DES 07-60

Draft Oil Shale and Tar Sands Resource Management Plan Amendments to Address Land Use Allocations in Colorado, Utah, and Wyoming and Programmatic Environmental Impact Statement

Vol. 2

BLM

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## Volume 2: Chapters 4, 5, & 6

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# Draft Oil Shale and Tar Sands Resource Management Plan Amendments to Address Land Use Allocations in Colorado, Utah, and Wyoming and Programmatic Environmental Impact Statement

Volume 2: Chapters 4, 5, & 6

U.S. Department of the Interior
Bureau of Land Management

December 2007

## MISSION STATEMENT

It is the mission of the Bureau of Land Management (BLM), an agency of the Department of the Interior, to manage BLM-administered lands and resources in a manner that best serves the needs of the American people. Management is based upon the principles of multiple use and sustained yield taking into account the long-term needs of future generations for renewable and nonrenewable resources.

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# NOTATION

The following is a list of acronyms and abbreviations, chemical names, and units of measure used in this document. Some acronyms used only in tables may be defined only in those tables.

## GENERAL ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ACEC | Area of Critical Environmental Concern |
| AGFD | Arizona Game and Fish Department |
| AGR | aboveground retort |
| ANFO | ammonium nitrate and fuel oil |
| API | American Petroleum Institute |
| APLIC | Avian Power Line Interaction Committee |
| APP | Avian Protection Plan |
| AQRV | air quality related value |
| ARCO | Atlantic Richfield Company |
| ATP | Alberta Taciuk Process |
| AWEA | American Wind Energy Association |
| | |
| BA | biological assessment |
| BCD | barrels per calendar day |
| BLM | Bureau of Land Management |
| BMP | best management practice |
| BO | biological opinion |
| BOR | U.S. Bureau of Reclamation |
| BPA | Bonneville Power Administration |
| BSD | barrels per stream day |
| | |
| CAA | Clean Air Act |
| CAPP | Canadian Association of Petroleum Producers |
| CARB | California Air Resources Board |
| CASTNET | Clean Air Status and Trends NETwork |
| CBOSC | Cathedral Bluffs Oil Shale Company |
| CCW | coal combustion waste |
| CDOT | Colorado Department of Transportation |
| CDPHE | Colorado Department of Public Health and Environment |
| CDW | Colorado Division of Wildlife |
| CEQ | Council on Environmental Quality |
| CFR | *Code of Federal Regulations* |
| CHL | combined hydrocarbon lease |
| CIRA | Cooperative Institute for Research in the Atmosphere |
| CPC | Center for Plant Conservation |
| CRBSCF | Colorado River Basin Salinity Control Forum |

| | |
|---|---|
| CRS | Colorado Revised Statutes |
| CRSCP | Colorado River Salinity Control Program |
| CSS | cyclic steam stimulation |
| CSU | Controlled Surface Use |
| CWA | Clean Water Act |
| CWCB | Colorado Water Conservation Board |
| | |
| DOD | U.S. Department of Defense |
| DOE | U.S. Department of Energy |
| DOI | U.S. Department of the Interior |
| DOL | U.S. Department of Labor |
| DOT | U.S. Department of Transportation |
| | |
| EA | environmental assessment |
| EGL | EGL Resources, Inc. |
| EIA | Energy Information Administration |
| E-ICP | bare electrode in situ conversion process |
| EIS | environmental impact statement |
| EMF | electric and magnetic fields |
| E.O. | Executive Order |
| EOR | enhanced oil recovery |
| EPA | U.S. Environmental Protection Agency |
| EPRI | Electric Power Research Institute |
| EQIP | Environmental Quality Incentives Program |
| ESA | Endangered Species Act of 1973 |
| EUB | Alberta Energy and Utilities Board |
| | |
| FHWA | Federal Highway Administration |
| FLPMA | Federal Land Policy and Management Act of 1976 |
| FONSI | Finding of No Significant Impact |
| FR | *Federal Register* |
| FTE | full-time equivalent |
| FY | fiscal year |
| | |
| GCR | gas combustion retort |
| GHG | greenhouse gas |
| GIS | geographic information system |
| GSENM | Grand Staircase–Escalante National Monument |
| | |
| HAP | hazardous air pollutant |
| HAZCOM | hazard communication |
| HMA | Herd Management Area |
| HMMH | Harris Miller Miller & Hanson, Inc. |
| | |
| I-70 | Interstate 70 |
| IARC | International Agency for Research on Cancer |

| | |
|---|---|
| ICP | in situ conversion process |
| IEC | International Electrochemical Commission |
| IPPC | Intergovernmental Panel on Climate Change |
| ISA | Instant Study Area |
| ISWS | Illinois State Water Survey |
| | |
| JMH CAP | Jack Morrow Hills Coordinated Activity Plan |
| | |
| KOP | key observation point |
| KSLA | Known Sodium Leasing Area |
| | |
| LAU | Lynx Analysis Unit |
| LPG | liquefied petroleum gas |
| $L_{dn}$ | day-night average sound level |
| $L_{eq}$ | equivalent sound pressure level |
| | |
| M&I | municipal and industrial |
| MFP | Management Framework Plan |
| MIS | modified in situ recovery |
| MLA | Mineral Leasing Act |
| MMC | Multi Minerals Corporation |
| MMTA | Mechanically Mineable Trona Area |
| MOU | Memorandum of Understanding |
| MSHA | Mine Safety and Health Administration |
| MSL | mean sea level |
| MTR | military training route |
| | |
| NAAQS | National Ambient Air Quality Standards |
| NADP | National Atmospheric Deposition Program |
| NAGPRA | Native American Graves Protection and Repatriation Act |
| NCA | National Conservation Area |
| NCDC | National Climate Data Center |
| NEC | National Electric Code |
| NEPA | National Environmental Policy Act of 1969 |
| NHPA | National Historic Preservation Act of 1966 |
| NLCS | National Landscape Conservation System |
| NMFS | National Marine Fisheries Service |
| NNHP | Nevada Natural Heritage Program |
| NOI | Notice of Intent |
| NORM | naturally occurring radioactive materials |
| NOSR | Naval Oil Shale Reserves |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | National Park Service |
| NRA | National Recreation Area |
| NRHP | *National Register of Historic Places* |
| NSC | National Safety Council |

| | |
|---|---|
| NSO | No Surface Occupancy |
| NWCC | National Wind Coordinating Committee |
| | |
| OHV | off-highway vehicle |
| OOSI | Occidental Oil Shale, Inc. |
| OPEC | Organization of Petroleum Exporting Countries |
| OSEC | Oil Shale Exploration Company |
| OSHA | Occupational Safety and Health Administration |
| OTA | Office of Technology Assessment |
| | |
| PA | Programmatic Agreement |
| PADD | Petroleum Administration for Defense District |
| PAH | polycyclic aromatic hydrocarbon |
| PCB | polychlorinated biphenyl |
| PEIS | programmatic environmental impact statement |
| PFYC | Potential Fossil Yield Classification |
| P.L. | Public Law |
| PM | particulate matter |
| $PM_{2.5}$ | particulate matter with a mean aerodynamic diameter of 2.5 µm or less |
| $PM_{10}$ | particulate matter with a mean aerodynamic diameter of 10 µm or less |
| PPE | personal protective equipment |
| PSD | Prevention of Significant Deterioration |
| | |
| R&I | relevance and importance |
| RBOSC | Rio Blanco Oil Shale Company |
| RCRA | Resource Conservation and Recovery Act of 1976 |
| RD&D | research, development, and demonstration |
| RF | radio frequency |
| RMP | Resource Management Plan |
| ROD | Record of Decision |
| ROI | region of influence |
| ROW | right-of-way |
| | |
| SAGD | steam-assisted gravity damage |
| SDWA | Safe Drinking Water Act of 1974 |
| SFC | Synthetic Fuels Corporation |
| SHPO | State Historic Preservation Office(r) |
| SIP | State Implementation Plan |
| SMA | Special Management Area |
| SMP | suggested management practice |
| SPR | Strategic Petroleum Reserve |
| SRMA | Special Recreation Management Area |
| SSI | self-supplied industry |
| STSA | Special Tar Sand Area |
| SWCA | SWCA, Inc., Environmental Consultants |
| SWPPP | Stormwater Pollution Prevention Plan |

| | |
|---|---|
| TDS | total dissolved solids |
| THAI | toe to head air injection |
| TIS | true in situ recovery |
| TMDL | Total Maximum Daily Load |
| TOSCO | The Oil Shale Corporation |
| TSCA | Toxic Substances Control Act of 1976 |
| TSDF | treatment, storage, and disposal facility |
| | |
| UDEQ | Utah Department of Environmental Quality |
| UDNR | Utah Department of Natural Resources |
| UDWR | Utah Division of Wildlife Resources |
| USACE | U.S. Army Corps of Engineers |
| USC | *United States Code* |
| USDA | U.S. Department of Agriculture |
| USFS | U.S. Forest Service |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| | |
| VCRS | Visual Contrast Rating System |
| VOC | volatile organic compound |
| VRI | visual resource inventory |
| VRM | Visual Resource Management |
| | |
| WDEQ | Wyoming Department of Environmental Quality |
| WGFD | Wyoming Game and Fish Department |
| WRAP | Western Regional Air Partnership |
| WRCC | Western Regional Climate Center |
| WSA | Wilderness Study Area |
| WSR | Wild and Scenic River |
| WTGS | wind turbine generator system |
| WYCRO | Wyoming Cultural Records Office |

## CHEMICALS

| | | | |
|---|---|---|---|
| $CH_4$ | methane | $NO_x$ | nitrogen oxides |
| CO | carbon monoxide | $O_3$ | ozone |
| $CO_2$ | carbon dioxide | Pb | lead |
| $H_2S$ | hydrogen sulfide | $SO_2$ | sulfur dioxide |
| $NH_3$ | ammonia | $SO_x$ | sulfur oxides |
| $NO_2$ | nitrogen dioxide | | |

**UNITS OF MEASURE**

| | |
|---|---|
| ac-ft | acre foot (feet) |
| bbl | barrel(s) |
| Btu | British thermal unit(s) |
| °C | degree(s) Celsius |
| cfs | cubic foot (feet) per second |
| cm | centimeter(s) |
| dB | decibel(s) |
| dB(A) | A-weighted decibel(s) |
| °F | degree(s) Fahrenheit |
| ft | foot (feet) |
| $ft^2$ | square foot (feet) |
| $ft^3$ | cubic foot (feet) |
| g | gram(s) |
| gal | gallon(s) |
| GJ | gigajoule(s) |
| gpd | gallon(s) per day |
| gpm | gallon(s) per minute |
| GW | gigawatt(s) |
| GWh | gigawatt hour(s) |
| h | hour(s) |
| ha | hectare(s) |
| Hz | hertz |
| in. | inch(es) |
| K | degree(s) Kelvin |
| kcal | kilocalorie(s) |
| kg | kilogram(s) |
| km | kilometer(s) |
| $km^2$ | square kilometer(s) |
| kPa | kilopascal(s) |
| kV | kilovolt(s) |
| kW | kilowatt(s) |
| kWh | kilowatt-hour(s) |
| L | liter(s) |
| lb | pound(s) |
| m | meter(s) |
| $m^2$ | square meter(s) |
| $m^3$ | cubic meter(s) |
| mg | milligram(s) |
| mi | mile(s) |
| $mi^2$ | square mile(s) |
| min | minute(s) |
| mm | millimeter(s) |
| $mm^2$ | square micrometers |
| MMBtu | thousand Btu |
| mph | mile(s) per hour |
| MW | megawatt(s) |
| Pa | pascal(s) |
| ppm | part(s) per million |
| psi | pound(s) per square inch |
| rpm | rotation(s) per minute |
| s | second(s) |
| scf | standard cubic foot (feet) |
| t | metric ton(s) |
| W | watt(s) |
| $yd^2$ | square yard(s) |
| $yd^3$ | cubic yard(s) |
| yr | year(s) |
| µg | microgram(s) |
| µm | micrometer(s) |
| $µm^2$ | square micrometer(s) |
| $µm^3$ | cubic micrometer(s) |

