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Oil and Gas Drilling/Development Impacts

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ABSTRACT

Activities that may cause environmental impacts include ground clearing, grading, drilling, waste management, vehicular and pedestrian traffic, and construction and installation of facilities. Impacts would be similar to those addressed for exploration; but would be more extensive due to an increased number of wells, access roads, pipelines, and other ancillary facilities (e.g., compressor stations or pumping stations) that would be required. Typical activities during the drilling and development of an oil or gas well include ground clearing and removal of vegetative cover, grading, drilling, waste management, vehicular and pedestrian traffic, and construction and installation of facilities. Activities conducted in locations other than at the oil and gas well pad site may include excavation/blasting for construction materials (sands, gravels), access road and storage area construction, and construction of gathering pipelines and compressor or pumping stations. Potential impacts from these activities are presented below, by the type of affected resource.

Acoustics (Noise)

Keywords : Oil and Gas, Drilling, Development, Impacts

I. INTRODUCTION

Primary sources of noise during the drilling/development phase would be equipment (bulldozers, drill rigs, and diesel engines). Other sources of noise include vehicular traffic and blasting. Blasting activities typically would be very limited, the possible exception being in areas where the terrain is hilly and bedrock shallow. With the exception of blasting, noise would be restricted to the immediate vicinity of the work in progress. Noise from blasting would be sporadic and of short duration but would carry for long distances. If noise-producing activities occur near a residential area, noise levels from blasting, drilling, and other activities could exceed the U.S. Environmental Protection Agency (EPA) guidelines. The movement of heavy vehicles and drilling could result in frequent-to-continuous noise.

The highest noise levels would occur from drilling and flaring of gas. Noise from drilling has been measured as 115 dBA at the source to above 55 dBA at distances 1,800 feet (549 meters) to 3,500 feet (1,067 meters) from the well. Drilling noise would occur continuously for 24 hours per day for one to two months or more depending on the depth of the formation. Exploratory wells that end up becoming production wells would continue to generate noise during the production phase.

Air Quality

Emissions generated during the drilling/development phase include vehicle emissions; diesel emissions from large construction equipment and generators, storage/dispensing of fuels, and, if installed at this stage, flare stacks; small amounts of carbon monoxide, nitrogen oxides, and particulates from blasting activities; and dust from many sources, such as disturbing and moving soils (clearing, grading, excavating, trenching, backfilling, dumping, and truck and equipment traffic), mixing concrete, and drilling.

During windless conditions (especially in areas of thermal inversion), project-related odors may be detectable at more than a mile from the source. Excess increases in dust could decrease forage palatability for wildlife and livestock and increase the potential for dust pneumonia.

Cultural Resources

Potential impacts to cultural resources during the drilling/development phase could include: destruction of cultural resources in areas undergoing surface disturbance; unauthorized removal of artifacts or vandalism as a result of human access to previously inaccessible areas (resulting in lost opportunities to expand scientific study and educational and interpretive uses of these resources); and visual impacts resulting from large areas of exposed surface, increases in dust, and the presence of large-scale equipment, machinery, and vehicles for cultural resources that have an associated landscape component that contributes to their significance (e.g., sacred landscapes or historic trails). While the potential for encountering buried sites is relatively low, the possibility that buried sites would be disturbed during pipeline, access road, or well pad construction does exist. Unless the buried site is detected early in the surface-disturbing activities, the impact to the site can be considerable. Disturbance that uncovers cultural resources of significant importance that would otherwise have remained buried and unavailable could be viewed as a beneficial impact. Vibration, resulting from increased traffic and drilling/development activities, may also have effects on rock art and other associated sites (e.g., sites with standing architecture).

II. ECOLOGICAL RESOURCES

Impacts to ecological resources would be proportional to the amount of surface disturbance and habitat fragmentation. Vegetation and topsoil would be removed for the development of well pads, access roads, pipelines, and other ancillary facilities. This would lead to a loss of wildlife habitat, reduction in plant diversity, potential for increased erosion, and potential for the introduction of invasive or noxious weeds. The recovery of vegetation following interim and final reclamation would vary by community (e.g., grasslands would recover before sagebrush or forest habitats). Indirect impacts to vegetation would include increased deposition of dust, spread of invasive and noxious weeds, and the increased potential for wildfires. Dust settling on vegetation may alter or limit plants' abilities to photosynthesize and/or reproduce. Over time, a composition of native and/or invasive vegetation would become established in areas disturbed by wildfire. Although oil and gas field development would likely increase the spread of invasive and noxious weeds by increasing traffic and human activity, the potential impacts could be partially reduced by interim reclamationand implementation of mitigation measures.

