United States
Department
of
Agriculture

Forest
Service
June
2016

Final

Environmental Assessment

SEECO, Inc., Ozark Highlands Unit 9-16 2-7H6, ARES 52178 & 52179 Gas Well Project

Conway, Van Buren, and Pope Counties, Arkansas
Ozark-St. Francis National Forests
Big Piney Ranger District

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Table of Contents

Chapter **Page**

Appendices

A. Public Involvement
B. Literature Cited
C. Reserve Pit Sampling Requirements
D. Comments Received and Agency Responses

Figures

Tables

Chapter I

Purpose and Need for Action

This chapter describes the proposed action, the purpose and need for action and the project area. This chapter also references direction from the Forest Plan and includes decisions to be made, other issues, concerns and opportunities.

A. The Proposed Action (PA)

The proposed action is for the Forest Service to approve the Surface Use Plan of Operations (SUPO) for the APD submitted for ARES 52178 and 52179 Ozark Highlands Unit 9-16 2-7H6 Gas Well. The SUPO describes and contains plans for surface occupancy including proposed access, pad plans, timing of operations, proposed surface restoration, and measures to be taken by SEECO, Inc. to mitigate effects. Also included in the proposed action is to allow for herbicide use on two existing well pad sites (ARES 51810 10-17 #14 & ARES 51900 10-19 #1-7) to control existing populations of non-native invasive species (NNIS) on and around the well pads (See Figure 2). The herbicide proposed is the same as the one proposed for the newly proposed well pad in Section 7 of Township 9 North, Range 16 West.

B. Location of Project Area

The SEECO, Inc. ARES 52178 and 52179 Ozark Highlands Unit 9-16 2-H6 Gas Well Project is located in Section 7 of Township 9 North, Range 16 West in Conway County, Arkansas. The site is located approximately 2.5 miles northwest of Cleveland, AR and 0.7 miles north along Brock Creek Road from the junction with Bridge Hill Road in Conway County. See the map below for the location.
Reclaimed gas well site ARES 51810 10-17 #14, Township 10 north Range 19 West, Section 08 in Pope County (See Figure 2), and Reclaimed gas well site, ARES 51900 10-19 #1-7, Township 10 North, Range 17 West, Section 04, Van Buren County, Arkansas (See Figure 2).

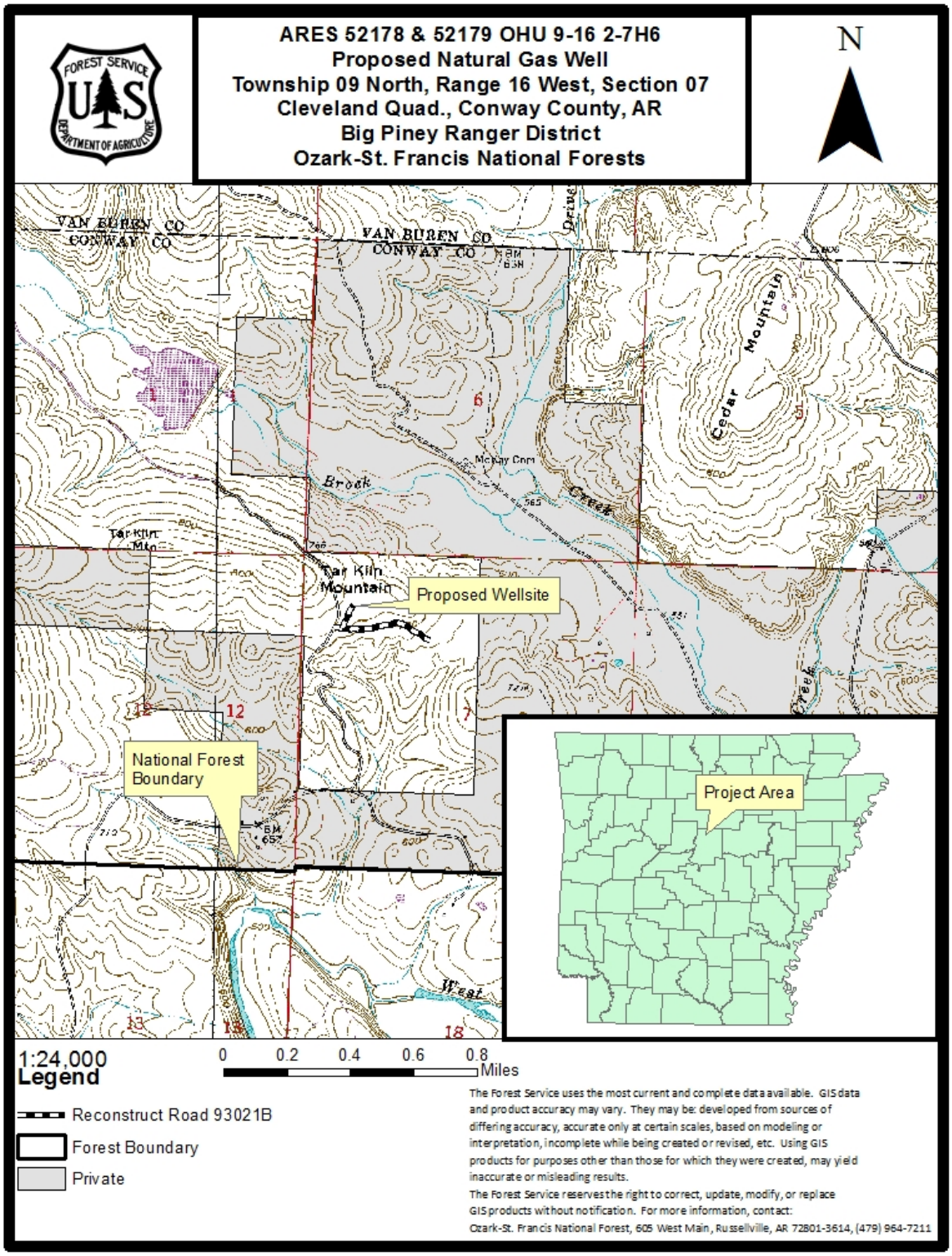


Figure 1: Project Area Map with Vicinity Area inset.

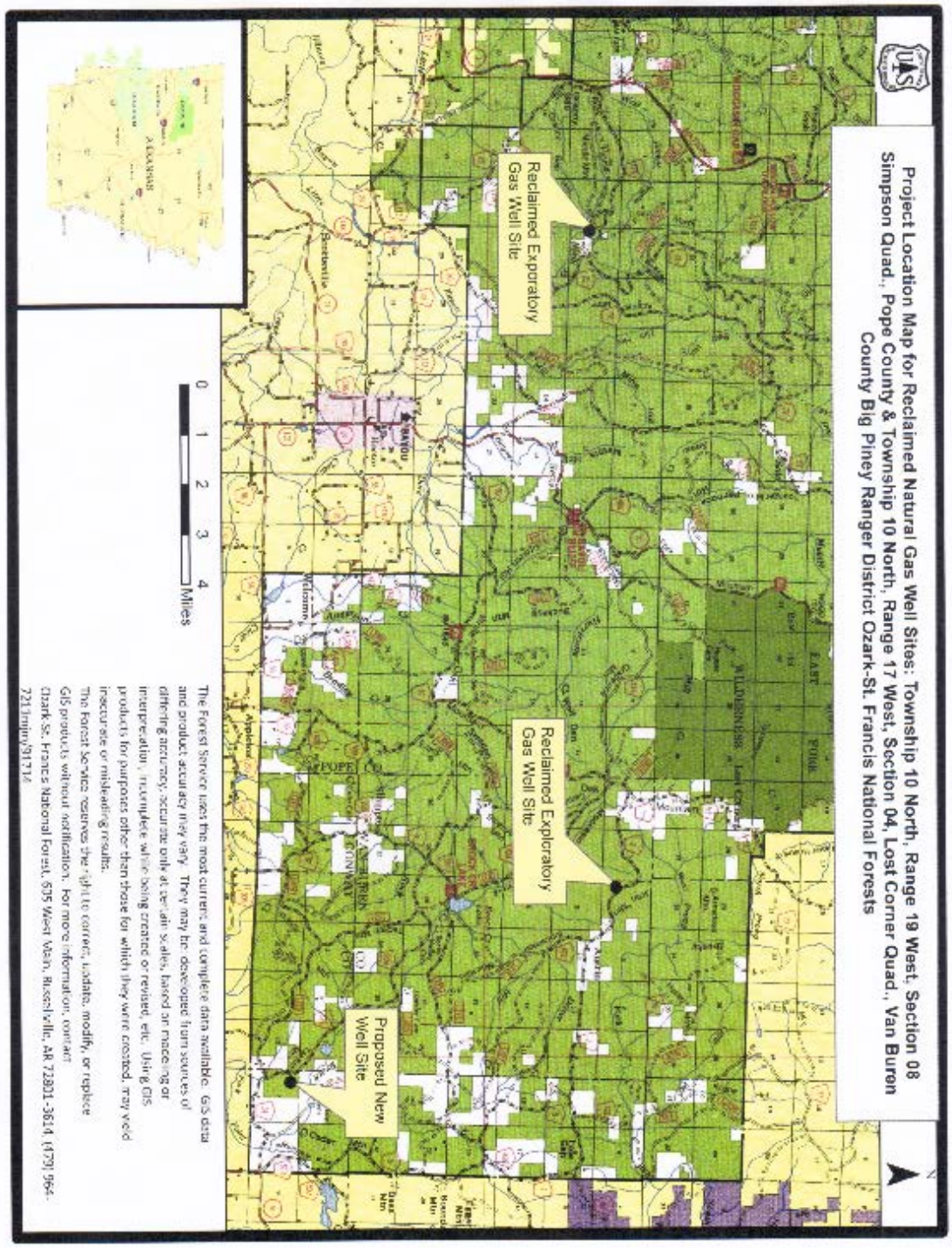


Figure 2: Project Location Map for Reclaimed Natural Gas Wells that would be treated with herbicides.

C. Purpose and Need

The purpose of this action is to respond to an Application for Permit to Drill (APD) on the federal mineral estate submitted by SEECO, Inc. The APD proposed construction of a gas well, road work to access the well, construction of a drill pad, and the construction of a reserve pit. In addition, SEECO, Inc., seeks to operate and maintain these facilities if the well is productive.

The United States of America owns the mineral rights to this area. These mineral rights are under an Oil and Gas Lease, Serial Numbers ARES 52178 & 52179, issued to SEECO, Inc.

This proposed action is needed because the lease grants SEECO, Inc. the right to drill for, extract and sell the federal minerals located within the lease area. The Forest Service is the surface management agency responsible for approval of surface disturbing activities on National Forest Lands. The Bureau of Land Management would approve the drilling plan or "downhole" operations.

This action would help the nation's oil and gas industry meet the U.S. annual demand of 22 trillion cubic feet per year of natural gas (Energy Information Administration 2006) and would comply with the Energy Policy Act. Estimated demand is 27 trillion cubic feet per year by the year 2030.

This action responds to the USDA Forest Service Strategic Plan for Fiscal Years 2007-2012 of helping meet energy resource needs (Land and Resource Management Plan, p. 1-6). It also helps to achieve:
(1) the Revised Land and Resource Management Plan (RLRMP) desired condition of administering minerals and energy developments to facilitate production of mineral and energy resources as well as to minimize adverse impacts to surface and groundwater resources and protect or enhance ecosystem health (RLRMP, 1-48), and
(2) the RLRMP priority of encouraging and facilitating the orderly exploration, development, and production of mineral and energy resources in order to promote self-sufficiency in those mineral and energy resources necessary for economic growth and national defense (RLRMP, 2-29).

The proposed natural gas well, access road, and gathering lines are in Management Area 3.A (Pine Woodland) as described on pages 2-56 through 2-58 of the RLRMP.

D. Objective of the Proposed Action

The purpose of this project is to move the existing conditions of the project area toward the desired conditions as referenced in the Revised Land Resource Management Plan.

E. Related Documents That Influence the Scope of This Proposed Action

Energy developments are administered to facilitate production of mineral and energy resources as well as to minimize adverse impacts to surface and groundwater resources and protect or enhance ecosystem health. The Final Environmental Impact Statement (FEIS) for the forests

compares and analyzes the impacts of a variety of treatments needed to achieve the desired future conditions identified in the RLRMP (pages 1.18-1.49). This EA tiers to the following documents:

- The Revised Land Resource Management Plan and accompanying Environmental Impact Statement for the Ozark-St. Francis National Forests (2005)
- Biological Evaluation for the SEECO Inc., Ozark Highlands Unit 9-16 2-7H6, ARES 52178 and 52179 Project
- Heritage Resource Report for the SEECO Inc., Ozark Highlands Unit 9-16 2-7H6, ARES 52178 and 52179 Project
- Region 8 Scenery Treatment Guide (2008)
- Memorandum of Understanding between USDI Bureau of Land Management and USDA Forest Service concerning oil and gas leasing and operations (2006).

The Revised Land and Resource Management Plan identifies Forest Wide Standards (pages 3.1-3.21) and MA Standards (pages 3.22-3.38) that will be applied to all methods of vegetation management. This direction is incorporated into this EA's design criteria (see Appendix E).

F. Issues Eliminated From Further Study

No issues were eliminated from further study.

G. Issues Studied in Detail

No issues that would generate another alternative were identified.

H. Other Concerns and Relevant Effects

The following concerns were raised:

Water Quality and Quantity- Are there management actions, namely drilling and hydraulic fracturing that may contaminate surface and groundwater? There is also a concern about the amount of water that would be used for hydraulic fracturing. *Source: ID Team and Public Responses.*

Air Quality- Would emissions generated from the proposed actions degrade air quality? Would emissions cause health problems to those living downwind of the project area? *Source: ID Team and Public Responses*

Recreation- Would the proposed actions degrade the recreational experience of forest visitors in the vicinity of the project area? *Source: ID Team and Public Responses*

Visual Resources- Would the proposed actions compromise the scenic integrity of the project area? *Source: Public Responses*

Heritage Resources- Would the proposed actions impact both historic and prehistoric sites through project implementation and by exposing workers or forest visitors to areas containing sensitive cultural sites? *Source: Public Responses*

Wildlife and Fisheries- Would the proposed actions cause unacceptable impacts to wildlife and fisheries populations or habitats? *Source: ID Team and Public Responses*

Threatened, Endangered, and Sensitive (TES) Species and Habitats- Would the proposed actions impact populations of TES or their habitats? *Source: Public Responses*

Climate Change- Would the proposed actions cause or contribute to greenhouse gas (GHG) emissions and contribute to increased climate change? *Source: ID Team*

Herbicide Use- There is a concern about herbicide use. *Source: Public Responses*

Human Health Factors- Would the proposed actions be hazardous to human health and safety? *Source: Public Responses*

I. Decision to Be Made

The decision to be made is whether to approve, subject to specified conditions, or disapprove for stated reasons, the Surface Use and Operation Plans for Ozark Highlands Unit 9-16 2-7H6, ARES 52178 and 52179 Gas Well. Tim Jones, District Ranger of the Big Piney Ranger District has the authority to make this decision.

If a determination were made that the impact is not significant, then a "Finding of No Significant Impact" (FONSI) would be prepared. A Decision Notice would document the decision.

J. Noted Changes Between the Draft and Final EA

Listed below are specific changes which were made between the Draft and Final EA. Some of the changes were where numbers were transposed, words were misspelled or grammar was incorrect. Other changes were made to improve the understanding of the analysis of potential effects. They are as follows;

- Van Buren and Pope Counties were added to the title page of this EA
- Comments received and agency responses to those comments have been attached as Appendix D.
- The first paragraph of Chapter II of this document, page II-1was updated to reflect the latest scoping and 30 day comment effort.
- Under the proposed action in chapter II (page II-3) under the description of the temporary water line. The size of the temporary water line was taken out of that sentence due to it could change with a request from SEECO.
- In reviewing Chapter II of this EA it was discovered that the information in section H. Site Specific Design Criteria, was in fact Project Designs which is section F. Additionally, no Site Specific Design Criteria was found so section H. was deleted, and

the information contained there moved into section F. This more accurately reflects where the Project Designs belong, this does not change the analysis or reveal any new information.

- Chapter IV Coordination and Consultation list was updated to include Andrew McCormick, Geologist

There were no changes to the alternatives nor were any of the findings of the analyses changed; therefore, there is no need to undergo a new public comment period.

Chapter II

Alternatives Including the Proposed Action

The Big Piney Ranger District Interdisciplinary Team (IDT) initiated internal scoping for the SEECO, Inc. Ozark Highlands Unit 9-16 2-7H6, ARES 52178 and 52179 on July 24, 2014. A project notification letter was mailed out in September 2014. Scoping letters requesting comments on the proposal were mailed to tribes, agencies, groups, and individuals. The legal notice was posted in Russellville's, *The Courier*, on September 23, 2014. The project was also published in the Ozark- St. Francis National Forests Schedule of Proposed Actions and on the Forests planning website.
http://www.fs.usda.gov/detail/osfnf/landmanagement/planning/?cid=stelprdb5212180
The draft EA was made available to the public for comments on 02/19/2016.

A. Process Used to Develop the Alternatives

The IDT represents the range of resources across the Forests, such as recreation, timber, wildlife, soils, and water. The IDT considered the following elements when they developed the alternatives for this analysis:

- The goals, objectives, and desired future conditions for the project area as outlined in the Revised Land and Resource Management Plan (RLRMP) for the Ozark–St. Francis National Forests.
- Comments received from the public, State and other agencies during the scoping process.
- The laws, regulations, and policies that govern land management on national forests.

B. Alternatives Considered

A "No Action" Alternative (Alternative 1) was developed in this environmental analysis. The "No Action" alternative is a requirement of NEPA each action alternative was designed to be consistent with RLRMP direction and respond to "Key" issues:

The Proposed Action (PA)

The following descriptions and tables display the proposed activities and treatments in detail.

The Proposed Action is the proposal submitted by SEECO, Inc. in their Application for Permit to Drill (APD) Ozark Highlands Unit 9-16 2-7H6 Gas Well with modifications to comply with the Revised Forest Land and Resource Management Plan and the Fayetteville Shale Best Management Practices.

SEECO, Inc. is proposing to construct a gas well on National Forest land. Preparation for this drilling activity would include roadwork to access the well, construction of drill pad, and construction of a reserve pit.

If the well produces, production facilities would be installed on that drill pad. Production equipment that would be installed on the drill pad would consist of, but not be limited to, a wellhead, a separator unit, a meter shed, a produced water tank, and if needed, a compressor and/or dehydrator. Maintenance of the location (including the access road and well pad) would be required during the life of the well; mechanical (mowing), glyphosate herbicide, or both may be used to achieve this. Glyphosate herbicide would be applied using ground-based methods such as hand application using gloves, or spray using a backpack containing the herbicide attached to a flexible sprayer, wand or other hand application device that directs the chemical onto the target Non Native Invasive Species (NNIS) or other unwanted vegetation. Any portion of the drill pad not used for the production site and defensible space would be reclaimed for use by the Forest Service. Upon depletion of reserves or abandonment of the well, the production facilities would be removed from the site and the entire area reclaimed as specified by the Forest Service.

If drilling results in a dry hole, the well casing would be plugged with cement below the ground surface in a manner approved by the Arkansas Oil and Gas Commission and the BLM and a location marker installed. The cleared area and the reserve pit would then be reclaimed as specified by the Forest Service.

Drilling operations are expected to begin upon approval of the SUPO by the Forest Service and the APD by the BLM. This is anticipated to be November, 2016.

These activities are located in Section 7, Township 9 North, Range 16 West on the Big Piney Ranger District. This site is located approximately 2.5 miles northwest of Cleveland, AR and 0.7 miles north along Brock Creek Road from the junction with Bridge Hill Road in Conway County.

Proposals for the well are as follows:

Table 1: Proposed Activities

Activity	**Amount**
Drill Pad and Reserve Pit Construction *(includes clearing limits)*	Approximately 5.8 acres
Temporary Water Line Installation	Approximately 1.4 miles of water line would be placed on the surface in the right of way along Brock Creek Road.

Activity	Amount
Road Relocation/Reconstruction *(30-foot right-of-way)*	1,000 ft. FS Rd. 93021B 500 ft. reconstruction of FS Rd. 93021B
Road Obliteration	Approximately 1,320 feet of FS Rd. 93021B
Lease Road Construction (50 foot right of way)	Approximately 531 feet.
Construction of Dispersed Camping Area at end of FS Rd. 93021B	150' x 150'.

Drill Pad and Reserve Pit Construction

Approximately 5.8 acres would be cleared in the construction of a drill pad and a reserve pit. This includes an approximate 25-foot clearing limit around the pad and pit. Existing trees would be marked and sold to SEECO, Inc. SEECO, Inc. would remove the merchantable timber from the Forest.

Whether a producing well or a non-producing well, upon completion of the drilling activities, samples of the cuttings and fluids remaining in the reserve pit would be analyzed by a licensed laboratory for its chemical and metal content. Based upon test results, mitigation may be required prior to closing. Mitigation may include, but not be limited to hauling the remaining fluids and cuttings to authorized disposal facilities.

Temporary Water Line Installation

The source of water required for drilling the proposed well would be obtained from an off-site private pond. Water used for the drilling operation would be piped through temporary water lines placed in the right-of-way along Brock Creek Road. The water line will be on the surface. Total water usage for fracture stimulation would be approximately 5,250,000 gallons of freshwater. Portions of the temporary waterline that are on the Forest and off the lease would be covered under a special use permit.

Access Road Construction

Approximately 531 feet of access road would be constructed for SEECO, Inc. Ozark Highlands Unit 9-16 2-7H6 gas well. This road would not be added to the Forest Service road inventory. This access road would be gated approximately 100 feet from the junction with FS Road 93021B to allow for safe entry and exit of the access road.

Road Relocation/Construction/Reconstruction
Approximately 1,000 feet of Forest Service Road 93021B would be relocated south of the proposed gas well location and then reconnected to the existing portion of 93021B at a point 400 feet east of the proposed gas well pad. The lease road would spur off of Forest Service Road 93021B and end at the gas well pad. The proposed relocated road right of way would be approximately 30 feet wide with the road surface being approximately 15 feet wide. There would be approximately 15 feet of clearing required on each side of the centerline of the road. An existing section of Forest Service Road 93021B would be reconstructed from the point where the relocated section ties into it. The reconstructed road would be approximately 500 feet long and have the same dimensions as above. A dispersed campsite would be relocated to the end of the reconstructed road. The dispersed campsite would be approximately 150' by 150'. The dispersed campsite parking area would be built to replace an existing dispersed campsite parking area that would be obliterated by the proposed gas well location. Safety signs would be required along roads and trails as directed by the Forest Service.

Road Obliteration
Approximately 1,320 feet of existing Forest Service Road 93021B would be obliterated beginning at the junction of Brock Creek Road to approximately 400 feet east of the proposed gas well location. Obliteration would include re-contouring, scarifying, erosion control, construction of berms at each end, seeding, fertilizing, mulching and other necessary measures. The relocated section of road would replace the obliterated road section.

Road Maintenance
Existing access roads would be maintained to a condition equal or better than the condition of the roads at the time the work commences on the proposed gas well. Routine maintenance of the existing road would include re-grading the road, adding additional gravel as required and repairing failures that result from the drilling activities. Semi-permanent dust control would be placed and maintained on any road sections where dust would adversely affect adjacent landowners and residents.

Use of Herbicides to Treat Invasive Plants on the Proposed Location
Herbicides would be used to maintain the proposed location and to control invasive plants along with mechanical means. Herbicides would also be used on two existing well pad sites (ARES51819 10-17 #1-4 & ARES51900 10-19 #1-7) to control existing populations of non-native invasive species (NNIS) on and around the well pads (See Figure 2). Glyphosate herbicide would be used. Herbicide would be used as a spot application to keep the well pad clear of vegetation during use and to control invasive species. Forest Service Standards for herbicide application would be followed as well as appropriate Best Management Practices designed to limit risk to water quality. The application would be according to label rates.

Alternatives to the Proposed Action

Alternative 1: No Action
This alternative would not implement any part of the Proposed Action but ongoing National Forest permitted and approved activities would continue.

Past, Present and Reasonably Foreseeable Future Actions
Within the project area there are some past, present, and reasonably foreseeable treatments that are **NOT** part of the Proposed Action **or** any part of the alternatives to the Proposed Action, but have occurred or are expected to occur within the foreseeable future. Table 2 shows the treatments considered in this EA as cumulative effects:

Table 2: Table Showing Past, Present and Future Management Activities

Treatments	Acres/ #	Year Treated
Watershed where the Proposed Gas Well would be located		
Eastside Blk. E Prescribed Burn	1556ac	2014
Eastside Blk. A Prescribed Burn	1273ac	2013
Gas Wells	362#	NA
Watershed North of the Proposed Gas Well Location		
Kincannon Mtn. Prescribed Burn	1375 ac	2013
Gas Wells	6	NA
Future Actions	**Approx. Acres or Miles**	**Approx. Year**
Eastside Blk. E Prescribed Burn	1556ac	2017
Eastside Blk. A Prescribed Burn	1273ac	2016

C. Comparison of Alternatives

This section provides a summary of the actions involved in implementing each alternative.

