are not specific proposals" It is reasonably foreseeable that opening this acreage to oil and gas leasing will result in the commercial production of oil and gas.	The BLM acknowledges there could be additional mineral development in the future on both federal and private lands (see Section 4.16, Cumulative Effects). Further analysis has been included in Section 4.1, Land Use, regarding reasonable foreseeable oil and gas development and effects. A discussion of potential cumulative effects to land use as a result of potential future mineral development is included in Section 4.16.2.9, Recreation and Land Use. At this stage it is not possible to determine the likelihood of commercial production of oil and gas in the Marietta Unit or vicinity as a result of the Proposed Action. Additional analysis will be conducted at the APD stage, should development be proposed. At that time, the BLM will conduct additional analysis on cumulative effects including an assessment of whether commercial development is a reasonably foreseeable activity that should be evaluated in greater detail.
Land Use/Visual Resources	
The Draft EA should list the townships and provide land use information on each one including the number of inholdings, waterways, wetlands, geology and soils, history, possible agriculture or special use permits the FS has in place and managed riparian areas	The sections on Land Use in the Final EA (see Sections 3.1 & 4.1) provide a sufficient level of detail to assess the potential effects of reasonably foreseeable oil and gas development on land uses in the area. Other sections of the EA include baseline information on resources such as biological, water, geology and soils, and cultural resources, among others. At this stage, site-specific mineral development plans are not known and therefore the level of detail presented in the EA on land use is commensurate with what can be reasonably projected. Further NEPA analysis, including land use, will be conducted at the site-specific APD stage if development is proposed in the future.
The proposed action may permanently impair scenic resources, due to BLM's failure to ensure full reclamation of idle wells and the difficulty of restoring sites to their original condition.	Section 4.14 of the Final EA acknowledges there may be some long-term effects to visual resources/scenic quality. Further analysis would be conducted at the APD stage, where specific mitigations to be placed on the application would be identified such as moving the proposed location, low profile tanks, paint color, 3D modeling or various other measures to meet the scenic integrity objectives where development is allowed. Upon completion of drilling and completion operations, the well pad, pipeline

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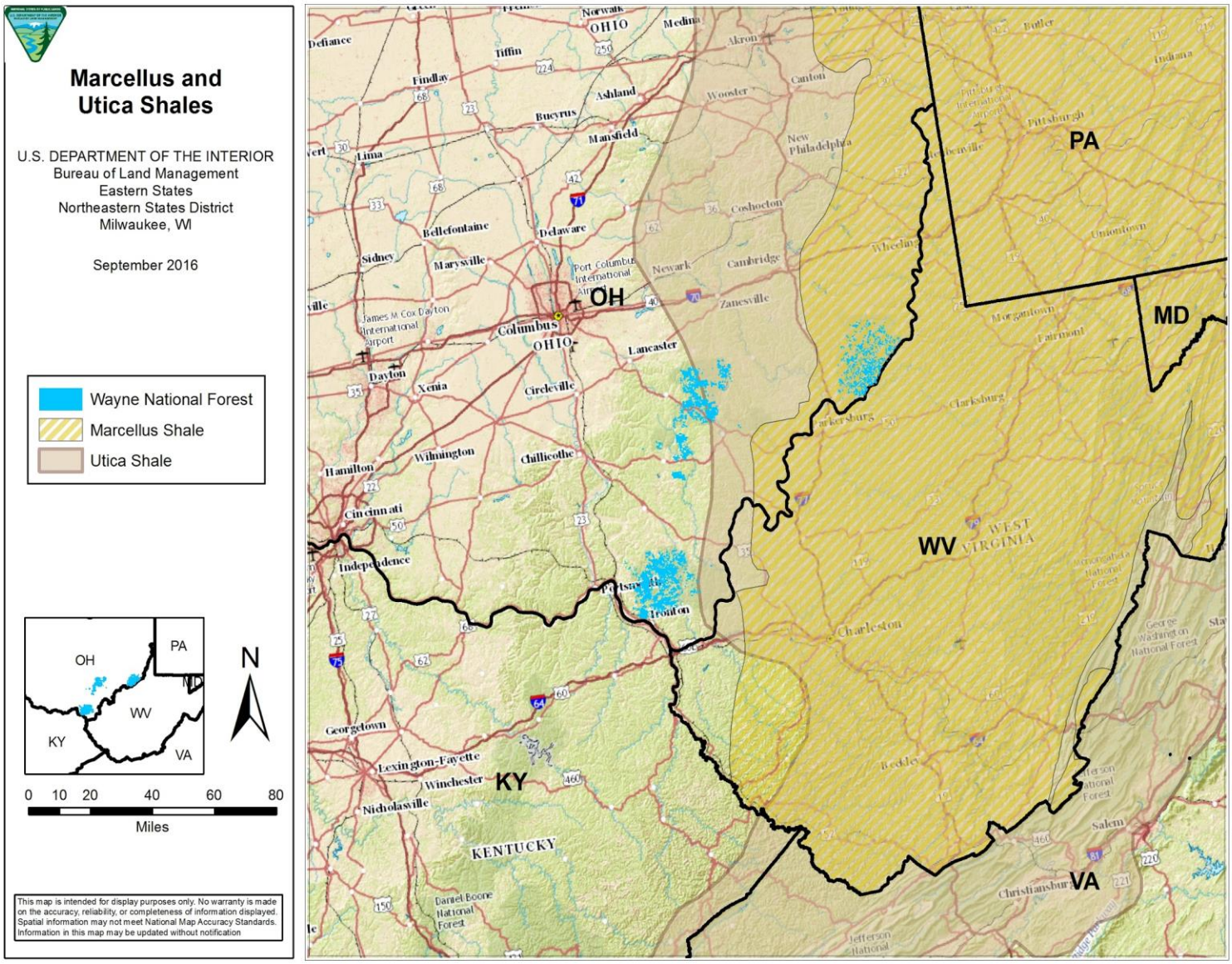
	and any areas not necessary for production would be placed into interim reclamation further reducing the footprint and visual impacts of the oil and gas activities.
The Draft EA should acknowledge that the characters and use of the land will be permanently changed due to construction and operation of well pads and related activities.	The Final EA acknowledges that there may be some permanent land use changes as a result of future mineral development in the Marietta Unit; however, reclamation would minimize some of these effects over the long-term (see Sections: 4.5, 4.14, 4.16.2.4, 4.16.2.9., 4.16.2.12. & 5.4.).
Mitigation	
The EA incorrectly assumes that all impacts of oil and gas leasing within the Marietta Unit would be mitigated by Forest Plan regulations or by surface use agreements with the Forest Service.	Impacts would be mitigated to a level where they would not be considered significant, as discussed throughout the Final EA.
Hydraulic fracturing has little federal or state oversight. For example, ODNR does not require or perform monitoring for contamination of drinking water, surface water, or groundwater around injection wells). Therefore the BLM and FS have a legal obligation to review, analyze, disclose, and avoid the impacts of oil and gas leasing decisions.	Appendix C (a new appendix in the Final EA) discusses state oversight of operations on private surface, as well as the other aspects of oil and gas development regulated by Ohio.