Adverse impacts to fish and wildlife could occur during the drilling/development phase from:

1. Erosion and runoff;
2. Dust;
3. Noise;
4. Introduction and spread of invasive nonnative vegetation;
5. Modification, fragmentation, and reduction of habitat;
6. Mortality of biota;
7. Exposure to contaminants;
8. Interference with behavioral activities; and
9. Increased harassment and/or poaching.

Depletion of surface waters from perennial streams could result in a reduction of water flow, which could lead to habitat loss and/or degradation for aquatic species.

2.1 Environmental Justice

If significant impacts were to occur in any of the resource areas and these were to disproportionately affect minority or low-income populations, there could be an environmental justice impact. It is anticipated that the development could benefit low-income, minority, and tribal populations by creating job opportunities and stimulating local economic growth via project revenues and increased tourism. However, noise, dust, visual impacts, and habitat destruction could have an adverse affect on traditional tribal lifeways and religious and cultural sites. Development of wells and ancillary facilities could affect the natural character of previously undisturbed areas and transform the landscape into a more industrialized setting. Development activities could impact the use of cultural sites for traditional tribal activities (hunting and plant-gathering activities, and areas in which artifacts, rock art, or other significant cultural sites are located).

2.2 Hazardous Materials and Waste Management

Solid and industrial waste would be generated during development and drilling activities. Much of the solid wastes would be expected to be nonhazardous; consisting of containers and packaging materials, miscellaneous wastes from equipment assembly and presence of construction crews (food wrappers and scraps), and woody vegetation. Industrial wastes would include minor amounts of paints, coatings, and spent solvents. Most of these materials would likely be transported off-site for disposal. In forested areas, commercial-grade timber could be sold, while slash may be spread or burned near the well site. Drilling wastes include hydraulic fluids, pipe dope, used oils and oil filters, rigwash, spilled fuel, drill cuttings, drums and containers, spent and unused solvents, paint and paint washes, sandblast media, scrap metal, solid waste, and garbage. Wastes associated with drilling fluids include oil derivatives (e.g., such as polycyclic aromatic hydrocarbons (PAHs), spilled chemicals, suspended and dissolved solids, phenols, cadmium, chromium, copper, lead, mercury, nickel, and drilling mud additives (including potentially harmful contaminants such as chromate and barite). Adverse impacts could result if hazardous wastes are not properly handled and are released to the environment.

Produced water (water that coexists with oil and gas in the formation and is recovered during well development) generation can be an issue during the drilling/development phase, although it usually becomes a greater waste management concern over the long-term operation of an oil or gas field because water production typically increases with the age of the production well. One exception to this is the drilling and development of coalbed methane reserves; produced water is generated at high volumes during the initial completion and development of coalbed methane wells and then declines considerably as methane production increases. Regulations govern the disposal of this produced water; the majority of it is disposed of by underground injection either in disposal wellsor, in mature producing fields, in enhanced oil recovery wells (i.e., wells by which produced water and other materials are injected into a producing formation in order to increase formation pressure and production).

In some locations, produced water may carry naturally occurring radioactive materials (NORM) to the surface. Typically, the NORM radionuclides (primarily radium-226, radium-228, and their progeny) are dissolved in the produced water but a portion of the NORM can precipitate into solid form in scales and sludges that collect in pipelines and storage vessels. Proper management of NORM-bearing produced water and solid wastes is critical to prevent both occupational and public human health risks and environmental contamination. NORM wastes are a problem generally associated with long-

term operation of an oil or gas field, but can also be associated with the drilling/development phase. The NORM Technology Connection Web site provides information about the regulation of NORM bearing wastes generated by the petroleum industry.