Table 3: Comparison of Alternatives

Treatments	PA	Alternative 1
Construction of drill pad and reserve pit	5.8 acres	0
Temporary Water line installation	1.4 miles	0
Road Relocation/Reconstruction	1,000 feet relocation-construction, 500 feet reconstruction	0
Road Obliteration	Approximately 1,320 ft.	0
Lease Road Construction	Approximately 531 ft.	0
Construction of Dispersed Camping Area	150’ by 150’	0

D. Effects Comparison of Treatments to Alternatives

Table 4: Comparing Treatments to Alternatives

Treatments	Proposed Action	Alternative 1
Acres of Soil taken out of production and dedicated to roads and gas well	3.4	0
**Sediment Created (tons)		
Brock Creek Watershed	499.35	0
Rock Creek Watershed	728.59	0
Herbicide Use (acres)	10	0

**** Current sediment in this project area is 490.55 tons in Brock Creek Watershed and 691.5 tons in Rock Creek Watershed.**

E. Protective Measures

In order to protect the environment and lessen possible negative impacts, the measures contained in the Forest Wide (FW) Standards of the RLRMP and management area standards for the Ozark/St-Francis National Forest (OSFNF) would be applied to the PA and Alternatives and are incorporated in this EA. Best Management Practices (BMP) Guidelines for Silviculture Activities in Arkansas and Fayetteville Shale Best Management Practices would also apply as standard protective measures for all proposed actions.

F. Project Designs

A project design is a direction that is applied to similar areas on all projects and is not site specific to one project area, stand, road, or area. A list of applicable project designs is incorporated into this document below in two parts. The first is a list of Project Designs which are applied to the above ground portion of all gas well projects on federal lands. The second is Project Designs for Downhole Protection of Groundwater in Wells.

Above Ground Project Designs:

1) Machinery noise that has the potential to disturb wildlife, livestock, and private landowners or neighbors would be controlled to reduce sound levels. Suitable mufflers would be installed on all internal combustion engines and certain compressor components. Engineered sound barriers or sound-insulated buildings may be required to meet Federal Energy Regulatory Commission (FERC) standards for sound levels.

2) The current specified environmental paint color “shale green” that allows facilities to blend in with the natural landscape background would be required for permanent and semi-permanent equipment. This would enable the facilities to blend in as seen from a viewing distance and locations typically used by the public. The paint color and specifications are listed on the Bureau of Land Management (BLM) Standard Environmental Colors Chart CC-001: June 2008.

3) Individual or combinations of erosion control features including straw bales, silt fences, rock filters, and sediment basins would be placed at the ends of all drainage ditches constructed around the project area and at the toe of fill slopes to filter any sediment that might be contained in the runoff.

4) A minimum depth of six inches of loose depth gravel would be spread on the access road. All of the driving surface will be armored and anything not armored will be vegetated.

5) Two culverts would be placed on the access road as directed by a Forest Representative.

6) SEECO Inc. would be required to follow the road maintenance agreement or obtain appropriate road permits for use of Forest Service roads.

7) Clearing and soil disturbance would be held to the minimum area needed. Topsoil would be stockpiled at points designated by the Forest Representative.

8) Drill pads would be constructed in successive lifts no greater than eight-inch layers each compacted uniformly until visual displacement ceases, including the fill slope. The fill slope would not exceed a ratio of 3:1.

9) During site preparation and drilling preparations; trash, garbage, paper, cans or other debris would be contained at all times in an approved receptacle and disposed as needed at an approved sanitary landfill.

10) During all construction and drilling operations, a restroom facility would be located on site.

11) Site rehabilitation of the drill pad sites would begin as soon as drilling operations are complete and the weather permits. The operator would be required to rip compacted sites to a minimum depth of 12” and spread the stockpiled topsoil uniformly over the site. The Forest Service would specify the species of grasses, shrubs and/or trees to be planted. Restoration would be considered satisfactory when a summer survival of desired grasses provide at least an average 80% cover evenly distributed over the site outside the areas used for production equipment and roadway. Tree and shrub planting would be considered successful when there is at least 80% survival, evenly distributed over the area, one year after planting.

12) When SEECO Inc. no longer needs the drill sites, revegetation work would be repeated until the sites are satisfactorily revegetated and approved in writing by a Forest Service Representative.

13) There would be one reserve pit per well site.

14) The walls of the reserve pits would be less than ten feet in height above the natural surface, measured from the outside of the pit. There would be at least a 3:1 slope on the interior wall and a 2:1 slope on the exterior wall. The wall material would be placed and

compacted in approximately 6-8” lifts. The pits would be built so that no surface runoff from outside the wall of the pit enters the pit.

15) The Forest Service would require the interior of the reserve pits to be lined with a material that meets a hydraulic conductivity standard of 10^{-7}.

16) Water would not be allowed to fill the reserve pits any higher than within two vertical feet of the lowest point of the wall.

17) Drill cuttings and/or drilling fluids in the reserve pits would be handled in an approved manner (See APD).

18) SEECO Inc. would be responsible for monitoring the water quality in the reserve pits. SEECO Inc. would insure that water samples are both collected and analyzed by a laboratory approved by the Forest Service. A letter from the Ozark-St. Francis National Forest Supervisor (July 10, 2008) to the District Rangers and Staff outlines the pit sampling requirements for gas well activities (attached to this EA as Appendix C).

19) Merchantable timber would be purchased and disposed of off Forest.

20) Except for those areas needed for access and/or production, areas where soil has been disturbed would be reseeded. The seeding includes cut-and-fill slopes, ditches (wing, lead-off, etc.), shoulders, and any other exposed areas created by the project. Seeding specifications would be provided by the Forest Service.

21) SEECO Inc. would post signs along Brock Creek Road to notify road users of activity in the area. Specifications, placement, and spacing of the signs would conform to the Manual on Uniform Traffic Control Devices for Streets and Highways (2009 Edition including Revision 1 dated May 2012 and Revision 2 dated May 2012, U.S. Department of Transportation Federal Highway Administration).

22) It is SEECO Inc.’s responsibility to obtain any necessary permits from the U.S. Corps of Engineers or other agencies if necessary.

23) Heritage resource sites that are determined eligible for the National Register of Historic Places and sites that have undetermined eligibility would be protected from any ground-disturbing activities associated with this project. If additional heritage resource sites are found during implementation of this project, they would be examined and necessary mitigation measures prescribed by the Forest Archaeologist would be implemented.

24) A review of listings and locations of all known occurrences of proposed, endangered, threatened, or sensitive species (PETS) has been conducted. In addition, field surveys have been made on the area to be impacted by the action alternative. No critical or essential habitat for any PETS species was identified in the project area. If any additional PETS species are discovered prior to or during implementation, the project would be

halted and a new biological evaluation would be made to determine the effects on the species and its habitat.

Down Hole or Below Ground Project Designs:
For wells drilled in Arkansas on Federal minerals, both the Arkansas Oil and Gas Commission (AOGC) and the Bureau of Land Management (BLM) have requirements for the protection of underground source of drinking water (USDW) by the Surface Casing. For the AOGC, the Rules are B-15 and B-19. For the BLM, Onshore Order # 2 applies.

Among these are:

- casing size, type, condition, and strength; and,
- cement and cement volume; and,
- setting depth; and,
- integrity testing; and,
- pressure monitoring during hydraulic fracturing operations.

The proposed casing and cementing programs shall be conducted as approved to protect and/or isolate all usable water zones, lost circulation zones, abnormally pressured zones and any prospectively valuable deposits of minerals. Any isolating medium other than cement shall receive approval prior to use. The casing setting depth shall be calculated to position the casing seat opposite a competent formation which will contain the maximum pressure to which it will be exposed during normal drilling operations. Determination of casing setting depth shall be based on all relevant factors, including: presence/absence of hydrocarbons; fracture gradients; usable water zones; formation pressures; lost circulation zones; other minerals; or other unusual characteristics. All indications of usable water shall be reported.

All casing, except the conductor casing, shall be new or reconditioned and tested casing. The conductor casing is usually put into the well first to prevent the sides of the hole from caving into the well bore (Schlumberger Oilfield Glossary). All casing shall meet or exceed American Petroleum Institute (API) standards for new casing. The use of reconditioned and tested used casing shall be subject to approval by the authorized officer: approval will be contingent upon the wall thickness of any such casing being verified to be at least 87 1/2 percent of the nominal wall thickness of new casing.

The surface casing shall be cemented back to surface either during the primary cement job or by remedial cementing.

All indications of usable water shall be reported to the authorized officer prior to running the next string of casing or before plugging orders are requested, whichever occurs first.

Usable Water means generally those waters containing up to 10,000 parts per million (ppm) of total dissolved solids.

All casing strings below the conductor shall be pressure tested to 0.22 pounds per square inch (psi) per foot of casing string length or 1500 psi, whichever is greater, but not to exceed 70 percent of the minimum internal yield (burst strength). If pressure declines more than 10 percent in 30 minutes, corrective action shall be taken.

AOGC General Rule B-19 requires surface casing to be set to a depth of at least 100 feet below the deepest fresh water zone encountered. Surface casing in the Fayetteville Shale, where most of the hydraulic fracturing is occurring, is required to be set to a depth of 1,000 feet, or 500 feet below the lowest surface elevation within one mile of the well. The BLM agrees with the AOGC setting depth rule.

The production casing must be cemented from the top of the Fayetteville Shale to the surface. These casing strings are the first line of defense in protecting fresh groundwater during hydraulic fracturing operations. The rule also requires the operator to monitor the annular space (space between the drill string and outer casing) of all casing and report any changes of pressure that indicate movement of fluid into the surface casing annulus or exceed the minimum yield pressure on any casing string.

When the casing and cementing requirements are met and prior to hydraulic fracturing initiation, four (4) layers of protection are in place between any USDW and fracturing operations – two layers of steel and two of cement. For post fracturing flowback or produced fluids, there will be five (5) layers of protection – three of steel and two of cement. A close example of the casing and cement protection in cross-section is shown below:

Figure 3: Casing and cement in cross-section (VA DMME)

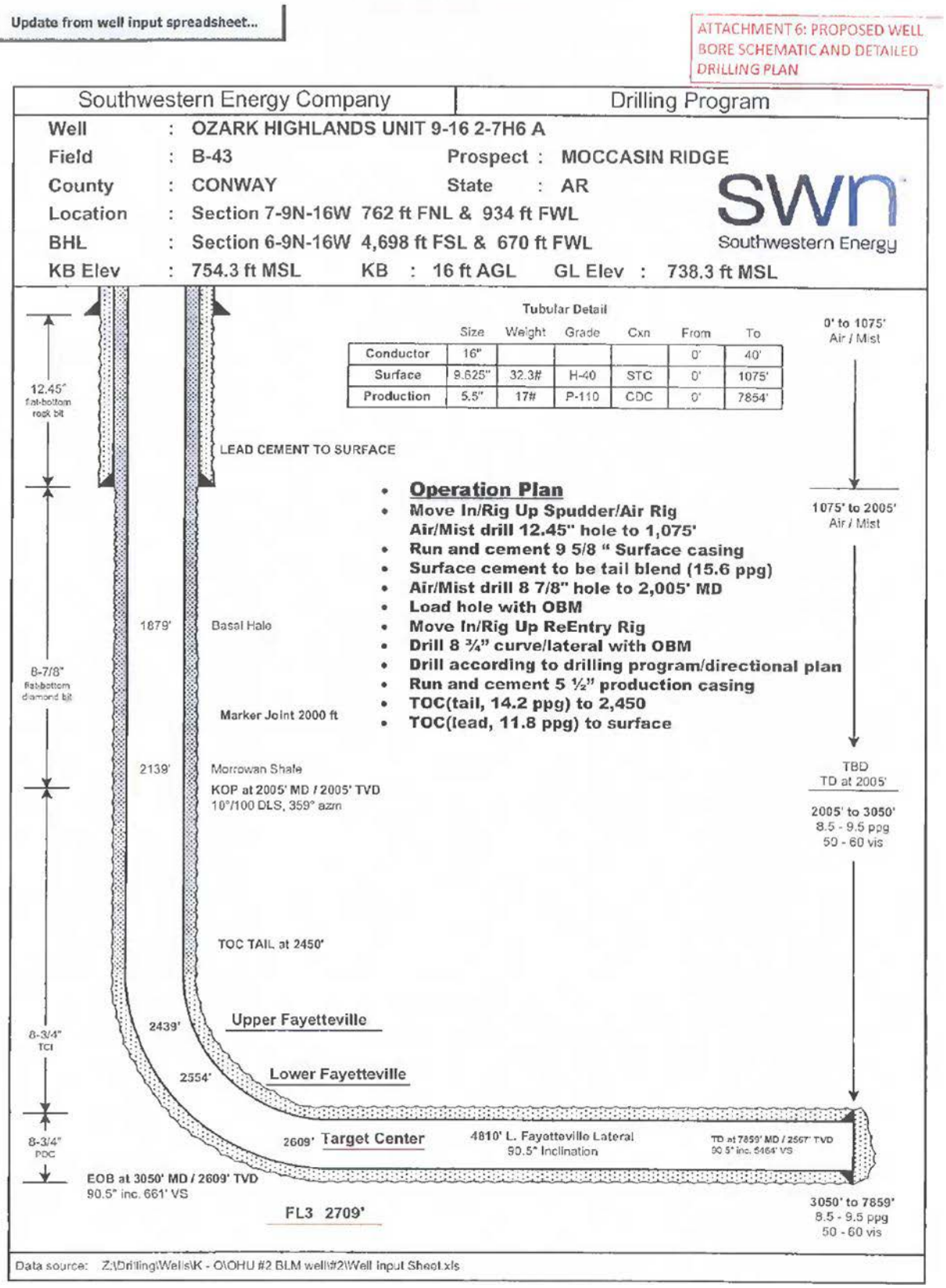


Figure 4: Wellbore Schematic OHU 9-16 #2-7H6

USDW is protected in wells by both the BLM's and the AOGC's predrill oversight of casing type, grade, setting depth, and cementing of the surface protection string in addition to the rigorous onsite application of the various agency rules and regulations by the BLM inspector.

G. Monitoring

1) Monitoring would be accomplished through inspections conducted by U.S. Forest Service and Bureau of Land Management inspectors. Appropriate standards and guidelines would be implemented and maintained through active treatment to protect soil productivity, water quality and all other resources.

2) For those actions prescribing the use of herbicides, monitoring to ensure that herbicide label instructions are being followed would be conducted as part of the "on the ground" contract administration. To monitor any off-site movement of herbicides, the Forest Service conducts random samples on 10% of sites annually where herbicides are used.

3) A review of all known occurrences of proposed, endangered, threatened or sensitive species (PETS) has been conducted. In addition, field surveys have been made on the area to be impacted. If any new proposed, threatened or endangered species are discovered, the activity will be halted and the District Biologist will be contacted to determine what, if any, consultation with the US Fish and Wildlife service is needed, and what specific measures to implement to avoid any adverse effects.

Chapter III

Environmental Effects

A. SOIL

Existing Condition

The analysis area for soil is the area covered by the clearing limits for the drill pad and reserve pit, and associated road work consisting of the decommissioning of a section of FDR 93021B, relocation of a section of FDR 93021B, construction of the access road to the pad, and reconstruction of an existing section of FDR 93021B, and construction of a turnaround/dispersed camping area.

The analysis area for soil for the two existing gas well pads ARES 51810 10-17 #1-4 and ARES 51900 10-19 #1-7 is the well pad for each well. Non-native invasive species (NNIS) of plants on the pads would be treated with Glyphosate.

The soil type for SEECO, Inc. Ozark Highlands Unit 9-16 2-7H6, ARES 52178 & 52179 is Enders gravelly fine sandy loam, 12-45% slopes (Townsend et.al. 1980).

Enders gravelly fine sandy loam, 12-45% slopes is made up of 60 percent Nella soils, up to 30 percent Enders soils, and included soils make up the rest. This association consists of deep, well-drained, loamy and clayey soils. Enders soils are well drained, low in organic content, low in natural fertility, and strongly to extremely acid. Permeability is very slow and the available water capacity is medium.

The hazard of erosion off-roads and off-trails for the soils in the project area is moderate. Ratings for the hazard of off-road or off-trail erosion are based on slope and on soil erodibility factor K. The soil loss is caused by sheet or rill erosion in off-road or off-trail areas where 50 to 75 percent of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance. The hazard is described as slight, moderate, severe, or very severe. A rating of slight indicates that erosion is unlikely under ordinary climatic conditions; moderate indicates that some erosion is likely and that erosion-control measures may be needed; severe indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised; and very severe indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical (NRCS).

The hazard of erosion on roads and trails for the soils in the project area is severe. Ratings for the hazard of erosion on roads and trails are based on the soil erodibility factor K, slope, and content of rock fragments. The ratings apply to unsurfaced roads and trails. The hazard is described as slight, moderate, or severe. A rating of slight indicates that little or no erosion is likely; moderate indicates that some erosion is likely, that the roads or trails may require

occasional maintenance; and that simple erosion-control measures are needed; and severe indicates that significant erosion is expected, that the roads or trails require frequent maintenance, and that costly erosion control measures are needed (NRCS).

Proposed Action

Direct/Indirect Effects

Clearing of the drill pad may initially increase erosion on this site. Sediment would be trapped by silt fences and sediment basins. Disturbed soils would be protected by vegetation slash, roots, rocks, limbs and other debris during clearing. During clearing the cleared area would be smoothed and tracked with the dozer to prevent runoff from concentrating before storms occur. All cutting and filling would be done within the clearing limits with the exception of waterbars and terraces, which would extend beyond the clearing limits to allow sediment to settle out onto the undisturbed forest floor. During construction everything would be done within the clearing limits in an effort to retain all sediment within the clearing limits. Work would only be done outside the clearing limits during the interim and/or final reclamation processes for erosion control and establishing vegetation. Erosion control measures such as silt fences, sediment basins, and hay bales would be installed when clearing of the site is completed. The drill pad would be surfaced with aggregate. Additionally the trees, shrubs, and litter covered soils outside the clearing limits would help to capture sediment that escapes other erosion control measures listed in the Surface Use Plan of Operations.

Site Specific Design Criteria #3 (see page II-10) would prevent sediment or runoff from entering ephemeral stream channels which would be approximately 500 feet south of the well pad on the east side and 400 feet north of the proposed northwest corner of the pad.

Erosion would increase during access road construction but would decrease when vegetation becomes established. The erosion rate would increase with an increase in rainfall intensity and amount. Plants in the erosion control seed mix germinate within 10 to 14 days, if weather conditions are favorable. Vegetation should be established within six months if weather conditions are favorable. Changes in road grade along with lead-off ditches would cause sediment to settle out on the undisturbed forest floor at the outlet of lead-off ditches. Implementing the project design criteria would decrease erosion potential.

Up to 2.26 acres of soil would be taken out of vegetative production and devoted to the gas well drill pad and reserve pit. Approximately 0.6 acre of soil would be taken out of production and devoted to the access road. Approximately 0.7 acre would be taken out of production and devoted to the relocated section of Forest Developed Road (FDR) 03021B. Approximately 0.19 acre would be taken out of production and devoted to the reconstructed section of FDR 93021B. Approximately 0.06 acre would be taken out of production and dedicated to use as a turnaround/dispersed camping area. A total of 3.81 acres would be taken out of vegetative production and devoted to the access road, drill pad, reserve pit, relocated road section, reconstructed section of road, and turnaround/dispersed camping area. A section of FDR 93021B would be decommissioned which would return approximately 0.4 acres to production. The net amount of soil taken out of production would be approximately 3.41 acres. Top soil from the drill pad area would be stock piled and stored for use during rehabilitation. Reserve pit standards

would be followed, and the pit would be laid out in coordination with the Forest Service and BLM. All waste would be handled in an approved manner according to the APD. Arkansas Oil and Gas Commission standards would also be followed.

In the case of a dry hole, and/or abandonment, the downhole requirements established by the BLM and the Arkansas Oil and Gas Commission to protect the environment and provide for safety would be incorporated. Requirements for abandonment, signage, etc. are listed in Arkansas Oil and Gas Commission General Rule B-9.

The rehabilitation of the surface as described in Project Design Criteria #12 would comply with Forest Service regulations and would be done in a timely manner to Forest Service specifications.

Glyphosate herbicide would be used as a spot application after the well pad is completed to keep the well pad clear of vegetation and to control invasive plant species. Herbicide use for this purpose is not broadcasted but applied by direct injection, cut surface, or foliar spray. The soil would not be impacted by the herbicide because the foliage and roots of the treated plants would remain on the site to protect the surface soil and the soil would not be disturbed. Glyphosate is readily absorbed by foliage. In general, glyphosate will bind tightly to soil and its leaching capacity is extremely low, i.e. glyphosate is relatively immobile ((e.g., Alex et al. 2008, Landry et al. 2005, Mamy and Burruso et al. 2005) as cited in Syracuse Environmental Research Associates, Inc. 2011). It is strongly adsorbed to soil, remains in the upper soil layers, and has a low propensity for leaching (U.S. E.P.A 2013). Glyphosate readily and completely biodegrades in soil even under low temperature conditions. Its average half-life in soil is about 60 days (U.S. E.P.A. 2013). There is relatively detailed literature regarding the effects of glyphosate and glyphosate formulations to terrestrial microorganisms. While the mechanism of action of glyphosate in plants is also relevant to microorganisms, there is little indication that terrestrial microorganisms will be adversely affected by glyphosate (Syracuse Environmental Research Associates, Inc. 2011).

The two existing gas well pads ARES 51810 10-17 #1-4 and ARES 51900 10-19 #1-7(See Figure 2 on page I-3) would also be treated with glyphosate to control identified populations of NNIS. Past manual and mechanical treatments to control the NNIS on these two well pads have been unsuccessfull. The effects to soil on the existing pads would be the same as those described above for the proposed well pad.

<u>Cumulative effects</u>
Cumulative effects include the combination of direct and indirect effects from past, present, and reasonably foreseeable activities. New system roads are discussed to provide extent of impacts but essentially are considered dedicated lands. Evaluation of cumulative effects to soil productivity does not require an integrated “watershed-type” assessment since that is not considered an appropriate geographic area for this analysis. This is because assessment of soil quality within too large an area can mask or “dilute” site specific effects and because of the variability in soil texture, the amount of organic matter and ground cover, soil response to past projects and the intensity of the past projects.

Pine thinning is proposed as part of the 2015 Fuels Management Project west of Brock Creek Road across from the proposed relocation of the beginning section of Forest Development Road (FDR) 93021B and north of the existing section of FDR 93021B and along a narrow strip south of the road and west and east of FDR 93021C . The proposed pine thinning would take place north and east of the proposed natural gas well pad. Prescribed burning is also proposed as part of the 2015 Fuels Management Project west of Brock Creek Road across from FDR 93021B and the proposed relocation of a section of the road. The impacts from these proposed activities would not add to the soil impacts predicted for the proposed gas well because the activity areas would not overlap in space.

If the well does not produce, the disturbed areas associated with well pad and access road would be rehabilitated.

Impacts to soil productivity would be limited to the activity areas, which consist of the clearing limits for the well pad, the clearing limits for the access road, relocated section of road, reconstructed section of road, and turnaround/dispersed camping area.

Alternative 1 (No Action)

Direct/Indirect Effects
There would be no increase in soil disturbance. Soil impacts would be limited to the existing road system and on-going forest management activities. At this time there are no other specific reasonably foreseeable forest management actions planned within the area of effects.

Cumulative Effects
There would be no cumulative effects to soils as a result of the no action alternative.

B. SURFACE WATER

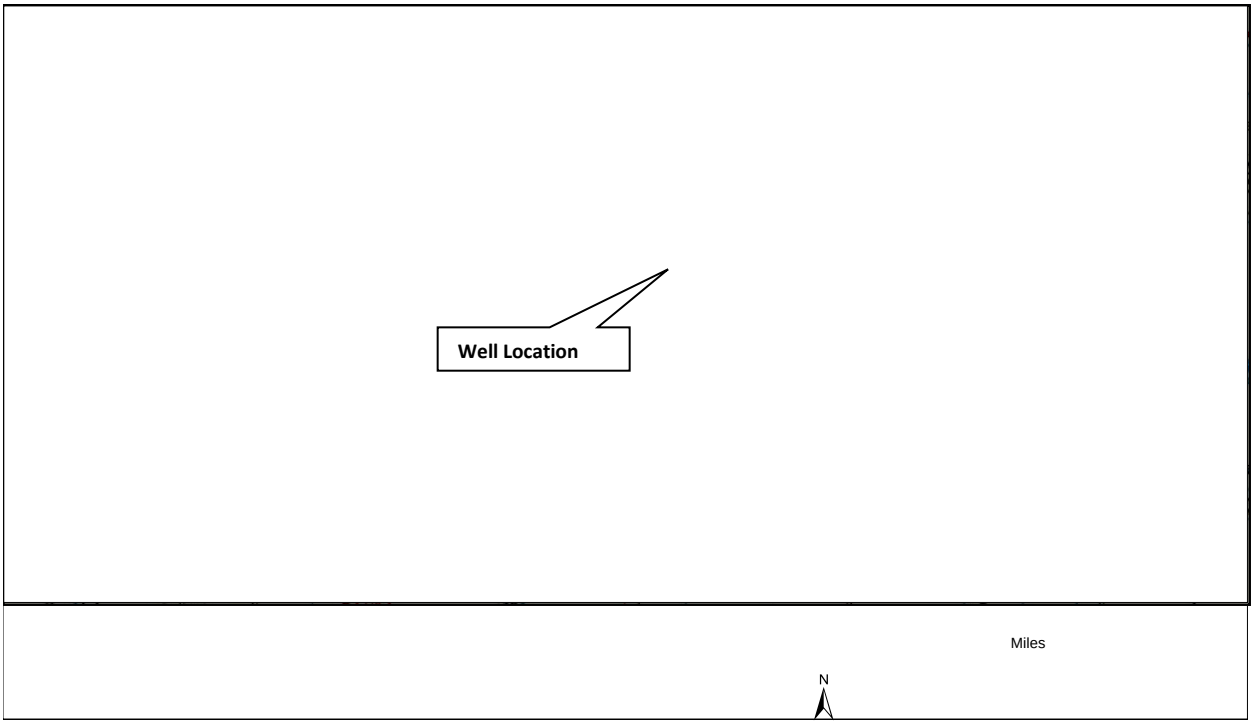
Existing Condition

The well pad for the proposed well would be approximately 1.9 acres with a maximum clearing limit of 5.8 acres. The pad and clearing limits are split between two watersheds: Rock Creek – West Fork Point Remove Creek watershed (Hydrologic Unit Code (HUC) 111102030105) to the south and Brock Creek (HUC 111102030101) to the north. These watersheds will serve as the analysis area boundary for surficial effects and analyzed individually. The Rock Creek watershed contains 38,632 acres, of which, 5,338 acres or 14% is National Forest System land. The Brock Creek watershed contains 27,964 acres with 21,596 acres within the National Forest System. According to the Arkansas Oil and Gas Commission website, there are 362 previously drilled gas wells within the Rock Creek watershed and 6 within the Brock Creek watershed.