## ENGLISH/METRIC AND METRIC/ENGLISH EQUIVALENTS

The following table lists the appropriate equivalents for English and metric units.

| Multiply | By | To Obtain |
|---|---|---|
| ***English/Metric Equivalents*** | | |
| acres | *0.4047* | hectares (ha) |
| cubic feet ($ft^3$) | 0.02832 | cubic meters ($m^3$) |
| cubic yards ($yd^3$) | 0.7646 | cubic meters ($m^3$) |
| degrees Fahrenheit (ºF) –32 | 0.5555 | degrees Celsius (ºC) |
| Feet (ft) | 0.3048 | meters (m) |
| gallons (gal) | 3.785 | liters (L) |
| gallons (gal) | 0.003785 | cubic meters ($m^3$) |
| inches (in.) | 2.540 | centimeters (cm) |
| miles (mi) | 1.609 | kilometers (km) |
| miles per hour (mph) | 1.609 | kilometers per hour (kph) |
| pounds (lb) | 0.4536 | kilograms (kg) |
| short tons (tons) | 907.2 | kilograms (kg) |
| short tons (tons) | 0.9072 | metric tons (t) |
| square feet ($ft^2$) | 0.09290 | square meters ($m^2$) |
| square yards ($yd^2$) | 0.8361 | square meters ($m^2$) |
| square miles ($mi^2$) | 2.590 | square kilometers ($km^2$) |
| yards (yd) | 0.9144 | meters (m) |
| ***Metric/English Equivalents*** | | |
| centimeters (cm) | 0.3937 | inches (in.) |
| cubic meters ($m^3$) | 35.31 | cubic feet ($ft^3$) |
| cubic meters ($m^3$) | 1.308 | cubic yards ($yd^3$) |
| cubic meters ($m^3$) | 264.2 | gallons (gal) |
| degrees Celsius (ºC) +17.78 | 1.8 | degrees Fahrenheit (ºF) |
| hectares (ha) | 2.471 | acres |
| kilograms (kg) | 2.205 | pounds (lb) |
| kilograms (kg) | 0.001102 | short tons (tons) |
| kilometers (km) | 0.6214 | miles (mi) |
| kilometers per hour (kph) | 0.6214 | miles per hour (mph) |
| liters (L) | 0.2642 | gallons (gal) |
| meters (m) | 3.281 | feet (ft) |
| meters (m) | 1.094 | yards (yd) |
| metric tons (t) | 1.102 | short tons (tons) |
| square kilometers ($km^2$) | 0.3861 | square miles ($mi^2$) |
| square meters ($m^2$) | 10.76 | square feet ($ft^2$) |
| square meters ($m^2$) | 1.196 | square yards ($yd^2$) |

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# 4 EFFECTS OF OIL SHALE TECHNOLOGIES

In the NOI announcing the preparation of this PEIS (70 FR 73791–73792), the BLM indicated its intent to amend land use plans to allow for leasing of oil shale and tar sands resources in Colorado, Utah, and Wyoming. Through a public scoping process, the BLM solicited comments on the proposed PEIS and undertook additional analysis and consultation as part of the PEIS process. After preparation and analysis of an internal draft PEIS and discussion with its cooperating agencies, the BLM has modified its proposed action and, therefore, the scope of analysis for this PEIS. For oil shale, rather than amending plans to support immediate issuance of leases for commercial development of these resources without further NEPA analysis, the BLM proposes to amend land use plans to (1) identify the most geologically prospective oil shale areas in Colorado, Utah, and Wyoming; (2) designate lands that will be open to application for commercial leasing, exploration, and development; (3) identify any technology restrictions; (4) stipulate requirements for future NEPA analyses and consultation activities; and (5) specify that the BLM will consider and give priority to the use of land exchanges to facilitate commercial oil shale development pursuant to Section 369(n) of the Energy Policy Act of 2005. Specific land use plan amendments are provided in Appendix C. (See Chapter 5 for the discussion of tar sands resources.) In the case of both oil shale and tar sands, additional NEPA analysis will be conducted prior to the issuance of leases.

Although the proposal analyzed in this PEIS has now shifted away from supporting issuance of commercial leases of oil shale and tar sand resources, substantial information was identified regarding current and emerging development technologies that will still be useful for decision makers and the public with respect to the proposal to amend the land use plans. Chapter 4 of this PEIS contains a summary of this information on oil shale technologies and their potential environmental and socioeconomic impacts. Also included in this chapter is a brief description of mitigation measures that the BLM may consider for use if warranted by the results of NEPA analysis undertaken prior to issuance of site-specific oil shale commercial leases and/or approval of detailed plans of development for facilities. Use of the mitigation measures will be evaluated at that time.

Some sections of Chapter 4 are organized on the basis of impacts of specific technologies or practices involved in oil shale development, while other sections of Chapter 4 focus on the particular resource(s) impacted. For example, Sections 4.7 Noise Resources, 4.13 Hazardous Materials and Waste Management, and 4.14 Health and Safety are organized by technology or project activity, because impacts within these disciplines are distinguished on the basis of these project-specific elements. Alternately, Sections 4.4 Paleontological Resources, 4.5 Water Resources, 4.8 Ecological Resources, and 4.10 Cultural Resources are organized by type of impact on the particular resource, such as land disturbance, water use, or soil contamination, because focus on impacts on the particular resource provides more information, in these instances, than emphasis on specific technologies or practices (i.e., the types of impacts by technology are consistent and the magnitude of impacts would vary on the basis of site-specific considerations).

It is important to understand that information on the technologies presented here is provided for the purpose of general understanding and does not necessarily define the range of possible technologies and issues that may develop in the coming years. Prior to approval of future commercial leases, additional NEPA analysis would be completed that would consider site- and project-specific factors for proposed development activities. The magnitude of impacts and the applicability and effectiveness of the mitigation measures would need to be evaluated on a project-by-project basis in consideration of site-specific factors (e.g., existing land use, presence of paleontological and cultural resources, proximity to surface water, groundwater conditions, existing ecological resources, proximity to visual resources) and project-specific factors (e.g., which technologies would be used, magnitude of operations, water consumption and wastewater generation, air emissions, number of employees, development time lines).

## 4.1 ASSUMPTIONS AND IMPACT-PRODUCING FACTORS FOR INDIVIDUAL FACILITIES BY COMMERCIAL OIL SHALE TECHNOLOGY

This section summarizes some of the assumptions and potential impact-producing factors related to the different commercial oil shale technologies being considered, as well as the potential impacts associated with establishing transmission line and crude oil pipeline ROWs, building employer-provided housing, and expanding the existing electricity supply. Impact-producing factors are defined as activities or processes that cause impacts on the environmental or socioeconomic setting, such as surface disturbance, water use, numbers of employees hired, and generation of solid and liquid waste. Specifically, this section identifies the data used and assumptions made to define potential impact-producing factors for hypothetical future oil shale development facilities. Future production levels are unknown at this time; for purposes of analysis in this PEIS, a level of 50,000 bbl/day of oil for surface mining and underground mining and 200,000 bbl/day of oil for in situ facilities has been assumed. Also, for the purposes of analysis, this assessment looks at the potential impacts from a hypothetical facility, although the actual level of development that could occur in the future is not known. Subsequent NEPA analysis will occur prior to leasing when more information on specific technologies and production levels is available. The information presented here is summarized, in part, from more detailed discussions contained in Appendix A (the oil shale development background and technology overview), as well as previous environmental documents. In those instances where specific data are not available to define a potential impact-producing factor, best professional judgments have been made to establish reasonable assumptions. Discussions relating to air emissions are not included in this section but are instead presented in Section 4.6.

A key assumption is that all applicable federal, state, and local regulatory requirements will be met (see Section 2.2 and Appendix D). Within the following text, specific assumptions that have been made for each technology or major activity that could occur during commercial operations have been identified. In most instances, these assumptions represent good engineering practice or reflect the BLM's understanding of design or performance limitations of various oil shale development activities. In those instances where various options have equal standing as practicable within the industry, the option offering the greatest potential environmental impacts was selected so as not to inadvertently understate these impacts.

### 4.1.1 Surface Mine and Surface Retort Projects

The information presented in Table 4.1.1-1 identifies the key assumptions associated with surface mining and surface retorting of oil shale for a facility whose size would support production of 50,000 bbl/day of oil. As discussed in Section 2.3.1 and Appendix A (Section A.3.1.1), the scope of this PEIS does not include surface mining for commercial development of oil shale in Colorado; therefore, values presented in Table 4.1.1-1 are for surface mine with surface retort projects in Utah and Wyoming only. In addition, in both Utah and Wyoming, surface mining is restricted to those areas where the overburden is 0 to 500 ft thick.

As shown in Table 4.1.1-1, for surface mining facilities, development is assumed to occur with a rolling footprint so that, at any given time, portions of the lease area would be (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing restoration after development; and (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. Permanent surface facilities would be expected to occupy about 100 acres (DOI 1973a). The mine area and spent shale disposal areas would be reclaimed on an ongoing basis. Spent shale may be disposed of by being returned to the mine as operations would permit; there also would be some spent shale disposal on other parts of the lease area. The amount of land used for spent shale disposal would vary from project to project but is expected to be encompassed within the estimated development area identified in Table 4.1.1-1.

Considering the possible range of technology components, it is assumed that 2.6 to 4 bbl of water would be required for production of 1 bbl of shale oil using surface mining/surface retort. Water sources would be varied but may include a combination of groundwater, surface water, and treated process water. Groundwater pumped from the mine or from dewatering wells would be of variable quality; the higher quality water would most likely be used for industrial processes, dust control, and revegetation. Water of lower quality would be reinjected or otherwise disposed of pursuant to state requirements. Retorts produce 2 to 10 gal of wastewater per ton of processed shale that contains various organic and inorganic components that may need treatment depending on final use (DOI 1973a).

Assumptions regarding surface mining, surface retorts, spent shale from surface retorting, and upgrading activities associated with surface retorting include the following.

#### Surface Mining

- Only areas with overburden thicknesses of 500 ft or less would be developed by using surface mining techniques.

- Topsoil and subsoil removed as overburden would be separately stockpiled and vegetated to mitigate or eliminate erosion.