2.3 Health and Safety

Potential impacts to worker and public health and safety during the drilling/development phase would be similar to other projects that involve earthmoving, use of large equipment, transportation of overweight and oversized materials, and construction and installation of industrial facilities. The risks of serious accidents or injuries associated with oil and gas production apply primarily to well site workers. Statistical data on occupational accidents and fatalities for the oil and gas extraction labor category are available from the U.S. Bureau of Labor Statistics. In 2005, the oil and gas industry experienced a nationwide rate of 2.1 accidents per 100 full-time workers and 25.6 fatalities per 100,000 workers. Potential for occupational accidents and mortality would be highest during peak drilling periods and would likely drop in proportion to the decline in drilling and development activities. The development of oil and gas includes the potential for well fires or explosions. Well blowouts are rare but can be extremely dangerous (e.g., they can destroy rigs and kill nearby workers). They usually occur during drilling but can also occur during production (especially during well workover operations). If natural gas is in the blowout materials, the fluid may ignite from an engine spark or other source of flame. Blowouts may take days to months to cap and control. Also, increased human activity and increased public access could result in a higher potential for wildfires in the production area. Workers could also be exposed to air pollutants and could have body contact with product or other chemicals. Reckless driving by oil or gas workers would also create safety hazards. In addition, health and safety issues include working in potential weather extremes and possible contact with natural hazards, such as uneven terrain and dangerous plants, animals, or insects.

In locations where NORM-bearing produced water and solid wastes are generated, occupational and public health risks may occur if the wastes are not properly managed.

2.4 Land Use

Land use impacts would occur during the drilling/development phase if there are conflicts with existing land use plans and community goals; existing recreational, educational, religious, scientific, or other use areas; or existing commercial land use (e.g., agriculture, grazing, or mineral extraction). In general, the development of oil and gas facilities would change the character of the landscape from a rural to a more industrialized setting. Existing land use would be affected by intrusive impacts such as increased traffic, noise, dust, and human activity, as well as by changes in the visual landscape. In particular, these impacts could affect recreationists seeking solitude or recreational opportunities in a relatively pristine landscape. Ranchers or farmers could be affected by loss of available grazing or crop lands, potential for the introduction of invasive and noxious plants that could affect livestock forage availability, and possible increases in livestock/vehicle collisions. In forested areas, oil and gas well drilling could result in the long-term loss of timber resources. The expanded access road system could increase the numbers of off-highway vehicle (OHV) users, hunters, and other recreationists in the area. While the change in landscape character could discourage hunters who prefer a more remote backcountry setting; the potential for illegal hunting activities could increase due to the expanded access road system. Construction and drilling noise could potentially be heard 20 miles (32 kilometers) or more from the project area. While it would be barely audible at this distance, it could

affect residents and recreationists perceptions of solitude.

Most land use impacts that occur during the drilling/development phase would continue throughout the life of the oil and gas field. Overall, land use impacts could range from minimal to significant depending upon both the areal extent of the oil and gas field, the density of wells and other ancillary facilities, and the compatibility of the oil and gas field with the existing land uses.

III. PALEONTOLOGICAL RESOURCES

Impacts to paleontological resources can occur directly from construction and drilling activities or indirectly as a result of soil erosion and increased accessibility to fossil localities (e.g., unauthorized removal of fossil resources or vandalism to the resource). This would result in lost opportunities to expand scientific study and educational and interpretive uses of these resources. Disturbance that uncovers paleontological resources of significant importance that would otherwise have remained buried and unavailable could be viewed as a beneficial impact. Direct impacts to unknown paleontological resources can be anticipated to be proportional to the total area impacted by drilling and development activities.

3.1 Socioeconomics

Drilling/development phase activities would contribute to the local economy by providing employment opportunities, monies to local contractors, and recycled revenues through the local economy. Additional revenues would be generated in the form of royalty payments to mineral rights owners and taxes collected by federal, state, and local governments. Indirect impacts could occur as a result of the new economic development (e.g., new jobs at businesses that support the expanded workforce or that provide project materials). Depending on the source of the workforce, local increases in population could occur. Development of an oil or gas field also could potentially affect property values, either positively from increased employment effects or negatively from proximity to the oil or gas field and any associated or perceived adverse environmental effects (noise of compressor stations, visual effects, air quality, etc.). Some economic losses could occur if recreationists (including hunters and fishermen) avoid the area. Increased growth of the transient population could contribute to increased criminal activities in the project area (e.g., robberies, drugs).