The closest stream to the proposed well site is Brock Creek approximately 1,700 feet north of the proposed wells site. From north of the proposed site, Brock Creek flows southeast approximately two miles to its confluence with West Fork Point Remove Creek.

Several defined channels are also present in the area. The definition of a defined channel is a feature that clearly exhibits most of the following characteristics: displays signs of water flow velocity sufficient to move soil material, litter, and fine debris; shows a defined bank and streambed; shows accumulated deposits of sands and gravels; and is continuously connected with other hydrologic features (LRMP, p. A-9). This includes channels that may only support water flow immediately following a precipitation event; bed forms that can include large, stable rock; and areas that possibly support riparian-dependent plants and animals. Furthermore, defined channels would not support year-round aquatic organism habitat.

Figure 5. Location Map



There is no evidence to suggest that water quality standards are not being met at this time in any stream within the analysis area. The streams are expected to meet the designated uses identified by ADEQ Regulation No.2 (Arkansas Pollution Control and Ecology Commission, 2011).

There are no registered wetlands identified within the project area. This determination was made by comparing the project area to the National Wetland Inventory database and by a field visit to the site. No floodplains were identified within the project area but floodplains do exist within the watersheds in narrow strips along some of the stream courses.

There are no designated Wild and Scenic Rivers or impaired waterbodies within this analysis area.

Proposed Action

<u>Direct Effects</u>

Clearing of the drill pad along with road construction may initially increase erosion from the site. This would be temporary because the drill pad and access road would be surfaced with aggregate. The use of silt fencing and/or hay bales and slash would also help to control erosion and prevent movement of sediment into streams.

The use of the herbicide Glyphosate is expected once the well pad is completed. This herbicide would be used only as spot application to keep the well pad clear of vegetation during use and to control invasive species. Herbicide use for this purpose is applied by direct injection, cut surface, or foliar spray. For these purposes, herbicide use is infrequent and direct application methods would minimize off-site movement. Forest-wide Standards for herbicide application would be followed as well as appropriate BMPs designed to limit risk to water quality.

Fracturing of the rock around the drill hole in the target zone for natural gas is necessary to create pathways for gas to be extracted thru the drill hole. The fracturing process is closely monitored to ensure fractures are not propagated outside the target zone, creating a route thru which the gas could escape and not be captured.

Water would be required for carrying propants (sand) and chemicals such as scale inhibitor, acid for cleaning cement from the casing perforations, friction reducers and surfactant to increase the viscosity. An oil-based drilling mud would be used in a closed-loop system for carrying cuttings to the surface. No diesel would be used in the fracturing fluid during the fracture process of this well. Typical fracturing fluids consist of 99.51% water and 0.49% other liquids as noted above (AOGC website).

According to the Application for Permit to Drill, this well would require approximately 5.25 million gallons of water to complete the fracturing process. This water would be obtained from private land and pumped approximately 1.8 miles by overland pipe to the site. Typical recovery is approximately 10-20%. There would likely be another 1-2 barrels per day of produced water that would be stored on-site. Produced water is groundwater that is encountered during the drilling process or from water vapor from the target formation that is expelled during gas extraction. Water that comes back to the surface would not go into the cuttings pit but would be stored in tanks at the site and hauled by truck to authorized disposal facilities. SEECO, Inc. has an established Spill Prevention, Controls and Countermeasures (SPCC) plan and spill reporting guide which requires notification of designated local, state and federal officials should a spill occur in reportable quantities.

After drilling is complete, cuttings would be removed from the mud pit and hauled by truck to a designated disposal facility. These materials are subject to the same spill prevention and reporting requirements as liquid waste. Disposal of all liquid and solid wastes would involve driving across bridges over streams. Transportation of these materials has no higher risk than any other typical transport and spills or accidents are covered by the SPCC plan and are subject to applicable state and federal regulations.

Potential impacts from field operations associated with gas wells could include migration of oil, gas or contaminated water through poorly cemented or corroded well casings. See the Ground Water section for a discussion of potential impacts to ground water on page III- 9-18. Regulations require that the well construction procedures be designed in such a manner to reduce the potential for contamination of any aquifers. All downhole activities are subject to the

standards and requirements of the Bureau of Land Management (BLM). See the Project Designs section on pages II-8-10. This includes approval of the type of equipment used downhole, cementing of the surface casing, and, eventually, proper abandonment of the well. Reserve pit standards are laid out in coordination with the Forest Service and BLM and must be followed during installation of the pit. All waste must be removed from the site and disposed of at an appropriate waste disposal facility. Arkansas Oil and Gas standards must also be followed. Adhering to these standards and requirements should prevent contamination of any aquifers in the area.

Upon completion of drilling activities, the rehabilitation of the surface would comply with conditions contained in the approved permit, the Forest Wide Conditions of Approval, and the Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development, The Gold Book. Reclamation activities would be completed in a timely manner and subject to acceptance by Forest Service personnel.

Indirect Effects

Water quality may be affected by indirect effects at a later time or further distance from the triggering management activity. Indirect effects are from management activities that do not have a direct connection to a stream course or water supply.

The proposed activities where ground disturbance would occur have potential to adversely affect water quality by increasing sediment levels and changing the chemical and biological characteristics of the water quality within a watershed that could have detrimental effects to fish and public water supply.

The direct and indirect impacts from this project are not expected to contribute to degradation of the current water quality. The most likely effects from this alternative, beyond current conditions, are a short-term increase in sediment that would result from storm runoff following construction activities. Erosion control through revegetation of the disturbed ground, use of silt fencing, slash and other catchment devices, and contouring of the slopes would limit the expected erosion and runoff. Using measures that would minimize run-off and help to establish natural vegetation would limit long-term concerns to water quality.

Cumulative Effects

The aquatic cumulative effects model was used to capture the effects of other management activities in the same watershed that may combine with the proposed project to produce cumulative effects. Changes in land use and other disturbances can be modeled with respect to estimated increases in sediment. This model estimates the current condition and the effects of various management alternatives. These predictions are then compared to risk levels established by the effects of sediment increase on fish communities. Other projects within the analysis areas include vegetation management and prescribe burn activities from both past projects and a proposed project involving fuels reduction burns and vegetation management. It also includes an estimate of other gas wells drilled in the same watershed in the last three years. It is estimated that five of these wells were completed in each the last three years and that they each contain approximately six acres of cleared area. The closest activity to construction of a well pad that is listed in the model is construction of a pond. Timber is completely removed from these sites so

in the cumulative effects model, 30 acres of clearcut and 30 acres of pond construction are used for past activities.

Within the model, the Brock Creek analysis area watershed starts with a rating of Moderate due to the past and other proposed project activities. After applying the proposed activities, the rating for the watershed remains as a moderate risk to water quality. In the Rock Creek analysis area watershed, the combination of past and proposed projects with only 14% Forest Service surface ownership results in a high risk rating initially with only a small sediment increase due to the addition of the well pad.

Alternative 1 (No Action)

Direct Effects
For the No Action alternative, any additional risk to surface water quality from construction of the well pad and access road would not be realized. Existing processes would continue and the watersheds would remain at moderate and high risk levels for effects to surface water quality. The already low risk to groundwater would be further diminished since the well would not be drilled.

Indirect Effects
There would be no indirect effects with this alternative since no activities would be implemented.

Cumulative Effects
There would be no cumulative effects with this alternative since no activities would be implemented.

Table 5. Results of the Water Resources Cumulative Effects Analysis

Sediment increase above undisturbed conditions						
	Current		**Future**			
			No Action		Proposed	
6th level Watershed Analysis Area	Tons/year	Concern Level	Tons/year	Concern Level	Tons/year	Concern Level
	490.55	Moderate	496.59	Moderate	499.35	Moderate

111102030101 Brock Creek						
111102030105 Rock Creek – West Fork Point Remove Creek	691.51	High	720.82	High	728.59	High

C. Ground Water

Existing Condition
Hydro-geologic Characteristics

The Boston Mountains are represented by a group of formations that comprise dominantly fractured shale and sandstone rocks, which are characterized by low secondary porosity and permeability with resulting low yields. Regional hydro-geologic framework studies (Imes and Emmett, 1994) characterize this system of formations as a regional confining unit, referred to as the Western Interior Plains (WIP) confining system. Although regionally these formations are designated as a confining system, the formations are important locally as a valuable water supply.

The Western Interior Plains confining system comprises 11 different predominantly clastic (sand, siltstone, shale) formations of Upper Mississippian and Pennsylvanian age. These formations are relatively thin in the northern Boston Mountains and thicken considerably to the south at rates of approximately 180 ft./mi. Total thickness of the formations is greater than 6,000 ft. beneath the Arkansas River Valley (Imes and Emmett, 1994). The lithology and hydrogeological characteristics of these formations are very similar. Consequently, a detailed discussion of each formation is not integral to the understanding of this shallow aquifer system. For additional information on the stratigraphy of the individual formations composing the confining system, the reader is referred to McFarland (2004). A general knowledge of the basic rock types is sufficient to understanding the hydrologic characteristics and geochemistry of groundwater from the WIP confining system.

Chemical and physical weathering processes result in the development of secondary porosity through expansion and fracturing of the rocks. Fractures tend to exhibit denser distribution and larger apertures near the surface because of unloading expansion that is a mechanical response to decreased compressive stress as overlying rocks are eroded and removed. The hydraulic properties of the Western Interior Plains confining system exhibit low primary porosity, secondary porosity from fractures associated with compression, uplift and weathering, and low yields that rarely exceed 1–5 gal/min, similar to that of the shale- and sandstone-dominated Ouachita Mountains aquifer.

Imes and Emmett (1994) noted that local groundwater-flow systems in the Western Interior Plains confining system are dominantly present in the upper 300 ft. of the weathered confining system. This is because fractures generally have a larger aperture near the surface and diminishing width with depth. Porosity and permeability generally decrease to a magnitude insufficient to support production from wells at depths greater than approximately 300 ft. (Cordova, 1963; Kilpatrick and Ludwig, 1990, Imes and Emmett, 1994; Kresse and others, 2012). Kresse and others (2012) reported on 58 wells in the central part of the Western Interior Plains confining system with depths ranging from 25 to 385 ft. with a median of 87 ft. Many wells in the Western Interior Plains confining system often go dry during pumping, particularly during drought periods (Cordova, 1963; Kresse and others, 2012). The quantity of groundwater available in the Western Interior Plains confining system is related directly to the density, size, openness, and degree of interconnection of fractures (Cordova, 1963).

Groundwater generally is recharged by precipitation that infiltrates in upland areas, percolates to the water table, flows downgradient toward lowland areas, and discharges into streams (Imes and Emmett, 1994). A conceptual model of groundwater flow for the Western Interior Plains confining system is controlled by expansion fractures with limited groundwater storage and has sufficient yields almost solely for use as domestic supply. Groundwater flow paths are constrained by small-scale topographic boundaries with flow from elevated areas to valley floors in small stream systems (Cordova, 1963; Imes and Emmett, 1994; Kresse and others, 2012). Water-level measurements in any one well represent averages of all the water-yielding layers in the Western Interior Plains confining system (Imes and Emmett, 1994).

Because of the low porosity of the Western Interior Plains confining system, well yields generally are sufficient only for household, small public supply, and nonirrigation farm uses. Cordova (1963) noted that most wells yielded less than 60 gal/min, which is the maximum yield in the Western Interior Plains confining system. Thicker sandstone units in the Atoka Formation and the Batesville Sandstone in the eastern part of the confining system commonly yield 5–10 gal/min to wells less than 300 ft. deep (Albin and others, 1967a). Kilpatrick and Ludwig (1990b) also noted that yields typically are less than 10 gal/min. Well yields for 16 shallow wells in southwestern Washington County ranged from 2 to 19 gal/min (Muse, 1982). Water levels in the WIP confining system typically range from near land surface to approximately 50 ft. below land surface. Seasonal fluctuations are approximately 10 ft. with drawdowns from pumping as much as 45 ft. (Cordova, 1963; Albin and others, 1967a).

Groundwater in formations of the WIP confining system was noted to have bicarbonate as the principal anion, with sodium, calcium, or magnesium dominating the cations dependent on the formation type (Cordova, 1963). Lamonds (1972) stated that groundwater ranged from a calcium- to a sodium-bicarbonate type with dissolved-solids concentrations ranging from 20 to 1,200 milligrams per liter (mg/L). Dissolved-solids concentrations for groundwater in sandstones of the Atoka Formation typically ranged up to 200 mg/L; whereas groundwater from shale formations typically had dissolved-solids concentrations more than 200 mg/L. Cordova (1963) attributed sodium- and magnesium-chloride water types to proximity of hydrocarbon accumulations and attributed the sulfate water type to oxidation of pyrite. Cordova also noted that iron concentration varied widely, ranging from non-detectable to 19 mg/L. Odors of

hydrogen sulfide and iron staining on plumbing fixtures were the major complaints of household residents (Cordova, 1963).

Albin and others (1967a) reported on water resources of Jackson and Independence Counties, which are located in the eastern extent of the WIP confining system. Analyses for the Atoka Formation indicated that groundwater generally was of good quality with low concentrations for most chemical constituents; though, in a few areas, the water was hard with elevated iron concentrations. The poorest quality groundwater was noted in groundwater from the Fayetteville Shale, which contained elevated concentrations of iron, sodium, sulfate, chloride, and dissolved solids relative to other formations (Albin and others, 1967a). Lamonds (1972) also noted that groundwater from black shale can be high in sulfide and sulfate.

Recent groundwater studies (Kresse and Hays, 2009; Kresse and others, 2012; Warner and others, 2013; Kresse and others, 2014) collected a more extensive and comprehensive geochemical database and provided an analysis of isotopic compositions to better understand rock/water interactions and evolution of groundwater geochemistry with respect to rock type in the Interior Highlands. These recent studies confirmed the poor quality of groundwater from shale formations and showed marked differences in the geochemistry of groundwater from quartz formations (sandstone, chert, and novaculite) and shale formations in the Interior Highlands.

Much of the variation in groundwater geochemistry within the WIP confining system can be explained by the dominant geology in the region, which mainly consists of alternating shale and sandstone units. In most areas, shale dominates the lithology with minor occurrences of thin sandstone units within any one vertical section. In some other areas, thicker sandstone units occur. Distinct geochemical differences were noted in groundwater extracted from shale compared to groundwater extracted from quartz formations in the Ouachita and Boston Mountains areas (Kresse and Hays, 2009; Kresse and others, 2012; Kresse and others, 2014). These differences in groundwater geochemistry were definable, reproducible, and consistent across both areas and were controlled by mineralogy.

Similar to most aquifers in Arkansas, groundwater in the WIP confining system generally is a strong bicarbonate water type. Bicarbonate accounted for more than 50 percent of the total anions in 202 of 249 (81 percent) samples with complete anion (chloride, sulfate, bicarbonate) analyses. Eighty-three of these 202 samples had percent bicarbonate exceeding 90 percent. Bicarbonate concentrations ranged up to 980 mg/L with a median of 129 mg/L. For samples with bicarbonate as the dominant anion, groundwater ranged from calcium- and calcium-magnesium-bicarbonate to a sodium-bicarbonate water type. Bicarbonate concentrations increased with increasing dissolved-solids concentrations. This relation indicates that dissolution of carbonate minerals accounts for the increasing bicarbonate concentrations, which drives the concomitant increases in dissolved solids (Kresse and others, 2014). Shale formations in the WIP confining system have abundant carbonate minerals because the source sediments accumulated in marine environments (McFarland, 2004). Similarly, increasing values of pH correlated to increasing concentrations of bicarbonate and dissolved solids (Kresse and others, 2014).

Similar to most aquifers in Arkansas, recharge of slightly acidic precipitation with a mean pH value of approximately 4.7 (Kresse and Fazio, 2002) is neutralized with the dissolution of carbonate minerals. This results in increasing pH values along a continuum of increased residence time with resultant increasing dissolved-solids concentrations in the WIP confining system (Kresse and Fazio, 2002; Kresse and Hays, 2009; Kresse and others, 2012). Values of pH in 266 groundwater samples ranged from 3.5 to 8.8, and 16 samples had pH values less than 4.7 (Kresse and others, 2014). Values of pH lower than the pH of rainwater are attributed to formation of carbonic acid by dissolution of carbon dioxide with recharging precipitation in the unsaturated zone of carbonate-free sandstone units (Kresse and Hays, 2009; Kresse and others, 2012). Bicarbonate concentrations and pH values show no clearly discernible spatial trends. However, some groupings of lower values for each constituent (for example, in extreme southern Van Buren County) suggest that wells may be producing from areal extensive sandstone units. Similarly, a grouping of higher pH values in northern Faulkner County may indicate wells completed in predominately shale rocks (Kresse and others, 2014).

Iron concentrations in 163 groundwater samples from the WIP confining system ranged from 0.05 to 13,800 micrograms per liter (µg/L) with a median of 27 µg/L. Iron concentrations were below the Federal secondary drinking-water regulation of 300 µg/L in 120 (74 percent) of the samples. Groupings of concentrations exceeding 500 µg/L generally occur in Faulkner County and into eastern Conway County and similarly throughout Cleburne and White Counties. However, wells with high iron concentrations occur next to wells with low concentrations, indicating the lack of a well-defined and consistent spatial distribution trend. The lack of any spatial trend suggests that the occurrence of iron is a function of mineralogical and reduction-oxidation processes occurring with increased residence time along localized and relatively short groundwater flow paths (Kresse and others, 2014). Kresse and others (2012) showed that dissolved iron was lowest (less than 500 µg/L) in groundwater with dissolved solids less than 60 mg/L, generally correlating to regions with high nitrate concentrations. Iron concentrations increased with increasing dissolved-solids concentrations up to approximately 290 mg/L and decreased for dissolved-solids concentrations greater than 290 mg/L. Natural arsenic concentrations had similar trends with increasing dissolved solids.

Sulfate concentrations generally were low throughout the Western Interior Plains confining system. Sulfate concentrations ranged from 0.02 to 1,030 mg/L with a median of 4.7 mg/L. Out of 267 samples, 243 (91 percent) had concentrations less than 50 mg/L. Only three samples were more than the secondary drinking-water regulation of 250 mg/L (Kresse and others, 2014). Cordova (1963) attributed sulfate in groundwater to oxidation of pyrite; however, Kresse and others (2012) hypothesized that appreciable sulfate concentrations result from gypsum dissolution. Sulfate concentrations increased with increasing dissolved-solids concentrations. For dissolved-solids concentrations less than 100 mg/L, sulfate was less than 10 mg/L. For dissolved-solids concentrations between 100 and 200 mg/L, sulfate was less than 25 mg/L. All sulfate concentrations more than 50 mg/L occurred at dissolved-solids concentrations more than 200 mg/L. This is a region that was shown by Kresse and others (2012) to be under iron- and possibly sulfate-reducing conditions in which pyrite would be stable. Additionally, increases in sulfate generally correlated to increases in calcium/bicarbonate equivalent ratios more than 1.0 and up to 8.0. This correlation suggested that excess calcium not accounted for by dissolution of carbonate minerals may be derived from dissolution of gypsum.

Chloride concentrations generally are low in groundwater throughout the WIP confining system. Chloride concentrations ranged from 0.9 to 1,100 mg/L with a median concentration of 5.0 mg/L. Out of 282 samples, 195 (69 percent) were less than 10 mg/L, and only 5 samples exceeded the Federal secondary drinking-water regulation of 250 mg/L. Residual salinity from the marine environment in which shale of the Atoka and Bloyd Formations were deposited generally has been flushed over time by infiltrating precipitation In low permeability zones or hydraulically isolated areas that have not been flushed over time, higher salinity water can be released into the well bore. This raises chloride concentrations above the generally low concentrations found across much of the WIP confining system. Chloride concentrations increase with increasing dissolved solids. This suggests that a higher chloride concentration in groundwater is more likely in regions of more evolved groundwater with a longer residence time along a given flow path, affording greater rock/water interaction over time (Kresse and others, 2014).

Table 6. Stratigraphic column and correlated geo-hydrologic units of the Ozark Plateaus Province in northern Arkansas.

Time-Stratigraphic Unit		Formation	Regional Geo-hydrologic Unit
Era	**System**		
Paleozoic	Pennsylvanian	McAlester Formation Hartshorne Sandstone Atoka Formation Bloyd Shale Hale Formation	Western Interior Plains Confining System
	Mississippian	Pitkin Limestone Fayetteville Shale Batesville Sandstone Moorefield Formation	
		Boone Formation St. Joe Limestone Member	Springfield Plateau Aquifer
	Devonian	Chattanooga Shale	Ozark Confining Unit
		Clifty Limestone Penters Chert	Upper Ozark Aquifer
	Silurian	Lafferty Limestone St. Clair Limestone	

		Brassfield Limestone	
	Ordovician	Cason Shale Fernvale Limestone Kimmswick Limestone Plattin Limestone Joachim Dolomite St. Peter Sandstone Everton Formation Smithville Formation Powell Dolomite Cotter Dolomite Jefferson City Dolomite Roubidoux Formation	
		Gasconade Dolomite Gunter Sandstone Member Van Buren Formation	Lower Ozark Aquifer
	Cambrian	Eminence Dolomite Potosi Dolomite	
		Doe Run Dolomite Derby Dolomite Davis Formation	St. Francois Confining Unit
		Bonetere Formation Reagan Sandstone Lamotte Sandstone	St. Francois Aquifer
Precambrian	Precambrian	Precambrian intrusive and volcanic igneous rocks	Basement Confining Unit

The Proposed Action

Direct/Indirect Effects

The Mississippian Fayetteville Shale serves as an unconventional gas reservoir across north-central Arkansas. Gas-well drilling and completion activities in the Fayetteville Shale have the potential to affect surface and subsurface water quality through various sources and transport pathways. Potential groundwater-quality impacts in shallow aquifers are through the loss of

fluids used in every step of gas production, including drilling, hydraulic fracturing, and storage and handling of flow-back water. Groundwater transport pathways for surface-derived contaminants include potential leakage from earthen pits used to store drilling, hydraulic fracturing, and flow-back fluids, leakage from pipes, and losses from pond overflows and spills during transport (King, 2012). Groundwater contamination possibly can be associated with hydraulic fracturing through changes in the permeability of the shale gas formation and overlying geological units because of the hydraulic fracturing process, migration of hydraulic fracturing fluids through existing vertical fractures that connect to the shallow aquifer (Warner and others, 2012), and, more likely, upward migration of gas and pressurized fluids through poorly cased and grouted sections of the shale-gas well bore (Atlantic Council, 2011; King, 2012). However, hydraulic fracturing in a properly cased and cemented wellbore has been cited as the lowest risk for shallow groundwater contamination in the entire well-development process (King, 2012).

The potential for migration of fracturing fluids into shallow groundwater aquifers can increase where the target formation is shallower, thus reducing the separation distance between the gas-production zone and the shallow groundwater, or where increased hydraulic connectivity exists through deep faulting zones (Warner and others, 2012). The thickness of the Fayetteville Shale ranges from approximately 50 to 550 feet (ft.) and varies in depth from approximately 1,500 ft. to 6,500 ft. below the ground surface (Southwestern Energy, 2012). Kresse and others (2013) reported on 58 water wells in the western part of the Fayetteville Shale production area with well depths ranging from 25 to 385 ft. with a median of 87 ft.—only 3 of these wells had depths exceeding 200 ft. This is in agreement with Imes and Emmett (1994), who noted that local groundwater-flow systems in the Western Interior Plains confining system are dominantly present only in the upper 300 ft. of the weathered confining system. This is because fractures generally have a larger aperture near the surface and diminishing width with depth. Porosity and permeability generally decrease to a magnitude insufficient to support production from wells at depths greater than approximately 300 ft. (Cordova, 1963; Kilpatrick and Ludwig, 1990b, Imes and Emmett, 1994; Kresse and others, 2013). If one uses a conservative estimate of 500 ft. for the maximum depth to shallow groundwater, then the separation distance based on the depth to the Fayetteville Shale provided above ranges from 1,000 to 5,500 ft. Because of the thick layers of shale separating the fresh-water zone from the gas-production zone, this lessens considerably any potential effects of upward migration of fluids associated with gas production into shallow groundwater.