Appendix B: Shale Layer Map


Marcellus and Utica Shales
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
Eastern States
Northeastern States District
Milwaukee, WI
September 2016
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Marcellus Shale
Utica Shale
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Wilmington
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Charleston
Georgetown
Lexington-Fayette
Winchester
Nicholasville
KENTUCKY
Daniel Boone National Forest
Pittsburgh
Butler
Indiana
Uniontown
Morgantown
Fairmont
Clarksburg
WEST VIRGINIA
Beckley
Salem
Christiansburg

Appendix C: Permitting of Oil and Gas Operations on Non-Federal Surface

Permitting of Oil and Gas Operations on Non-Federal Surface

During the scoping and comment period for DOI-BLM-Eastern States-0030-2016-0002-EA, Oil and Gas Leasing, Wayne National Forest Marietta Unit of the Athens Ranger District, Monroe, Noble, and Washington Counties, Ohio (Environmental Assessment), many questions were raised regarding the permitting and regulation of oil and gas operations on non-federal surface. As noted in the Environmental Assessment, mineral ownership is highly split in the Wayne National Forest with some mineral under federal ownership, and other under private ownership. While the Bureau of Land Management (BLM) and United States Forest Service (USFS) do not have the same permitting and regulatory powers when drilling activities are conducted on non-federal land overlying non-federal minerals as opposed to operations on federal lands, at least six state and federal agencies have jurisdiction over such operations. As discussed in this paper, these agencies fulfill the same role in ensuring environmentally responsible development of mineral resources.

Regulation of Oil and Gas Operations on Private Surface

The Ohio Department of Natural Resources (ODNR) is primary authority for oil and gas drill operations in the State of Ohio. Within ODNR the Division of Oil & Gas Resource Management (ODNR-DOGRM) and Division of Soil & Water Resources (ODNR-DSWR) regulate and permit various aspects of drilling and production operations. The Ohio Environmental Protection Agency Division of Surface Water (OEPA-DSW) and Division of Air Pollution Control (OEPA-DAPC) both fulfill roles in ensuring environmental compliance of said operations. The Ohio Department of Health Bureau of Radiation Protection also has jurisdiction over some oil and gas operations involving radioactive materials.

Although in Ohio permitting of oil and gas operations on private surface and private minerals is primarily a function of the State, other Federal agencies may also have regulatory authority. Depending on circumstances, the United States Fish and Wildlife Services (USFWS); United States Army Corps of Engineers (USACE); United States Environmental Protection Agency (USEPA); or may be required to approve or consult regarding oil and gas operations.

The authority and regulations of these agencies extend to pre-operational and operational oil and gas operations.

Pre-Operation Permitting and Regulation

Endangered and Threatened Species Act Considerations

Prior to initiating operations, oil and gas operators are subject to Endangered Species Act (ESA) consideration. USFWS is the primary administer of the ESA, which aims to actively conserve

biological diversity.[2] "Endangered Species" is defined as "any species which is in danger of extinction throughout all or significant portion of its range."[3] "Threatened Species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or significant portion of its range."[4] Once a species is listed as endangered or threatened, protective measures apply to the species and its habitat under Section 9 of the ESA.[5] Section 4 of the ESA broadly defines "persons" to whom the act applies as to include any person or entity subject to the jurisdiction of the United States."[6]

Section 7 of the ESA, primarily involves agency actions, and consultation requirements for said actions. The purpose is to utilize USFWS expertize to determine whether an action is likely to jeopardize a listed species or adversely modify a critical habitat, and if so, identify suitable alternatives.[7] However, a private party may be affected by section 7 if its project or activity requires a federal permit.[8] Section 7 mandates that the Secretary of Interior work with federal agencies on "any action authorized, funded, or carried out" by that agency to ensure that action will not "jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of its habitat."[9] Thus, operations originating on private surface that require a federal application for permit to drill (APD) because federal minerals are penetrated, may be impacted by BLM's section 7 consultation requirements.

As mentioned, even without a federal nexus a private person is subject to the ESA. Section 9 of the ESA prohibits the possession, sale, import, and/or export of endangered species, as well as the "take" of a listed wildlife species by a private or public entity. Section 3 of the ESA defines the term "take" broadly to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."[10] To harass includes "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to breeding feeding or sheltering."[11] Harm includes "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering." [12] Activities that are not designed

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[2] 16 USC 1531-44.
[3] 16 USC 1532(6).
[4] 16 USC 1532(20).
[5] The prohibitions of section 9 reach beyond actions of the federal government to encapsulate the actions of all persons within the jurisdiction of the United States. 16 USC 1538(a)(1)
[6] 16 USC 1532(13)
[7] Gabriel Eckstein & Jesse Snyder, Endangered Species in the Oil Patch: Challenges and Opportunities for the Oil and Gas Industry, 1 Tex. A&M L. Rev. 379, 387 (2013)
[8] *Id.*
[9] 16 USC 1536(a)(2)
[10] 16 USC 1532
[11] 50 CFR 17.3
[12] *Id.*

or intended to harm a species, but that could do so indirectly, such as servicing a well, can constitute a take prohibited by the ESA.[13]

Section 11 subjects any person who violates the statute or it's implementing regulations to an array of civil and criminal sanctions. These may include civil penalties up to $25,000 per violation, and criminal penalties up to $50,000 and/or one year in prison.[14] In prosecuting a take under the ESA, only general intent is required, and knowledge that a particular species is protected is not dispositive.[15]

Section 10 authorizes USFWS to grant an incidental take permit, allowing an entity to incidentally kill an endangered species or to modify its habitat in the course of business activity.[16] A take is incidental if it is prohibited under section 9, but "is incidental to, and not the purpose of carrying out an otherwise lawful activity."[17] Incidental takings will be allowed if the applicant prepares a Habitat Conservation Plan (HCP) that effectively makes the species' chances better than if the status quo was left in place, and minimizes and mitigates harmful effects of the activity.[18] The HCP must contain specific information, analysis, and plans- including financial support- that specify how the applicant will "minimize and mitigate" the adverse impacts on the protected species.[19] The HCP must also discuss alternatives considered by the applicant, and reasons why these alternatives are not being pursued.[20] The regulations further require USFWS to include precise measures to address any changed circumstances arising during the lifetime of the permit which may jeopardize the survival and recovery of the threatened or endangered species covered by the plan.[21] The Secretary of Interior will issue permits if the HCP is acceptable, and "the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild."[22] The Secretary of Interior may revoke a permit if the holder does not comply with the terms.[23]

An oil and gas operator may act preemptively to potentially insulate itself from ESA liability by entering into a conservation agreement prior to the listing of a species. Candidate Conservation Agreements with Assurances ("CCAAs") are agreements, whereby non-federal property owners commit to implement voluntary conservation measures for a candidate species, and in return receive regulatory assurances that additional conservation measures will not be required and

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[13] Eckstein, 389.
[14] 1540(a)(1),(b)(1).
[15] Eckstein, 382.
[16] 16 USC 1539(a)(1)(B).
[17] *See* 50 CFR 17.22 for detailed provisions.
[18] 16 USC 1539(a)(2)(A).
[19] *Id.*
[20] 16 USC 1539(a)(2)(A)(i)-(iv); see also 50 CFR 17.22(b).
[21] 50 CFR 17.22(b)(1)(iii)(B), 17.32(b)(1)(iii).
[22] 16 USC 1539(a)(2)(B)(iv).
[23] 16 USC 1539(a)(2)(C).

additional restrictions will not be imposed should the species become listed in the future.[24] Furthermore, the proactive conservation efforts performed through CCAAs may remove or reduce perceived threats to the covered species, so that USFWS could determine that listing the species under the ESA is unnecessary.[25]

Any mitigating measures and alternatives established through the consultation or permitting described above will be applied to the additional permitting and regulatory activities discussed below.