3.2 Soils and Geologic Resources

Potential impacts to soils during the drilling/development phase would occur due to the removal of vegetation, mixing of soil horizons, soil compaction, increased susceptibility of the soils to wind and water erosion, contamination of soils with petroleum products, loss of topsoil productivity, and disturbance of biological soil crusts. Impacts to soils would be proportionate to the amount of disturbance. Sands, gravels, and quarry stone could be excavated for use in the construction of access roads; foundations and ancillary structures; and for well pad and storage areas. Construction of well pads, pipelines, compressor or pumping stations, access roads, and other project facilities could cause topographic changes. These changes would be minor, but long term. Well pads located on canyon rims or the side slopes of canyons could result in bedrock disturbances. Additional bedrock disturbance could occur due to construction of access roads, pipelines, rock borrow pits, and other ancillary facilities. Possible geological hazards (earthquakes, landslides, and subsidence) could be activated by drilling and blasting. Altering drainage patterns could also accelerate erosion and create slope instability.

3.3 Transportation

Development of an oil and gas field would result in the need to construct and/or improve access roads and would result in an increase in industrial traffic (e.g., hundreds of truck loads or more per well site). Overweight and oversized loads could cause temporary disruptions and could require extensive modifications to roads or bridges (e.g., widening roads or fortifying bridges to accommodate the size or weight of truck loads). An overall increase in heavy truck traffic would accelerate the deterioration of pavement, requiring local government agencies to schedule pavement repair or replacement more frequently than under the existing traffic conditions. Increased traffic would also result in a potential for increased accidents within the project area. The locations at which accidents are most likely to occur are intersections used by project-related vehicles to turn onto or off of highways from access roads. Conflicts between industrial traffic and other traffic are likely to occur, especially on weekends, holidays, and seasons of high use by recreationists. Increased recreational use of the area could contribute to a gradual increase in traffic on the access roads. Over 1,000 truckloads per well could be expected during the drilling/development phase.

IV. VISUAL RESOURCES

During the drilling/development phase, impacts to visual resources would occur as a result of the addition of oil or gas facilities. The addition of wells, pipelines, access roads, and other ancillary facilities would result in an industrial landscape throughout the oil or gas field area. Additional components that would adversely affect the visual character of the landscape are pipelines, pumping units, compressor stations, aggregate borrow areas, equipment storage areas, and, if needed, worker housing units and airstrips. Proposed facilities would introduce new elements of form, line, color, and texture into the landscape, which would dominate foreground views. In some instances, the facilities would be visible from the middle- and background and could, occasionally, dominate the view. Vehicles and the dust they generate would also contribute to visual impacts. Because drilling activities typically take place 24 hours per day, visual impacts would include lighting of drill rigs during nighttime hours. Nighttime lighting on drill rigs would be visible from long distances.

V. WATER RESOURCES (SURFACE WATER AND GROUNDWATER)

Impacts to water resources could occur due to water quality degradation from increases in turbidity, sedimentation, and salinity; spills; cross-aquifer mixing; and water quantity depletion. During the drilling/development phase, water would be required for dust control, making concrete, consumptive use by the construction crew, and in drilling of wells. Depending on availability, it may be trucked in from off-site or obtained from local groundwater wells or nearby surface water bodies. Where surface waters are used to meet drilling and development needs, depletion of stream flows could occur. Drilling and well development often remove enormous amounts of groundwater, referred to as produced water. The generation of produced water can create several problems: water may be depleted from nearby aquifers; and produced groundwater that is saline or contaminated with drilling fluids can contaminate soils or surface waters, if brought to the surface and not reinjected to a suitable subsurface unit. Produced water also may contain organic acids, alkalis, diesel oil, crankcase oils, and acidic stimulation fluids (e.g., hydrochloric and hydrofluoric acids).

Drilling activities may affect surface and groundwater flows. If a well is completed improperly such that subsurface formations are not sealed off by the well casing and cement, aquifers can be impacted by

other non-potable formation waters. The interaction between surface water and groundwater may also be affected if the two are hydrologically connected, potentially resulting in unwanted dewatering or recharging. Soils compacted on existing roads, new access roads, and well pads generate more runoff than undisturbed sites. The increased runoff could lead to slightly higher peak storm flows into streams, potentially increasing erosion of the channel banks. The increased runoff could also lead to more efficient sediment delivery and increase turbidity during storm events. During development, water quality can be affected by:

1. Activities that cause soil erosion or dust that can be washed into water bodies;
2. Weathering of newly exposed soils, causing leaching and oxidation that can release chemicals into the water;
3. Discharges of waste or sanitary water;
4. Use of herbicide and dust suppressants (e.g., magnesium chloride); and
5. Contaminant spills.