Kresse and others (2013) sampled 127 domestic wells in the western one-third of the Fayetteville Shale production zone area. All samples were analyzed for a complete suite of major and minor ions and trace metals; 51 samples were analyzed for presence of methane; and selected samples (based on salinity and other considerations) were sampled for various isotopes. Chloride was selected as the main indicator constituent for defining potential influx of high-salinity flow-back water associated with gas production into shallow aquifers in the area. Chloride is a conservative, non-reactive ion that is elevated in flow-back water (as high as 20,000 mg/L) compared to shallow groundwater, which had an overall median concentration for chloride of 3.7 mg/L from 127 samples. They used two comparative analysis methods to assess the potential impacts from shale-gas activities: (1) comparison of the water-quality results from their sampling to historical well-water analyses in the general area, and (2) domestic wells within 2 miles of

gas-production pads to those greater than 2 miles. For the comparison to historical analyses, nonparametric statistics revealed significantly higher concentrations in the historical data. Because different wells were sampled for both studies, no implications were made that water quality had improved, rather that the water quality in wells sampled for the Kresse and others (2013) study were within the range of water-quality constituents in the historical wells. Of the wells sampled for comparison of distance to gas-production well pads—94 wells were less than 2 miles from pads (63 <0.5 miles; 29 <0.25 miles) and 33 wells were greater than 2 miles (maximum of 16 miles)—median chloride concentrations were 3.7 mg/L in each grouping of wells, and statistical analysis showed no difference between the two groups of wells. An investigation of geochemical evolution based on constituent concentrations along a trend of increasing dissolved-solids concentrations was made to search for outliers in the water-quality data that might signal effects from gas-production activities. Although preproduction water-quality data were lacking for the wells sampled for their study, geochemical data presented a well-defined pattern of geochemical evolution based on natural rock-water and microbialloy mediated processes, strongly suggesting that the resulting water quality is derived from these natural processes with no effects from gas-production activities.

Results of methane (CH_4)analysis for 51 domestic wells from the Kresse and others (2013) study showed that all methane greater than 0.5 mg/L (upwards to 28 mg/L) was biogenic and the result of natural reducing conditions within shallow groundwater in organic-rich shale, rather than migration of thermogenic-sourced methane—formed from high heat and pressure associated with gas-production zones—that might indicate migration along faulty casing or other avenues associated with gas-production within the Fayetteville Shale. Isotopes of methane, boron (B), strontium (Sr), hydrogen (H), oxygen (O), and carbon (C) were also analyzed and used to assist in validating or refuting interpretations in Kresse and others (2013) based on the major ion chemistry. Isotopes from the groundwater samples were compared to the isotopic geochemistry of flow-back fluids associated with production of gas in the Fayetteville Shale. The Sr ($^{87}Sr/^{86}Sr$ = 0.7097–0.7166), C ($\delta^{13}C_{DIC}$ = −21.3‰ to −4.7‰), and B ($\delta^{11}B$ = 3.9–32.9‰) isotopes clearly reflect water/rock interactions within the aquifer rocks, while the stable O and H isotopic composition mimics the local meteoric water composition. The chemical and isotopic compositions of the bulk shallow groundwater samples were distinct from the Na–Cl type Fayetteville flow-back/produced waters (dissolved solids ~10,000–20,000 mg/L). Additionally, no spatial relationship was found between CH_4 and salinity occurrences in shallow drinking water wells with proximity to shale-gas drilling sites (Warner and others, 2013). The integration of multiple geochemical and isotopic proxies showed no direct evidence of contamination in shallow drinking-water aquifers associated with natural gas extraction from the Fayetteville Shale. Results of Kresse and others (2012) and Warner and others (2012) suggest that activities associated with drilling and production of shale-gas from the Fayetteville Shale pose minimal potential for contamination of shallow groundwater in the production area.

In addition to results directly related to shale-gas activities in Arkansas, studies in other parts of the country have shown relatively few incidents of significant impact to water resources compared to the number of gas wells drilled to date; however, these studies note that impacts remain difficult to assess due to the lack of transparent and accessible data, and that direct contamination of shallow groundwater related to hydraulic fracturing is controversial based on existing data (Brantley and others, 2014; Vengosh and others, 2014). Kell (2011) performed a

review of groundwater contamination in Ohio and Texas and documented changes in regulations that protect groundwater based on lessons learned during early periods of oil and gas production from as early as 1950. Most documented cases of groundwater contamination were caused by drilling or production activities, with improper construction or maintenance of reserve pits as the primary source of groundwater contamination, and storage-tank or flow-line leaks as a second leading source of contamination previous to extensive shale-gas production. With the advancement of horizontal drilling and fracturing for shale-gas production, greater than 16,000 horizontal shale-gas wells with multi-staged hydraulic fracturing stimulations were completed in Texas without a single groundwater contamination event from site preparation, drilling, well construction, completion, fracturing, or production operations. This lack of contamination was attributed primarily to elimination of earthen pits for storage of produced water and plugging of abandoned wells.

Due to the rules and regulations outlined under Project Designs in Chapter II, there are a minimum four (4) layers of protection in place between any underground source of drinking water (USDW) and actual hydraulic fracturing operations and five (5) layers of protection between any flow-back and produced waters (See Figures 3 and 4 in Chapter II).

It should be noted also that over 6500 wells have been drilled or permitted in Fayetteville Shale through June 1, 2015.

Cumulative Effects

According to the Arkansas Oil and Gas Commission website, there are 362 previously drilled gas wells within the Rock Creek watershed and 6 within the Brock Creek watershed. According to Exhibit F of the Application for Permit to Drill, there are five existing gas wells within a one-mile radius of the proposed well. A records search on the U.S. Geological Survey well mapper internet site (http://ar.water.usgs.gov/PROJECTS/WWData.html) shows there are no private ground water supply wells within one mile of the proposed well site. No cumulative effects to ground water are expected to occur due to sub-surface or downhole activities because no past, present, or future activities are expected to overlap in time or space with the proposed activities. The limited permeability of the underlying rock, the narrowing and disappearance of fractures in the rock with depth, the casings and cementation, activation of the spill response plan and other prevention measures as described above would limit the potential migration of contaminants into ground water, existing water wells, and other existing or future natural gas wells.

Alternative 1: (No Action)

Direct Effects

The proposed well would not be drilled so there would be no direct effects to ground water.

Indirect Effects

The proposed well would not be drilled so there would be no indirect effects to ground water due to the proposed well.

Cumulative Effects

The proposed well would not be drilled so there would be no cumulative effects to ground water due to the proposed well.

D. Air Quality

Existing Condition

The analysis area for air quality is Conway and Van Buren Counties because air quality is reported by county. A subset of the analysis area consists of the Brock Creek Watershed (27,959 acres) and the Rock Creek - West Fork Point Remove Creek Watershed (38,626 acres) surrounding the gas well site.

The Clean Air Act requires the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The NAAQS establish thresholds for six pollutants that adversely impact public health and the environment: sulfur dioxide, nitrogen dioxide, ozone, particulate matter, lead and carbon monoxide. Construction equipment and vehicles emit volatile organic compounds (VOCs), sulfur oxides (SO_x), and nitrogen oxides (NOx), which can contribute to the formation of ground-level ozone. Construction equipment and vehicles may also produce dust during activities, which can add to fine particulate matters in the atmosphere.

Episodes of regional haze occur mainly in the spring and summer due to higher humidity, which causes sulfate particles, which are one of the particles that cause haze, to scatter more light. Eastern states have higher sulfate levels in the air compared to western states.

Proposed activities would be within Conway County. As of January 30, 2015, Conway and Van Buren Counties were in attainment for all the six EPA criteria air pollutants (U.S. Environmental Protection Agency 2015). EPA defines attainment areas as “A geographic area in which levels of a criteria air pollutant meets the health-based primary standard (national ambient air quality standard, or NAAQS) for the pollutant”. EPA defines non-attainment areas, as “A geographic area in which the level of a criteria air pollutant is higher than the level allowed by the federal standards”.

Based on RLRMP standards, the desired condition for the air resource in the analysis area is to meet NAAQS.

There are 2,570 natural gas wells in Conway County and 3,388 in Van Buren County. A portion of the gas well pad would be in the Brock Creek Watershed and the remainder would be in the Rock Creek - West Fork Point Remove Creek Watershed. There are 362 natural gas wells in Rock Creek - West Fork Point Remove Creek Watershed and six natural gas wells in Brock Creek Watershed.

The Proposed Action

<u>Direct Effects</u>
Vehicles travelling to and from the site would be a source of emissions. During drilling and

completion of the well approximately 1,232 round trips would be made by trucks during the construction, drilling and fracturing operations. If a workover is needed an additional 120 round trips would be made. The use of the temporary water line to supply water for the project would eliminate the pollutant emissions by trucks that would deliver water.

Estimated emissions of trucks during the drilling and completion of the well are shown in Table 7 below.

Table 7 Potential Emissions by Trucks during well drilling and completion.

Pollutant	VOC	THC	CO	NO_x	$PM_{2.5}$	PM_{10}	CO_2
Estimated. Pounds Emitted	263	272	2,178	531	8	10	247,454

Calculated using Average In-Use Emissions from Heavy-Duty Trucks, U.S. Environmental Protection Agency Office of Transportation and Air Quality EPA420-F-08-027 2008.

Emissions can occur from a variety of processes and points throughout the oil and natural gas sector. Primarily, these emissions are organic compounds such as methane, ethane, volatile organic compounds (VOCs) and organic hazardous air pollutants (HAPs). Sources include internal combustion engines that power compressors

To estimate emissions from drilling the well, plugging the well if it does not produce gas and the day to day operations for one year calculations were done using data from typical oil and gas production operations. It was assumed that to drill one natural gas well, certain equipment is necessary, with each piece of equipment having its own emissions. Table 7. Shows the estimated emissions (in pounds) of volatile organic compounds (VOCs), carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter (PM) from three distinct phases of natural gas development (drilling, plugging, and day-to-day operations) per well drilled.

Table 8: Estimated Emissions Per Well on the OSFNFs.

Estimated Emissions Per Well on the Ozark-St. Francis NFs				
Operational Types	**VOC Emissions (lbs./well)**	**CO Emissions (lbs./well)**	**NOx Emissions (lbs./well)**	**PM Emissions (lbs./well)**
Actual Drilling Operations	307	5,205	794	16
Plugging of Wells	16	305	19	0.1
Day-to-Day Operations	12,811	39,417	2,602	336

Sources of Emissions Factors (exclusively U.S. Environmental Protection Agency publications)**:**
EPA420-F-97-014 - Emission Standards Reference Guide for Heavy-Duty & Nonroad Engines, September 1997
EPA420-R-979-009 - Exhaust Emission Factors for Nonroad Engine Modeling - Spark Ignition, Feb. 24, 1998, Revised March 30, 1999
EPA420-P-02-016- Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression Ignition, November 2002

All oil and natural gas wells must be "completed" after initial drilling in preparation for production. Well completion activities include multiple steps after the well borehole has reached the target depth.

Flowback emissions are short-term in nature and occur as a specific event during completion of a new well or during recompletion activities that involve re-drilling or re-fracturing an existing well. The flowback stage of a well completion is highly variable but typically lasts between 3 and 10 days for the average well (EPA 2011). SEECO, Inc. routes all methane captured during the flowback and completion process to a completion combustion device as required by EPA's 40 CFR Part 60, subpart OOOO emission standards. The flame produced as a result of the completion combustion is expected to burn clear and produce no smoke. Depending upon the equipment used the flame may only be visible on site or may be visible up to one mile away.

Completion combustion is a high-temperature oxidation process used to burn combustible components, mostly hydrocarbons, found in waste streams. The efficiency of completion combustion devices, or exploration and production flares, can be expected to achieve 95 percent, on average, over the duration of the completion or recompletion. Table 9. displays the potential emission reduction by combustion for each well completion category (EPA 2011).

Table 9 Potential Emission Reduction by Combustion[a]

Well Completion Category	Emission Reduction (tons/event)		
	Methane	**VOC**	**HAP**
Natural Gas Well Completion without Hydraulic Fracturing	0.76	0.11	0.0081
Natural Gas Well Completion with Hydraulic Fracturing	150.6	21.9	1.597

[a.] Taken from Table 4-6 EPA-453R-11-002 Oil and Natural Gas Sector: Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution Background Technical Support Document for Proposed Standards.

Noise and heat are the primary secondary outcomes of completion combustion device operation. In addition, combustion and partial combustion of many pollutants also create secondary pollutants including nitrogen oxides (NOx), carbon monoxide (CO), sulfur oxides (SOx), carbon dioxide (CO2), and smoke particulates (PM). Table 10. displays the net emissions after the flowback gasses are combusted in the completion combustion device.

Table 10 Net Emissions after Completion Combustion[a]

Well Completion Category	Net Emissions (tons/event)		
	Methane	**VOC**	**HAP**
Natural Gas Well Completion without Hydraulic Fracturing	0.0438	0.01	0.0009
Natural Gas Well Completion with Hydraulic Fracturing	7.95	1.23	0.083

[a]Calculated using Table 4-2 and Table 4-6 EPA-453/R-11-002 Oil and Natural Gas Sector: Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and

Distribution Background Technical Support Document for Proposed Standards..

Table 11. displays the secondary emissions produced by combusting the flowback gasses in the completion combustion device for wells with hydraulic fracturing.

Table 11 Potential Secondary Emissions after Completion Combustion with Hydraulic Fracturing[a]

Pollutant	Emissions tons/event [bc]
Total Hydrocarbon	0.66
Carbon Monoxide	1.76
Nitrogen Oxides	0.32
Particulate Matter	0.011
Carbon Dioxide	628

[a]. Taken from Table 4-9 EPA-453/R-11-002 Oil and Natural Gas Sector: Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution Background Technical Support Document for Proposed Standards.
[b]. Assumes 8,716 Mcf of natural gas is sent to the combustion unit per completion.
[c]. Based on 1,089.3 Btu/scf saturated gross heating value of the "raw" natural gas.

Potential Emissions from well completion for the proposed well are expected to be within the range of those for wells completed with hydraulic fracturing after reduction by the completion combustion device (see Table 10.). Potential secondary emissions due to completion combustion of the flowback gasses are expected to be within the range of those with hydraulic fracturing (see Table 11.).

No activities would result in violations of federal air quality standards. During project implementation, fugitive dust would likely arise from travel on roadways and from well site and production facilities construction.

Following the construction activities, emissions of fugitive dust are expected to be negligible due to infrequent vehicle traffic necessary to conduct inspections and customary vehicular traffic through the project area.

Use of herbicides on the proposed natural gas well pad and the reclaimed exploratory well pads ARES 51810 10-17 #1-4 and ARES 51900 10-19 #1-7 would not be expected to impact air quality because herbicide would be spot applied by direct injection, cut surface, or foliar spray, label rates, and Revised Land and Resource Management Plan (RLRMP) standards for herbicide application would be followed. RLRMP standards include maximum temperatures, maximum windspeeds, and minimum humidities at which herbicide application would be suspended. Treated vegetation would remain to protect the soil from wind erosion.

Cumulative Effects

Minimal cumulative effects to air quality are expected to occur. There are 362 existing natural gas wells in the Rock Creek-West Fork Point Remove Creek Watershed, 6 natural gas wells in the Brock Creek Watershed, 2,570 total natural gas wells in Conway County and 3,388 natural gas wells in Van Buren County. Conway and Van Buren Counties are currently meeting the

NAAQS with the existing natural gas wells, so the addition of this well is not expected to cause either county to exceed the NAAQS. See Table 12 below for a comparison of the estimated emissions from the proposed well to the county emissions from all sources.

Table 12 Emissions Comparison from Proposed Natural Gas Well to County Emissions All Sources.

Source	VOC (tons)	CO (tons)	NO_x (tons)	PM (tons)
Proposed Natural Gas Well	7.9	25.3	2.3	0.2
Conway County –all sources	19,997	13,762	4,428	5,088
Van Buren County – all sources	30,608	32,735	2,929	8,166
Projected Percentage of Total Emissions from the Proposed Natural Gas Well	0.02%	0.05%	0.03%	0.002%

Emissions for the proposed natural gas well are the total estimated emissions from Tables 8, 9, 10, and 11. County emissions are taken from the EPA website for County Emissions data at: http://www.epa.gov/air/emissions/index.htm

Emissions from the proposed natural gas well would not be expected to increase emissions in Conway and Van Buren Counties of any criteria air pollutant by more than 0.05% over current levels. Emissions from Conway and Van Buren Counties include those from vegetation and soil, fuel combustion, waste disposal, fire which includes prescribed burning, agricultural burning, and wildfires, industrial processes which include oil and gas production and pulp and paper manufacture, and mobile sources which include on-road and non-road vehicles.

Activities proposed for the 2015 Fuels Management Project may occur in Conway and Van Buren Counties over the next several years. Proposed activities include native cane restoration, firewood cutting, glade woodland restoration, pine, hardwood, and cedar thinning, and prescribed burning. The two main pollutants of concern from the proposed activities would be ozone and fine particulate matter. Projected emissions from the proposed natural gas well would not be expected to increase any criteria air pollutant by more than 0.05% over current levels, so emissions from the proposed natural gas well and fuels management project proposed activities added to current Conway and Van Buren County emissions would not be expected to exceed the RLRMP standard that requires that all National Forest management activities be conducted in a manner that does not result in (1) a significant contribution to a violation of National Ambient Air Quality Standards or (2) a violation of applicable provisions in the State Implementation Plan.

Alternative 1 (No Action*)*

Direct Effects
The gas well would not be drilled. There would be no emissions or dust created from construction vehicles and equipment associated with the proposed project. No direct effects would occur.

Indirect Effects
The gas well would not be drilled. There would be no emissions or dust created from construction vehicles and equipment associated with the proposed project. No indirect effects would occur.

Cumulative Effects
No cumulative effects to air quality are expected because the proposed project would not be implemented.

E. Visual Quality

Existing Condition
The ARES 52178 and 52179 Ozark Highlands Unit 9-16 2-7H6 analysis area for visual quality is the viewable area east of Tar Kiln Mtn. along Brock Creek Road. The proposed activities would take place within a wooded area that is mostly forested with a dispersed hunting campsite on the proposed site for the well pad. Shortleaf pine is the dominate tree species in this area with some oak and hickory.

The analysis area for visual quality for two existing vegetated well pad sites (ARES 51810 10-17 #14 & ARES 51900 10-19 #17) would be the well pads. The existing pads would be treated with herbicide to control populations of non–native invasive plant species (NNIS) on the well pad.

Visual quality impacts are defined by the degree of alteration to the characteristic landscape. A Scenic Integrity Objective for the proposed location has been established as moderate. As listed in the Revised LRMP (p. G-4). Scenic integrity for ARES 52178 and 52179 is in the Moderate category (appears slightly altered- partial retention) refers to landscapes where the valued landscape character “appears slightly altered”. Deviations would be allowed with a goal that any activities would repeat the form, line, color, texture, and pattern common to the surrounding landscape character at such a scale that the proposed action would appear common/natural and not create an attraction by its appearance.

Proposed Action

Direct/Indirect Effects
A viewshed analysis was deemed not necessary because the proposed site for the gas well would not be seen from high points in any direction. Short-term visual impacts from activities such as the well pad and road construction, road reconstruction, access road construction and re-location of the dispersed campsite would have limited visibility along Brock Creek Road except during winter months (leaf off). The existing vegetation trees and shrubs would hide the well pad during leaf on and may not be distinguishable to general observation even during leaf off since the pad would be a minimum of 150 feet from Brock Creek Road. The impacts associated with

the construction and disturbance would fade over time as the area is reseeded and vegetation reclaims the road right-of-ways and pad. Facilities and specific equipment needed on site would be painted to blend in with the natural landscape. This would enable the facilities to blend in with the natural landscape when seen from a distance. The paint color would be "shale green" which is listed on the Bureau of Land Management (BLM) Standard Environmental Colors Chart CC-001: June 2008.

The proposed access road into the proposed Ozark Highlands Unit 9-16 2-7H6 natural gas well pad would be designed to limit sight distance to prevent an opportunity to view the well pad from a distance. Short term impacts would include presence of the drilling equipment and viewing the cleared area. If the well is a producer, long-term impacts may include the presence of production equipment. If any facilities are required on the drill pad site after drilling is completed, a paint color that allows facilities to blend in with the natural landscape would be required.

A temporary water line would be placed on top of the ground paralleling Brock Creek Road for approximately three weeks during drilling and completion. It would be a short term impact with visual impacts limited to sight of the water line and the short term impact on the vegetation that would be pressed down by the line.

Topography and vegetation would shield visitor's view of the proposed actions during completion except possibly the flame produced by burning the gas in the flow-back. The methane captured during the flow-back and the completion process would be routed to a combustion device as required by EPA's 40 CFR Part 60, subpart OOOO emission standards. The flame produced as a result of the combustion is expected to burn clear and produce no smoke.
The two existing vegetated well pads ARES 51810 10-17 #14 and ARES 51900 10-19 #1-7 would be treated with herbicide to control NNIS. Treated NNIS plants would turn brown and die causing short term visual impacts. Native plants would grow over time to replace the NNIS. The proposed treatment of NNIS would have little or no effect on the scenic integrity of the well pads.

Cumulative Effects
Pine thinning is proposed as part of the 2015 Fuels Management Project west of Brock Creek Road across from the proposed relocation of the beginning section of Forest Development Road (FDR) 93021B and north of the existing section of FDR 93021B and along a narrow strip south of the road and west and east of FDR 93021C . The proposed pine thinning would take place north and east of the proposed natural gas well pad. The thinning would have a short term negative effect visual effect for approximately three years until the slash partially decomposes and exposed areas have re-vegetated. Prescribed burning is also proposed as part of the 2015 Fuels Management Project west of Brock Creek Road across from FDR 93021B and the proposed relocation of a section of the road. Burning also has a temporary negative visual effect lasting until vegetation greens up in the spring. The combination of past, present, and future activities would meet the Scenic Integrity Objective of Moderate Slightly Altered.

Alternative 1 (No Action)

Direct Effects
The proposed project would not be implemented, however ongoing National Forest approved activities would continue. Visual quality would not be expected to change.

Indirect Effects
The gas well would not be constructed or drilled. No indirect visual effects would occur.

Cumulative Effects
No cumulative effects would occur because the proposed project would not be implemented.

F. Recreation

Existing Condition
The recreation analysis area is east of Tar Kiln Mountain in the far southeast corner of the district with limited Forest Service ownership and no special designations. The analysis area is east of Brock Creek Road and north of Bridge Hill Road. The proposed activities would take place within a forest setting that is mostly wooded with a dispersed hunting campsite on part of the location for the proposed well pad. Shortleaf pine is the dominate tree species in this area with some oak and hickory.

The analysis area for recreation for the two existing vegetated well pad sites (ARES 51810 10-17 #14 & ARES 51900 10-19 #17) would be the well pads. The existing pads would be treated with herbicide to control populations of non –native invasive plant species (NNIS) on the well pads.

Tar Kiln Mountain area is used mostly by hunters and locals for access to the south east corner of the district or by visitors coming to Lower and Upper Brock Creek lakes. Hunting for whitetail deer and eastern wild turkey is a popular recreational activity in this area. Other recreational activities within the analysis area include horseback riding, driving for pleasure and occasional firewood gathering.

The Recreation Opportunity Spectrum (ROS) provides a framework for defining classes of outdoor recreation opportunity environments (USDA FS 1986). There are six ROS designations ranging from primitive to urban classifications. The analysis area is designated as Roaded Natural (RN). Roaded natural settings are located within a half mile of a road and usually accept higher levels of development.

The two existing vegetated well pads 51810 10-17 #14 and 51900 10-19 #1-7 would be treated with herbicide to control NNIS.

Proposed Action

Direct/Indirect Effects
Proposed activities would temporarily increase the traffic in the Tar Kiln Mountain area. Site Specific Design Criteria #21 requires SEECO, Inc. to post signs along Brock Creek Road,

warning road users of increased traffic and activities in the area. Users of these roads (hunters and pleasure drivers) may be inconvenienced during implementation of the proposed activities.

Hunters and horseback riders in the area may be distracted by noise from construction and drilling activities associated with the development. This would be temporary until well drilling activities are completed.

The greatest recreational impact would be to the users of a dispersed campsite that has been in use for several decades, because this site would be relocated. The new site location would be close enough that machinery or other noise associated with the well location would have the potential to disturb the recreating public; however site specific design criteria would be used to reduce sound levels. Suitable mufflers would be installed on all internal combustion engines and certain compressor components. Engineered sound barriers or sound-insulated buildings may be required.

The two vegetated well pads ARES 51810 10-17 #14 and ARES 51900 10-19 #1-7 would be treated to control NNIS plants. Little or no effect to the recreational use in the area would occur as a result of NNIS treatment on the well pads.

Cumulative Effects
Pine thinning is proposed as part of the 2015 Fuels Management Project west of Brock Creek Road across from the proposed relocation of the beginning section of Forest Development Road (FDR) 93021B and north of the existing section of FDR 93021B and along a narrow strip south of the road and west and east of FDR 93021C . The proposed pine thinning would take place north and east of the proposed natural gas well pad. The thinning would limit access to the area by hunters and other forest visitors until harvesting is completed which could be up to 3 years. Prescribed burning is also proposed as part of the 2015 Fuels Management Project west of Brock Creek Road across from FDR 93021B and the proposed relocation of a section of the road. Burning would also temporary limit access to the area by hunters and other forest visitors while the burn is being conducted. The combination of past, present, and future activities along with this proposal would not exceed the Recreation Opportunity Spectrum classification of Roaded Natural.