Well Pad Design and Construction Plan

Well pad construction permitting is a fundamental regulatory function of the Ohio Department of Natural Resources, Division of Oil & Gas Resources Management (ODNR-DOGRM). Within ODNR-DOGRM, geologists perform a complete and thorough review of every permit application to drill and plug wells for oil and gas in Ohio. Detailed examinations verify that wells are designed to minimize environmental impacts, that proper environmental safeguards are in place, and that all legal requirements are met.

ODNR-DOGRM controls negative environmental impacts by regulating location, spacing, construction, design and operation of oil and gas wells in accordance with Chapter 1509 of the Ohio Revised Code (ORC) and Chapter 1501 Ohio Administrative Code (OAC). These regulations are applicable to all natural gas, oil, Class II injection, and enhanced recovery wells.[26] ODNR-DOGRM will require a permit whenever an operator plans to drill, deepen, reopen, plug back, convert, or plug a well.[27] A key method to ODNR-DOGRM's oversight of oil and gas operations is through the notification and reporting requirements found in the ORC and OAC. Examples of information that must be submitted to ODNR-DOGRM include that regarding (1) cementing; (2) well completion; (3) stimulation; and (4) production. Operators are also required to formally implement procedures during the drilling stage for spill prevention (discussed below), and other safety measures.[28] These requirements are augmented by onsite inspection and enforcement by the ODNR-DOGRM.

ODNR-DOGRM considers site restoration measures prior to authorizing any oil and gas operations. Operators must submit detailed plans as to reclamation ensuring the maximum

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[24] Eckstein, 391.
[25] Ohio Environmental Protection Agency, *Ohio's Regulations: A Guide for Operators Drilling in the Marcellus and Utica Shales*, 2 (March 2012)
[26] *Id.*
[27] *Id.*
[28] *Id.*

numbers of disturbed acres are returned to pre-development state.[29] Compliance with the measures established by the operator and ODNR-DOGRM is secured via bonding.[30]

Well Pad Construction Impacts on Waters

The Ohio Environmental Protection Agency, Division of Surface Water (OEPA-DSW) and United States Army Corps of Engineers (USACE) authorize any construction activity where there is impact to wetland, stream, river, and other waters of the state.[31] Regulated activities include: (1) excavating or placing fill material in water way to construct pad sites, access roads, water lines, or production lines; (2) stream piping, rerouting or straighten for construction; (3) dredging a wetland to create a pond; (4) culverting streams or filling wetlands for roadways water or wastewater piping.[32]

Projects in Ohio impacting wetland, stream, river, lake, or other water of the United States require a Section 404 Dredge and Fill permit from the USACE and a Section 401 Water Quality Certification (401 WQC) permit from OEPA-DSW.[33] Under Section 404 of the Clean Water Act, which calls for said permitting process, anyone who wishes to discharge dredged or fill material into the waters of the United States, regardless of whether on private or public property, must obtain a Section 404 permit from the USACE.[34] 401 WQC from OEPA-DSW is also a required component of Section 404 Dredge and Fill permits issued by the USACE.[35] Though USACE and OEPA-DSW are regulating the same activities, they have different authority and jurisdiction, and each office uses their own processes to ensure environmental compliance of said operations.[36]

Storm Water Runoff and Erosion during Construction

Operators must include in drilling plans preventive measures for storm water runoff and erosion from well pad construction activities. ODNR-DOGRM requires for urban drilling, and recommends for all drilling, the following best management practices (BMPs): (1) installing perimeter controls, sediment basin/traps and a stabilized construction entrance; (2) isolating drainage from the site to eliminate storm water run-on; (3) using a stabilized entrance or wheel was station to reduce mud on streets or roads from vehicle drag; and/or (4) contain and properly

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[29] *Id.*
[30] *Id.*
[31] *Id.* at 5.
[32] *Id.*
[33] *Id.*
[34] *Id.*
[35] *Id.*
[36] *Id.*

dispose of drilling fluids, including fluids associated with setting casing and plugging operations; and/or regular inspection to ensure adequate stabilization.[37]

Oil and gas operations do not require United States Environmental Protection Agency (USEPA) Clean Water Act (CWA) permit for storm water runoff and erosion.[38] However, the CWA remains enforceable if there is a discharge of any reportable quality of material, or discharge from the site contributes to a violation of water quality standard.[39]

Oil and Gas Operations Permitting and Regulations

Emissions

Prior to any industrial operation with the potential to produce emissions, Ohio Environmental Protection Agency, Division of Air Pollution Control (OEPA-DAPC) requires a Permit-to-Install and Operate (PTIO), which will include requirements such as emission limits, operating restrictions, monitoring requirements, and reporting requirements.[40] As with many common industrial operations, OEPA-DAPC has a general permit for most oil and gas operations. This permit addresses emissions from (1) internal combustion engines; (2) generators, (3) dehydration systems; (4) storage tanks; and (3) flaring used during oil and gas operations.[41] To determine if an operator qualifies for the general permit, or if a custom PTIO must be accomplished, discussions between the operator and OEPA-DAPC regarding details of the operations must occur, including the types of equipment to be used.

Water Withdrawals

ODNR, Division of Soil and Water Resources (ODNR-DSWR) provides oversight for any in-state water withdrawals for oil and gas operations. ORC Section 1521.16 requires registration of a water withdrawal facility, or combination of facilities, capable of withdrawing water at greater than 100,000 gallons of water per day.[42] This registration requirement is triggered by capability of withdrawal, not actual withdrawal.[43]

Ohio has also enacted other specific measures to reduce effects of water withdrawals for the purpose of oil and gas operations. For example, the Great Lakes-St. Lawrence River Basin Water Resources Compact (Great Lakes Compact) is a binding agreement prohibiting any new or increased diversions of any amount of water out of the Lake Erie Basin.[44] OEPA regulates

[37] *Id.* at 6.
[38] *Id.*
[39] *Id.*
[40] *Id.*
[41] *Id.*
[42] *Id.* at 3.
[43] *Id.*
[44] *Id.*

water withdrawals for oil and gas operations from other public water supplies according to the requirements found in OAC 3745-95.[45] These requirements mainly address containment devices to prevent backflow.[46] As discussed above, USACE 404 and OEPA-DSW 401 authorizations may be required for pipe construction impacting waterways.[47] Water withdrawals from other sources must be reported to ODNR, and are handled on case-by-case basis.[48]

Fluids from Oil and Gas Drilling Operations

ODNR-DOGRM has exclusive authority for regulating the disposal of brine and fluids from oil and gas operations.[49] Brine is all saline geological formation water from oil and gas operations, including iron, calcium, magnesium, barium, and sulfur.[50] ODNR-DOGRM approves design and operation of pits and tanks used for temporary storage, and Ohio does not authorize long term storage.[51] ODNR-DOGRM recommends steel tanks to store any fluids from oil and gas operations, and mandates their use when in close proximity to drinking water resources, floodplain areas, or where shallow groundwater is susceptible to contamination.[52] As discussed above, ESA considerations may also dictate additional storage requirements such as prohibition of open pits.