**TABLE 4.1.1-1 Assumptions Associated with a Surface Mine with Surface Retort with Production of 50,000 bbl of Shale Oil per Day[a]**

| Impact-Producing Factor | Value Used in Impact Analyses |
|---|---|
| Footprint of development area (acres)[b] | |
| Utah | 600–1,200 |
| Wyoming | 1,000–2,000 |
| ·Surface Disturbance[c] | 5,760 |
| Water use (ac-ft/yr)[d] | 6,100–9,400 |
| Wastewater (gal/ton of shale)[e] | 2–10 |
| Direct employment for surface mining | |
| Construction | 910 |
| Operations | 1,300 |
| Direct employment for surface retort | |
| Construction | 530 |
| Operations | 620 |
| Total employment[f] | |
| Construction | 2,200 |
| Operations | 2,900–3,000 |

[a] bbl = barrel; 1 bbl shale oil = 42 gal.

[b] These acreages represent the estimated range of surface disturbance that could occur at any given time during the life of the project once a surface mine with surface retort project reaches commercial levels of production. Development is expected to occur with a rolling footprint so that, ultimately, the entire lease area would be developed and then restored. Because the shales are not as rich in Wyoming as they are in Utah, a larger area is necessary to get the same oil equivalent.

[c] It is assumed that the entire lease area will be disturbed during the 20-year time frame analyzed in this PEIS. The assumed lease area of 5,760 acres is based on provisions of the MLA as revised by Section 369(j) of the Energy Policy Act of 2005.

[d] These estimates were calculated on the basis of estimates that surface mine/surface retort projects would require 2.6 to 4 bbl of water per barrel of shale oil produced. 1 bbl = 0.0470 ac-ft/yr.

[e] Source: DOI (1973a).

[f] Total employment numbers include both direct and indirect jobs for mining and retorting. The range represents the difference in indirect employment between states for a project of the same size. The methodology is discussed in Section 4.11 and Appendix G.

- Where mine site dewatering is necessary, recovered water would be used for fugitive dust control, moisturizing spent shale, and other nonconsumptive uses, to the extent allowable given water quality considerations.

- Explosives would be used in the mining process to remove overburden and fracture the oil shale.

- Raw shale would be loaded by shovel into trucks for delivery to the crusher, which would be adjacent to the retort and would feed the retort by conveyor belt.

- Strip mine development would provide for disposal of spent shale in areas already mined, to the extent it can be accommodated by available capacity.

- Reclamation would be conducted contemporaneously with mining activities.

**Surface Retorts**

- Surface retorts would be patterned after the Paraho Direct Burn Retort, the TOSCO II Indirect Mode Retort, or the ATP (see Appendix A of the PEIS).

- Surface retorts are considered to be the primary rate-limiting step in any oil shale development process of which they are a part; consequently, because they operate at elevated temperatures (650°F or higher), they would be operated continuously for maximum energy efficiency. Mining and raw shale crushing operations that support the retorts would be of a size to provide a relatively constant supply of properly sized shale to allow the retort to operate continuously at its rated capacity; multiple, simultaneous mining and crushing operations may, therefore, be required.

- Retorts would be positioned at or near the mine entrance, and raw shale would be delivered by truck to the crushing operation, which would be adjacent to the retort and feed the retort by conveyor.

- Primary and secondary crushing would take place adjacent to the retort.

- Flammable gases from retorting would be captured, filtered to remove suspended solids, dewatered, and consumed on-site as supplemental fuel in external combustion devices.

- Condensable liquids would be filtered, dewatered, and delivered to the adjacent upgrading facility.

- Indirect heat sources for surface retort would be provided by external combustion sources fueled by natural gas delivered to the site by pipeline,

propane stored in pressure tanks on-site, or diesel fuel provided by commercial suppliers and stored in on-site aboveground tanks. Each commercial fuel source would be supplemented by combustible gases recovered from the retort.

- Fuel for direct-burn surface retorts would be provided by natural gas, propane, or diesel fuel, each of which would be delivered to the site and stored as noted above and supplemented by combustible gases recovered from the retort.

**Spent Shale from Surface Retorting Activities**

- Regardless of the retort, spent shale volume would increase by 30%.
- All spent shale would be disposed of within the leased parcel.

**Upgrading Activities Associated with Surface Retorting**

- All crude shale oil recovered from surface retorting would require some degree of upgrading.
- Shale oil upgrading requirements would be based on factors such as initial composition of crude shale oil recovered from surface retorts or in situ retorts and desired endpoints.
- At a minimum, upgrading of crude shale oil would consist of:
  - Dewatering;
  - Filtering of suspended solids;
  - Conversion of sulfur-bearing compounds to $H_2S$;
  - Removal of $H_2S$ and conversion to elemental sulfur by using a conventional Claus process or equivalent;[1]
  - Conversion of nitrogen-bearing compounds to ammonia, recovery of ammonia gas, and temporary storage and sale of ammonia gas as fertilizer feedstock; and
  - Hydrogenation or hydrocracking of organic liquids only to the extent necessary to sufficiently change physical properties (American Petroleum

[1] The Claus process is one of many processes used by petroleum refiners to control $H_2S$, a common by-product of crude oil refining, in accordance with air emission regulations and permits. The $H_2S$ is removed from the production gas stream by direct separation and/or by amine extraction. It then is converted into elemental sulfur by a combination of thermal oxidation and catalytic conversion.

Institute [API] gravity, pour point[2]) of the resulting syncrude to allow for conveyance from the mine site by conventional means (tanker truck and/or pipeline).

- Hydrogen used in upgrading would be supplied by a commercial vendor and stored temporarily in transport trailers (high-pressure tube trailers) before use in upgrading reactions; no long-term storage of hydrogen would take place on-site; no steam reforming of $CH_4$ to produce hydrogen would be conducted on-site.

- Fuel for upgrading activities would be commercial natural gas, propane, or diesel, augmented to the greatest extent practical by combustible gases recovered from upgrading activities.

- Water for upgrading would be recovered from surface water bodies (including on-site stormwater retention ponds), mine dewatering operations, or on-site groundwater wells.

- Treatment of wastewaters from upgrading activities would occur on-site; water recycling would be practiced to the greatest extent practical.

### 4.1.2 Underground Mine and Surface Retort Projects

The information presented in Table 4.1.2-1 identifies the key assumptions associated with underground mining and surface retorting of oil shale for a facility of a size to support production of 50,000 bbl of shale oil per day.

As shown in Table 4.1.2-1, permanent surface facilities supporting underground mining operations would be expected to occupy about 150 acres (DOI 1973a). It is assumed that up to 30% of the processed spent shale could be returned to the mine for disposal. If 30% of spent shale is returned to the mine, surface disposal is estimated to require approximately 60 ac/yr with disposal heights and depths of 250 ft. To develop a conservative estimate of land surface disturbance for underground mining operations, if it is assumed that all spent shale is disposed of on the land surface, 75 ac/yr would be required for disposal (DOI 1973a). This would result in 1,500 acres disturbed over the 20-year study period (in addition to the 150 acres disturbed for surface facilities). The amount of land used for spent shale disposal would vary from project to project but is expected to be encompassed within the estimated development area identified in Table 4.1.2-1.

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2 The pour point is the temperature at which the petroleum liquid's viscosity is sufficiently low to allow pumping and transfer operations with conventional liquid handling equipment. API gravity is an arbitrary scale for expressing the specific gravity or density of liquid petroleum products. Heavier viscous petroleum liquids have the lower API values.

**TABLE 4.1.2-1 Assumptions Associated with an Underground Mine with Surface Retort with Production of 50,000 bbl of Shale Oil per Day[a]**

| Impact-Producing Factor | Value Used in Impact Analyses[b] |
|---|---|
| Footprint of development area (acres) | 150 |
| Surface Disturbance[c] | 1,650 |
| Water use (ac-ft/yr)[d] | 6,100–9,400 |
| Wastewater (gal/ton of shale)[e] | 2–10 |
| Direct employment for underground mining | |
| Construction | 940 |
| Operations | 1,300 |
| Direct employment for surface retort | |
| Construction | 530 |
| Operations | 620 |
| Total employment[f] | |
| Construction | 2,200–2,600 |
| Operations | 2,900–3,300 |

[a] bbl = barrel; 1 bbl shale oil = 42 gal.

[b] The values apply to activities within all three states.

[c] For underground mines, it is assumed that 1,650 acres of the lease area would be disturbed (150 acres required for surface facilities; up to 1,500 acres used for spent shale disposal over a 20-yr project lifetime). An assumed lease area of 5,760 acres is based on provisions of the MLA as revised by Section 369(j) of the Energy Policy Act of 2005. The preference right lease area associated with the OSEC RD&D project is 5,120 acres as defined by the terms of the RD&D program (see Section 1.4.1).

[d] Calculated on the basis of estimates that underground mine with surface retort projects would require 2.6 to 4 bbl of water per barrel of shale oil produced. 1 bbl = 0.0470 ac-ft/yr.

[e] Source: DOI (1973a).

[f] Total employment numbers include both direct and indirect jobs for mining and retorting. The range represents the difference in indirect employment between states for a project of the same size. The methodology is discussed in Section 4.11 and Appendix G.

Considering the possible range of technology components, it is assumed that 2.6 to 4 bbl of water would be required for production of 1 bbl of shale oil. Water sources would be varied but may include a combination of groundwater, surface water, and treated process water. Groundwater pumped from the mine or from dewatering wells would be of variable quality; the higher quality water would most likely be used for industrial processes, dust control, and revegetation. Water of lower quality would be reinjected or otherwise disposed of pursuant to state requirements. Retorts produce 2 to 10 gal of wastewater per ton of processed shale that contains various organic and inorganic components that may need treatment depending on final use (DOI 1973a).

Assumptions regarding surface retorts and upgrading activities associated with surface retorting are discussed above in Section 4.1.1. Additional assumptions regarding underground mining include the following.

**Underground Mining**

- Some mines would be "gassy"; both $H_2S$ and $CH_4$ would be present, placing additional demands on the ventilation system for worker safety and introducing additional controls for the use of explosives.
- Explosives would be used in the mining process.
- Primary crushing would occur at the surface and not within the mine.[3]
- Conventional room-and-pillar techniques would be used.
- At least two levels of room-and-pillar development would occur.
- Mine dewatering would occur continuously throughout the life of the mine. Recovered water would be used for fugitive dust control, moisturizing spent shale, and other nonconsumptive uses, to the extent allowable given water quality considerations. All recovered water would be contained on-site.
- No more than 30% of the spent shale would be disposed of within the mine; the remainder would be disposed of on the surface. This assumption is based on a best estimate of what may be feasible at any given site; specific mine development procedures may accommodate disposal of a greater percentage of the spent shale inside the mine.
- Resource extraction would depend on local structural features, but at no location would extraction go beyond 60% (by volume) of the formation.

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3 Although some primary crushing typically takes place within the mine, to assess maximum potential impacts conservatively, it is assumed that all crushing and sizing of raw shale would take place on the surface.

### 4.1.3 In Situ Retort Projects

The information presented in Table 4.1.3-1 identifies the key assumptions associated with in situ retort projects whose size would support production of 200,000 bbl of shale oil per day. Development is assumed to occur with a rolling footprint so that, at any given time, portions of the lease area would be (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing restoration after development; and (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. Permanent surface facilities would be expected to occupy about 200 acres (BLM 2006d).

It is assumed that 1 to 3 bbl of water would be required for production of 1 bbl of shale oil (Bartis et al. 2005) using in situ technologies. Water would come from wells, surface sources, and treated process water.

Groundwater and process water would be of variable quality, with the higher quality water being used for industrial processes, dust control, revegetation, etc. Water of lower quality would be reinjected or otherwise disposed of pursuant to state requirements.