Alternative 1 (No Action)

Direct Effects
The proposed project would not be implemented, however ongoing National Forest approved activities would continue. Recreation would not be expected to change.

Indirect Effects
The gas well would not be constructed or drilled. There would be no indirect effects to recreation.

Cumulative Effects
No cumulative effects would occur because the proposed project would not be implemented.

G. Vegetation Management

Existing Condition

For the purpose of description and analysis, vegetation communities are divided into a series of ecological regions called ecoregions and habitat communities. An ecoregion (ecological region), is a geographically distinct assemblage of natural communities and species, covering a relatively large area of land or water (Wiken 1986, Omernik 1987, Commission for Environmental Cooperation [CEC] 1997). Ecoregion definitions were developed to separate the landscape into areas that have relatively similar characteristics of landform, land use, soil and historical natural vegetation (CEC 1997). In Arkansas, there are 7 level III ecoregions and 32 level IV ecoregions.

The Seeco, Inc., Ozark Highlands Unit 9-16 2-7H6, ARES 52178 & 52179 Gas Well Project is located on the Big Piney Ranger District of the Ozark-St Francis National Forests in Arkansas which is located within the Boston Mountains Level III ecoregion. This level III ecoregion is further divided into Upper Boston Mountains and Lower Boston Mountains Level IV ecoregions. The ecological communities or major forest types which are found within this ecoregion include Dry-Oak Forest and Woodland, Shortleaf Pine-Oak Forest and Woodland, Dry-Mesic Oak Forest, Mesic Hardwood Forest, Loblolly Pine Forest, and Riparian Forest. The following offers a description of each level III and IV ecoregion and major forest type found in the project area on the Big Piney Ranger District.

<u>Ecoregion III Boston Mountains</u>

The Boston Mountains are mountainous, forested and underlain by Pennsylvanian sandstone, shale and siltstone. The maximum elevations are higher, soils have a warmer temperature regime and carbonate rocks are much less extensive than in the Ozark Highlands. Physiography is distinct from the Arkansas Valley with the upland soils being mostly Ultisols that developed under oak–hickory and oak–hickory–pine forests (Omernik 1987). The forests are still widespread across the ecoregion and commonly contain northern red oak, southern red oak, white oak and hickories in the uplands (Gerstacker 1881, USDA Forest Service 1999a, Lockhart et al. 1995, Harmon et al. 1996). Shortleaf pine grows on drier, south- and west-facing slopes underlain by sandstone. Pasture- or hayfields occur on nearly level ridgetops, benches and valley floors (USDA Forest Service 1999a). Population density is low; recreation, logging and livestock farming are the primary land uses. Water quality in streams is generally exceptional; biochemical, nutrient and mineral water quality parameter concentrations all tend to be very low (Woods et al. 2004).

<u>Ecoregion IV Upper Boston Mountain</u>

The Upper Boston Mountains are dissected, rugged mountains with steep slopes, sharp ridges and narrow valleys (USDA Forest Service 1999a,). Benches on the mountainsides occur frequently and are characteristic of the area. The Upper Boston Mountains ecoregion is generally higher and moister than the Lower Boston Mountains with elevations varying from 1,000 to 2,800 feet (USDA Forest Service 1999a). Mostly wooded, the Upper Boston Mountain region is composed of mixed deciduous forest and oak woodlands. The clearings are used as pasture or hayfields.

The major natural vegetation community of the Upper Boston Mountains ecoregion is oak–hickory forest. On upland areas: Northern red oak, White oak, Pignut hickory and Mockernut hickory dominate. Sweetgum, willows, birch, American sycamore, hickories, Southern red oak and White

oak are found on narrow floodplains and low terraces (USDA Forest Service 1999a, Woods et al. 2004). The forests of the Upper Boston Mountains are more closed and contain far less pine than those of the Lower Boston Mountains. North-facing slopes support mesic forests. The ecoregion is underlain by Pennsylvanian sandstone, shale and siltstone (USDA Forest Service 1999a). Water quality in streams reflects geology, soils and land use, and is typically exceptional; mineral, nutrient and solid concentrations as well as turbidity all tend to be very low. Summer flow in many streams is zero or near zero (Woods et al. 2004, USDA Forest Service 1999a).
The Upper Boston Mountain Ecoregion is just to the North of the project area.

Ecoregion IV Lower Boston Mountain
The Lower Boston Mountains are characterized by low mountains, rounded high hills and undulating plateaus. The ecoregion contains moderately-to-highly dissected high hills containing steep slopes and significant local relief and elevations of up to 1000 ft. (Ozark Ecoregional Assessment Team 2003). The Lower Boston Mountains ecoregion is a mosaic of woodland, forest and savanna that contrasts with the denser, moister and more closed forests of the Upper Boston Mountains. Mostly forest and woodland; the ecoregion becomes more open to the west. Flatter areas are used as pastureland or hayfields (USDA Forest Service 1999a, Woods et al. 2004).

The natural vegetation of the Lower Boston Mountains ecoregion is oak–hickory–pine and oak–hickory forests. Mixed oak and oak-pine forests, woodlands or savanna occur on uplands. Northern red oak, white oak, post, scarlet, black, blackjack oak, pignut hickory, shagbark hickory, mocker nut hickory and Shortleaf pine are the dominant native tree species of the area. On lower, drier south- and west-facing sites shortleaf pine dominates. On narrow floodplains and low terraces, Sweetgum, willows, birch, American sycamore, hickories, Southern red oak and White oak are common (USDA Forest Service 1999a, Woods et al. 2004). The ecoregion is underlain by Pennsylvanian sandstone, shale, chert and siltstone (USDA Forest Service 1999a). Summer flow in many streams is zero or near zero, but enduring pools fed by interstitial flow occurs (Woods et al., 2004, USDA Forest Service 1999a).

The project area is located on the Northern edge of the Lower Boston Mountain Ecoregion and is in Management area 3.A. Pine Woodland. The major ecological community types present within the project area are Shortleaf Pine-Oak Woodland, Dry Oak Forest and Woodland, and Riparian Forest.

Ecological Communities/ Major Forest Types within the project area

Shortleaf Pine-Oak Woodland
The Shortleaf Pine-Oak Woodland community is comprised of forest and woodland with canopies dominated (>50%) by shortleaf pine. A variety of oaks, including post, blackjack, white, and northern red oaks, often are also found within the canopy. *Vaccinium* and bluestem grasses are typical understory components.

This community type is commonly found on xeric and dry sites, typical of ridges and steep south and southwest aspects. It may also be found on gentler slopes and flats where soil types result in xeric and dry conditions. This community may also occupy mesic sites where periodic fire has

influenced community composition resulting in dominance by shortleaf pine and fire-tolerant oak species. This community is most abundant on the southern portions of the forest.

Historically, open woodland structure, created and maintained by periodic fire and grazing, was the predominate condition within this community. Due to fire suppression, denser closed-canopy forests are now typical. These dense forests are generally more susceptible to forest health threats such as southern pine beetle (USDA Forest Service 2005).

Dry Oak Forest and Woodland

The Dry Oak Forest and Woodland community is comprised of forest and woodland with canopies dominated (>50%) by post oak, blackjack oak, and/or black oak. It also includes forests and woodlands dominated (>50%) by other oaks and/or hickories (typically white oak or northern red oak) where they occur on xeric and dry sites. Minor components (<30% of canopy) of shortleaf pine may also be present.

This community is commonly found on xeric and dry sites, typical of ridges and steep south and west aspects. It may also be found on gentler slopes and flats where soil types result in xeric and dry conditions. This community may also occupy mesic sites where frequent fire has influenced community composition, resulting in dominance by post, blackjack, or black oaks.

Historically, open woodland structure, created and maintained by parodic fire and grazing, was the predominant condition within this community. Due to fire suppression, denser closed-canopy forests are now typical. This community has been impacted by significant oak mortality, thought in large part to be due to susceptibility of these overly-dense forests to forest health threats (USDA Forest Service 2005).

Riparian Forest

The Riparian Forest community is comprised of forests with canopies (>50%) by ash, elm, sycamore, River birch, Sugarberry, cottonwood, willow, and/or other trees typical of riverfront or floodplain forests. It includes forests dominated by Sweetgum when on floodplain sites. Willow oak, Laurel oak, and Water oak may be components.

This community is commonly found on floodplains of larger streams and rivers. The forest community type of Riparian Forest should not be confused with riparian ecological site type or riparian management areas. Other community types such as Dry-Mesic Oak Forest and Mesic Hardwood Forests may also occur on riparian sites or in riparian management areas (USDA Forest Service 2005).

Invasive Species

Invasive species is one of the four threats to the health of the National Forests and Grasslands identified by former Forest Service Chief Dale Bosworth. An invasive species is identified as "[a] species that can move into an area and become dominant either numerically or in terms of cover, resource use, or other ecological impacts. An invasive species may be either native or non-native" (USDA-Forest Service 2005a p. 132; USDA-Forest Service 2005b p. 172). Invasives destroy fish and wildlife habitats, alter nutrient cycling and natural fire regimes, and can reduce biodiversity and degrade native ecosystem health. Infestations of invasive plants have

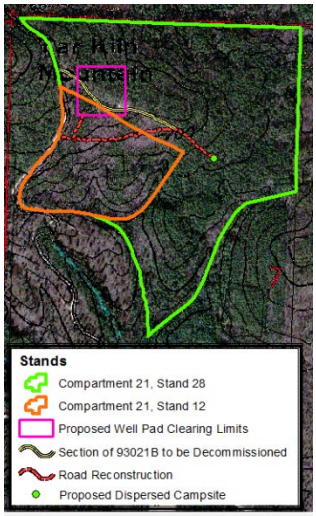
reached epidemic proportions, spreading rapidly over hundreds of millions of acres, across all landscapes and ownerships. Invasive forest diseases, such as Chestnut Blight, wiped out entire forest species in the East (i.e., the American Chestnut) and Dutch Elm disease virtually eliminated an urban forest tree- the American Elm. Invasive Species pose a long-term risk to forest health. These species interfere with natural and managed ecosystems, degrade wildlife habitat, reduce the sustainable production of natural resource based goods and services, and increase the susceptibility of ecosystems to other disturbances such as fire and disease. There are several non-native invasive plant species known to occur throughout the Big Piney Ranger District and could be present within the Seeco, Inc., Ozark Highlands Unit 9-16 2-7H6, ARES 52178 & 52179 Gas Well Project. These species include shrubby Lespedeza (*Lespedeza bicolor*), Chinese Lespedeza (*Lespedeza cuneata*), Royal Paulownia- (*paulownia tomentosa)*, privet (*Ligustrum spp.*), Japanese Honeysuckle (*Lonicera japonica)*, Nonnative Rose (*Rosa multiflora*), Mimosa (*Albizia julibrissn*), Tree of Heaven- (*Ailanthus altissima*), and Japanese stiltgrass (*Microstegium vimineum).*

Effects of Management Activities on Forest Vegetation

Proposed Action

Direct Effects

The proposed actions would occur across two separate stands located in Compartment 21 of the Big Piney Ranger District. Stand 28, the larger of the two, is a mature shortleaf pine stand that is approximately 106 acres in size. Currently, this stand is overstocked with over 102 trees per acre. Tree diameters range from 6 inches to 26 inches with an average of 17 inches at breast height. Dominant and Co-dominant tree heights average 78 feet tall. The stand basal area, which is another measure of stand stocking, ranges from 130 to 190 ft^2 per acre with an average basal area of 160 ft^2 per acre. Stand 12 is mixed loblolly pine/ hardwood stand that is approximately 30 acres in size. This stand was once an old field and contains remnants of scattered open grown oak trees and field terraces. This stand was planted with loblolly pine in 1992. Portions of the stand had poor survival of the planted pine seedlings. In those areas hardwood species such as white oak, post oak, red oak, hickory, eastern red cedar, and other shrub species have taken over. Currently, this stand is fully stocked with stocking levels ranging from 64 to over 170 trees per acre depending on location. Tree diameters range from 6 inches to 26 inches with an average of 12 inches at breast height. Dominant and Co-dominant tree heights average 78 feet tall. The stand basal area, which is another measure of stand stocking, ranges from 50 to 130 ft^2 per acre with an average basal area of 86 ft^2 per acre. This stand has two ephemeral drains which contain more of a small hardwood component comprised of white oak, red oak, maple, and hickory species.



Under the proposed action, approximately 8 acres of forested land would be cleared for road relocation and construction of the well pad and dispersed camping sites. Stand 28 would have approximately 6 acres of forested area cleared and stand 12 would have approximately 2 acres of

forested area cleared. Upon depletion of reserves or abandonment of the well, the production facilities would be removed from the well pad site and the area would be re-vegetated with native trees, shrubs, and/or grasses. The small scale of surface disturbance proposed under this project would have a negligible impact on forest health, species composition, and age class distribution.

Indirect Effects
Upon depletion of reserves or abandonment of the well, the production facilities would be removed from the well pad site and the area would be re-vegetated with native trees, shrubs, and/or grasses. This would change the age class structure and alter species composition on the 5.8 acres of land cleared for the well pad. The small scale of surface disturbance proposed under this project would have a negligible impact on overall forest health, species composition, and age class distribution.

Cumulative Effects
The proposed actions for this project combined with past, present, and reasonable foreseeable actions listed in Table 2 on page II-10 of this EA would have a negligible impact on overall forest health, species composition, and age class distribution.

Alternative 1: No Action

Direct Effects:
Under this alternative none of the proposed actions would occur, therefore there would be no direct effects to forest vegetation.

Indirect Effects:
Under this alternative none of the proposed actions would occur. Current conditions would remain the same therefore; there would be no indirect effects to forest vegetation.

Cumulative Effects:
Under this alternative none of the proposed actions would occur. Current conditions would remain the same therefore; there would be no cumulative effects to forest vegetation.

Effects of Management Activities on Non-Native Invasive Species (NNIS)

Proposed Action

Direct Effects:
Activities such as well pad construction, heavy vehicle traffic into and out of the well pad site, road maintenance, recreation, camping, could transport NNIS to uninfected parts of the project area. Under this alternative, NNIS populations would be suppressed, contained, or eradicated. Identified populations would be treated with an herbicide application. This would aid in slowing and/or stopping the spread of NNIS into and out of the project area and help the re-establishment of native plant communities across the project area. Because some species have persistent seeds

that remain viable in the soil for years, monitoring would determine the effectiveness of the treatments and if further treatments would be required.

Indirect Effects:

Ground disturbing activities such as timber harvest, road construction, and road maintenance, could increase the population and spread of non-native invasive species by destroying individual stems which would result in prolific sprouting. They would also provide seedbeds for NNIS germination. Mechanical equipment could also dislodge seeds and transport them to unaffected areas. Treating known NNIS populations prior to or in conjunction with other proposed management activities would help contain infestations while they are relatively small and prevent their spread into uncontaminated areas by vehicles, equipment, foot traffic, etc. Implementation of Best Management Practices would reduce the possibility of introducing or spreading non-native invasive plants during project implementation.

Treating existing populations of NNIS would allow native vegetation to become re-established and reduce or eliminate the establishment or spread of any future infestations of NNIS. Once NNIS populations are reduced or eradicated, plant diversity would be re-established from existing native seeds in the soil and from adjacent areas. Grasses or other early-seral vegetation would recover within treated areas within the first growing season (typical for recovery on most sites) while abundance and diversity of native vegetation would increase over subsequence years. Re-establishment of native vegetative cover is key to prevent the re-infestation of NNIS populations.

Cumulative Effects:

Other past, present and future management projects in the vicinity of the Seeco, Inc., Ozark Highlands Unit 9-16 2-7H6, ARES 52178 & 52179 Gas Well Project are listed in Table 2 on page II-10 of this EA. The Big Piney Fuels Management Project may increase the possibility of spreading existing NNIS populations and introducing new populations into the project area through planned timber harvest and road maintenance activities. However, the Big Piney Fuels Management Project does address the control of NNIS populations utilizing herbicide application and prescribed burning techniques. The Big Piney Fuels Management Project proposes up to 2,500 acres of NNIS control each year using herbicide application as well as identifying several prescribed burn blocks. This project combined with The Big Piney Fuels Management Project and other planned prescribed burn operations would allow for control of any new NNIS populations as a result of the proposed actions as well as any identified NNIS populations in the vicinity of the Gas Well Project area.

Reduction of NNIS would allow native species that had been temporarily lost from the habitat to become re-established. Activities such as road maintenance, recreation, camping, could transport the NNIS to uninfected parts of the project area. However, by treating existing populations of NNIS and allowing native vegetation to become re-established, future infestations and spread of NNIS would be reduced or eliminated. Once NNIS populations are reduced or eradicated, plant diversity would be re-established from existing native seeds in the soil and from adjacent areas. Grasses or other early-seral vegetation would recover within treated areas within the first growing season (typical for recovery on most sites) while abundance and diversity of

native vegetation would increase over subsequence years. Re-establishment of native vegetative cover is key to prevent the re-infestation of NNIS populations. The above applies to the two existing gas well pads as well.

Alternative 1: No Action

Direct Effects
No activities are proposed under this alternative, therefore there would be no direct change to NNIS populations.

Indirect Effects
Ongoing activities such as road maintenance and recreation could continue to spread the existing populations and introduce new populations of NNIS to the project area. With the absence of any management activities, the NNIS could continue to spread and dominate the native vegetation.

Cumulative Effects
Other past, present and future management projects in the vicinity of the Seeco, Inc., Ozark Highlands Unit 9-16 2-7H6, ARES 52178 & 52179 Gas Well Project are listed in Table 2 on page II-10 of this EA. The Big Piney Fuels Management Project may increase the possibility of spreading existing NNIS populations and introducing new populations into the project area through planned timber harvest and road maintenance activities. However, this project does address the control of NNIS populations utilizing herbicide application and prescribed burning techniques. The Big Piney Fuels Management Project proposes up to 2,500 acres of NNIS control each year using herbicide application as well as identifying several prescribed burn blocks. This project combined with other planned prescribed burn operations would allow for control of identified NNIS populations in the vicinity of the Gas Well Project area under the No Action Alternative.

Reduction of NNIS would allow native species that had been temporarily lost from the habitat to become re-established. Activities such as road maintenance, recreation, camping, could transport the NNIS to uninfected parts of the project area. However, by treating existing populations of NNIS and allowing native vegetation to become re-established, future infestations and spread of NNIS would be reduced or eliminated. Once NNIS populations are reduced or eradicated, plant diversity would be re-established from existing native seeds in the soil and from adjacent areas. Grasses or other early-seral vegetation would recover within treated areas within the first growing season (typical for recovery on most sites) while abundance and diversity of native vegetation would increase over subsequence years. Re-establishment of native vegetative cover is key to prevent the re-infestation of NNIS populations.

H. Heritage Resources

Existing Condition
This project proposal falls under an existing Programmatic Agreement (PA) between the United States Forest Service, Native American federally-recognized Tribes, and the Arkansas State Historic Preservation Office, (under the authority of the National Historic Preservation Act of 1966 (NHPA), as amended (80 Stat. 915 et seq.; 16 U.S.C. 470 et seq.), as implemented by 36

CFR 800). This area has received complete inventory under previous projects and additional archeological inventory has been completed in conjunction with this project. There are no known historic properties in the project area; therefore, a determination of *no adverse effect* has been made for this project.

Proposed Action

Direct Effects
This proposed action will have no adverse effect to historical properties.

Indirect Effects
This proposed action will have no adverse effect to historical properties.

Cumulative Effects
This proposed action will have no adverse effect to historical properties.

Alternative 1 (No Action)

Direct Effects
This alternative will have no adverse effect to historical properties.

Indirect Effects
This alternative will have no adverse effect to historical properties.

Cumulative Effects
This alternative will have no adverse effect to historical properties.

I. Wildlife

Existing Condition
The analysis area for wildlife is two watersheds encompassing the project area within the forest boundary (111102030102 Brock Creek &111102030107 Rock Creek-West Fork Point Remove Creek) including 2 miles of the Rock Creek watershed outside the forest boundary to the south. The Brock Creek Watershed includes larger contiguous tracts of FS land not broken up by private land. The Rock Creek Watershed is a mosaic of forest and field where private and FS land intermingle within the FS boundary. The private land south of the Forest Service (FS) boundary is a mix of agricultural, residential, and forested.

Private land accounts for approximately 32% of the analysis area and is composed of mixed hardwood pine forest, pine stands, open fields, ponds, and structure developments. Private inholdings inside the Forest Boundary account for 6,571 acres scattered throughout the analysis area in approximately 25 separate blocks. One watershed lake is located south of the FS boundary on Rock Creek northeast of Jerusalem, AR. Roads and road rights-of-ways account for at least 41 acres in the analysis area outside the forest boundary.

Forest Service lands within the analysis area totals approximately 26,916 acres. The Forest Service Vegetation database (FSVeg) reports indicate that the dominant forest types are shortleaf pine, pine-oak, oak-pine, and oak-hickory. Stand conditions are predominantly mature saw timber, immature saw timber, and immature pole timber. Stand age classes lean heavily toward the over 50 year categories; however, prescribed (Rx) burning and wildlife stand improvement (WSI) management techniques have created some understory early successional habitat within older stands of timber. Several small glades within the watershed provide a more self-sustaining early successional habitat, but these habitats are vulnerable to becoming overgrown with Eastern red cedar.

Road densities are high within the FS analysis area. Using minimum to average widths for level 1(basic custodial care (closed)), levels 2 (high clearance vehicles) &3 (suitable for passenger cars), and level 4 (moderate degree of user comfort) roads, a minimum estimate of road rights-of-way acreage is 455 acres on FS land within the analysis area.

Three watershed lakes are within the analysis area inside the FS boundary: Brock Creek Lake, Lower Brock, and Drivers Creek. Prior to the de-listing of the Bald Eagle as a threatened species, vegetated corridors around these lakes were under special management as corridors for roosting and winter habitat. Bald Eagle activity is still protected as a Regional Forester's sensitive species and will be discussed in the biological evaluation as well as the TES section of this EA.

Proposed Action

This analysis is limited to the surface rights held by the Forest Service. Underground activities are managed and monitored by the Bureau of Land Management.

Management Indicator Species Analysis

This analysis will use, in part, Management Indicator Species (MIS) to help assess the potential impacts of this project on wildlife by the proposed actions in Chapter 2 of this EA according to the planning regulations under which the Forest Plan was developed. The foundation for MIS can be found in the Code of Federal Regulations (36 CFR 219). The National Forest System Land and Resource Management Planning 1982 Rule (219.19) explains in brief that MIS were selected because "their population changes are believed to indicate the effects of management activities" and they were used to help meet the Forest's legal requirement to "preserve and enhance the diversity of plants and animals consistent with overall multiple-use objectives." It is important to remember that MIS are a planning and monitoring tool that reflects a way to analyze a change in conditions. The list in the table below provides information on the current conditions for the 17 MIS chosen for the Forest. The latest data for assessing population and habitat trends for MIS was used to evaluate the proposed action and alternatives.

Table 13 Management Indicator Species for the Ozark-St. Francis National Forests

Northern Bobwhite *(Colinus virginianus)* – Preferred habitat on the Forest is oak savanna and woodland, restored glades, native fields, early seral forest (0-5) and thinned and burned forest areas. This species has been at historic lows on the Forest; however, management such as warm season grass planting and wildlife stand improvement (WSI) has increased. Long term Breeding Bird Surveys across this species entire range show a sustained decline. Data from the Ozark-St. Francis NFs also show a downward trend.
White-tailed Deer (*Odocoileus virginianus*) - For the Forest, the preferred habitat for deer can be described as areas of mature hardwood, hardwood-pine and pine-hardwood stands, which provide hard and soft mast, with 0-5 year old regeneration areas, food plots, oak savannas and woodlands and permanent water sources intermixed. The regeneration areas, savanna and woodlands provide cover and along with food plots provide forage. The population appears to be stable on the Ozark National Forest.
Black Bear (*Ursus americanus*) - On the Forest, the preferred habitat for bear can be described, as areas that are relatively isolated from human disturbance, comprised of mature hardwood, hardwood-pine and pine-hardwood forest types that provide hard mast, with 0-5 year old regeneration areas and food plots intermixed to provide cover, forage and soft mast. The numbers of bears remain high on the Ozark National Forest and continue to be stable to increasing.
Eastern wild turkey (*Meleagris gallapavo*) - The preferred habitat for wild turkeys can be described as mature hardwood or hardwood-pine stands with open areas and edges (fields, food plots or natural openings) nearby and a permanent water source readily available. Habitat is wide spread on the forest and total population fluctuates widely, but recent surveys indicate decline.
Prairie Warbler *(Dendroica discolor)* - Optimal habitat conditions include early seral habitat, regeneration areas that are in the 5-20 year old age class, pine-bluestem and oak savanna/woodland habitats. Species monitoring indicates a declining trend for this physiographic region.
Yellow-breasted Chat (*Icteria virens*) - On the Forest, the preferred habitat for the chat can be described as regeneration areas with dense second-growth and other openings with scrub vegetation 1-3 m (3-10 ft.) tall. Identified in RFLRMP as MIS for the St. Francis NF. Forest data shows an increasing trend.
Brown-headed Nuthatch *(Sitta pusilla)* - This species is tied to mature open pine stands or pine woodland conditions. The upland Ozarks fall outside of this species range although it is possible that historically it was more widespread where mature pine stands once occurred. This species is rare on the Forest, but available data shows an increasing trend.