Transportation of fluids and waste from oil and gas operations are also regulated by ODNR. Transport companies must be registered with ODNR-DOGRM, and are required to (1) have a valid ID number; (2) maintain a daily log; (3) submit an annual report; and (4) be bonded.[53] Direct discharge of brine into waters of the state is prohibited, and must be sent to ODNR permitted Class II injection well.[54] Some brine has potential for naturally low levels of radiation, and disposal of these materials is regulated by the Ohio Department of Health Bureau of Radiation Protection (ODH-BRP), but only if radioactive levels are higher than naturally occurring levels.

The OEPA regulates the off-site disposal of drill cuttings that have come in contact with drilling mud, oil, or other contaminants.[55] As discussed above, OEPA also authorizes any reuse of materials.[56] ODNR-DOGRM must approve any disposal at drill site.[57] As mentioned, ODH-

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[45] *Id.*
[46] *Id.*
[47] *Id.*
[48] *Id.*
[49] *Id.* at 6.
[50] *Id.* at 7.
[51] *Id.*
[52] *Id.*
[53] *Id.*
[54] *Id.*
[55] *Id.*
[56] *Id.*

BRP regulates disposal of radioactive drill cuttings with higher levels of radiation than in natural state.

Spill Prevention Control and Countermeasure (SPCC) Plans

As stated, Ohio does not allow long term storage of production or waste from oil and gas operations. However, USEPA places the following requirement when an operator's total above ground storage capacity exceeds 1,320 gallons or more: (1) provide adequate secondary containment for storage and transfer areas to contain releases; and (2) preparing a written SPCC plan.[58] The trigger for these requirements to be implemented is the storage capacity, not the actual amount stored.[59] ORC 3745.50 requires reporting of spills or releases of petroleum products to local state and/or federal authorities if exceeding reportable quantities.[60] Reportable quantities include any amount of petroleum that causes a film/sheen on a waterway, or any spill or release to the environment (not contained on the spiller's property) of 25 gallons or more.[61] Reporting is encouraged if the amount is unknown.[62]

Emergency Planning and Community Right-to-Know (EPCRA) is a reporting requirement that may apply to an oil and gas operator storing hazardous chemicals on-site.[63] Oil and gas operators are subject to these requirements if the facility: (1) is subject to the Occupational Safety and Health Administration (OSHA) Hazard Communications Standard; (2) uses, produces, and/or stores hazardous chemicals and or extremely hazardous substances (EHS); and (3) the quantity of hazardous chemicals or extremely hazardous substances stored is in excess of the threshold quantity.[64] ORC Chapter 1506 applies to operations subject to EPCRA. ODNR-OGRM, in partnership with emergency response commission, is authorized to establish the reporting format and necessary information for purposes of responding to emergencies.[65]

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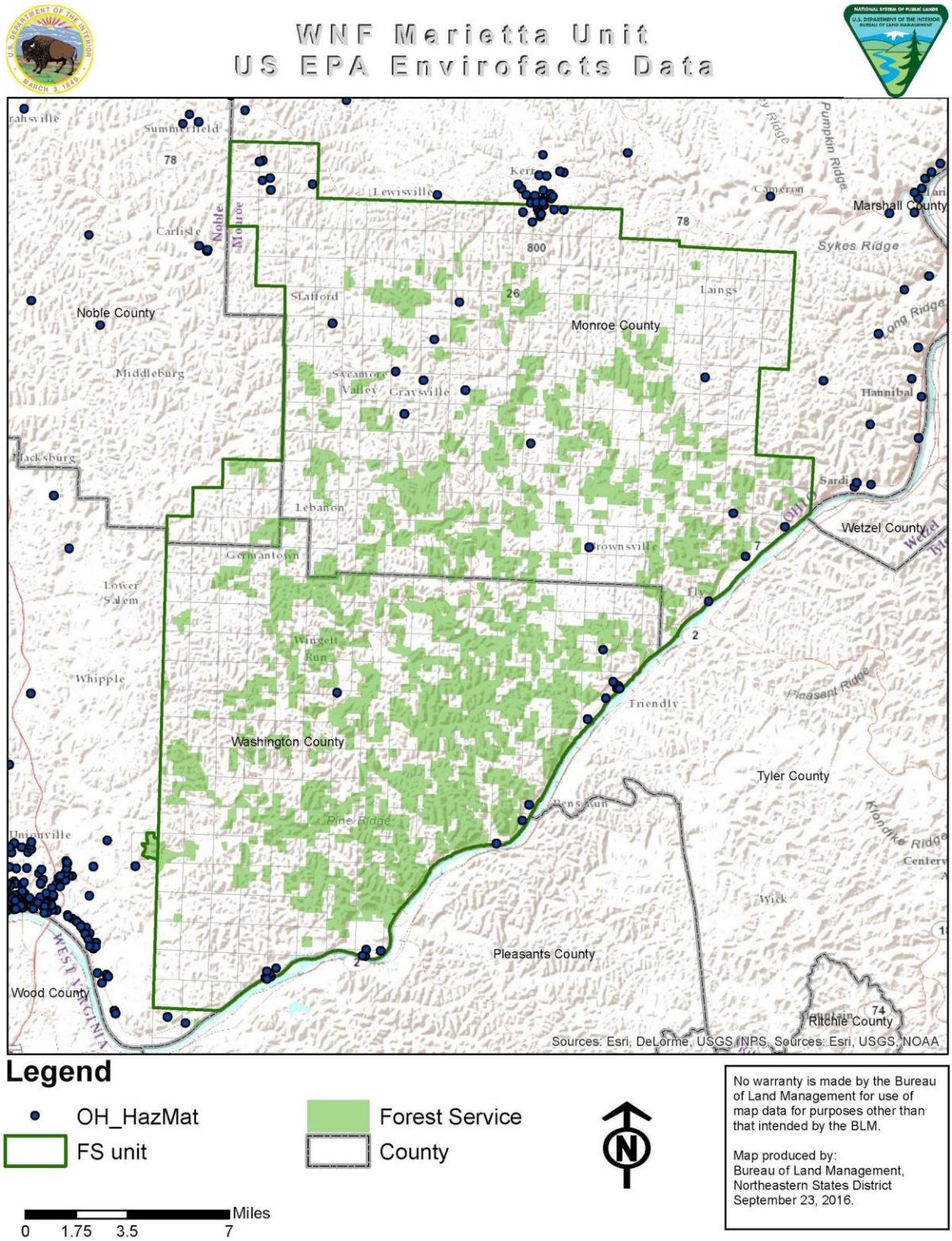
[57] *Id.*
[58] 40 CFR Part 112
[59] Ohio Environmental Protection Agency, 8.
[60] *Id.*
[61] *Id.*
[62] *Id.*
[63] *Id.*
[64] *Id.*
[65] *Id.*