Additional assumptions regarding in situ retorting include the following:

**In Situ Retorting**

- Some degree of upgrading of initial kerogen pyrolysis products can be expected to occur within the formation, before product recovery occurs.

- Minimal upgrading of recovered products would be required and is likely to include:

  - Dewatering;
  - Gas/liquid separations;
  - Filtering of suspended solids from both gaseous and liquid fractions;
  - Removal of hydrogen sulfide gas, conversion to elemental sulfur, temporary on-site storage, and sale;
  - Removal of $H_2S$ gas, temporary on-site storage, and sale as fertilizer feedstock;
  - Hydrogenation/hydrotreating/hydrocracking performed on condensable liquids only if necessary to adjust API gravity; and
  - Viscosity adjustments to allow for transport by conventional means (tanker truck and/or pipeline) to a conventional petroleum refinery.

- Recovered and/or upgraded liquid products would be stored temporarily on-site in aboveground tanks before delivery to market or conventional petroleum refineries by tanker truck or pipeline.

**TABLE 4.1.3-1 Assumptions Associated with an In Situ Retort Project with Production of 200,000 bbl of Shale Oil per Day[a]**

| Impact-producing Factor | Value Used in Impact Analyses |
|---|---|
| Footprint of development area (acres)[b] | |
| Colorado and Utah | 150–600 |
| Wyoming | 1,000–2,000 |
| Surface Disturbance[c] | 5,760 (5,120) |
| Water use (acre-ft/yr)[d] | 9,400–28,200 |
| Direct employment for in situ projects | |
| Construction | 1,500 |
| Operations | 500 |
| Total employment[e] | |
| Construction | 2,300–2,900 |
| Operations | 780–950 |

[a] bbl = barrel; 1 bbl shale oil = 42 gal.

[b] The acreages represent the estimated range of surface disturbance that could occur at any given time during the life of the project once an in situ project reaches commercial levels of production. Development is expected to occur with a rolling footprint so that, ultimately, the entire lease area would be developed and then restored. Because the shales are not as rich in Wyoming as they are in Colorado and Utah, a larger area is necessary to obtain the same oil equivalent.

[c] It is assumed that the entire lease area will be disturbed during the 20-year time frame analyzed in this PEIS. The assumed lease area of 5,760 acres is based on provisions of the MLA as revised by Section 369(j) of the Energy Policy Act of 2005. The preference right lease area associated with the five RD&D projects in Colorado is 5,120 acres as defined by the terms of the RD&D program (see Section 1.4.1).

[d] Calculated on the basis of estimates that in situ projects would require 1 to 3 bbl of water per barrel of shale oil produced (Bartis et al. 2005). 1 bbl equals 0.0470 ac-ft/yr.

[e] Total employment numbers include both direct and indirect jobs for in situ projects. The range represents the difference in indirect employment between states for a project of the same size. The methodology is discussed in Section 4.11 and Appendix G.

- 100% of combustible gases recovered from the formation would be dewatered, filtered of suspended solids, and consumed on-site as supplemental fuel in external combustion sources.

### 4.1.4 Transmission Line and Crude Oil Pipeline ROWs

Oil shale projects would need to connect to the existing transmission grid (or to new regional transmission lines) to obtain electricity. The maximum distance from an existing 500-kV transmission line to any of the oil shale resources is approximately 150 mi. The maximum distance from an existing 230-kV transmission line to any of the oil shale resources is approximately 45 mi. The greater distance of 150 mi has been assumed for all oil shale projects, although some projects could be located closer to existing transmission lines. Project economics would likely select for sites closest to existing infrastructure.

For the purposes of analysis, it is assumed that one connecting transmission line and ROW would serve each project and would be 150 mi long, 100 ft wide, and with construction impacts extending up to 150 ft in width (equivalent to a disturbed area of 1,800 acres during operations and 2,700 acres during construction). The 150-mi distance assumption and 100-ft ROW size represent probable maximum sizes.

It also has been assumed that all processing required to upgrade the oil shale product to render it suitable for pipeline transport and acceptance at refineries would be conducted on-site. Oil shale projects would need to connect to existing regional crude pipelines (or to new regional pipelines) through the installation of new feeder pipelines. It is assumed that one pipeline and ROW would serve each project. It is assumed that the pipeline ROW would be 55 mi long, 50 ft wide, with construction impacting an area as wide as 100 ft (equivalent to a disturbed area of 330 acres during operations and 670 acres during construction). The 55-mi distance assumption and 50-ft ROW size represent probable maximum sizes.

Although new transmission lines and pipelines could very likely be utilized by more than one oil shale production facility, the resulting reduction in overall land disturbance is not considered, and as a result, this analysis could overestimate impacts from such infrastructure.

### 4.1.5 Workforce Operational Details and Employer-Provided Housing

A number of assumptions have been made regarding the workforce, operations schedule, and housing for workers who move into the three-state study area to support future commercial oil shale development. It is assumed that at commercial scale, all projects would operate 24 hours a day, 7 days a week. It is further assumed that about 30% of the construction and operations workers, including those hired directly to work on oil shale projects as well as those hired for jobs indirectly related to the development, would bring families with them, with an average family size of 2.6 (see Section 4.11). Some portion of these incoming people would live in housing provided by the operators. The locations of the employer-provided housing are unknown at this time; however, housing is not expected to be located on public lands.

Employer-provided housing would be constructed as needed to house the workforce and also to provide facilities and infrastructure (e.g., groceries, basic medical care, schools, and recreation). A density of 35 people per acre is assumed for this employer-provided housing.

The BLM has made state-specific assumptions regarding what percentage of the workers and their families would be housed in employer-provided housing, as opposed to those that would move into existing communities. Section 4.11 provides a more detailed discussion of these and related assumptions. Table 4.1.5-1 provides estimates of the number of people that would be housed in local communities versus employer-provided housing, and the number of acres that would be required to support the employer-provided housing by technology.

### 4.1.6 Expansion of Electricity-Generating Capacity

Additional power generation capacity would need to be developed in the region to support commercial oil shale development; however, at this time, definitive information about

**TABLE 4.1.5-1 Estimated Housing Distribution of Incoming People and Acres Impacted by Employer-Provided Housing for the Construction and Operations Phases of Commercial Oil Shale Development**

| | Construction | Operations |
|---|---|---|
| Surface mine with surface retort (50,000 bbl/day) | | |
| Total population (including families)[a] | | |
| Employer-provided housing | 1,800–2,100 | 1,100–1,800 |
| Local communities | 1,200–1,500 | 2,600–3,400 |
| Maximum size of employer-provided housing (acres)[b] | 51–60 | 31–51 |
| Underground mine with surface retort (50,000 bbl/day) | | |
| Total population (including families)[a] | | |
| Employer-provided housing | 1,500–2,100 | 900–1,800 |
| Local communities | 1,200–2,400 | 2,600–4,100 |
| Maximum size of employer-provided housing (acres)[b] | 43–60 | 26–51 |
| In situ projects (200,000 bbl/day) | | |
| Total population (including families)[a] | | |
| Employer-provided housing | 1,500–2,200 | 250–470 |
| Local communities | 1,300–2,800 | 700–1,200 |
| Maximum size of employer-provided housing (acres)[b] | 43–63 | 7–13 |

[a] The total population, including families, was calculated on the basis of the total number of new direct and indirect workers that would move into the three-state study area, assuming that 30% of them bring families with an average family size of 2.6 people. The ranges for employment numbers take into consideration state-specific conditions; the methodology is discussed in Section 4.11 and Appendix G.

[b] These estimates are based on an assumed density of 35 people per acre for employer-provided housing. This acreage is not expected to be on public lands.

the power requirements of commercial oil shale development is not available. Nonetheless, some general observations can be made: power needs would vary by phase of development (pilot-scale versus commercial-scale); power needs would vary by technology, even between the different in situ technologies being evaluated; and the in situ processes that use nonelectric heating technologies would use less power than those that rely on electricity for heating the shale. To meet these additional power needs, it is assumed that existing capacity would be expanded through a combination of construction of new power plants and expansion of existing power plants.

For the purposes of analysis in this PEIS, the BLM has assumed that future in situ projects would require 2,400 MW of additional electricity generation capacity when commercial production levels are reached. This estimate is based in part on published information indicating that the Shell in situ technologies being evaluated as part of the oil shale RD&D program require about 1,200 MW of power for every 100,000 bbl of shale oil produced (Bartis et al. 2005). The BLM has projected that this new electricity capacity would be provided by conventional coal-fired plants. As noted above, in situ processes that use nonelectric heating technologies would use less power. For surface and underground mining projects, the BLM has assumed that power needs would be met through the expansion of existing power plants.

Information on assumptions and impact-producing factors for a 1,500-MW coal-fired power plant is available (BLM 2007a; Thompson 2006c). Table 4.1.6-1 summarizes these assumptions and provides extrapolated values for a 2,400-MW power plant.

### 4.1.7 Refining Needs for Oil Shale Development Projects

Factors that would likely impact the incorporation of oil shale into the refinery market are discussed in Attachment 1 to Appendix A. This attachment specifically examines the anticipated refinery market response to potential oil shale production over the 20-year time frame assessed in

**TABLE 4.1.6-1 Assumptions Associated with a 1,500-MW and a 2,400-MW Conventional Coal-Fired Electric Power Plant**

| Impact-Producing Factor | Value Used in Impact Analysis for a 1,500-MW Plant[a] | Value Used in Impact Analysis for a 2,400-MW Plant[b] |
|---|---|---|
| Land use (acres) | 3,000 total (includes construction acreage) | 4,800 |
| Water use (ac-ft/yr) | 8,000 ac-ft/yr | 13,000 |
| Employment (direct full-time equivalents) | Construction: 1,200–1,500; Operations: 150 | Construction: 1,900–2,400; Operations: 240 |

[a] BLM (2007a).

[b] Values for 2,400-MW power plant extrapolated from values for 1,500-MW plant.

this PEIS. It provides a brief overview of the U.S. petroleum refinery market and identifies some of the major factors that would influence decisions regarding construction or expansion of refineries and displacement of comparable volumes of crude.

During the initial period of oil shale development, when only pilot-scale production is anticipated, all product generated by oil shale projects would be transported to existing refineries located outside the study area via pipeline or tanker truck.

Refinery market development for the oil shale product is likely to occur in three phases: Phase 1, early adoption and local market penetration within the Rocky Mountain Region; Phase 2, market expansion outside of the Rocky Mountain Region (Petroleum Administration for Defense District) with increased logistical capability; and Phase 3, high-volume production and multimarket penetration of a mature shale oil industry. Phase 1 may be projected to occur during the first 5 years of commercial development of a facility. If approximately 1,000,000 bbl/day of oil shale were produced in Colorado during this time, that shale oil supply would be placed into a refinery market that already is experiencing excess domestic production. Transportation capacity would be the limiting factor during this phase. It is likely that the crude shale oil would only replace existing sources of crude of comparable quality, and that there would be construction of new crude pipelines in the Rocky Mountain refining region.

Phase 2, market expansion, is likely to involve an expansion of the crude oil transportation network to allow distribution of the crude shale oil outside the Rocky Mountain refining region. The most likely markets are the Midwest and the Gulf Coast refining markets. New market penetration would require displacement of alternative sources of crude. There could be some expansion at existing refineries. It is unlikely that new refineries would be constructed.