Northern Parula *(Parula americana)* – Habitat is typically mature, moist forests along streams and within riparian areas. Commonly found along Ozark wooded rivers and streams. Breeding Bird Data for the region indicates a declining trend, but on the OSF National Forest this species appears to be slightly increasing.
Rufous-crowned Sparrow *(Aimophila ruficeps)* – Primarily a species of the desert southwest but has a very small population that occurs on Mt. Magazine in Logan County. Habitat would include glades along bluff lines or dry open hillsides with thin shrub/seedling stands with sparse grasses and shrubs. Fluctuation in species counts has resulted in an inability to determine trends; however, habitat improvements have been made with prescribed fire and cedar thinning.
Cerulean Warbler *(Dendroica cerulean)* – The Arkansas Ozarks are on the southern edge of this species range. Primary habitat includes rich mature forest with a complex canopy structure and mesic to wet conditions. Typically they have larger diameter trees with a defined shrub layer. More commonly found in bottomland hardwoods, but on the main division of the forest they are found in upland habitats. This species is declining over its range but on the Ozark National Forest, it appears to be fairly stable.
Ovenbird *(Seiurus aurocapillus)* – Typical habitat would include large patches of closed canopy mid to late seral dry-oak deciduous forests with limited understory and deep leaf litter. Nesting occurs on the ground. Species well distributed in the Ozark Uplands. This species is common on the Ozark National Forest but has shown decline locally and regionally.
Red-headed Woodpecker *(Melanerpes erythrocephalus)* – Preferred habitat would include forest edges of open oak woodlands or pines and tree-rows in agricultural areas. Requires dead trees and snags for nesting. Species is uncommon on the Forest. On the OSF National Forest, this species has increased despite the overall declining trend.
Pileated woodpecker (*Dryocopus pileatus*) - The preferred habitat for the pileated woodpecker can be described as mature stands of any species or species mix with large dead snags and woody debris on the forest floor. USFWS Breeding Bird Surveys show this species is decreasing for this physiographic region and on the OSF National Forest.
Scarlet Tanager *(Piranga olivacea)* – Mature deciduous forest and rich upland forest is the preferred habitat for this species. Somewhat sensitive to fragmentation, the Scarlet Tanager prefers large tracts of forest with large trees. In suitable habitat this species is not uncommon on the Forest. Long term Breeding Bird Surveys indicates a decline overall for AR but is slightly increasing on Forest.
Acadian Flycatcher *(Empidonax virescens)* – Prefers moist deciduous forest near streams and bottomland hardwoods. Not uncommon and increasing on the Ozark NF in riparian areas.

Small-mouth Bass (*Micropterus dolomieui)* - Cool, clear, mid-order streams, greater than 10.5 m (35 ft.), wide with abundant shade, cover and deep pools, moderate current, and gravel or rubble substrate characterize optimum riverine habitat. The largest stream populations of smallmouth bass occur in streams with gradients of 0.75-4.70 m/km, (3-15 ft. /mi) that provide alternating pools and riffles, support. Standing crop is generally largest in pools deeper than 1.2 m (4 ft.). In suitable habitat this species is indicative of high water quality. The relative abundance of this species in streams on the Ozark National Forest is considered normal.
Largemouth Bass (*Micropterus salmoides)* – prefers larger ponds, lakes, reservoirs, slough and river backwaters. Usually found close to shore in lakes and reservoirs. This species prefers warm quiet waters with low turbidity, soft bottom and beds of aquatic plants. For lakes on the Forests, the overall relative weights, PSD, and RSD for largemouth bass stayed fairly stable from 2005 to 2010.

A more complete description of the habitat relationships for these species can be found in the Nature Serve database: http://www.natureserve.org/ , and a Land Manager's Guide to Birds of the South: http://www.srs.fs.usda.gov/pubs/2702

One of the MIS species was eliminated from the analysis due to the following reason: the Rufous-crowned Sparrow's occurrence on the Forest is limited to an area on the Mt. Magazine district. The remaining MIS will be divided into two groups: Low Disturbance Species (LDS) and High Disturbances Species (HDS). Low disturbance species occupy habitats that require a low intensity and/or frequency of disturbances; for example, a closed canopy forest. Habitats of HDS species require high intensity and/or frequency of disturbance to maintain them. Examples of these habitats are oak woodlands and 0 to 10 year old regeneration stands. The table below will identify the classification of each of the Terrestrial MIS species. Both LDS and HDS have been recorded in the analysis area through monitoring. LDS responses to management activities will serve as an indicator for how other LDS would respond. Responses of MIS species in the HDS classification will serve as an indicator for how other HDS species would respond to management activities.

Table 14 Classification of Management Indicator Species

Common Name	Classification (LDS or HDS)
Northern Bobwhite	HDS
White-tailed Deer	HDS
Black Bear	HDS

Common Name	Classification (LDS or HDS)
Wild Turkey	HDS
Prairie warbler	HDS
Yellow-breasted Chat	HDS
Brown-headed Nuthatch	HDS
Red-headed Woodpecker	HDS
Cerulean Warbler	LDS
Ovenbird	LDS
Northern Parula	LDS
Pileated Woodpecker	LDS
Scarlet Tanager	LDS
Acadian Flycatcher	LDS
Smallmouth Bass	NA
Largemouth Bass	NA

Direct/Indirect Effects

Clearing timber and some topsoil from the drill pad, new road location, and campsite would result in the loss of forested habitat on approximately 8 acres. The placement of this gaswell would be in a section of the analysis area that is already scattered with various openings due to lakes, agricultural fields, and private homes. This location is more advantageous to LDS species than punching a hole in a larger tract of contiguous forestland would be. LDS like the Scarlet tanager are sensitive to fragmentation of the landscape which creates more edge habitat, or where openings transition into forest. Alteration of the landscape would include the loss of roost trees, cavity trees, nesting sites, deep leaf litter, and woody debris that LDS species such as the Pileated woodpecker and Ovenbird prefer. This loss would not only be immediate but also sustained past the time of reclamation until the forest becomes mature enough for such structures to develop; however, a greater number of timber stands within the Forest are advancing toward the mature and old growth stages than there are early successional openings and regeneration according to the FSVeg stand data reports and internal monitoring reports. Past weather events and on-going insect and disease outbreaks are creating standing dead timber for cavity dependent species.

In contrast, a small clearing and road corridor would create edge habitat and open canopies for HDS. The clearing around the well pad and reserve pit would seed in with grass and herbaceous plants that would host an insect population that differs from the surrounding forest and provide variety in food resources. When the site is reclaimed and rehabilitated, more HDS species would benefit from the shrub and tree growth as well as the variance in canopy structure in the area.

Glyphosate herbicide would be used as a spot application after the well pad is completed to keep the well pad clear of vegetation and to control invasive plant species. The U.S. Fish and Wildlife Service explains that invasive species are harmful to our natural resources because they are a disruption to natural communities and ecological processes, competition for native resources, and can result in a less diverse ecosystem (2012). Disturbances in the soil layer often prepare favorable conditions for invasive plants because they can often become established faster than native species. Removing the canopy and top soil could stimulate invasive species already in the soil and duff layers that act as a seed bank. Introduction of seed from off forest, private land, or adjacent infestations on FS may be carried in on equipment, personnel, or wildlife creating a new infestation. Stockpiling the top soil removed in order to use it during rehabilitation would help reduce the potential for off-site introduction of invasive species. Any extra topsoil needed for rehabilitation would be from a "Weed-Free" source as stated in the operational plan.

Toxicity to non-target species varies with the formulation used, the addition of adjuvants and/or surfactants, the application method, and the size and type of species the non-target is, and the type of contact the non-target species has with the herbicide. There is relatively detailed literature regarding the effects of glyphosate and glyphosate formulations to terrestrial microorganisms. While the mechanism of action of glyphosate in plants is also relevant to microorganisms, there is little indication that terrestrial microorganisms would be adversely affected by glyphosate (Syracuse Environmental Research Associates, Inc. 2011). Furthermore, according to the Syracuse Environmental Research Associates, Inc. risk assessment,

> For terrestrial organisms other than plants, applications of up to 2.5 lb. a.e./acre of the more toxic formulations do not present any apparent risks, based on upper bound estimates of exposure levels. At application rates greater than 2.5 lb. a.e./acre, risks to mammals cannot be ruled out… however, no risks are apparent, based on central estimates of exposure. At application rates greater than approximately 3.3 lb. a.e./acre, the HQs for birds modestly exceed the level of concern; however, there is no demonstrated evidence that these exposure levels will cause overt toxicity in birds. Risks to terrestrial insects are a greater concern based on dietary exposures, relative to direct spray. The risk characterization for aquatic organisms suggests that amphibians are the group at greatest risk both in terms of sensitivity and severity of effects. The less toxic formulations of glyphosate do not appear to present any risks to terrestrial organisms other than terrestrial plants (2011).

Herbicide used for the purpose of controlling invasive species and gaswell pad maintenance would be applied by direct injection, cut surface, or foliar spray which would help limit exposure

to animals and insect prey. Glyphosate is strongly adsorbed to soil, remains in the upper soil layers, and has a low propensity for leaching (U.S. E.P.A 2013). It is readily absorbed by foliage, will bind tightly to soil and its leaching capacity is extremely low, i.e. glyphosate is relatively immobile (e.g., Alex et al. 2008, Landry et al. 2005, Mamy and Burruso et al. 2005) as cited in Syracuse Environmental Research Associates, Inc. 2011). Glyphosate will readily and completely biodegrade in soil even under low temperature conditions. Its average half-life in soil is about 60 days (U.S. E.P.A. 2013). SEECO's best management practices for herbicide application stipulate that herbicides would be administered by a state licensed applicator with notification to the Forest Service. Herbicides would be mixed according to label standards, and a spill plan and kit would be on site. Following these BMP and application measures would minimize the risk to terrestrial (as well as aquatic species which will be discussed in the Fisheries section) species.

A gaswell pad and reserve pit would be developed within the clearing limits. Associated with these developments would be an increase in traffic and noise. Access to the gaswell site would be by utilizing existing county and Forest Service roads, very little new construction would take place. Dust abatement would be used as needed which would help keep particulate matter from the air. A temporary water pipeline is proposed to transport freshwater to the well pad from a nearby private pond. Utilization of a pipeline would reduce water tender traffic. On-site equipment would be equipped with mufflers or sound insulation to reduce sound levels. Noise may be somewhat beneficial in keeping wildlife away from potential hazards such as the reserve pit and herbicide application areas.

Animals such as birds and flying mammals are at risk from oily substances that will hinder their ability to fly and insulate themselves. According to the U.S. Fish and Wildlife Service, one of the best options for preventing wildlife mortality is using a closed-loop drilling system (2009). A closed-loop system would be used on this project when drilling with oil-based mud. Cuttings from the drill hole during the use of the reentry rig will be contained in a closed loop system. Fracking flow-back has been a concern for its potential to release heavy metals and pollutants that are bound in soil (Cornell University, 2014). According to the operation plan, drilling fluids and water would be contained within the closed loop system and all flow-back and fracturing fluids would be stored in double contained frac tanks until they are trucked off-forest to approved disposal sites. In the event of a spill, procedures in the Spill Response Plan would be followed to minimize environmental hazards.

Only fluids associated with drilling operations would be stored in the reserve pit. These include all cuttings from the drill hole, water, mist soap, hammer oil and salts would be stored in a reserve pit during air drilling operations. Reserve pit standards would be laid out in coordination with the Forest Service and BLM and would be followed during installation of the pit. The pit would be double-lined polyethylene liner on top of clay that meets permeability standards; otherwise, a second synthetic liner would be added if clay is not acceptable. A leak detection system would be installed between liners to ensure that fluids are not leaking from the reserve pit. The operating plan contains a spill contingency plan in the event that leaks are found. Substances like heavy metals and arsenic are a byproduct of concern from mining and drilling operations. Whether a producing well or a non-producing well, upon completion of the drilling activities, samples of the cuttings and fluids remaining in the reserve pit would be analyzed by a

licensed laboratory for its chemical and metal content. Based upon test results, if low risk, the tailings left in the pit would be stabilized and solidified by applying fly ash or lime and covered with soil, however, if test results find a moderate or high risk of heavy metals, all the material would be removed from the reserve pit and hauled to an authorized disposal facilities off National Forest Land.

Potential escape of contaminates and soil through run-off and erosion would be mitigated by the project design and use of Best Management Practices. The gaswell would be located on a gentle slope just below the peak of the hill outside of riparian areas. Arkansas Oil and Gas Commission (AOGC) regulations state that "all reserve pits shall be constructed with a minimum of two (2) feet of freeboard, and shall be maintained to handle a storm event up to a 10-year, 24-hour storm event during the operation of the reserve pit." Upon pit closure, "the closed pit shall be filled with native materials and covered with topsoil at depths consistent with adjoining onsite areas, with the contour mounded or sloped to discourage erosion and restored as close to the original contours as is practicable. Topsoil and native materials removed during pit construction may be preserved and used during closure" (2015). In accordance with the operations plan, drainage areas leading away from the pad may require hay bales, rock berms and/or silt fencing to reduce sediment leaving the location as determined by the Reasonable and Prudent Practices for Stabilization (RAPPS) plan.

Fencing would be installed to protect wildlife, but birds and smaller mammals may still be at risk from contact with the reserve pit. Potential hazards associated with wildlife and reserve pits would be higher after wildlife becomes accustomed to operational noise and after drill completion until the pit is closed. According to AOGC, reserve pits must be closed within 180 days (6 months) of drill completion. Overhead netting has been used at some sites to further reduce the potential hazards of wildlife entrapment and harm, and the Forest Service should consider this as an option if any observations are made of wildlife accessing by air.

Cumulative effects

Burning and thinning adjacent to gaswell development would favor HDS that tolerate open canopies, edge habitat, and multiple human intrusions. Species such as the Wild Turkey have been observed foraging for food in areas that were recently burned. Bird species may avoid nesting in areas being actively managed but move into those areas in following years. The occurrence of HDS in the surrounding locale is likely to rise in subsequent years. LDS that are sensitive to repeated intrusions, open canopy, loss of leaf litter, and edge habitat would likely decline in number or disappear from the general locality in favor of interior forest until the gaswell site is reclaimed, reforested, and matured, and the thinned areas progress toward canopy closure.

Alternative 1 (No Action)

Direct/Indirect Effects

HDS and LDS are both present in the analysis area, and due to the mosaic structure of the land ownership and forest composition would likely remain relatively static in the area. Without projects that create various sized openings with edges that are made with the transition from open canopy to forest, HDS would likely decline; however, the loss of an activity only 8 acres in

size is not likely to contribute to a negative trend in HDS. LDS would slightly benefit by having a more continuous forest that is advancing in age. Less soil disturbance would reduce the chance of NNIS establishment.

Cumulative Effects

Even without the creation of an 8 acre opening, burning and thinning activities would still create some favorable conditions for various HDS, and the stress of noise pollution, risk of herbicide exposure and potential for heavy metal accumulation in the food chain would be lower than in the proposed action.

J. Fisheries

Existing Condition

The well pad for the proposed well would be approximately 2 acres with a maximum clearing limit of 6 acres. Clearing for the new section of road would be less than an acre. The pad and clearing limits are split between two watersheds: Rock Creek – West Fork Point Remove Creek watershed (Hydrologic Unit Code (HUC) 111102030105) to the south and Brock Creek (HUC 111102030101) to the north. These watersheds will serve as the analysis area boundary. The Rock Creek watershed contains 38,632 acres, of which, 5,338 acres or 13% is National Forest System land. The Brock Creek watershed contains 27,964 acres with 77% within the National Forest System. According to the Arkansas Oil and Gas Commission website, there are 362 previously drilled gas wells within the Rock Creek watershed and 6 within the Brock Creek watershed.

The closest stream to the proposed well site is Brock Creek approximately 1,700 feet north of the proposed wells site. From north of the proposed site, Brock Creek flows southeast approximately two miles to its confluence with West Fork Point Remove Creek. Several defined channels are also present in the area that would not support year-round aquatic organism habitat. Several drainages in the area were surveyed by the Center for Aquatic Technology Transfer (CATT), a division of the US Forest Service Southern Research Station in Blacksburg, VA., during the 2009-2010 summer field seasons. Species collected during the inventories are shown in the table below.

Table 15. Fish Species collected during inventories.

Species	Private Pond Drain	Other Drainage above Lower Brock Lake	Drainages below Lower Brock Lake	Rock Creek above lake
Creek chubsucker *Erimyzon oblongus*		✓	✓	✓
Grass Pickerel *Esox americanus*			✓	
Greenside darter *Etheostoma blennoides*			✓	
Fantail darter *Etheostoma flabellare*			✓	
Orangethroat darter *Etheostoma spectabile*	✓	✓	✓	✓
Redfin darter *Etheostoma whipplei*	✓	✓	✓	✓
Unidentified (UI) darter Percid spp.	✓		✓	
Green sunfish *Lepomis cyanellus*		✓	✓	✓
Bluegill *Lepomis macrochirus*		✓	✓	✓
Longear sunfish *Lepomis megalotis*			✓	✓
Central stoneroller *Campostoma anomalum*			✓	✓
UI minnow/shiner *Cyprinidae* spp.			✓	
Redfin shiner *Lythrurus umbratilis*			✓	✓
Bigeye shiner *Notropis boops*			✓	✓
Logperch *Percina caprodes*			✓	
Creek Chub *Semotilus atromaculatus*			✓	✓
Bluntnose minnow *Pimephales notatus*			✓	
Chain Pickerel *Esox niger*		✓	✓	
Blackspotted topminnow *Fundulus olivaceus*			✓	
Slender madtom *Noturus exilis*			✓	✓
Yellow bullhead *Ameiurus natalis*	✓		✓	✓

As stated in Section B, Surface Water, water quality standards are being met at this time in streams within the analysis area. The streams are expected to meet the designated uses identified by ADEQ Regulation No.2 (Integrated Water Quality Monitoring Assessment Report, 2014).

Alternative 1 Proposed Action

This analysis is limited to the surface rights held by the Forest Service. Underground activities are managed and monitored by the Bureau of Land Management.

Direct and Indirect Effects

Siltation in streams may impact certain species of fish, macro-invertebrates, and crustaceans by increasing particulate matter and causing water clarity issues, changing creek-bed conditions for spawning, and introducing pesticides and other chemicals into the stream. Clearing of the drill pad along with road and gathering line construction may initially increase erosion from the site. This would be temporary because the drill pad and access road would be surfaced with aggregate. Erosion control measures in the BMP's (e.g. silt fencing and/or hay bales, and slash) would help to control erosion and prevent movement of sediment into streams. Upon completion of drilling activities, the rehabilitation of the surface would comply with conditions contained in the approved permit, the Forest Wide Conditions of Approval, and the Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development, The Gold Book. Rehab may include, as needed, replacing top-soil, seeding, fertilizing, liming, and mulching. Reclamation activities would be completed in a timely manner and subject to acceptance by Forest Service personnel.

The use of the herbicide Glyphosate would be expected once the well pad is completed. This herbicide would be used only as spot application to keep the well pad clear of vegetation during use and to control invasive species. Herbicide use for this purpose is applied by direct injection, cut surface, or foliar spray. For these purposes, herbicide use is infrequent and direct application methods would minimize off-site movement. Glyphosate is strongly adsorbed to soil, remains in the upper soil layers, and has a low propensity for leaching (U.S. E.P.A 2013). Forest-wide Standards for herbicide application would be followed as well as appropriate BMPs designed to limit risk to water quality. Location of the well pad on the upper slopes away from drains with permanent water flow as well as BMP measures would help minimize the risk to local streams when herbicides are applied in the aforementioned manner.

Introduction of non-native and invasive species (NNIS) to aquatic habitats would be possible due to man-made pathways between habitats. According to the Application for Permit to Drill, this well would require approximately 5.25 million gallons of water to complete the fracturing process. This water would be obtained from private land and pumped through irrigation pipe approximately 1.8 miles overland to the site. The risk of introducing a new species from this private land source would be low due to close proximity to the project, the private land containing the pond is surrounded by FS and is collecting water from drainages on FS, and the collected water is from one of the main watershed drainages that the project drains into; however, some risk remains because the pond is under private management and may have unintentionally introduced NNIS by pond stocking or plant materials that have not shown up in the waters down-stream, and the project is located on a watershed break and drains into two watersheds.

Water for use in the air rig would be trucked in from a municipal water source. This water will have been treated by various forms of filtration and chemical treatment; however, water may still contain substances that have the potential to alter natural levels or composition of the natural system (Johnson, MR et al., 2008); however, this water would not be introduced directly into streams but stored in frac tanks or the rig storage tank. Escaped freshwater is likely to be filtered through the environment prior to becoming part of the aquatic system.

Water that comes back to the surface would not go into the cuttings pit but would be stored in tanks at the site and hauled by truck to authorized disposal facilities. The company has an established Spill Prevention, Controls and Countermeasures (SPCC) plan and spill reporting guide which requires notification of designated local, state and federal officials should a spill occur in reportable quantities. After drilling is complete, cuttings would be removed from the mud pit and hauled by truck to a designated disposal facility. These materials are subject to the same spill prevention and reporting requirements as liquid waste. Disposal of all liquid and solid wastes would involve driving across bridges over streams. Transportation of these materials has no higher risk than any other typical transport and spills or accidents are covered by the SPCC plan and are subject to applicable state and federal regulations.

Cumulative Effects

Other projects within the analysis area includes vegetation management and prescribe burn activities from both past projects and a proposed project involving fuels reduction burns and vegetation management. It also includes an estimate of other gas wells drilled in the same watershed in the last three years. The cumulative effects model for the surface water section (B) in this EA predicts that the recent past management and proposed future management should not raise the risk level higher than its current status. Distribution of disturbance over time and rehabilitation will help minimize cumulative effects.

Alternative 2 (No Action)

Direct Effects

For the No Action alternative, any additional risk to surface water quality or groundwater from construction of the well pad, access road, and drilling would not be realized. Existing processes would continue and the watersheds would remain at current risk levels for effects to surface water quality. The risk of transporting NNIS and foreign substances from other water sources would become a non-issue.

Indirect Effects

There would be no indirect effects with this alternative since no activities would be implemented.

Cumulative Effects

There would be no cumulative effects with this alternative since no activities would be implemented.

K. Proposed Endangered, Threatened and Sensitive Species (PETS)

Terms Used in PETS Analysis

Biological Evaluation (BE) - a document that discloses the effects of management activities on PETS species and their associated habitat that occur or are likely to occur in the analysis area.

Endangered Species (E) - Any species (plant or animal) which is in danger of extinction throughout all or a significant portion of its range and listed as such by the Secretary of the Interior in accordance with the Endangered Species Act of 1973.

Threatened Species (T) - Any species (plant or animal) that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range and one that has been designated as a threatened by the Secretary of Interior in accordance with the Endangered Species Act of 1973.

Sensitive Species (RFSS)- Those plant and animal species identified by the Regional Forester for which population viability is a concern, as evidenced by significant current or predicted downward trends in population numbers or density, or significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

Existing Conditions

A BE has been completed that examines all known occurrences of Proposed, Endangered, Threatened and Sensitive (PETS) species that occur on the Regional Forester's Sensitive Species list and applicable to the Ozark-St. Francis National Forest. In addition, the 19 federally proposed, endangered and threatened species identified through informal consultation with the USFWS (Forest Plan BA) were also considered. All but 12 of the PETS species were eliminated from further evaluation due to one or more of the following factors:

- The Project Area is not within their known, documented geographic range.
- The species has never been documented within the 12 digit watersheds that are adjacent to or encompass the project area or its sphere of influence in field surveys, monitoring activities, reports, or the scientific literature.
- The treatment area does not have suitable habitat for these species

PETS species known to occur or which may occur within project treatment areas or area of influence include:

Table 16. Classification of Species being considered

COMMON NAME	SCIENTIFIC NAME	CLASSIFICATION
Indiana bat	*Myotis sodalis*	Endangered
Northern Long-eared bat	*Myotis septentrionalis*	Endangered
Bald Eagle	*Haliaeetus leucocephalus*	Sensitive
Bachman Sparrow	*Aimophila aestivalis*	Sensitive
Ozark Chinquapin	*Castanea pumila ozarkensis*	Sensitive
COMMON NAME	***SCIENTIFIC NAME***	**CLASSIFICTION**
Southern Lady's Slipper	*Cypripedium kentuckiense*	Sensitive
Eastern Small Footed Myotis	*Myotis leibii*	Sensitive
Small headed pipewort	*Eriocaulonn koernickianum*	Sensitive
Moore's Larkspur	*Delphinium newtonianum*	Sensitive
Ovate-leaf or Blue Ridge Catch**fly**	*Silene ovata*	Sensitive
An isopod	*Lirceus bicuspidatus*	Sensitive
Nearctic Paduniellan Caddisfly	*Paduniella nearctica*	Sensitive

The BE has been completed for the actions and alternatives proposed and is hereby incorporated by reference. A copy is also available in the process file. The BE made use of internal expertise, earlier discussions with the US Fish and Wildlife Service (Conway, AR Office), conversations and species data from the Department of Arkansas Heritage, field reviews by District personnel and collected inventory data on the District and field surveys conducted within the proposed project area.

No critical habitat for any PET species has been identified within the analysis area. For a complete description of each species needs and habitat conditions, reference the BE found in the process file for this project.