Also, increased sediment loading could potentially increase salinity levels.

Primary waste during production is produced water, which can comprise 98% of material brought to the surface. Conventional natural gas wells typically produce less water than oil wells. Substances found in high concentrations in produced water include chloride, sodium, calcium, magnesium, and potassium. Other contaminants can include PAHs, lead, arsenic, barium, antimony, sulfur, zinc, and NORM. Other wastes include residual wastes that remain after separation of the oil and natural gas.

VI. REQUIREMENTS AND IMPACT SOURCES

Acreage

An average oil or gas field has about 4 to 16 wells per square mile. Some coal bed methane fields have wells located every 20 acres, but typical gas methane well spacing varies from one per 40 acres to 320 acres. An individual well pad would occupy less than 5 acres; however, up to 40 acres/well could be disturbed depending upon the length of access roads, pipelines, size of equipment and equipment storage yards, number of wells being drilled from a pad, and other factors associated with the well. Horizontal well drilling techniques can minimize surface disturbance. For example six to eight horizontal wells on a multi-well drill pad can access the same shale gas reservoir volume as sixteen vertical wells.

Emissions

Dust emissions would be produced during clearing, grading, excavation, and blasting; also vehicular and well drilling equipment emissions; and volatile organic compounds (VOCs) from storage and use of equipment fuels. Well drilling emissions could include natural gas (including methane, a greenhouse gas), other VOCs, polycyclic aromatic hydrocarbons (PAHs), BTEX (benzene, toluene, ethylbenzene, and xylenes), carbon dioxide, carbon monoxide, and hydrogen sulfide.

Waste Generation

A potentially large quantity of solid waste would include woody vegetation and miscellaneous wastes associated with site clearing and assembly activities. The main wastes associated with oil and gas production are drilling-waste fluids (muds) – up to 300,000 gallons per day, drilling-waste solids, produced water, and VOCs. Other assorted wastes include sanitary wastes, dispersants, corrosion inhibitors, surfactants, flocculating agents, concrete, casing, and paraffins.

Water Needs

Water would be required for dust control and for making concrete and for use in drilling fluids. Small

amounts of water would be needed for potable use and for cleaning operations throughout construction and drilling. A supply of water in case of accidental fire would also be required. Hundreds of thousands to millions of gallons of water could be required to drill and complete a well. About 3 million gallons or more of water could be required for hydraulic fracturing of the formation. Water recycling employed to process the drilling fluid can reduce water needs by 50 to 65%.

Workforce

About 800 worker-days could be required to construct a well (including workers needed to construct and drill the well and construct access roads and pipelines). On average, about five people, mostly equipment operators, would work on the construction of an individual well pad. Drilling activities for an individual well would require about 12 workers and take about 13 days for a shallow well and up to 46 days for a deep well. Well completion would require about 15 workers and would take 29 to 54 days, depending on depth of the well and number of completion zones. About 10 to 25 construction and supply-related workers would be needed to install new sections of a pipeline gathering system. Access roads would take about one day to construct 1.5 mi of road (on flat areas) to 2 to 3 days for 1.5 mi on steep terrain. About five people would be needed to construct access roads (10 to 25 workers to work in several crews for trunk roads to multiple well pads).

Time

Construction of a well pad, access roads, gathering pipelines, and other ancillary facilities could take more than 20 days to construct. It could take about three months to drill an individual well.

Utility Requirements

Electricity needed to power the drill rigs would probably be supplied by electric power generators that run on diesel fuel.

VII. CONCLUSION

Potential impacts from the drilling and development of an oil or gas field affect much of the project area. Most impacts from drilling and development are temporary in nature, but much of the well site and ancillary facility areas would be altered for the full production period.

Industrial wastes would be produced that are routinely associated with industrial facility construction activities (e.g., waste oils, lubricants, and coolants from the on-site maintenance of construction vehicles and equipment, spent solvents, cleaning agents, paints, and other corrosion control coatings applied to structures, sanitary wastes, and small amounts of wastewaters from cleaning operations).

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