During Phase 3, assuming large volumes of crude shale oil would be produced (approximately 2 million bbl/d), the shale oil would break into every U.S. refining market. By this time, it is reasonable to expect that West Coast refineries that have been utilizing Alaskan North Slope crude would be searching for alternative sources of supply, which could bring these refineries into the shale oil market equation. These West Coast refineries, and also Midwest refineries, would likely accept shale oil at that time, so there would not be a need for additional refinery capacity. Therefore, development of additional refinery capacity is not considered to be necessary as a result of oil shale development and is not considered further in this PEIS.

### 4.1.8 Additional Considerations and Time Lines

The above assumptions broadly describe the impact-producing factors for commercial oil shale development. Within these general facility descriptions, many permutations are possible. For example, various surface retort designs exist, each with its own unique set of environmental impacts and resource demands. A detailed definition of each possible permutation and a subsequent analysis of its impacts would be impractical and speculative, because there is no way to identify the precise development schemes that may be proposed by future developers. Furthermore, while it is likely that commercial development would be accompanied by the centralization or consolidation of some services (e.g., product storage, waste management, and

equipment maintenance), it is not possible at this time to predict how this would evolve. This PEIS, therefore, provides an analysis of the range of impacts from each of the major technologies that might be deployed in the future, along with an analysis of the supporting services that would be required by each technology, but it does not analyze specific facility configurations or technology combinations. Efficiencies and economies that would be realized from integrated systems or centralized services are not considered. As a result, outcomes from this analysis could inadvertently overstate some impacts especially if the resulting impacts are added together to accommodate multiple projects.

Although there are many unknowns with respect to time lines for construction and operations of commercial-scale shale oil production facilities, in general, it can be assumed that projects using in situ technologies would require about 3 years of construction and permitting before pilot testing; that pilot testing would last 6 years; and that additional construction to scale up to commercial levels would take 2 more years. It can be assumed that the permitting and construction phases for both surface and underground mines would take longer than such phases for in situ projects, such that construction and permitting before pilot testing would take about 7 years, that pilot testing would last 6 years, and that permitting and construction to scale up to commercial levels would take 5 more years. For all commercial oil shale projects, regardless of the technologies used, it can be assumed that maximum production levels would be reached after 3 to 5 years of commercial operations.

## 4.2 LAND USE

### 4.2.1 Common Impacts

As discussed in Section 3.1, lands within the three-state study area where commercial oil shale development might occur are currently used for a wide variety of activities, including recreation, mining, hunting, oil and gas production, livestock grazing, wild horse and burro herd management, communication sites, and ROW corridors (e.g., roads, pipelines, and transmission lines). Commercial oil shale development activities would have a direct effect on these uses, displacing them from areas being developed to process oil shale.

Indirect impacts of oil shale development would be associated with changing existing off-lease land uses including conversion of land in and around local communities from existing agricultural, open space, or other uses to provide services and housing for employees and families that move to the region in support of commercial oil shale development. Increases in traffic, increased access to previously remote areas, and development of oil shale facilities in currently undeveloped areas would continue changing the overall character of the landscape that has already begun as a result of oil and gas development. The value of private ranches/residences adjacent to oil shale developments or ROWs may be reduced because of perceived noise, human health, or aesthetic concerns.

Although transmission and pipeline ROWs associated with commercial oil shale development would not necessarily preclude other land uses, they would result in both direct and

indirect impacts. Direct impacts (e.g., the loss of available lands to physical structures, maintenance of ROWs free of major vegetation, maintenance of service roads, and noise and visual impacts on recreational users along the ROW) would last as long as the transmission lines and pipelines were in place. Indirect impacts, such as the introduction of or increase in recreational use to the area due to improved access, avoidance of the area adjacent to public lands for residential or recreational use for aesthetic reasons, and increased traffic, could occur and be long-term.

The specific impacts on land use and their magnitude would depend on project location; project size and scale of operations; proximity to roads, transmission lines, and pipelines; and development technology. The following sections discuss the common impacts on different types of land uses and potential mitigation measures that may be applicable on a site-by-site basis.

#### 4.2.1.1 Other Mineral Development Activities

A significant portion of the land within the most geologically prospective oil shale areas is already undergoing mineral development, particularly for the development of oil and gas resources. Commercial oil shale development, using any technology under consideration in this PEIS, is largely incompatible with other mineral development activities and will likely preclude these other activities while oil shale development and production are ongoing. Areas with oil shale resources where there are existing oil and gas or other mineral leases may be precluded from development, since currently the leases that are first in time have priority. Without some accommodation being made between oil shale developers and prior leases holders, oil shale development may not be able to proceed. Conflicts between competing mineral resource uses would be resolved in the future at the leasing or plan of development stages.

While it is possible that undeveloped portions of an oil shale lease area could be available for other mineral development, such development would be unlikely to occur on a widespread basis, except possibly in areas where a single company was developing multiple resources. Similarly, it is possible that oil shale extraction technologies could evolve to a point where other mineral development activities could be conducted simultaneously; however, predicting how that would translate into land use impacts is not possible at this time.

Similarly, as discussed in Section 2.3.3, the BLM has determined that it will carry forward decisions in the White River RMP (BLM 1997) establishing the Multimineral Zone within which mineral development would be allowed only if recovery technologies are implemented to ensure that the development of one mineral does not prevent recovery of other minerals (see Section 3.1.1.3 and Figure 3.1.1-3). As a result, impacts on nahcolite and dawsonite development are expected to be negligible within the Multimineral Zone. The BLM also has determined that it will not carry forward decisions in the White River RMP to restrict oil shale leasing from the Piceance Creek Dome area. By making lands within the Piceance Creek Dome area available for application for commercial leasing, potential conflict between oil shale and oil and gas development could occur.

The authorization of ROWs for connecting transmission lines and oil pipelines would result in fewer impacts on other mineral development activities than would commercial oil shale development projects. It is assumed that the ROWs could be located in a manner that would largely avoid impacts on mineral development activities by avoiding areas of mineral development or being co-located in a manner that is consistent with planned resource development.

#### 4.2.1.2 Conversion or Transfer of Water Rights

Demand for reliable, long-term water supplies to support oil shale development could lead to the conversion of existing water rights from current uses. Water would be needed to support direct oil shale operations and to support both additional population and potential power plant operation. In the Piceance Basin, there has already been acquisition of agricultural water rights by oil shale development companies. While it is not presently known how much surface water will be needed to support future development of an oil shale industry, or the role that groundwater would play in future development, it is likely that additional agricultural water rights could be acquired. Depending on the locations and magnitude of such acquisitions, there could be a noticeable reduction in local agricultural production and land use.

#### 4.2.1.3 Grazing Activities

Grazing activities would be precluded by commercial oil shale development in those portions of the lease area that were (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing restoration after development; or (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. Grazing might be possible in the remaining undeveloped portions of the lease area or on portions that were successfully restored after development. On the basis of assumptions discussed above regarding the amount of land that would be disturbed at any given time for different technologies, it is possible that 3,120 to 4,970 acres within a 5,760-acre lease area would remain available for grazing. Depending on conditions unique to the individual grazing allotment, temporary or long-term reductions in authorized grazing use may be necessary because of loss of a portion of the forage base.

Once established, transmission line and pipeline ROWs would not prevent use of the land for grazing other than the areas physically occupied by aboveground facilities. The establishment of employer-provided housing might preclude grazing activities, depending upon how the housing is developed and the location, although this development is not expected to occur on public lands. Construction of new power plants or expansion of existing ones would likely preclude grazing on lands within the 4,800-acre footprint, although this development is also not expected to occur on public lands.

#### 4.2.1.4 Recreational Use

Commercial oil shale development activities are largely incompatible with recreational land use (e.g., hiking, biking, fishing, hunting, bird watching, OHV use, and camping). As discussed in Section 4.2.1.3 regarding grazing activities, recreational land use could be precluded from those portions of the lease area, depending on the technology employed. While recreational use could be possible in undeveloped or restored portions of the lease area, the amount of land that would be available would vary from project to project. The change in the overall character of the undeveloped BLM-administered lands to a more industrialized, developed area would displace people seeking more primitive surroundings in which to hunt, camp, ride OHVs, etc. Many BLM Field Offices have designated lands as open, closed, or available for limited OHV use. Areas that would be open to application for commercial oil shale development may be currently available for some level of OHV use, and commercial oil shale development in these areas would displace this use. Even if access could be granted to portions of the lease area for recreational use, visitors might find the recreational experience to be compromised by the nearby development activities. Such impacts could also occur on recreational users of adjacent, off-lease lands. In addition, impacts on vegetation, development of roads, and displacement of big game could degrade the recreational experiences and hunting opportunities near commercial oil shale projects. To the extent that commercial developments might be clustered together (e.g., possibly in the Piceance Basin), the effect on recreation uses would be magnified by changing the overall character of a larger area and by dominating a larger portion of the landscape.

Once established, transmission line and pipeline ROWs would present fewer impacts on recreation users than would the actual commercial development projects. Access to the land in the ROWs would not be precluded; however, depending on the type of recreation, the overall recreational experience could be adversely affected by the visual disturbance to the landscape and potential noise impacts associated with overhead transmission lines. The establishment of employer-provided housing, although not likely to be located on public lands, would preclude recreational land use and might cause indirect impacts on recreational land use on adjacent lands, depending upon how the housing is developed and the location. Construction of new power plants, although this development also is not likely to occur on public lands, or expansion of existing plants would likely preclude recreational use on lands within the 4,800-acre plant footprint and may displace recreation uses on adjacent lands.

#### 4.2.1.5 Specially Designated Areas, Potential ACECs (in Utah), and Areas with Wilderness Characteristics

As discussed in Section 1.2, the BLM has determined that certain designated areas are excluded from commercial oil shale leasing. These areas include all designated Wilderness Areas, WSAs, other areas that are part of the NLCS (e.g., National Monuments, NCAs, WSRs, and National Historic and Scenic Trails) and existing ACECs that are closed to mineral development. Because of these exclusions, these designated areas would not incur direct impacts associated with commercial oil shale development. They might, however, incur indirect impacts (e.g., dust and degraded viewshed) resulting from commercial oil shale development on adjacent

lands or areas within the general vicinity. Section 4.9 discusses impacts on visual resources in greater detail.

Existing ACECs that are not closed to mineral development and potential ACECs that are currently under consideration for designation as part of ongoing land use planning efforts would be available for application for commercial leasing in the future. In general terms, commercial development in both existing and potential ACECs could result in direct or indirect loss of the R&I values that support either designation or identification of the areas leading to the removal/nondesignation of the ACECs. Decisions regarding either designating potential ACECs or committing the areas to other uses would be made by local BLM Field Offices utilizing the BLM planning process and NEPA analyses.

Another category of lands are those that have been recognized by the BLM as having one or more wilderness characteristics, yet are not eligible for formal recognition as a WSA. Lands that have been identified in this manner by the BLM are discussed in Section 3.1. Commercial oil shale development activities and the development of transmission line and pipeline ROWs within these areas would cause a loss of the wilderness characteristics in and around the disturbed areas. Decisions regarding either the protection and management of these wilderness characteristic areas or committing the areas to other uses would be made by local BLM Field Offices utilizing the BLM planning process and NEPA analyses.