Proposed Action and All Alternatives

Direct/Indirect Effects

The Northern Long-eared bat is present in the project area and these activities are likely to affect their habitat by removing trees, potential increase in heavy metals, increased activity/noise disturbances and using herbicides. The Northern Long-eared bat was given a determination of likely to adversely affect the northern long-eared bat; however, there are no effects beyond those previously disclosed in the programmatic biological opinion dated August 5, 2015. Any taking that may occur incidental to this project on Forest Service land is excepted from the prohibitions for taking threatened species under 50 CFR 17.31 and 17.32. This project is consistent with the forest plan, the biological opinion, and activities excepted from taking prohibitions under the rule adopted under the ESA section 4(d) rule applicable to the northern long-eared bat; therefore, the programmatic biological opinion satisfies the Forest Service's responsibilities under the ESA section 7(a) (2) relative to the northern long-eared bat for this project.

Indiana bat has never been documented in the 12 digit watershed that encompass the project or the adjacent watersheds but the species has potential habitat in these areas according to the Fish and Wildlife Service. Some potential roost trees and foraging habitats would be altered slightly and there would be some herbicide used in the project. The BE found that the risk was low, if any to the species because the area affected would be small. The toxicity of the herbicide with the methods to be used for distribution would represent a low risk to the forage prey base or any unknown individual using the area. None of these alternatives are likely to adversely affect the Indiana bat. Arkansas State Forestry Commission's Best Management Practices and all standards identified in the RLRMP, Arkansas Best Management Practices for Fayetteville Shale Natural Gas Activities and project would be applied to the Proposed Action. These measures should minimize or eliminate any potential effect to these species.

For the sensitive species, the Arkansas State Forestry Commission's Best Management Practices, Arkansas Best Management Practices for Fayetteville Shale Natural Gas Activities and all standards identified in the Revised Forest Plan should minimize any impacts to these species. Individuals may be impacted by the action alternatives but are not likely to cause a trend to federal listing or loss of viability for any of the Regional Forester's Sensitive Species.

Cumulative Effects

Based upon the Biological Assessment for the Forest Plan, implementation of these practices at the levels identified in the RLRMP would not result in an adverse effect for Indiana bat or a trend toward listing for the Regional Forester's Sensitive species. At the project level, all cumulative effects from past, present and foreseeable future actions would result in a "may affect -not likely to adversely affect" determination for the Indiana bat.

These activities are likely to adversely affect the northern long-eared bat; however, there are no effects beyond those previously disclosed in the programmatic biological opinion dated August 5, 2015. Any taking that may occur incidental to this project on Forest Service land is excepted from the prohibitions for taking threatened species under 50 CFR 17.31 and 17.32. This project is consistent with the forest plan, the biological opinion, and activities excepted from taking prohibitions under the rule adopted under the ESA section 4(d) rule applicable to the northern long-eared bat; therefore, the programmatic biological opinion satisfies the Forest Service's responsibilities under the ESA section 7(a) (2) relative to the northern long-eared bat for this project.

Of the sensitive species identified as occurring within the analysis area, Ozark chinquapin will likely continue to decline overall due to the effects of the chestnut blight across its known range. Because of the protection measures identified, sensitive species are not likely to be impacted. For these sensitive species identified in the project area, the determinations range from actions that may impact individuals but are not likely to cause a trend to federal listing or loss of viability to NO IMPACT. For more details, see the **Lower Brock Gas Well Unit 9-16 2-7H6, AREAS 52178 & 52179 Biological Evaluation (BE).**

L. Climate Change

Existing Condition

Research and analysis of evidence dating many years ago show intervals of warming and cooling on earth. The current warming trend is particularly important because it is proceeding at an unusual rate. Assessments by the Intergovernmental Panel on Climate Change (IPCC) suggest that the Earth's climate has warmed between 0.6 and 0.9 degree Celsius over the past century and that human activity affecting the atmosphere is "very likely" an important driving factor. (U.S. Department of Energy, Energy Information Administration; 2008).

The following information is from the National Climatic Data Center's website (National Climatic Data Center, 2011): Many chemical compounds present in Earth's atmosphere behave as greenhouse gases. These are gases, which allow direct sunlight (relative shortwave energy) to reach the Earth's surface unimpeded. As the shortwave energy (that in the visible and ultraviolet portion of the spectra) heats the surface, longer-wave energy (heat) is reflected to the atmosphere. Greenhouse gases absorb this energy, thereby allowing less heat to escape back to space, and 'trapping' it in the lower atmosphere. Many greenhouse gases occur naturally in the atmosphere, such as carbon dioxide, methane, water vapor, and, nitrous oxide, while others are synthetic. Those that are man-made include the chlorofluorocarbons, hydrofluorocarbons and perfluorocarbons, as well as sulfur hexafluoride. Atmospheric concentrations of both the natural and man-made gases have been rising over the last few centuries. As global population increases and reliance on fossil fuels (such as coal, oil and natural gas) is firmly solidified, emissions of these gases continue to rise. While gases such as carbon dioxide occur naturally in the atmosphere, through our interference with the carbon cycle, we artificially move carbon from solid storage to its gaseous state, thereby increasing atmospheric concentrations (National Climatic Data Center, 2011).

The principal greenhouse gases that enter the atmosphere because of human activities are carbon dioxide, methane, nitrous oxide, and fluorinated gases (U.S. Environmental Protection Agency, 2011d). Atmospheric carbon dioxide concentration is now higher than at any time in the past 10 million years (Kennedy and Hanson, 2006). Humankind has altered the natural carbon cycle by burning coal, oil, natural gas and wood and since the industrial revolution began in the mid-1700s, each of these activities has increased in scale and distribution. Prior to the industrial revolution, concentrations were fairly stable at 280 parts per million (ppm). Today, they are around 370 ppm, an increase of well over 30 percent (National Climatic Data Center, 2011). In 2006, carbon dioxide emissions from the United States accounted for about 20 percent of the amount added to the atmosphere globally. Fuel combustion accounted for 94.0 percent of U.S.

carbon dioxide emissions in 2007; this figure represents approximately 85.4 percent of the nation's total greenhouse gas emissions that year. Changes in land use and forestry practices can also emit carbon dioxide through conversion of forest land to agricultural or urban use or can act as a sink for carbon dioxide (U.S. Environmental Protection Agency, 2011d).

Numerous processes collectively known as the "carbon cycle" naturally regulate concentrations of carbon dioxide in the atmosphere. Natural processes, such as plant photosynthesis, dominate the movement ("flux") of carbon between the atmosphere and the land and oceans. Carbon sequestration is the process by which atmospheric carbon dioxide is taken up by trees, grasses, and other plants through photosynthesis and stored as carbon in biomass (trunks, branches, foliage and roots) and soils. The sink of carbon sequestration in forests and wood products helps to offset sources of carbon dioxide to the atmosphere, such as deforestation, forest fires and fossil fuel emissions. Carbon accumulation in forests and soils, however, eventually reaches a saturation point, beyond which additional sequestration is no longer possible. This happens, for example, when trees reach maturity, or when the organic matter in soils builds back up to original levels before losses occurred (U.S. Environmental Protection Agency, 2011d). While natural processes can absorb some of the net 6.2 billion metric tons (7.2 billion metric tons less 1 billion metric tons of sinks) of anthropogenic (human-caused) carbon dioxide emissions produced each year (measured in carbon equivalent terms), an estimated 4.1 billion metric tons are added to the atmosphere annually. This positive imbalance between greenhouse gas emissions and absorption results in the continuing increase in atmospheric concentrations of greenhouse gases. (U.S. Department of Energy, Energy Information Administration; 2008).

In computer-based models, rising concentrations of greenhouse gases produce an increase in the average surface temperature of the Earth over time. Rising temperatures may, in turn, produce changes in precipitation patterns, storm severity, and sea level commonly referred to as "climate change" (U.S. Department of Energy, Energy Information Administration; 2008). Projected climate change impacts include air temperature increases, sea level rise, changes in timing, location and quantity of precipitation and increased frequency of extreme weather events such as heat waves, droughts, and floods. These changes would vary regionally and affect renewable resources, aquatic and terrestrial ecosystems, and agriculture. Changes in temperature and precipitation would alter the growth patterns and distribution of plant and animal species. There are uncertainties regarding the timing and extent magnitude of climate change impacts, but continued increases in human greenhouse gas emissions would likely lead to increased climate change.

Proposed Action

Direct Effects

Forests and soils have a large influence on atmospheric levels of carbon dioxide. The carbon stored in live biomass, dead plant material and soil represents the balance between carbon dioxide absorbed from the atmosphere and its release through plant respiration as well as decomposition and burning.

With this alternative, some of the carbon currently sequestered in vegetation and soils would be released back to the atmosphere. In the short-term, greenhouse gas emissions and alteration to

the carbon cycle would be caused by harvest of timber for well pad and access road construction and by well drilling and completion activities. Harvest would remove some of the mature stems with diminished ability to sequester additional carbon; some of the carbon sequestered in harvested stems would continue to be stored in manufactured wood products. Residual stems adjacent to the proposed project area would continue to sequester and store carbon. Although naturally occurring methane is typically encountered during drilling operations, it is not anticipated to be produced at levels high enough to affect climate change. SEECO, Inc. routes all methane captured during the flowback and completion process to a completion combustion device as required by EPA's 40 CFR Part 60, subpart OOOO emission standards.

Indirect Effects

As greenhouse gas emissions are integrated across the global atmosphere, it is not currently possible to ascertain the degree of indirect effects this project would have on a global climate. The nominal reduction in carbon sequestration and the nominal increase in methane release along with other potential pollutants would not result in quantifiable impacts.

Cumulative Effects

As greenhouse gas emissions are integrated across the global atmosphere, it is not currently possible to ascertain the degree of cumulative effects this project would have on a global climate. The nominal reduction in carbon sequestration and the nominal increase in methane release along with other potential pollutants would not result in quantifiable impacts.

See the Air Quality section above for estimated emissions from this project.

Alternative 1 (No Action)

It is currently not possible to predict the actual effects of a project on global climate change, so a baseline comparison cannot be made using the no action alternative relative to climate change.

No activities would take place so no greenhouse gasses would be added to the atmosphere due to the project.

M. Transportation

Existing Condition

Conway County Road 539 (Brock Creek Rd) is currently open for public use. Conway County Road 539 is in overall good condition, receives annual maintenance, and was designed to accommodate large vehicles such as semi-trucks and trailers. FDR 93021B is eroded in places, but is in good condition overall.

Proposed Action

Direct/Indirect Effects

SEECO, Inc. would be required to obtain a Special Use Permit from the Forest Service to conduct commercial operations on all Forest Service jurisdiction roads that are needed for

operations. FDR 1309 and 93021B and the access road connecting FDR 1309 and Ozark Highlands Unit 9-16 2-7H6, ARES 52178 & 52179 location both would require a permit. In addition, SEECO, Inc. would be responsible for the maintenance of all roads listed in the Special Use Permit. This maintenance would include blading, spot placement of aggregate, cleaning ditches and cutting back encroaching brush from the roads right-of-way.
Approximately 1,320 feet of existing Forest Service Road 93021B would be obliterated beginning at the junction of Brock Creek Road to approximately 400 feet east of the proposed gas well location. Obliteration would include re-contouring, scarifying, erosion control, construction of berms at each end, seeding, fertilizing, mulching and other necessary measures. The relocated section of road would replace the obliterated road section.

Approximately 1,000 feet of Forest Service Road 93021B would be relocated south of the proposed gas well location then reconnect to the existing portion of 93021B at a point 400 feet east of the proposed gas well pad. The lease road would spur off of Forest Service Road 93021B and end at the gas well pad. The proposed relocated road right of way would be approximately 30 feet wide with the road surface being approximately 20 feet wide. There would be approximately 15' of clearing required on each side of the centerline of the road. An existing section of Forest Service Road 93021B would be reconstructed from the point where the relocated section ties into it. The reconstructed road would be approximately 500 feet long. The reconstructed road right of way would be approximately 30 feet wide with the road surface being approximately 20 feet wide. A dispersed campsite parking area would be relocated to the end of the reconstructed road. The dispersed campsite would be approximately 150' by 150'. The dispersed campsite parking area would be built to replace an existing dispersed campsite parking area that would be obliterated by the proposed gas well location. Safety signs would be required along roads and trails as directed by the Forest Service.

Existing access roads would be maintained to a condition equal or better than the condition of the roads at the time the work commences on the proposed gas well. Routine maintenance of the existing roads would include re-grading the road, adding additional gravel as required and repairing failures that result from the drilling activities. Semi-permanent dust control would be placed and maintained on any road sections where dust would adversely affect adjacent landowners and residents.

Erosion would increase during access road construction but would decrease when vegetation becomes established. The erosion rate would increase with an increase in rainfall intensity and amount. Plants in the erosion control seed mix germinate within 10 to 14 days, if weather conditions are favorable. Vegetation should be established within six months if weather conditions are favorable. Changes in road grade along with lead-off ditches would cause sediment to settle out on the undisturbed forest floor at the outlet of lead-off ditches. Implementing the project design criteria would decrease erosion potential.

Approximately 0.6 acre of soil would be taken out of production and devoted to the access road. Approximately 0.7 acre would be taken out of production and devoted to the relocated section of FDR 03021B. Approximately 0.19 acre would be taken out of production and devoted to the reconstructed section of FDR 93021B. Approximately 0.06 acre would be taken out of

production and dedicated to use as a turnaround/dispersed camping area. A section of FDR 93021B will be decommissioned which will return approximately 0.4 acres to production. The net acres that would be taken out of production and dedicated to use as roads would be approximately 1.2 acres.

Cumulative Effects
Pine thinning is proposed as part of the 2015 Fuels Management Project west of Brock Creek Road across from the proposed relocation of the beginning section of Forest Development Road (FDR) 93021B and north of the existing section of FDR 93021B and along a narrow strip south of the road and west and east of FDR 93021C . The proposed pine thinning would take place north and east of the proposed natural gas well pad. Prescribed burning is also proposed as part of the 2015 Fuels Management Project west of Brock Creek Road across from FDR 93021B and the proposed relocation of a section of the road. Activities proposed by the 2015 Fuels Management Project may overlap with the proposed gas well, but the impacts to roads are expected to be acceptable because regular maintenance would be required during the proposed activities which would mitigate the impacts to roads.

Alternative 1 (No Action)

Direct/Indirect Effects
Transportation impacts would be limited to those caused by on-going forest management activities.

Cumulative Effects
Future impacts to the transportation system could occur as a result of activities proposed by the 2015 Fuels Reduction Project, but no cumulative effects would occur with this alternative.

N. Human Health Factors

Existing Conditions
The analysis area for human health factors is the project area.

There are negligible risks to human health from the use of herbicides or cutting tools in the project area. Dead and dying trees along traveled roadways and in camping/hunting areas in the analysis area may give pause for concern for forest workers and visitors. Falling trees and limbs can cause personal injury and damage personal property. Accumulations of forest litter in the analysis area create a potential for wildfires.

Proposed Action

Direct/Indirect Effects
There would be a limited number of potential impacts to human health and safety. These risks include the physical risks associated with general construction practices, heavy equipment, or other associated hazards.

Dust emissions associated with the proposed actions is discussed under Air Quality. Noise

impacts are discussed under Recreation.

Implementation of Design Criteria #10 and #11 would insure sanitary conditions are being met at the drill sites.

The APD contains a Spill Response Plan that would be followed in the event of a spill. This plan is found in Attachment 15: Spill Response Document of the APD.

The Proposed Action would include the use of chemical and non-chemical treatments of vegetation. Herbicides kill the existing plant but often allow remaining seeds to germinate. Herbicides are known through experience with similar activities to be one of the most effective treatment methods for eradicating or controlling weed species (For the purpose of this document weed species consists of vegetation that may be outside of management desired objective such as non-native invasive species or aggressive native species that are found in the Southern Regional Forester's List and Ranking of Invasive Exotic Plant Species of Management Concern in Appendix D.). When herbicides are used in conjunction with an integrated treatment effort, it improves the effectiveness of non-chemical treatments, either concurrently or as follow-up treatments.

The herbicide proposed for use within the Project Area has glyphosate as its active ingredient. Because the herbicide proposed for use does not persist in the soil at effective levels for more than a few months (at the maximum), follow-up treatments may be needed to eliminate new sprouts that were in seed during the initial treatment. The most noticeable consequences from weed treatment would be the beneficial improvements to native ground vegetation such as grasses, forbs and shrubs that would last for 3 to 5 years or more.

Glyphosate formulas/products that have been registered with the Environmental Protection Agency (EPA) for rangeland, forestland, or aquatic use would be applied. In addition, the Forest Service has completed a risk assessment for glyphosate that has analyzed the risk of glyphosate on human health and safety, on wildlife/fish, and on non-target plants. The web site address is: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

No aerial application of herbicides would be used for this project. Herbicides would be applied using ground-based methods such as hand application using gloves, or spray using a backpack containing the herbicide attached to a flexible sprayer, wand or other hand application device that directs the chemical onto the target weed. The following table explains terminology commonly used in evaluating health risk associated with herbicides

Table 17 Herbicide Risk Assessment Standard Terminology

Term	Abbrev	Explanation (see risk assessments for specific definitions)
Toxic		The short-term effects of exposure to a chemical, which appear immediately upon exposure. See specific sections of the risk assessments for definition of the various "end points" of exposure, e.g. nervous system.

Sub-chronic		The effects that do not appear immediately, but that would appear over a short period of time after exposure, or if exposure continues for a period of time.
Chronic		Effects over a number of years (or over a lifetime) of repeated exposure
No Observed Adverse Effect Level	NOAEL	The amount of a substance that shows no toxic effects given short term (mg/kg body weight) or to show lack of chronic effects over long duration may be expressed as a dose over time (mg/kg/day).
No Observed Effect Concentration	NOEC	Used for plants to determine the lowest concentration at which a concentration of herbicide had no effect.
Safety Factor		Once a no observable effect level is established, safety factors are applied for the human risk assessments in order to set a reference dose. Safety factors depend on the information used for the no effect finding. Factors include such circumstances as uncertainties in species-to species extrapolation as well as accounting for sensitive individuals in the population. Each factor reduces the exposure dose by dividing by 10, so that a NOAEL of 5 would become an RfD of 0.05 if three safety factors were applied.
Reference Dose	RfD	The amount of a substance that would not have an adverse effect if this does were given every day over a lifespan of 70 years. It is measured in milligrams of substance per kilogram body weight of the person of concern, per day (mg/kg/day). An RfD is basically defined as a level of exposure that would not result in any adverse effects in any individual. The U.S. EPA RfDs are used because they generally provide a level of analysis, review, and resources that far exceed those that are or can be conducted in support of most Forest Service risk assessments. In addition, it is desirable for different agencies and organization within the Federal government to use concordant risk assessment values.
Hazard Quotient	HQ	The result of dividing the reference dose by the expected exposure to provide a measure of the hazard and so a relationship to the expected risk.

The information in this analysis was provided from the Syracuse Environmental Research Associates Herbicide Risk Assessment for Glyphosate.

Note: Tank mixes and adjuvants (such as Cide-Kick) may be added to the herbicide to improve effectiveness and control of target species. Herbicide would be applied at rates and use only application methods specified on the label. Additional spot treatments would be needed to reach the desired future condition in some areas.

These are standard risk assessment procedures, tested by several years of EPA use and scrutiny by the larger scientific community. As noted in the risk assessment, the anticipated effects can be minimized or avoided by prudent industrial hygiene practices during proper handling of the herbicide. Scientific evidence considered in the risk assessment requires that normal and reasonable care should be taken in the handling of this or any other chemical. Notwithstanding these reservations, the use of herbicides does not appear to pose any risk of systemic toxic effects to workers or the general public in Forest Service Programs.

Glyphosate

Description
The active ingredient herbicide *glyphosate* (examples of trade name RoundUp, RoundUp Pro**,** Accord SP) would typically be applied to target vegetation with a directed ground application by backpack or vehicle mounted sprayer, at manufacture's labeled rates per acre. Mixing rates would vary depending on topography and amount of vegetation to be controlled. Repetitive treatments may occur in follow up years until NNIS are eliminated or for the life of the well. Spot applications would occur in years following the initial treatments to control future growth. Spot applications would be made at the same rate and mixture or less, but would be applied only to small areas as needed, and typically made with backpack or vehicle-mounted sprayer.

Risk Summary
The risk characterization for both workers and members of the general public are reasonably consistent and unambiguous. For both groups, there is very little indication of any potential risk at the typical application rate. Even at the upper range of plausible exposures in workers, exposure is below the level of concern, even at the upper levels when broadcast spray is used. For members of the general public, none of the longer-term exposure scenarios exceed or even approach a level of concern. There is no route of exposure or exposure scenario suggesting that the general public would be at risk from longer-term exposure to *glyphosate*. Only exposure scenarios that contemplate consumption of water directly out of a pond immediately after a spill exceed the levels of concern.

The current risk assessment for *glyphosate* supports the conclusions reached by U.S. EPA: Based on the current data, it has been determined that typical application rate does not approach the level of exposure in the reference dose.

At the typical application rate, the exposure to hazardous levels would not be reached or exceeded under worst-case conditions (SERA 2011a).

<u>Cumulative Effects</u>
Pine thinning is proposed as part of the 2015 Fuels Management Project west of Brock Creek Road across from the proposed relocation of the beginning section of Forest Development Road (FDR) 93021B and north of the existing section of FDR 93021B and along a narrow strip south of the road and west and east of FDR 93021C . The proposed pine thinning would take place north and east of the proposed natural gas well pad. Prescribed burning is also proposed as part of the 2015 Fuels Management Project west of Brock Creek Road across from FDR 93021B and the proposed relocation of a section of the road. Strict adherence to the Final Environmental

Impact Statement and the Revised Forest Land and Resources Management Plan guidelines, a site-specific burn plan and Arkansas Voluntary Smoke Management Guidelines ensure that smoke or other combustion products do not reach, or greatly affect smoke sensitive areas. The above proposed activities in the area adjacent to the proposed gas well would not be expected to add to the risk to human health because the safety standards described above would be applied to minimize the risk to human health.

Cumulative effects to water and air that could have an impact on human health are discussed in their respective sections above.

Alternative 1 (No Action)

Direct Effects
Under this alternative, conditions would remain the same. There would be no concern for human health and safety.

Indirect Effects
Under this alternative, conditions would remain the same. There would be no concern for human health and safety.

Cumulative Effects
There would be no cumulative effects to human health as a result of the no action alternative.

O. Socioeconomics and Environmental Justice

Existing Condition
This project area encompasses a portion of northern Conway County, Arkansas. The total population of Conway County was estimated to be 21,245 in 2013. This is a slight decrease from the 2010 census population of 21,273.

The racial mix is comprised of White (85.1%), Black or African-Americans (11.4. %), Asians (0.5%), and American Indian and Alaska Natives (0.9%) Three and nine-tenths percent are of Hispanic or Latino origin. (United States Census Bureau 2013).

The 2012 per capita income for Conway County was $19,833, slightly lower than the estimated per capita income for Arkansas, which was $22,007. The 2012 median household income for Conway County was $32,625 compared to the median household income for Arkansas of $40,531. Approximately 23.4% of the total county population lives below poverty, slightly lower than the state rate of 18.7% (United States Census Bureau 2013).

In 2013, there were 9,664 housing units in Conway County with 7.7% being multi-unit structures. The homeownership rate in 2013 was 73.8%, which is higher than the state rate of 67.2%. The median value of owner-occupied housing units was $84,500, which was significantly lower than the median value of owner-occupied housing units for the state ($106,300). (United States Census Bureau 2013)

Proposed Action

Direct/Indirect Effects
Minor, short-term beneficial effects are expected under this alternative. The labor for the proposed activities would be provided by local and/or regional contractors, which may result in increases in the population of the area for a period of six months to one year. Materials and other expenditures would mostly be obtained through merchants in the area, giving direct economic benefits. Road and well pad construction materials, such as aggregate and fill would be obtained locally. Cement and other construction materials would be obtained locally. Drilling pipe would be obtained from somewhere beyond the local area. There would be no known disproportionate effects to minority groups resulting from this alternative. The proposed action would affect all segments of the population equally because there are no specific minority groups living in the area.

Cumulative Effects
The proposed action would be expected to combine with the revenue and employment impacts from existing and future wells to increase income and employment opportunities in the local area. All segments of the population are expected to benefit equally.

Alternative 1 (No Action)

Direct Effects
Conditions would generally remain the same. There would be no additional jobs brought in the area and no economic benefits would be realized. There would be no disproportionate effects to minority groups resulting from this alternative.

Indirect Effects
Conditions would generally remain the same. There would be no additional jobs brought in the area and no economic benefits would be realized. There would be no disproportionate effects to minority groups resulting from this alternative.

Cumulative Effects
No activities would take place the gas well would not be constructed or drilled. No cumulative economic benefits would be realized.