Appendix D: Marietta Unit Envirofacts Hazardous Sites Data Map



Appendix E: U.S. EPA Emissions Factors for Greenhouse Gas Inventories

Table 4 Mobile Combustion CH_4 and N_2O Emission Factors for On-road Diesel and Alternative Fuel Vehicles

Vehicle Type	Vehicle Year	CH_4 Factor (g / mile)	N_2O Factor (g / mile)
Diesel Passenger Cars	1960-1982	0.0006	0.0012
	1983-1995	0.0005	0.0010
	1996-present	0.0005	0.0010
Diesel Light-duty Trucks	1960-1982	0.0011	0.0017
	1983-1995	0.0009	0.0014
	1996-present	0.0010	0.0015
Diesel Medium- and Heavy-duty Vehicles	1960-present	0.0051	0.0048
Gasoline Motorcycles	1960-1995	0.0899	0.0087
	1996-present	0.0672	0.0069
CNG Light-duty Vehicles		0.7370	0.0500
CNG Heavy-duty Vehicles		1.9660	0.1750
CNG Buses		1.9660	0.1750
LPG Light-duty Vehicles		0.0370	0.0670
LPG Heavy-duty Vehicles		0.0660	0.1750
LNG Heavy-duty Vehicles		1.9660	0.1750
Ethanol Light-duty Vehicles		0.0550	0.0670
Ethanol Heavy-duty Vehicles		0.1970	0.1750
Ethanol Buses		0.1970	0.1750

Source: EPA (2014) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012. All values are calculated from Tables A-104 through A-106.

Table 5 Mobile Combustion CH_4 and N_2O Emission Factors for Non-road Vehicles

Vehicle Type	CH_4 Factor (g / gallon)	N_2O Factor (g / gallon)
LPG Non-Highway Vehicles	0.50	0.22
Residual Oil Ships and Boats	0.11	0.57
Diesel Ships and Boats	0.06	0.45
Gasoline Ships and Boats	0.64	0.22
Diesel Locomotives	0.80	0.26
Gasoline Agricultural Equip.	1.26	0.22
Diesel Agricultural Equip.	1.44	0.26
Gasoline Construction Equip.	0.50	0.22
Diesel Construction Equip.	0.57	0.26
Jet Fuel Aircraft	0.00	0.30
Aviation Gasoline Aircraft	7.06	0.11
Biodiesel Vehicles	0.57	0.26
Other Diesel Sources	0.57	0.26
Other Gasoline Sources	0.50	0.22

Source: EPA (2014) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012. All values are calculated from Table A-107.
Note: LPG non-highway vehicles assumed equal to other gasoline sources. Biodiesel vehicles assumed equal to other diesel sources.

Table 6 Electricity Emission Factors

eGRID Subregion	Total output emission factors			Non-baseload emission factors		
	CO_2 Factor (lb CO_2/MWh)	CH_4 Factor (lb CH_4/MWh)	N_2O Factor (lb N_2O/MWh)	CO_2 Factor (lb CO_2/MWh)	CH_4 Factor (lb CH_4/MWh)	N_2O Factor (lb N_2O/MWh)
AKGD (ASCC Alaska Grid)	1,256.87	0.02608	0.00718	1,387.37	0.03405	0.00693
AKMS (ASCC Miscellaneous)	448.57	0.01874	0.00368	1,427.76	0.05997	0.01180
AZNM (WECC Southwest)	1,177.61	0.01921	0.01572	1,210.44	0.02188	0.00986
CAMX (WECC California)	610.82	0.02649	0.00603	932.82	0.03591	0.00455
ERCT (ERCOT All)	1,218.17	0.01685	0.01407	1,181.70	0.02012	0.00763
FRCC (FRCC All)	1,196.71	0.03891	0.01375	1,277.42	0.03873	0.01083
HIMS (HICC Miscellaneous)	1,330.16	0.07398	0.01388	1,690.72	0.10405	0.01912
HIOA (HICC Oahu)	1,621.88	0.09930	0.02241	1,588.23	0.11948	0.02010
MROE (MRO East)	1,810.80	0.02429	0.02752	1,755.66	0.03153	0.02799
MROW (MRO West)	1,536.36	0.02653	0.02629	2,054.55	0.05986	0.03553
NEWE (NPCC New England)	722.07	0.07176	0.01298	1,106.82	0.06155	0.01207
NWPP (WECC Northwest)	842.58	0.01605	0.01307	1,340.34	0.04138	0.01784
NYCW (NPCC NYC/Westchester)	622.42	0.02381	0.00280	1,131.63	0.02358	0.00244
NYLI (NPCC Long Island)	1,336.11	0.08149	0.01028	1,445.94	0.03403	0.00391
NYUP (NPCC Upstate NY)	545.79	0.01630	0.00724	1,253.77	0.03683	0.01367
RFCE (RFC East)	1,001.72	0.02707	0.01533	1,562.72	0.03593	0.02002
RFCM (RFC Michigan)	1,629.38	0.03046	0.02684	1,744.52	0.03231	0.02600
RFCW (RFC West)	1,503.47	0.01820	0.02475	1,982.87	0.02450	0.03107
RMPA (WECC Rockies)	1,896.74	0.02266	0.02921	1,808.03	0.02466	0.02269
SPNO (SPP North)	1,799.45	0.02081	0.02862	1,951.83	0.02515	0.02690
SPSO (SPP South)	1,580.60	0.02320	0.02085	1,436.29	0.02794	0.01210
SRMV (SERC Mississippi Valley)	1,029.82	0.02066	0.01076	1,222.40	0.02771	0.00663
SRMW (SERC Midwest)	1,810.83	0.02048	0.02957	1,964.98	0.02393	0.02965
SRSO (SERC South)	1,354.09	0.02282	0.02089	1,574.37	0.02652	0.02149
SRTV (SERC Tennessee Valley)	1,389.20	0.01770	0.02241	1,873.83	0.02499	0.02888
SRVC (SERC Virginia/Carolina)	1,073.65	0.02169	0.01764	1,624.71	0.03642	0.02306
US Average	1,232.35	0.02414	0.01826	1,520.20	0.03127	0.01834

Source: EPA Year 2010 eGRID 9th edition Version 1.0 February 2014.
Note: Total output emission factors are used for quantifying emissions from purchased electricity. Non-baseload emission factors are used for quantifying the emission reductions from purchased green power.

This is a representational map; many of the boundaries shown on this map are approximate because they are based on companies, not on strictly geographical boundaries.
Source: EPA Year 2010 eGRID 9th edition Version 1.0 February 2014.

Table 2 Mobile Combustion CO_2 Emission Factors

Fuel Type	kg CO_2 per unit	Unit
Aviation Gasoline	8.31	gallon
Biodiesel (100%)	9.45	gallon
Compressed Natural Gas (CNG)	0.0545	scf
Diesel Fuel	10.21	gallon
Ethane	4.05	gallon
Ethanol (100%)	5.75	gallon
Jet Fuel (kerosene type)	9.75	gallon
Liquefied Natural Gas (LNG)	4.46	gallon
Liquefied Petroleum Gases (LPG)	5.68	gallon
Methanol	4.10	gallon
Motor Gasoline	8.78	gallon
Propane	5.72	gallon
Residual Fuel Oil	11.27	gallon

Source:
Federal Register (2009) *EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule*, 30Oct09, 261 pp. Tables C-1 and C-2. Table of Final 2013 Revisions to the Greenhouse Gas
LNG sourced from: EPA (2008) *Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance - Direct Emissions from Mobile Combustion Sources*, Table B-5.
Methanol sourced from: The Climate Registry (2013); *General Reporting Protocol for the Voluntary Reporting Program Version 2.0*, Default Emission Factors, Table 13.1 US Default CO_2 Emission Factors for Transport Fuels.