All specially designated areas, potential ACECs, and areas with wilderness characteristics that are located in the vicinity of the most geologically prospective oil shale areas evaluated in this PEIS are identified in Section 3.1.

#### 4.2.1.6 Wild Horse and Burro Herd Management Areas

As discussed in Section 3.1.1, the most geologically prospective oil shale resources evaluated in this PEIS coincide with a number of designated Wild Horse HMAs; they do not coincide with any Wild Burro HMAs. Specifically, the following HMAs overlie the oil shale resources: the Piceance-East Douglas Creek HMA in the White River Field Office, Colorado; the Hill Creek HMA in the Vernal Field Office, Utah; and the Adobe Town, Little Colorado, Salt Wells Creek, and White Mountain HMAs in the Rawlins and Rock Springs Field Offices, Wyoming. At least some portion of each of these HMAs coincides with lands proposed to be available for application for leasing under the oil shale alternatives.

As discussed in Section 4.2.1.3 regarding grazing activities, the management of wild horse herds is not compatible within those portions of commercial oil shale lease areas that are (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing restoration after development; or (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. Animals would likely be displaced from the areas of commercial development, and, depending upon the conditions in the individual HMA, it might be necessary to reduce herd numbers to match forage availability on the undisturbed portion(s) of the HMA. If horses emigrate out of HMA boundaries because of the disturbance within the HMA, they could be removed via the capture and adoption program.

Transmission line and pipeline facilities would not prevent use of the land by horses or burros other than in the areas physically occupied by aboveground facilities, although they could be subject to disturbance or harassment from people using the ROWs for access. For more information about impacts on wild horses, see Section 4.8.1.3 and Table 4.8.1-1.

#### 4.2.1.7 Different Oil Shale Development Technologies

For the most part, impacts on land use would be the same regardless of the development technology used. There are a few exceptions, as follows:

- In situ technologies would not generate spent shale and other waste rock (e.g., overburden) for disposal. Spent shale would be generated by retorting of mined oil shale. The volume of spent shale could be very significant. Spent shale would be disposed of on the lease area as approved by the BLM. Additional lands beyond the mine footprint could be disturbed for spent shale disposal. Following successful reclamation, these additional lands could be largely available for other land uses again.

- Underground mines would require fewer acres of surface disturbance than surface mines. To some degree, they might also impact fewer surface acres than in situ projects. The amount of surface disturbance will depend on the technology employed, the characteristics of the project site, and the approved plan of development.

### 4.2.2 Mitigation Measures

The direct and indirect impacts on land use described above could be mitigated to some extent by a number of actions, including in some instances application of specific engineering practices. The effectiveness of these potential mitigation measures and the extent to which they are applicable would vary from project to project and need to be examined in detail in future NEPA reviews of leasing and project plans of development. Potential mitigation measures include the following:

- Consulting with federal and state agencies, property owners, and other stakeholders as early as possible in the planning process to identify potentially significant land uses and issues, rules that govern commercial oil shale development locally, and land use concepts specific to the region;

- During the project design and planning phase, incorporating considerations regarding the use of lands in undeveloped or restored portions of the lease area to maximize their potential for other uses (e.g., grazing, recreational use, or wild horse herd management);

- During the project design and planning phase, incorporating considerations regarding the use of adjacent lands to minimize direct and indirect off-lease land use impacts;

- During the project design and planning phase, providing for consolidation of infrastructure wherever possible to maximize efficient use of the land;

- During the siting, design, and planning phase for employer-provided housing, incorporating considerations regarding the use of adjacent lands to minimize direct and indirect off-lease land use impacts;

- During the siting, design, and planning phase for the construction of additional electricity power generation, providing for consolidation of infrastructure wherever possible and incorporating considerations regarding the use of adjacent lands to minimize direct and indirect off-lease land use impacts; and

- Developing and implementing effective land restoration plans to mitigate long-term land use impacts.

To address more specific impacts on land use, such as impacts on grazing, recreational use, and wild horse herd management, potential mitigation measures also could include the following:

- Coordinating the activities of commercial operators with livestock owners to ensure that impacts on livestock grazing on a portion of a lease area were minimized. Issues that would need to be addressed could include installation of fencing and access control, delineation of open range, traffic management (e.g., vehicle speeds), and location of livestock watering sources.

- Coordinating the activities of the commercial operators with the BLM and local authorities to ensure that adequate safety measures (e.g., access control and traffic management) were established for recreational visitors.

- Coordinating the activities of the commercial operators with the BLM to ensure that impacts on the wild horse herds and their management areas were minimized. Issues that would need to be addressed could include installation of fencing and access control, delineation of open range, traffic management (e.g., vehicle speeds), and access to water sources.

## 4.3 SOIL AND GEOLOGIC RESOURCES

### 4.3.1 Common Impacts

The potential impacts on soil and geologic resources vary somewhat according to the three different technologies under consideration. There are also some basin-specific impacts. However, many of the impacts are common to each technology and among project phases (construction, operations, and reclamation). Thus, this section discusses the common impacts on soil resources and geologic resources, including phase-specific impacts within each subsection.

#### 4.3.1.1 Soil Resources

Oil shale operations pose an impact on soil resources. A significant concern is increased soil erosion resulting from ground disturbance. This problem pertains to each technology considered in this PEIS.

Soil erosion by water and wind is common across the four basins. In the Piceance Basin, upland soil is thin and the slopes are high. The soils of relatively flat areas in valleys are also subject to localized erosion. Critically high erosion is prevalent in the Uinta Basin. Cryptobiotic soils are present in some portions of Utah and may be present in the study area. The biological soil crusts serve to reduce wind and water erosion of these soils when intact. The Green River and Washakie Basins have moderate to high erosion, with wind erosion playing a larger role than water erosion because of the arid conditions.

Soil erosion can be increased in areas disturbed through construction activities. The maximum land area that is assumed to be disturbed for oil shale facilities is the entire leased area for surface mines and in situ facilities (up to 5,760 acres), or about 1,650 acres for underground mine facilities. The degree of the impact depends on factors such as soil properties, slope, vegetation, weather, and distance to surface water. Specific activities that could create soil erosion (and possibly increase turbidity in surface water) include removal and stockpiling of overburden for surface mining (and to a lesser extent for subsurface mining); traffic on unpaved roads; vegetation clearing, grading, and contouring that can affect the vegetation, soil structure, and biological crust; and erosional gullies formed on land regraded for in situ work areas, support facilities, roads, etc. The drainage along roads may contribute additional soil erosion as surface runoff is channeled into the drainages. Compaction by vehicles or heavy equipment may reduce infiltration, promote surface runoff, and decrease soil productivity. Wind erosion is enhanced through ground disturbance.

In addition to buildings, construction or installation of other facilities and utilities would require disturbance of soil. These activities would include, but not be limited to, utility tower installation, telephone pole installation, parking area construction, buried utility installation (e.g., water mains, wastewater lines, electrical or communication cables), drilling for installation of electrical subsurface heating and freeze-wall equipment (for in situ processing), drilling for resource evaluation, and drilling for groundwater monitoring well installation. Some of these

activities, such as exploratory drilling and road grading, may also take place during preliminary site assessment.

It is assumed that ROWs for transmission lines would be built to connect new project sites with regional utilities (up to 1,800 acres of longer-term disturbance and 2,700 acres of disturbance during construction; see Section 4.1.4). A pipeline ROW is also assumed to be constructed for each project site (up to 330 acres of longer-term disturbance and 670 acres disturbed during construction). Likewise, newly constructed employer-provided housing would likely be built, with limited longer-term disturbance (see Table 4.1.5-1). The locations of employer-provided housing are unknown at this time; however, housing is not expected to be located on public lands.

Erosion rates are expected to be higher along ROWs and at construction sites, access roads, surface mines, and river banks. Site grading and drainage design would cause changes to local hydrology and may result in increased runoff focused at certain discharge locations. This activity may cause increased erosion in creeks and drainages and on hill slopes, with subsequent increases in downstream sediment loads. Following site construction, soil conditions may stabilize, resulting in reduced erosion and sediment input to surface water. Localized erosion may continue to take place, requiring maintenance and remedial measures.

The pipelines associated with oil shale development include those conveying hydrocarbons extracted from in situ retorting or from surface retorts or upgrading facilities, as well as possible pipelines for water or sanitary waste. Flood events have the potential to cause pipeline breakage and subsequent contamination of surface water.

Soil and geology impacts would differ during oil shale operations depending on the technological approach. All techniques would involve ongoing issues with soil erosion and runoff management in disturbed soil areas (water and wind erosion, rutting, potential salinity impacts, etc.) as described above. The use of pesticides and herbicides and accidental spills or leaks of product, fuels, or chemicals could result in soil contamination. The potential soil contamination would be localized in extent and could be addressed with appropriate remediation measures.

The surface mining approach requires removing and stockpiling the overburden, source rock, and waste rock, thereby creating a potentially large source of sediment and salinity in site runoff. The various stockpiles are also susceptible to wind erosion. No surface mining is anticipated for Colorado. In Utah, 600 to 1,200 acres would be disturbed at any one time during commercial operations, with a total of 5,760 acres potentially disturbed. In Wyoming, 1,000 to 2,000 acres would be disturbed at any one time, also with a total of 5,760 acres potentially disturbed. Some of the spent shale could be returned to the mine, but there would be overflow in disposal areas outside of the excavation. Ongoing stabilization of the waste piles would likely be required.

In underground mining, the disturbed soil footprint would be smaller than that for surface mining; source rock stockpiles and spent oil shale piles, however, would occupy a large amount of space and would be sources of sediment and salinity in runoff (total area assumed to be

disturbed is 1,650 acres over 20 years). Current assumptions regarding spent shale are that from 0 to 30% of the spent material could be returned to the mine for disposal, with the remainder disposed of at the surface. Ongoing stabilization of the waste piles would likely be required.

In situ techniques would result in rolling operations and would result in continuous ground disturbance areas and reclamation areas. In Colorado or Utah, 150 to 600 acres would be disturbed at any one time, while in Wyoming, the figure would be 1,000 to 2,000 acres. A total of 5,760 acres (5,120 acres for any RD&D projects that go to commercial production) would potentially be disturbed and subject to erosion and sediment runoff.

During reclamation, potential geologic and soil impacts would be similar to those of the construction phase. The replacement of stockpiled topsoil on former work or support areas, roads, or in reclaimed surface mines would require time to reestablish with stabilizing vegetation and may be a source of erodable material, depending on factors such as slope and weather conditions. Monitoring of soil reclamation areas for erosion and ecology are also part of a reclamation phase (DOI and USDA 2006).

A key concern for impacts on soil is the associated impact on water quality. As discussed in Section 4.5, soil erosion increases both the sediment load to streams and the salinity of runoff reaching these streams. The sensitivity of the surface water throughout the PEIS study area causes soil management to be a key factor in environmentally acceptable energy development. Infiltration of precipitation through stockpiled oil shale or through waste piles of spent material has the potential of impacting surface water or shallow aquifers with leached hydrocarbons and salts.

#### 4.3.1.2 Geologic Resources

Oil shale development could have an impact on other geologic resources, including the loss of these resources. Various geologic resources are present in the four oil shale basins. Sand and gravel and crushed stone supplies are widespread throughout the study areas, and their use at project sites (for construction, fill, etc.) would not be expected to impact their availability.