Chapter IV

Coordination and Consultation

The Forest Service consulted the following individuals, Federal, Tribal, State, and local agencies during the development of this environmental assessment:
ID Team Members by Location:

Ozark National Forest – Big Piney Ranger District:

Terry Hope - Recreation Assistant
Jim Dixon – Integrated Resources Team Leader
Dwayne Rambo - Wildlife Biologist
Rickey Adams – Engineering Technician
Sarah Davis – Wildlife Biologist
Kenney Smedley – Engineering Technician
Mike Mulford – NEPA Coordinator
Sam Clark – Silviculturist
Anthony Harris – Timber Management Officer
Mark Hellen – District Forester
Leif Anderson – District Forester
Mike Walden – Heritage Resources Technician
Robert Foxworth– Archeologist
Chris Brightwell – Assistant Fire Management Officer

Ozark National Forest – Supervisor's Office:

Rick Monk – Hydrologist
Shawn Cochran – Ecosystems Staff Officer
J. Keith Whalen – Forest Fisheries Biologist
Marvin L. Weeks – Forest Soil Scientist
Dr. David Jurney – Archeologist
Kathy King – Writer/Editor
Steve Duzan – Forest NEPA Coordinator
Andrew T. McCormick – Geologist for Ozark-St. Francis and Ouachita National Forests

Arkansas Game and Fish Commission

A J Riggs – Wildlife Management Supervisor

Federal, Tribal, State, and Local Agencies:

Tim Kresse – Hydrologist-U. S. Geological Survey
William Bagnall-Fluids Geologist-Bureau of Land Management
Theo Witsell – Arkansas Natural Heritage Commission
Arkansas State Historic Preservation Office (SHPO)
US Forest Service Research
US Fish and Wildlife Service
Karen Kaniatobe THPO Absentee Shawnee Tribe of Oklahoma
Augustine Ashberry Alabama-Quassarte Tribal Town Historic Preservation Office

Darin Cisco Apache Tribe of Oklahoma Tribal Historic Preservation Office
Robert Cast THPO Caddo Nation of Oklahoma
Richard Allen, PhD Historic Preservation Officer Cherokee Nation of Oklahoma
Gordon Yellowman Cheyenne-Arapaho Tribes of Oklahoma
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Brian Jones Cultural Coordinator Fort Sill Apache Tribe of Oklahoma
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Jeremy Finch THPO/NAGPRA Citizen Potawatomi Nation
Betty Durkee Kaw Tribe of Oklahoma
Phyllis Wahahrockah-Tasi Comanche Indian Nation
Henry Harjo Environmental Director Kialegee Tribal Town
Tamara Francis Historic Preservation Officer Delaware Nation
Historic Preservation Office Kickapoo Tribe of Oklahoma
Robin Dushane Historic Preservation Officer Eastern Shawnee Tribe
Dewey Tsonetokoy, Sr. NAGPRA/Historic Preservation Office Kiowa Tribe of Oklahoma
Michael Darrow Historian Fort Sill Apache Tribe of Oklahoma
Josh Sutterfield Historic Preservation Officer Miami Nation of Oklahoma
Historic Preservation Office Peoria Tribe of Oklahoma
Jack Shadwick Historic Preservation Officer Modoc Tribe of Oklahoma
Historic Preservation Officer Ponca Tribe of Oklahoma
Joyce Bear Historic Preservation Officer Muskogee (Creek) Nation
John Berry Tribal Historic Preservation Officer
Dr. Andrea Hunter Historic Preservation Officer Osage Nation
Sandra Massey Historic Preservation Officer Sac and Fox Nation of Oklahoma
Rhonda Dixon Historic Preservation Officer Ottawa Tribe of Oklahoma
Natalie Deere Historic Preservation Office Seminole Nation of Oklahoma
Richard Goulden Historic Preservation Officer Otoe-Missouri Tribe of Oklahoma
Chris Franks Historic Preservation Officer Seneca-Cayuga Tribe of Oklahoma
Frank Morris Repatriation Coordinator Pawnee Nation of Oklahoma
Historic Preservation Office Shawnee Tribe of Oklahoma
Historic Preservation Office Thlopthlocco Tribal Town
Josh Waffle Historic Preservation Officer Tonkawa Tribe of Oklahoma
Lisa Stopp Historic Preservation Officer United Keetoowah Band of Cherokee
Stratford Williams Historic Preservation Officer Wichita and Affiliated Tribes
Sherry Clemons Historic Preservation Officer Wyandotte Tribe of Oklahoma

APPENDIX A
Public Involvement

The Big Piney Ranger District Interdisciplinary Team (IDT) initiated internal scoping for the SEECO, Inc. Ozark Highlands Unit 9-16 2-7H6, ARES 52178 and 52179 on July 24, 2014. A project notification letter was mailed out in September 2014. Scoping letters requesting comments on the proposal were mailed to tribes, agencies, groups, or individuals. The legal notice was posted in Russellville's, *The Courier,* on September 23, 2014. The project was also published in the Ozark- St. Francis National Forests Schedule of Proposed Actions and on the Forests planning website.

Three responses were received from this initial scoping effort.

On February 19, 2016 the Draft Environmental Analysis was made available to the public. Comments were received for 30 days. This effort resulted in comments received from one member of the public. See Appendix D in this document for specific comments and agency responses.

APPENDIX B

Literature Cited

Tiered Documents

U.S. Department of Agriculture, Forest Service. 2005. Final Environmental Impact Statement: Land and Resources Management Plan, Ozark-St. Francis National Forest. Russellville, AR: U.S. Department of Agriculture Forest Service, Southern Region.

References

Albin, D.R., Hines, M.S., and Stephens, J.W., 1967, Water resources of Jackson and Independence Counties, Arkansas: U.S. Geological Survey Water Supply Paper 1839–G, 29 p.

Arkansas Department of Environmental Quality. (2014). *Integrated Water Quality Monitoring Assessment Report.* Retrieved from http://www2.adeq.state.ar.us/water/branch_planning/303d/pdfs/integrated_wqmar_20140401.pdf

Arkansas Oil and Gas Commission. General rules and regulations. As of January 15, 2015. 212 p. http://www.aogc.state.ar.us/pnlineData/Forms/Rule Accessed 7/2015.

Arkansas Pollution Control and Ecology Commission. 2004. Regulation 2 - Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas, obtained from http://www.adeq.state.ar.us/regs/default.htm, 01/12/2007.

Arkansas Public Policy Panel, 2011, Violations of water quality standard from gas production in Arkansas: Arkansas Public Policy Panel, Little Rock, Ark. Report can be accessed at www.arpanel.org.

Atlantic Council, 2011, European unconventional gas developments—Environmental issues and regulatory challenges in the EU and the U.S: Proceedings from A Joint Project of the Atlantic Council of the United States and the Institut Francais des Relations Internationales, Brussels, June 2011, 29 p.

Beasley, R. S., E. L. Miller and E. R. Lawson. 1987. Chemical properties of soils and streams in natural disturbed forest ecosystems in the Ouachita Mts. Ark. Water Resour. Res. Center. Publication NO. 132. 93 pp.

Brantley, S.L., Yoxtheimer, D., Arjmand, S., Grieve, P., Vidic, R., Pollak, J., Llewellyn, G.T., Abad, J., and Simon, C., 2014, Water resource impacts during unconventional shale gas

development: The Pennsylvania experience: International Journal of Coal Geology, v. 126, p. 140-156.

Clingenpeel Alan J. & Michael A. Crump Water Resource Analysis for Cumulative Effects V.1 10/17/2005

Cordova, R.M. 1963. Reconnaissance of the groundwater resources of the Arkansas valley region, Arkansas. U.S.G.S. AR Water Science Center. Water Supply Papers 1669-BB. U.S. G.P.O. 33 p.

Hines, M.S. Flow duration and low flow frequency determinations of selected Arkansas streams. Arkansas Geological Commission Water Resources Circular No. 12. U.S.G.S. in cooperation with Arkansas Geological Commission. Little Rock, AR. 1975. 86p.

Imes, J.L., and Emmett, L.F., 1994, Geohydrology of the Ozark Plateaus aquifer system in parts of Missouri, Arkansas, Oklahoma, and Kansas: U.S. Geological Survey Professional Paper 1414–D, 127 p.

Intergovernmental Panel on Climate Change (IPCC) IPCC Fourth Assessment Report: Climate Change 2007 http://ipcc.ch/publications_and_data/ar4/syr/en/spms2.html Accessed 7/2015.

Johnson MR, Boelke C, Chiarella LA, Colosi PD, Greene K, Lellis K, Ludemann H, Ludwig M, McDermott S, Ortiz J, Rusanowsky D, Scott M, Smith J. 2008. *Impacts to marine fisheries habitat from nonfishing activities in the Northeastern United States* (Technical Memorandum NMFS-NE-209). National Oceanic and Atmospheric Administration: Northeast Fisheries Science Center. Retrieved from http://www.nefsc.noaa.gov/publications/tm/tm209/pdfs/ch7.pdf

Kell, S., 2011, State Oil and Gas Agency Groundwater Investigations And their Role in Advancing Regulatory Reforms - A Two-State Review: Ohio and Texas: Ground Water Protection Council, August, 2011, accessed in 2015 at http://fracfocus.org/sites/default/files/publications/state_oil__gas_agency_groundwater_investigations_optimized.pdf.

Kilpatrick, J.M., and Ludwig, A.H., 1990, Ground-water resources of the upper White River Basin in Arkansas: U.S. Geological Survey Open-File Report 88–724, 48 p.

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: Society of Petroleum Engineers Hydraulic Fracturing Conference, Woodlands, Tex, February 6-8, 2012, 80 p.

Kresse, T.M., and Hays, P.D., 2009, Geochemistry, comparative analysis, and physical and chemical characteristics of the thermal waters east of Hot Springs National Park, Arkansas, 2006–2009: U.S. Geological Survey Scientific Investigations Report 2009–5263, 48 p.

Kresse, T.M., Warner, N.R., Hays, P.D., Down, Adrian, Vengosh, Avner, and Jackson, R.B., 2012, Shallow groundwater quality and geochemistry in the Fayetteville Shale gas-production area, north-central Arkansas, 2011: U.S. Geological Survey Scientific Investigations Report 2012–5273, 31 p.

Kresse, T.M., and Fazio, J.A., 2002, Pesticides, water quality, and geochemical evolution of ground water in the alluvial aquifer, Bayou Bartholomew Basin, Arkansas: Arkansas Department of Environmental Quality, Water Quality Report WQ02–05–1, 111 p.

Lamonds, A.G., 1972, Water-resources reconnaissance of the Ozark plateaus province, northern Arkansas: U.S. Geological Survey Hydrologic Atlas 383, 2 sheets.

Lyon, D. and T. Chu. Emissions inventory and ambient air monitoring of natural gas production in the Fayetteville shale region. Arkansas Department of Environmental Quality . 2011. 31p http://www.epa.gov/ttnchie1/conference/ei20/session6/dlyon.pdf Accessed 7/2015.

McFarland John D., 2004. Stratigraphic Summary of Arkansas by John David McFarland, 2004, Arkansas Geological Survey (Commission) Information Circular 36.

National Climatic Data Center. 2015. http://lwf.ncdc.noaa.gov/oa/climate/gases.html. Accessed 7/2015.

Robison, H.W., and T.M. Buchanan, 1984. Fishes of Arkansas. University of Arkansas Press, Fayetteville, AR. 536p.

SEECO, Inc. 2013. Application for Permit to Drill for Proposed Gas Well Location, Drill Pad, Reserve Pit, and Access Road. Federal Lease Serial No. ARES-52178 & 52179. OHU 9-16 2-7H6.

Syracuse Environmental Research Associates, Inc. 2011. "Glyphosate – Human Health and Ecological Risk Assessment, Final Report." Prepared for: USDA, Forest Service. Forest Health Protection. Arlington, VA.
http://www.fs.fed.us/foresthealth/pesticide/pdfs/Glyphosate_SERA_TR-052-22-03b.pdf

Townsend, W.R.; and C.R.; Wilson. 1980. Soil Survey of Conway County, Arkansas. U.S. Department of Agriculture; Soil Conservation Service and Forest Service with Arkansas Agricultural Experiment Station.

U.S. Bureau of Land Management. The Gold Book.
http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/gold_book.html

U.S. Census Bureau. Selected social characteristics in the U.S. 2007-2011 American community survey 5 year estimates. Arkansas, Conway County, Arkansas
http://factfinder2.census.gov/faces/nav/jsf/pages/community_facts.xhtml

U.S. Census Bureau Selected economic characteristics 2007-2011 American community survey 5-year estimates Conway County, AR.
http://factfinder2.census.gov/faces/nav/jsf/pages/community_facts.xhtml Accessed 7/2015.

U.S. Census Bureau Selected housing characteristics 2007-2011 American community survey demographic and housing estimates.
http://factfinder2.census.gov/faces/nav/jsf/pages/community_facts.xhtml Accessed 7/2015.

U.S. Department of Agriculture Forest Service, Southern Research Station Center for Aquatic Technology Transfer [CATT]. (2010). *Summary of Stream Habitat and Fish Inventories on the Big Piney Ranger District, Ozark National Forest, 2009-2010*.

U.S. Department of Agriculture, Forest Service. 2005. Revised Land and Resources Management Plan; Ozark-St. Francis National Forests. Russellville, AR; U.S. Department of Agriculture, Southern Region.

U.S. Department of Agriculture, Forest Service. 1999. Ozark-Ouachita Highlands Assessment, Air Quality, Prt. 2. U.S. Department of Agriculture, Southern Research Station GTR SRS-32.

U.S. Department of Agriculture, Forest Service. 1986. 1986 ROS Book. Southern Region. Washington, D.C.; U.S. Department of Agriculture, Forest Service.

U.S. Department of Agriculture, Forest Service. 2001. Management Indicator Species Population and Habitat Trends; Ozark-St. Francis National Forests. Russellville, AR; U.S. Department of Agriculture, Southern Region.

U.S. Department of Agriculture, Forest Service. 2007. General Tech. Report NRS-9. Population Trends and Habitat Occurrence of Forest Birds on Southern National Forests, 1992-2004. 260 pp.

U.S. Department of Agriculture, Forest Service. 2008. Scenery Treatment Guide - Southern Regional National Forests. U.S. Department of Agriculture, Southern Region.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2005. Soil survey geographic (SSURGO) database for Logan County, AR. U.S.D.A. NRCS, Fort Worth, TX.

U.S. Department of Energy Energy and Efficiency and Renewable Energy

http://www.fueleconomy.gov/feg/Find.do?action=sbs&id=33198&id=32426&id=32756&id=33211 CO2 tailpipe emissions. Accessed 1/10/2014.

U.S. Energy Information Administration. Energy and the environment explained. Greenhouse gases effect on the climate. http://www.eia.gov/energyexplained/index.cfm?page=environment_how_ghg_affect_climate Accessed 7/2015.

U.S. Energy Information Administration. 2015 Annual energy outlook. http://www.eia.gov/forecasts/aeo/ Accessed 7/2015.

U. S. Environmental Protection Agency. 2008 Average In-Use Emissions from Heavy Duty Trucks US EPA420-F-08-027 2008 6 p. Accessed 1/9/201 http://www.epa.gov/otaq/consumer/420f08027.pdf

U. S. Environmental Protection Agency Emission Standards Reference Guide for Heavy-Duty and NonroadEngines, EPA420-F-97-014 September, 1997.16p. Accessed 1/9/2014. http://www.epa.gov/otaq/cert/hd-cert/stds-eng.pdf

U. S. Environmental Protection Agency Exhaust emission factors for nonroad engine modeling-spark ignition, 2010. 58 p. Accessed 1/9/2014. http://www.epa.gov/otaq/models/nonrdmdl/nonrdmdl2010/420r10019.pdf

U. S. Environmental Protection Agency Exhaust emission factors for nonroad engine modeling-compression ignition. 141 p. Accessed 1/9/2014. http://www.epa.gov/otaq/models/nonrdmdl/nonrdmdl2010/420r10018.pdf

U.S. Environmental Protection Agency. 2015. Currently Designated Nonattainment Areas for All Criteria Pollutants. *http://www.epa.gov/oar/oaqps/greenbk/ancl.html#ARKANSAS.*

U.S. Environmental Protection Agency. Drinking water contaminants. http://water.epa.gov/drink/contaminants/index.cfm Accessed 7/2015.

U.S. Environmental Protection Agency. 2012. Oil and Natural Gas Sector: Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution. EPA-453/R-11-002. http://www.epa.gov/airquality/oilandgas/pdfs/20120418tsd.pdf Accessed 7/2015.

U.S. Geological Survey Water Resources Arkansas. Web accessible water well database. http://ar.water.usgs.gov/PROJECTS/WWData.html Accessed 7/2015.

U.S. Fish and Wildlife Service. 2007 Best management practices for Fayetteville Shale natural Gas activities. U.S. Fish and Wildlife Service. Conway, Arkansas. 30 pp.

Warner, N.R., Kresse, T.M., Hays, P.D., Down, A., Karr, J.D., Jackson, R.D., and Vengosh, A., 2013, Geochemical and isotopic variations in shallow groundwater in areas of the Fayetteville Shale development, north-central Arkansas: Applied Geochemistry, v. 35, p. 207–220.

Vengosh, A., Jackson, R.B., Warner, N., Darrah, T.H., and Kondash, A., 2014, A Critical Review of the Risks to Water Resources from Unconventional Shale Gas Development and Hydraulic Fracturing in the United States: Environmental Science and Technology, v. 48, p. 8334-8348.

APPENDIX C

Reserve Pit Sampling Requirements

File Code: 2520/2550/2830-2/1300-1 **Date:** July 10, 2008
Route To: (2520)

Subject: Pit Sampling Requirements for Gas Well Activities

To: District Rangers, SO Staff

The Forest will continue to request that operators provide a chemical analysis of both sediment and water samples taken from retention ponds/pits/blooie pits as part of the surface use (36 CFR §228.108) and compliance (36 CFR §228.112) requirements involved with oil and gas resource extraction. This requirement should be included in the operator's Application for Permit to Drill or as a Condition of Approval along with the Decision document. A document which lists these requirements for external distribution can be found attached to this letter, and on the Forest's Minerals intranet website.

The protocols and list of constituents for analysis are as follows:

Two soil/sediment samples and one water sample collected in the presence of a Forest Service representative, and representative of the pit site. Sediment/soil samples should be a representative composite that includes substrate from the bottom and sides of the pit. Samples should be collected and analyzed in accordance with the methods and guidance found in EPA SW-846. An EPA and State approved laboratory should be utilized for sample analysis. Analysis results and QA/QC reports should be submitted to the responsible office.

The collected soil/sediment samples should be tested for the following constituents.

Arsenic	Mercury	Sulfides
Cadmium	Nickel	Chlorides
Hexavalent Chromium	Zinc	Oil and Grease
Chromium	Antimony	TPH – (Total Petroleum
Copper	Barium	Hydrocarbons)
Lead	Cobalt	pH

Alpha/Beta/Gamma Radiological Analysis should be conducted on samples taken from pit locations within Madison, Newton, Johnson, Pope, Searcy, and Van Buren Counties until further notice. Analysis results will be accepted subsequent to pit closure.

USDA

The collected water samples should be tested for the following constituents.

Arsenic
Barium
Chromium
Lead
Sodium
Zinc
Chloride
Nitrate as N
Sulfate
Oil and Grease
Total Dissolved Solids
Specific Conductance
Hardness (CaCO3)
Mercury

The addition of several testing components will allow the Forest to continue to fulfill our obligations for surface use management and to accommodate multiple use management objectives of public lands. Questions or assistance with this activity should be addressed to Connie Jankowiak (479) 964-7276 or Michael Crump (479) 964-7513.

/s/ Judith L. Henry
JUDITH L. HENRY
Forest Supervisor

Enclosure

cc: Wayne King
Connie L Jankowiak
Rickey D Adams
James R Bicknell

Appendix D
Comments Received and Agency Responses

1. *Comment:* This gas play should remain on private property only.

   Agency Response: SEECO currently holds federal leases for gas and oil rights for portions of the Ozark-St. Francis National Forests and in doing so they have legal authority to extract gas from those areas. This topic is beyond the scope of the project.

2. *Comment:* My opinion is that the gas industry's fracturing technology will be detrimental to the health of the national forest. Unlike the timber industry which has the ability to reforest a thinned area the gas industry's ill effects will remain.

   Agency Response: The commenter does not give specific information about how the fracturing technology will be detrimental to the health of the National Forest, however, on page III-6 of the Environmental Analysis (EA) the potential effects of surface water is discussed; "Water would be required for carrying proponents (sand) and chemicals such as scale inhibitor, acid for cleaning cement from the casing perforations, friction reducers and surfactant to increase the viscosity. An oil-based drilling mud would be used in a closed-loop system for carrying cuttings to the surface. No diesel would be used in the fracturing fluid during the fracture process of this well. Typical fracturing fluids consist of 99.51% water and 0.49% other liquids as noted above (AOGC website)." The document goes into other potential effects as well and all foreseen potential effects have been addressed by the Forest Conditions of Approval, Spill Prevention, Controls and Countermeasures (SPCC), Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development, or Arkansas Best Management Practices for Fayetteville Shale. Additionally, other effects to surface water were evaluated and have been determined to be temporary, not lasting for longer than three growing seasons.

3. *Comment:* The gas industry is way ahead of the technologies it is using. Please read the list of chemicals used in the fracturing process.

   Agency Response: Effects of the fracturing process are covered under groundwater on pages III-9 through III-17 of the Environmental Assessment. Additionally, operators must follow all existing federal and state laws in regard to use and disclosure of chemicals.

4. *Comment:* Remember the only reason fracturing is allowed by law is that the Clean Water Act was revised, I believe, in 1995. That one added sentence simply states that the fracturing process cannot be held liable for ground water contamination. For this revision to have been made only to allow fracturing to occur tells me that fracturing "is" harmful to the environment.

Agency Response: Comment noted. Operators must comply with the Clean Water Act.

5. *Comment:* It takes over 5 million gallons of water to "frack" a well. That is some kind of a terrible technology they are using. Every aspect of today's gas technology is out of sync with the environment.

   Agency Response: Comment noted. The amount of water to “frack” a well varies with each proposal, and the specifics of this proposal is on page II-3 under the proposed action.

6. *Comment:* Other forms of pollution (in addition to water pollution) are taking place today in the shale play area. Air pollution is occurring (including H2S gas, harmful fugitive emissions at well sites and transmission stations), naturally found elements are being released before they are ready to be released naturally (in addition to the gas that is not fully matured) including mercury.

   Agency Response: The results of the analysis on air quality found that; “Potential Emissions from well completion for the proposed well are expected to be within the range of those for wells completed with hydraulic fracturing after reduction by the completion combustion device (see Table 10.). Potential secondary emissions due to completion combustion of the flowback gasses are expected to be within the range of those with hydraulic fracturing (see Table 11).”

   No activities would result in violations of federal air quality standards. During project implementation, fugitive dust would likely arise from travel on roadways and from well site and production facilities construction (pages III-18 through III-22 of the Environmental Assessment).

   For the effects to soils (pages III-1 through III-4) there are some temporary negative identified effects however these would diminish over time (3-5 years after reclamation) to the point of being not measurable.

   Addressing the element Mercury specifically, according to Forest Geologist, Mercury can become a gas, however, it must be above 357 degrees Celsius in order for that to happen. The drilling process keeps the temperature below this threshold. Also, Mercury only rarely occurs in the Ozarks due to the types of structural deformity required in the rock formations and not in any known high concentrations. If a gas well were to drill into an area containing Mercury, traces would end up in the reserve pit which according to Appendix C of the EA (the Reserve Pit Sampling Requirements) requires testing for numerous heavy metals including Mercury. If testing results in abnormal readings of heavy metals then the water or slurry in the pit would be properly disposed of off-site at an approved facility.

7. *Comment:* There is extreme noise pollution (at well site and pumping stations), an increase of trash on the road ways due to heavy traffic to and from well sight and trucking accidents (spilling fracking fluid...), and heavy big truck traffic contributes to air and noise pollution.

   Agency Response: Mitigation of the potential noise is addressed in this assessment on pages II-10 and II-11 and provides site specific design criteria which addresses noise and spills. Mitigations include use of mufflers as well as engineered sound barriers as needed to control noise. Any trash issues associated with the gas well would be addressed by BLM and Forest Service Inspectors.

8. *Comment:* Placing gas wells and pipelines in the national forest will disrupt the enjoyment for many people. A hunter sitting a stand, a group of young people on a camping and hiking trip do not want to see, hear or smell the gas industry in "their" forest.

   Agency Response: "The proposed site for the gas well would not be seen from high points in any direction. **Short-term visual impacts** from activities such as the well pad and road construction, road reconstruction, access road construction and re-location of the dispersed campsite would have limited visibility along Brock Creek Road except during winter months (leaf off). The existing vegetation, trees, and shrubs would hide the well pad during leaf on and may not be distinguishable to general observation even during leaf off since the pad would be a minimum of 150 feet from Brock Creek Road. **The impacts associated with the construction and disturbance would fade over time** as the area is reseeded and vegetation reclaims the road rights-of-way and pad. Facilities and specific equipment needed on site would be painted to blend in with the natural landscape. This would enable the facilities to blend in with the natural landscape when seen from a distance." Page III-23 of the EA. Additionally, "Proposed activities would **temporarily** increase the traffic in the Tar Kiln Mountain area. Site Specific Design Criteria #21 requires SEECO, Inc. to post signs along Brock Creek Road, warning road users of increased traffic and activities in the area. Users of these roads (hunters and pleasure drivers) may be inconvenienced during implementation of the proposed activities.

   Hunters and horseback riders in the area may be distracted by noise from construction and drilling activities associated with the development. This would **be temporary** until well drilling activities are completed.

   The greatest recreational impact would be to the users of a dispersed campsite that has been in use for several decades, because this site would be relocated. The new site location would be close enough that machinery or other noise associated with the well location would have the potential to disturb the recreating public; however, site specific design criteria would be used to reduce sound levels. Suitable mufflers would be

installed on all internal combustion engines and certain compressor components. Engineered sound barriers or sound-insulated buildings may be required."

9. *Comment:* I am opposed to the use of herbicides. Mow the grass with a brush cutter in the fall and be done until late spring.

   Agency Response: The practice suggested by the commenter would not be effective with the type of Non-Native Invasive Species present on the two additional well pad sites. This practice could actually aid in spreading of the type of species documented on these well pads. The agency is proposing an herbicide method of treatment after attempting mechanical methods of controlling the Non-Native Invasive Species for approximately six years.