Table 3 Mobile Combustion CH_4 and N_2O Emission Factors for On-road Gasoline Vehicles

Vehicle Type	Year	CH_4 Factor (g / mile)	N_2O Factor (g / mile)
Gasoline Passenger Cars	1973-74	0.1696	0.0197
	1975	0.1423	0.0443
	1976-77	0.1406	0.0458
	1978-79	0.1389	0.0473
	1980	0.1326	0.0499
	1981	0.0802	0.0626
	1982	0.0795	0.0627
	1983	0.0782	0.0630
	1984-93	0.0704	0.0647
	1994	0.0531	0.0560
	1995	0.0358	0.0473
	1996	0.0272	0.0426
	1997	0.0268	0.0422
	1998	0.0249	0.0393
	1999	0.0216	0.0337
	2000	0.0178	0.0273
	2001	0.0110	0.0158
	2002	0.0107	0.0153
	2003	0.0114	0.0135
	2004	0.0145	0.0083
	2005	0.0147	0.0079
	2006	0.0161	0.0057
	2007	0.0170	0.0041
	2008	0.0172	0.0038
	2009-present	0.0173	0.0036
Gasoline Light-duty Trucks (Vans, Pickup Trucks, SUVs)	1973-74	0.1908	0.0218
	1975	0.1634	0.0513
	1976	0.1594	0.0555
	1977-78	0.1614	0.0534
	1979-80	0.1594	0.0555
	1981	0.1479	0.0660
	1982	0.1442	0.0681
	1983	0.1368	0.0722
	1984	0.1294	0.0764
	1985	0.1220	0.0806
	1986	0.1146	0.0848
	1987-93	0.0813	0.1035
	1994	0.0646	0.0962
	1995	0.0517	0.0908
	1996	0.0452	0.0871
	1997	0.0452	0.0871
	1998	0.0391	0.0728
	1999	0.0321	0.0564
	2000	0.0346	0.0621
	2001	0.0151	0.0164
	2002	0.0178	0.0228
	2003	0.0155	0.0114
	2004	0.0152	0.0132
	2005	0.0157	0.0101
	2006	0.0159	0.0089
	2007	0.0161	0.0079
	2008-present	0.0163	0.0066
Gasoline Heavy-duty Vehicles	<1981	0.4604	0.0497
	1982-84	0.4492	0.0538
	1985-86	0.4090	0.0515
	1987	0.3675	0.0849
	1988-1989	0.3492	0.0933
	1990-1995	0.3246	0.1142
	1996	0.1278	0.1680
	1997	0.0924	0.1726
	1998	0.0641	0.1693
	1999	0.0578	0.1435
	2000	0.0493	0.1092
	2001	0.0528	0.1235
	2002	0.0546	0.1307
	2003	0.0533	0.1240
	2004	0.0341	0.0285
	2005	0.0326	0.0177
	2006	0.0327	0.0171
	2007	0.0330	0.0153
	2008-present	0.0333	0.0134

Source: EPA (2014) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012. All values are calculated from Tables A-101 through A-105.

Emission Factors for Greenhouse Gas Inventories

Last Modified: 4 April 2014

Red text indicates an update from the 2011 version of this document.

Typically, greenhouse gas emissions are reported in units of carbon dioxide equivalent (CO_2e). Gases are converted to CO_2e by multiplying by their global warming potential (GWP). The emission factors listed in this document have not been converted to CO_2e. To do so, multiply the emissions by the corresponding GWP listed in the table below.

Gas	100-year GWP
CH_4	25
N_2O	298

Source: Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007. See the source note to Table 9 for further explanation.