Halite, dawsonite, and nahcolite are distributed within the Piceance Basin. They are associated with the Green River Formation and occur at thicknesses and proportions that vary depending on location and depth. The central Piceance Basin contains an area known as the Multimineral Zone, within which oil shale, nahcolite, and dawsonite cannot be developed without the loss of one of the others. A designated KSLA surrounds the Multimineral Zone. Oil, natural gas, and coal are also present. In the Uinta Basin, the oil shale extends into two STSAs. Gilsonite, oil, and gas are also present. The Green River Basin contains trona and halite, and the MMTA is off-limits to oil shale development. Oil, gas, and coal are also present. Little or no economic geologic resources other than oil shale are available in the Washakie Basin.

### 4.3.2 Mitigation Measures

Various mitigation measures may be taken to reduce the impact of oil shale activities on soil and geologic resources during construction, operations, and reclamation. The subsequent effects on water quality may therefore be reduced (see Section 4.5).

- Guidance, recommendations, and requirements related to management practices are described in detail in the BLM Solid Minerals Reclamation Handbook (BLM 1992), the BLM Gold Book (DOI and USDA 2006), BLM pipeline crossing guidance (Fogg and Hadley 2007), and in BLM field office RMPs. These actions include, but are not limited to, minimizing the amount of disturbed land; stockpiling topsoil prior to construction or regrading; mulching and seeding in disturbed areas; covering loose materials with geotextiles; using silt fences to reduce sediment loading to surface water; using check dams to minimize the erosive power of drainages or creeks; and installing proper culvert outlets to minimize erosion in creeks.

- Surface pipeline crossings must be constructed above the highest anticipated flood stage, and subsurface crossings must be installed below the scouring depth. The BLM (Fogg and Hadley 2007) provides guidance on hydraulic analysis necessary for proper design of pipeline crossings.

- Mapping of highly erosive soils and soils of high salt content should be performed in proposed project areas and their connecting roads, so that site-specific information can be used to guide project planning. A proper road grading analysis should be performed to reduce the potential for problems such as erosion or cut slope failure (DOI and USDA 2006).

- The revegetation and restoration potential of soil, as with many other soil factors described previously, is site-specific and would be addressed in a project-level NEPA analysis. Mitigation measures involving soil erosion control, stabilization, and reseeding would limit the impact of soil erosion.

- Stockpiling of topsoil prior to the construction of roads, parking areas, buildings, work areas, or surface mining is a practice that should aid reclamation efforts following the completion of work activities in a certain area. During restoration, replacement of the stockpiled topsoil would aid in a return to somewhat natural conditions for local vegetation.

- Detailed geotechnical analyses would be required to address stability of quarry walls, underground mines, and stability of slopes, including assessment of slope cuts and the creation of roads or work areas.

## 4.4 PALEONTOLOGICAL RESOURCES

### 4.4.1 Common Impacts

Significant paleontological resources could be affected by commercial oil shale development. The potential for impacts on paleontological resources from commercial oil shale development, including ancillary facilities such as access roads, transmission lines, pipelines, and employer-provided housing, and construction of possible new power plants, is directly related to the amount of land disturbance and the location of the project. Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces and from increased accessibility to possible site locations are also considered.

Impacts on paleontological resources could result in several ways as described below.

- Complete destruction of the resource could result from the clearing of the project area; grading, excavation, and construction of facilities and associated infrastructure; and extraction of the oil shale resource, if paleontological resources are located within the development area.

- Degradation and/or destruction of near-surface resources could result from the alteration of topography; alteration of hydrologic patterns; removal of soils; erosion of soils; runoff into and sedimentation of adjacent areas; and oil or other contaminant spills if near-surface paleontological resources are located on or near the project area. Such degradation could occur both within the project footprint and in areas downslope or downstream. While the erosion of soils could negatively impact near-surface paleontological localities downstream of the project area by potentially eroding away materials and portions of sites, the accumulation of sediment could serve to protect some localities by increasing the amount of protective cover. Agents of erosion and sedimentation include wind, water, ice, downslope movements, and both human and wildlife activities.

- Increases in human access and subsequent disturbance (e.g., looting and vandalism) of near-surface paleontological resources could result from the establishment of corridors or facilities in otherwise intact and inaccessible areas. Increased human access (including OHV use) exposes paleontological sites to a greater probability of impact from a variety of stressors.

Paleontological resources are nonrenewable, and, once damaged or destroyed, they cannot be recovered. Therefore, if a paleontological resource is damaged or destroyed during oil shale development, it would constitute an irretrievable commitment of this scientific specimen. Data recovery and resource removal are ways in which at least some information can be salvaged should a paleontological site be developed, but certain contextual data are invariably lost. The discovery of otherwise unknown fossils would be beneficial to the scientific community, even if

such resources are ultimately lost, but only as long as sufficient data can be recorded prior to destruction or loss.

### 4.4.2 Mitigation Measures

For all potential impacts, the application of mitigation measures developed in consultation with the BLM could reduce or eliminate (if avoidance of the resource is chosen) the potential for adverse impacts on significant paleontological resources. Consultations between the operator and the BLM would be required for all projects before lease areas could be developed. The use of BMPs, such as training/education programs to reduce the amount of inadvertent destruction to paleontological sites, could also reduce the occurrences of human-related disturbances to nearby sites. The specifics of these BMPs would be established in project-specific consultations between the operator and the BLM.

A paleontological overview was completed for the project area (Murphey and Daitch 2007). The overview synthesized existing information and generated maps showing areas with the potential fossil yield classification and paleontological condition. This phase of the analysis did not identify geographical areas that would preclude moving areas forward for leasing. During the leasing phase, the overview will be reviewed to help determine areas of sensitivity and appropriate survey and mitigation needs.

Mitigation measures to reduce impacts on paleontological resources will be required and could include the following:

- The sedimentary context of the project area and its potential to contain paleontological resources would be identified prior to development in consultation with the BLM. A records search of published and unpublished literature may be required for past paleontological finds in the area. Paleontological researchers working locally in potentially affected geographic areas and rock units may be consulted in order to obtain invaluable information and insights that should be taken into account when considering alternative actions and developing mitigation strategies. Depending on the extent of paleontological information, the BLM may require completion of a paleontological survey. If paleontological resources are present at the site, or if areas with a high potential to contain paleontological material have been identified, the development of a paleontological resources management plan may be required to define required mitigation measures (i.e., avoidance, removal, and monitoring) and the curation of any collected fossils.

- If an area has a high potential but no fossils are observed during survey, monitoring by a qualified paleontologist may be required during all excavation and earthmoving in the area. Monitoring of high-potential areas during earthmoving activities would be conducted by a professional paleontologist, when required by the BLM. Development of a monitoring plan is recommended. An exception may be authorized by the BLM.

- If fossils are discovered during construction, the BLM will be notified immediately. If feasible (i.e., when safe to do so), work will be halted at the fossil site and continued elsewhere until a qualified paleontologist can visit the site and make site-specific recommendations for collection or (other) resource protection.

If these mitigation measures are implemented during the initial project design and planning phases and are adhered to throughout the course of development, the potential impacts on paleontological resources discussed under the common impacts section would be mitigated to the fullest extent possible. Adopting this approach does not mean that there would be no impacts on paleontological resources. The exact nature and magnitude of the impacts would vary from project to project and would need to be examined in detail in future NEPA reviews of lease areas and project plans of development.

## 4.5 WATER RESOURCES

### 4.5.1 Common Impacts

In general, the impacts on water resources from oil shale development can be attributed to the interdependent factors of ground surface disturbance, water withdrawal and use, wastewater disposal, alteration of hydrologic flow systems for both surface water and groundwater, and the interaction between groundwater and surface water. In addition, the locations where oil shale development may occur may not match the locations where water supplies are available. This last issue might require development of new infrastructure for water transport and water storage, which would cause additional adverse environmental impacts on water resources.

Common impacts could include:

- Degradation of surface water quality caused by increased sediment load or contaminated runoff from project sites;

- Surface disturbance that may alter natural drainages by both diverting and concentrating natural runoff;

- Surface disturbance that becomes a nonpoint source of sediment and dissolved salt to surface water bodies;

- Withdrawal of water from a surface water body that reduces its flow and degrades the water quality of the stream downgradient from the point of the withdrawal;

- Withdrawals of groundwater from a shallow aquifer that produce a cone of depression and reduce groundwater discharge to surface water bodies or to the springs or seeps that are hydrologically connected to the groundwater;

- Construction of reservoirs that might alter natural stream flow patterns, alter local fisheries, temporarily increase salt loading, cause changes in stream profiles downstream, reduce natural sediment transport mechanisms, and increase evapotranspiration losses;

- Discharged water from a project site that could have a lower water quality than the intake water that is brought to a site;

- Spent shale piles and mine tailings that might be sources of contamination for salts, metals, and hydrocarbons for both surface and groundwater;

- Degradation of groundwater quality resulting from injection of lower quality water; from contributions of residual hydrocarbons or chemicals from retorted zones after recovery operations have ceased; and, from spent shales replaced in either surface or underground mines;

- Reduction or loss of flow in domestic water wells from dewatering operations or from production of water for industrial uses; and,

- Dewatering operations of a mine, or dewatering through wells that penetrate multiple aquifers, that could reduce groundwater discharge to seeps, springs, or surface water bodies if the surface water and the groundwater are connected.

The following sections place these common impacts in the context of specific operating parameters and also show that many of the impacts are interconnected to the multiple activities that could occur in a single operation. Indeed, it is necessary to understand the context of each of the above summary findings to clearly understand the impact dynamics and the rationale behind the mitigative measures that follow the impact analysis.

#### 4.5.1.1 Ground Surface Disturbance

It is assumed that surface mine/surface retort facilities and in situ facilities could have ground disturbance over their entire lease areas (up to 5,760 acres). Underground mine/surface retort facilities are assumed to involve somewhat less ground disturbance (up to about 1,650 acres). Any of the technologies would have associated additional off-lease disturbance for transmission lines, pipelines, employee housing, and possibly new power plants (see Section 4.1 for details on ground disturbance assumptions).

Ground surface disturbance would tend to degrade surface water quality and increase stream flow in areas downstream of development sites. Disturbance caused by a wide array of

activities (e.g., access roads, building construction, spoil disposal piles, mining or other recovery operations, power line construction) would expose fresh soil to intensified surface runoff caused by precipitation as well as to wind erosion leading to increases in sediment and salt contributions to streams. The flow of streams downstream of disturbed areas would increase before the areas are stabilized.

Surface mines associated with production of oil shale would have the potential to alter natural drainages by both diverting and concentrating natural runoff. Downstream areas would be altered as a result of these actions. Depending on the construction of the mine and the ability to return spent shale from retort operations back into the excavation, additional surface disturbance associated with spent shale disposal would also occur that would have the potential to have impacts downstream.

Underground mines, while having a much smaller amount of surface disturbance associated with actual mining operations, would have a relatively larger amount of surface disturbance associated with the disposal of spent shale. Until successfully revegetated, these spent shale areas could contribute to increased runoff; be a source of contamination for salts, metals, and hydrocarbons; and would be exposed to wind erosion. Depending on the placement of the disposal areas, disruption of natural drainage patterns through diversion and concentration of flow may also occur. Such alteration and diversion could change the stream flow downstream of a project site.