Table 1 Stationary Combustion Emission Factors

Fuel Type	Heating Value	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 Factor	CH_4 Factor	N_2O Factor	Unit
	mmBtu per short ton	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per short ton	g CH_4 per short ton	g N_2O per short ton	
Coal and Coke								
Anthracite Coal	25.09	103.69	11	1.6	2,602	276	40	short tons
Bituminous Coal	24.93	93.28	11	1.6	2,325	274	40	short tons
Sub-bituminous Coal	17.25	97.17	11	1.6	1,676	190	28	short tons
Lignite Coal	14.21	97.72	11	1.6	1,389	156	23	short tons
Mixed (Commercial Sector)	21.39	94.27	11	1.6	2,016	235	34	short tons
Mixed (Electric Power Sector)	19.73	95.52	11	1.6	1,885	217	32	short tons
Mixed (Industrial Coking)	26.28	93.90	11	1.6	2,468	289	42	short tons
Mixed (Industrial Sector)	22.35	94.67	11	1.6	2,116	246	36	short tons
Coal Coke	24.80	113.67	11	1.6	2,819	273	40	short tons
Fossil Fuel-derived Fuels (Solid)								
Municipal Solid Waste	9.95	90.70	32	4.2	902	318	42	short tons
Petroleum Coke (Solid)	30.00	102.41	32	4.2	3,072	960	126	short tons
Plastics	38.00	75.00	32	4.2	2,850	1,216	160	short tons
Tires	28.00	85.97	32	4.2	2,407	896	118	short tons
Biomass Fuels (Solid)								
Agricultural Byproducts	8.25	118.17	32	4.2	975	264	35	short tons
Peat	8.00	111.84	32	4.2	895	256	34	short tons
Solid Byproducts	10.39	105.51	32	4.2	1,096	332	44	short tons
Wood and Wood Residuals	17.48	93.80	7.2	3.6	1,640	126	63	short tons
	mmBtu per scf	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per scf	g CH_4 per scf	g N_2O per scf	
Natural Gas								
Natural Gas (per scf)	0.001026	53.06	1.0	0.10	0.05444	0.00103	0.00010	scf
Fossil-derived Fuels (Gaseous)								
Blast Furnace Gas	0.000092	274.32	0.022	0.10	0.02524	0.000002	0.000009	scf
Coke Oven Gas	0.000599	46.85	0.48	0.10	0.02806	0.000288	0.000060	scf
Fuel Gas	0.001388	59.00	3.0	0.60	0.08189	0.004164	0.000833	scf
Propane Gas	0.002516	61.46	0.022	0.10	0.15463	0.000055	0.000252	scf
Biomass Fuels (Gaseous)								
Landfill Gas	0.000485	52.07	3.2	0.63	0.025254	0.001552	0.000306	scf
Other Biomass Gases	0.000655	52.07	3.2	0.63	0.034106	0.002096	0.000413	scf
	mmBtu per gallon	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per gallon	g CH_4 per gallon	g N_2O per gallon	
Petroleum Products								
Asphalt and Road Oil	0.158	75.36	3.0	0.60	11.91	0.47	0.09	gallon
Aviation Gasoline	0.120	69.25	3.0	0.60	8.31	0.36	0.07	gallon
Butane	0.103	64.77	3.0	0.60	6.67	0.31	0.06	gallon
Butylene	0.105	68.72	3.0	0.60	7.22	0.32	0.06	gallon
Crude Oil	0.138	74.54	3.0	0.60	10.29	0.41	0.08	gallon
Distillate Fuel Oil No. 1	0.139	73.25	3.0	0.60	10.18	0.42	0.08	gallon
Distillate Fuel Oil No. 2	0.138	73.96	3.0	0.60	10.21	0.41	0.08	gallon
Distillate Fuel Oil No. 4	0.146	75.04	3.0	0.60	10.96	0.44	0.09	gallon
Ethane	0.068	59.60	3.0	0.60	4.05	0.20	0.04	gallon
Ethylene	0.058	65.96	3.0	0.60	3.83	0.17	0.03	gallon
Heavy Gas Oils	0.148	74.92	3.0	0.60	11.09	0.44	0.09	gallon
Isobutane	0.099	64.94	3.0	0.60	6.43	0.30	0.06	gallon
Isobutylene	0.103	68.86	3.0	0.60	7.09	0.31	0.06	gallon
Kerosene	0.135	75.20	3.0	0.60	10.15	0.41	0.08	gallon
Kerosene-type Jet Fuel	0.135	72.22	3.0	0.60	9.75	0.41	0.08	gallon
Liquefied Petroleum Gases (LPG)	0.092	61.71	3.0	0.60	5.68	0.28	0.06	gallon
Lubricants	0.144	74.27	3.0	0.60	10.69	0.43	0.09	gallon
Motor Gasoline	0.125	70.22	3.0	0.60	8.78	0.38	0.08	gallon
Naphtha (<401 deg F)	0.125	68.02	3.0	0.60	8.50	0.38	0.08	gallon
Natural Gasoline	0.110	66.88	3.0	0.60	7.36	0.33	0.07	gallon
Other Oil (>401 deg F)	0.139	76.22	3.0	0.60	10.59	0.42	0.08	gallon
Pentanes Plus	0.110	70.02	3.0	0.60	7.70	0.33	0.07	gallon
Petrochemical Feedstocks	0.125	71.02	3.0	0.60	8.88	0.38	0.08	gallon
Petroleum Coke	0.143	102.41	3.0	0.60	14.64	0.43	0.09	gallon
Propane	0.091	62.87	3.0	0.60	5.72	0.27	0.05	gallon
Propylene	0.091	65.95	3.0	0.60	6.00	0.27	0.05	gallon
Residual Fuel Oil No. 5	0.140	72.93	3.0	0.60	10.21	0.42	0.08	gallon
Residual Fuel Oil No. 6	0.150	75.10	3.0	0.60	11.27	0.45	0.09	gallon
Special Naphtha	0.125	72.34	3.0	0.60	9.04	0.38	0.08	gallon
Still Gas	0.143	66.72	3.0	0.60	9.54	0.43	0.09	gallon
Unfinished Oils	0.139	74.54	3.0	0.60	10.36	0.42	0.08	gallon
Used Oil	0.138	74.00	3.0	0.60	10.21	0.41	0.08	gallon
Biomass Fuels (Liquid)								
Biodiesel (100%)	0.128	73.84	1.1	0.11	9.45	0.14	0.01	gallon
Ethanol (100%)	0.084	68.44	1.1	0.11	5.75	0.09	0.01	gallon
Rendered Animal Fat	0.125	71.06	1.1	0.11	8.88	0.14	0.01	gallon
Vegetable Oil	0.120	81.55	1.1	0.11	9.79	0.13	0.01	gallon
	mmBtu per gallon	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu				
Steam and Hot Water								
Steam and Hot Water		66.33	1.250	0.125				mmBtu

Source:

Solid, gaseous, liquid and biomass fuels: Federal Register (2009). EPA; *40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule*_ 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010). EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. With Amendments from Memo. Table of Final 2013 Revisions to the Greenhouse Gas Reporting Rule (PDF) to 40 CFR part 98, subpart C: Table C–1 to Subpart C—Default CO2 Emission Factors and High Heat Values for Various Types of Fuel and Table C–2 to Subpart C—Default CH4 and N2O Emission Factors for Various Types of Fuel.

Steam and Hot Water: EPA (2008) *Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance - Indirect Emissions from Purchases/Sales of Electricity and Steam*. Assumption: 80% boiler efficiency and fuel type assumed natural gas. Factors are per mmBtu of steam or hot water purchased.

http://www.epa.gov/ghgreporting/documents/pdf/2013/documents/memo-2013-technical-revisions.pdf
http://www.epa.gov/ghgreporting/reporters/subpartc/.html

Table 9 Global Warming Potentials (GWPs)

Gas	100-year GWP
CO_2	1
CH_4	25
N_2O	298
HFC-23	14,800
HFC-32	675
HFC-41	92
HFC-125	3,500
HFC-134	1,100
HFC-134a	1,430
HFC-143	353
HFC-143a	4,470
HFC-152	53
HFC-152a	124
HFC-161	12
HFC-227ea	3,220
HFC-236cb	1,340
HFC-236ea	1,370
HFC-236fa	9,810
HFC-245ca	693
HFC-245fa	1,030
HFC-365mfc	794
HFC-43-10mee	1,640
SF_6	22,800
NF_3	17,200
CF_4	7,390
C_2F_6	12,200
C_3F_8	8,830
$c\text{-}C_4F_8$	10,300
C_4F_{10}	8,860
C_5F_{12}	9,160
C_6F_{14}	9,300
$C_{10}F_{18}$	>7,500

Source:
100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007. IPCC AR4 was published in 2007 and is among the most current and comprehensive peer-reviewed assessments of climate change. AR4 provides revised GWPs of several GHGs relative to the values provided in previous assessment reports, following advances in scientific knowledge on the radiative efficiencies and atmospheric lifetimes of these GHGs and of CO_2. Because the GWPs provided in AR4 reflect an improved scientific understanding of the radiative effects of these gases in the atmosphere, the values provided are more appropriate for supporting the overall goal of organizational GHG reporting than the Second Assessment Report (SAR) GWP values previously used in the Emission Factors Hub.
While EPA recognizes that Fifth Assessment Report (AR5) GWPs have been published, in an effort to ensure consistency and comparability of GHG data between EPA's voluntary and non-voluntary GHG reporting programs (e.g. GHG Reporting Program and National Inventory), EPA recommends the use of AR4 GWPs. The United States and other developed countries to the UNFCCC have agreed to submit annual inventories in 2015 and future years to the UNFCCC using GWP values from AR4, which will replace the current use of SAR GWP values. Utilizing AR4 GWPs improves EPA's ability to analyze corporate, national, and sub-national GHG data consistently, enhances communication of GHG information between programs, and gives outside stakeholders a consistent, predictable set of GWPs to avoid confusion and additional burden.

Table 9b GWPs for Blended Refrigerants

ASHRAE #	100-year GWP	Blend Composition
R-401A	16	53% HCFC-22 , 34% HCFC-124 , 13% HFC-152a
R-401B	14	61% HCFC-22 , 28% HCFC-124 , 11% HFC-152a
R-401C	19	33% HCFC-22 , 52% HCFC-124 , 15% HFC-152a
R-402A	2,100	38% HCFC-22 , 6% HFC-125 , 2% propane
R-402B	1,330	6% HCFC-22 , 38% HFC-125 , 2% propane
R-403B	3,444	56% HCFC-22 , 39% PFC-218 , 5% propane
R-404A	3,922	44% HFC-125 , 4% HFC-134a , 52% HFC 143a
R-406A	0	55% HCFC-22 , 41% HCFC-142b , 4% isobutane
R-407A	2,107	20% HFC-32 , 40% HFC-125 , 40% HFC-134a
R-407B	2,804	10% HFC-32 , 70% HFC-125 , 20% HFC-134a
R-407C	1,774	23% HFC-32 , 25% HFC-125 , 52% HFC-134a
R-407D	1,627	15% HFC-32 , 15% HFC-125 , 70% HFC-134a
R-407E	1,552	25% HFC-32 , 15% HFC-125 , 60% HFC-134a
R-408A	2,301	47% HCFC-22 , 7% HFC-125 , 46% HFC 143a
R-409A	0	60% HCFC-22 , 25% HCFC-124 , 15% HCFC-142b
R-410A	2,088	50% HFC-32 , 50% HFC-125
R-410B	2,229	45% HFC-32 , 55% HFC-125
R-411A	14	87.5% HCFC-22 , 11 HFC-152a , 1.5% propylene
R-411B	4	94% HCFC-22 , 3% HFC-152a , 3% propylene
R-413A	2,053	88% HFC-134a , 9% PFC-218 , 3% isobutane
R-414A	0	51% HCFC-22 , 28.5% HCFC-124 , 16.5% HCFC-142b
R-414B	0	5% HCFC-22 , 39% HCFC-124 , 9.5% HCFC-142b
R-417A	2,346	46.6% HFC-125 , 5% HFC-134a , 3.4% butane
R-422A	3,143	85.1% HFC-125 , 11.5% HFC-134a , 3.4% isobutane
R-422D	2,729	65.1% HFC-125 , 31.5% HFC-134a , 3.4% isobutane
R-423A	2,280	47.5% HFC-227ea , 52.5% HFC-134a ,
R-424A	2,440	50.5% HFC-125, 47% HFC-134a , 2.5% butane/pentane
R-426A	1,508	5.1% HFC-125, 93% HFC-134a, 1.9% butane/pentane
R-428A	3,607	77.5% HFC-125 , 2% HFC-143a , 1.9% isobutane
R-434A	3,245	63.2% HFC-125, 16% HFC-134a, 18% HFC-143a, 2.8% isobutane
R-500	32	73.8% CFC-12 , 26.2% HFC-152a , 48.8% HCFC-22
R-502	0	48.8% HCFC-22 , 51.2% CFC-115
R-504	325	48.2% HFC-32 , 51.8% CFC-115
R-507	3,985	5% HFC-125 , 5% HFC143a
R-508A	13,214	39% HFC-23 , 61% PFC-116
R-508B	13,396	46% HFC-23 , 54% PFC-116

Source:
100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007. See the source note to Table 9 for further explanation. GWPs of blended refrigerants are based on their HFC and PFC constituents, which are based on data from http://www.epa.gov/ozone/snap/refrigerants/refblend.html.

Table 7 Business Travel Emission Factors

Vehicle Type	CO_2 Factor (kg / unit)	CH_4 Factor (g / unit)	N_2O Factor (g / unit)	Units
Passenger Car [A]	0.368	0.018	0.013	vehicle-mile
Light-duty Truck [B]	0.501	0.024	0.019	vehicle-mile
Motorcycle	0.197	0.070	0.007	vehicle-mile
Intercity Rail (i.e. Amtrak) [C]	0.144	0.0085	0.0032	passenger-mile
Commuter Rail [D]	0.174	0.0084	0.0035	passenger-mile
Transit Rail (i.e. Subway, Tram) [E]	0.133	0.0026	0.0020	passenger-mile
Bus	0.058	0.0007	0.0004	passenger-mile
Air Travel - Short Haul (< 300 miles)	0.275	0.0091	0.0087	passenger-mile
Air Travel - Medium Haul (>= 300 miles, < 2300 miles)	0.162	0.0008	0.0052	passenger-mile
Air Travel - Long Haul (>= 2300 miles)	0.191	0.0008	0.0060	passenger-mile

Source:
CO_2, CH_4, and N_2O emissions data for highway vehicles are from Table 2-15 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2012. Vehicle-miles and passenger-miles data for highway vehicles are from Table VM-1 of the Federal Highway Administration Highway Statistics 2012.
Fuel consumption data and passenger-miles data for rail are from Tables A.14 to A.16 and 9.10 to 9.12 of the Transportation Energy Data Book: Edition 32. Fuel consumption was converted to emissions by using fuel and electricity emission factors presented in the tables above.

Notes:
[A] Passenger car: includes passenger cars, minivans, SUVs, and small pickup trucks (vehicles with wheelbase less than 121 inches).
[B] Light-duty truck: includes full-size pickup trucks, full-size vans, and extended-length SUVs (vehicles with wheelbase greater than 121 inches).
[C] Intercity rail: long-distance rail between major cities, such as Amtrak
[D] Commuter rail: rail service between a central city and adjacent suburbs (also called regional rail or suburban rail)
[E] Transit rail: rail typically within an urban center, such as subways, elevated railways, metropolitan railways (metro), streetcars, trolley cars, and tramways.

Table 8 Product Transport Emission Factors

Vehicle Type	CO_2 Factor (kg / unit)	CH_4 Factor (g / unit)	N_2O Factor (g / unit)	Units
Medium- and Heavy-duty Truck	1.456	0.018	0.011	vehicle-mile
Passenger Car [A]	0.368	0.018	0.013	vehicle-mile
Light-duty Truck [B]	0.501	0.024	0.019	vehicle-mile
Medium- and Heavy-duty Truck	0.296	0.0036	0.0022	ton-mile
Rail	0.026	0.0020	0.0007	ton-mile
Waterborne Craft	0.042	0.0004	0.0027	ton-mile
Aircraft	1.301	0.0000	0.0400	ton-mile

Source:
CO_2, CH_4, and N_2O emissions data for highway vehicles are from Table 2-15 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2012. Vehicle-miles and passenger-miles data for highway vehicles are from Table VM-1 of the Federal Highway Administration Highway Statistics 2012.
CO_2e emissions data for non-highway vehicles are based on Table A-116 of the U.S. Greenhouse Gas Emissions and Sinks: 1990–2012, which are distributed into CO_2, CH_4, and N_2O emissions based on fuel/vehicle emission factors.
Freight ton-mile data for non-highway vehicles are from Table 1-50 of the Bureau of Transportation Statistics, National Transportation Statistics for 2012.

Notes:
Vehicle-mile factors are appropriate to use when the entire vehicle is dedicated to transporting the reporting company's product. Ton-mile factors are appropriate when the vehicle is shared with products from other companies.
[A] Passenger car: includes passenger cars, minivans, SUVs, and small pickup trucks (vehicles with wheelbase less than 121 inches).
[B] Light-duty truck: includes full-size pickup trucks, full-size vans, and extended-length SUVs (vehicles with wheelbase greater than 121 inches).