Because of the uncertainty of the size of the blocks of land that would be disturbed at any one time to support in situ production, and the unknown length of time between disturbance and reclamation of production areas, the effect of this technology on surface drainage is not yet known. Of the various types of in-situ technologies, it is not yet known if there will be any difference in surface disturbance or effects on surface drainage between the various in situ technologies.

Disturbed areas can become nonpoint sources of sediment and dissolved salt to surface water bodies. Airborne dust is expected to increase as a result of surface disturbance, processing/mining operations, and vehicle traffic. Because high salt content in soils is common in arid and semiarid environments, salt could be transported by wind and surface runoff from disturbed areas, even with the use of mitigation during site preparation. The impact would be larger during the construction and reclamation phases than during the operational phase of projects, when some sort of process to stabilize sites can be expected to be employed. The level of impact would decrease with time as the disturbed areas are reclaimed and stabilized with protective vegetation or other measures. The intensity of the impact would decrease with increasing distance between the disturbed areas and surface water bodies.

#### 4.5.1.2 Water Use

Water uses in both surface mine/surface retort and underground mine/surface retort projects could include water for mining and drilling operations; cooling of equipment; transport of ore and processed shale; dust control for mines, crushers, overburden and source rock storage

piles, and retort ash piles; cooling of spent shale exiting the retort; wetting of spent shale prior to disposal; fire control for the mine and industrial area; irrigation for revegetation; and sanitary and potable uses. Additional water uses required for in situ projects include water for hydrofracturing, steam generation, water flooding, quenching of kerogen products at producer holes, cooling of productive zones in the subsurface, cooling of equipment, and rinsing of oil shale after the extraction cycle. Depending on the quality of the shale oil produced directly from in situ processes, water may be required for additional processing of the product at the surface.

A large amount of water is required during the operations phase. Because of the uncertainty in process water requirements, this assessment assumes that 2.6 to 4.0 bbl of water could be required for each barrel of shale oil produced for surface mine/surface retort and underground mine/surface retort projects, and that 1 to 3 bbl of water could be required for each barrel produced for in situ projects (see Section 4.1). Surface mine or underground mine/surface retort plants with capacities of 18 million bbl/yr (or 50,000 bbl/day) could consume 6,100 to 9,400 ac-ft of water per year. Depending on availability and quality, water may be obtained from major streams, groundwater, or reservoirs. A major portion of the water may be lost in cooling towers and evaporation and must be replaced on an ongoing basis.

At power plants that may be constructed to meet the energy demands of oil shale facilities, water is required for steam generation, scrubber operation, cooling, and dust control. In a refinery, water is primarily used for steam, cooling the scrubber, and other refinery processes. Water is lost through various processes and needs to be replenished. Water is also needed for sanitary and potable uses. A 2,400-MW coal-fired power plant could require approximately 13,800 ac-ft of water per year. The impacts on water resources depend on the locations of the refinery or power plants. If they are assumed to be within 150 mi of an oil shale project site, they are likely to be located within the four oil shale basins and will create additional demands on water supplies in the basins.

Water may be drawn from surface water bodies or underground aquifers, depending on project locations, water availability, and water quality. Withdrawal from a surface water body would reduce its flow and cause sediment deposition in the stream channel. In the case of streams receiving groundwater discharge (which generally has a higher dissolved salt content), the withdrawal can degrade the water quality of the stream downgradient from the point of withdrawal because the relative proportion of groundwater remaining in the stream would increase.

Groundwater withdrawals from a shallow aquifer would produce a cone of depression and reduce groundwater discharge to surface water bodies or to the springs or seeps that are hydrologically connected to the groundwater. The withdrawal could reduce stream flows, and the effects would increase with the amount of water withdrawn.

Groundwater may be extracted from aquifers for use as a resource or for dewatering to control groundwater inflow into a mine. Mine dewatering would be necessary where saturated conditions, including perched aquifers, are present. Dewatering would lower the potentiometric surfaces and/or water table of the aquifers that are intercepted by the surface mine. Because some deeper groundwater is the source for springs and seeps in the region, the lowering of the

potentiometric surface would have the same effect as withdrawals from shallow, surficial aquifers, reducing or eliminating flow of the connected springs and seeps. Existing groundwater supply wells within the cones of depression also would have reduced yields or could be dewatered.

If surface water is used to supply oil shale operations, it may be necessary to construct storage reservoirs to accumulate enough water to provide the necessary supply. If reservoirs are required, they have their own set of impacts that would need to be addressed. Effects frequently associated with reservoirs include alteration of natural streamflow patterns, impacts on local fisheries, temporary increase of salt loading, changes in downstream channel profiles, loss of natural sediment transport mechanisms, increase in evapotranspiration losses, and loss of existing land uses in the reservoir area.

The water quality of surface water bodies and shallow alluvial aquifers generally is higher than that of deeper aquifers. Therefore, surface water or shallow groundwater is generally preferred as a source of supply if it is available. Withdrawal of surface water would reduce streamflow downstream from the point of diversion. Because of the reduced flow, the stream's capacity for carrying sediment would also be reduced, and in-channel sediment deposition would be increased. The morphology of the stream channel would also adjust to the reduced flows. For stream segments where natural groundwater discharge into the stream occurs, the water withdrawal could increase the relative proportion of the groundwater contribution to the stream, thereby lowering the overall quality of the stream.

For in situ processes, the impact of in situ processing on groundwater during the operations phase is twofold. First, the permeabilities of the aquifers and perhaps the aquitards between the aquifers in the retort areas would likely be permanently increased because of rock fracturing. Second, the residual hydrocarbons, salts, and trace metals in rock and the reagents or chemicals used in flooding treated areas that are not removed will be exposed for later groundwater leaching as a result of the increase of the permeabilities. It appears there would be some risk in allowing vertical flow of groundwater between previously isolated aquifers through fractures created by thermal expansion and contraction. The extent to which there would be the possibility of introducing lower-quality water into higher-quality aquifers previously isolated from one another is not yet known.

#### 4.5.1.3 Discharge, Waste Handling, and Contaminant Sources

Controlled discharge of water from a project site to a surface water body constitutes a point-source discharge. The discharged water may be from process wastewater, cooling, collected leachate from overburden rocks or spent shale, sewage, tailing ponds, utilities, and dewatering wells. Discharged waters generally have lower water quality than the water in the receiving water body and could potentially degrade the surface water quality. Discharged cooling water from coal-fired power plants commonly is warmer than local stream water, resulting in potential thermal contamination and its associated effects. In addition, contaminants released by nonpoint sources associated with the project (access roads, air emissions, and groundwater discharge) could further degrade the surface water quality.

Since discharge of surface runoff at a mining site is exempted from NPDES permits, surface runoff not intercepted at these sites could create a nonpoint source of contaminants and degrade the water quality of downgradient surface water bodies.

For in situ processes, groundwater extracted to dewater the oil shale zone is likely to be used on-site for general purposes with or without treatment, such as for dust control or as process water, or it may be discharged to surface streams. The degree of water treatment required before discharge or reuse of the water would need to be determined on a site-specific basis to protect the receiving streams. The discharged water from an oil shale project site would generally have a lower water quality than the intake water.

Underground injection, as a means to dispose of low-quality water, could affect groundwater quality. Commonly, the water quality of the receiving aquifer is less than that of the injected water. The impact on the aquifer being injected also may be positive. Permitting is governed by the EPA's Underground Injection Control program.

Another source of potential water contaminants is from the air, such as air emissions from retort facilities and power plants, and dust from access roads, overburden, and spent shale piles. Winds common in semiarid and arid environments could allow particulates to be dispersed and deposited on surface water bodies. Generally, the dust from spent shale piles and other disturbances is reduced after areas are reclaimed and stabilized or as a consequence of specific dust abatement practices.

If not properly designed, retention ponds for process water, leachate from spent shale, and fly ash could be sources of contamination for shallow groundwater. Overburden rock commonly is disposed of near a project site without underlying liners. Because the overburden rock generally has a high content of soluble salts, leachate from the rock piles may contain high salt content and become a contaminant source for groundwater as well as for surface water.

Spills of chemicals and oil shale products on-site are possible. They are also potential sources of contaminants for nearby surface water bodies and shallow aquifers. Another potential source of water contamination is from pesticides and herbicides, which are commonly used to control vegetation growth along pipelines and transmission lines. These treatments may adhere to soil particles and be carried by wind and surface runoff into nearby surface water bodies, creating nonpoint sources of contaminants for those waters. Vehicle traffic would also raise airborne dust levels along access roads and increase the sediment and salt loadings of nearby streams.

At river crossings, pipelines may be placed under streambeds or foundations may be built for elevated pipelines. A temporary increase of stream sediment at the crossings would likely occur during their construction. Regular disturbance of river banks through maintenance activities or vehicular traffic can also increase the sediment loading of the river. In the case of natural drainage channels that are rerouted, modified, or diverted, the surface runoff could be altered accordingly, affecting downstream flow.

There are also technology-specific impacts. At both surface and underground mining sites, the spent shale piles and mine tailings could be sources of contamination for salts, metals, and hydrocarbons. If surface retorting is used to upgrade oil shale, fly ash and boiler bottom ash would also be produced by the retorts as wastes. Leachates containing associated contaminants may enter nearby surface water bodies or groundwater and continue to degrade the water quality well after site reclamation, if the wastes are not properly managed.

In situ retorting could produce water as one by-product. One in situ retorting experiment produced organic groundwater contaminants, including aromatic hydrocarbons, phenols, azaarenes, and aliphatic ketones (Lindner-Lunsford et al. 1990). Inorganic leachate constituents from in situ retorted oil shale were studied in a laboratory setting by Bethea et al. (1983). Investigators reported that the amount of material leached depended on a variety of factors. The retort temperature had the greatest effect on leachate composition. The use of $CO_2$ during retorting reduced the formation of base-forming (alkaline) materials. Higher groundwater purity used in the leaching process was associated with an increase in the amount of leached material. The researchers also concluded that the leaching of retorted oil shale is complex and difficult to study in a laboratory.

As groundwater levels rebound and approach their original condition after in situ operations cease, residual hydrocarbons and inorganics in rocks and the chemicals used in the subsurface to enhance shale oil recovery may be leached by the groundwater. Such leaching could create a potential contaminant source in the subsurface. The source may contaminate groundwater and hydrologically connected seeps, springs, and surface water bodies, depending on the local interaction between groundwater and surface water.

#### 4.5.1.4 Alteration of Hydrologic Flow Systems

Because a large volume of rock is disturbed in surface mining operations, the permeability of the geologic material in the mine and in overburden disposal areas is permanently increased. The porosity and permeability of spent shale backfill is also relatively high. Precipitation could infiltrate these materials and produce leachate with relatively high dissolved solids and organics, potentially causing long-term contaminant sources for groundwater. The discharge of this groundwater through springs or seeps feeding water bodies located downgradient of the mine could negatively impact surface water quality. In addition, the filled mine could become a vertical conduit for groundwater, resulting in a discharge area for the shallow aquifer and a recharge area for the deeper aquifer.

The dewatering operations of a mine or dewatering through wells that penetrate multiple aquifers can reduce groundwater discharge to seeps, springs, or surface water bodies if the surface water and the groundwater are connected. The consequence could be diminished flows of seeps, springs, or water courses even at areas remote from the mine. Depending on pumping rates and site-specific hydrogeological factors, significant groundwater withdrawals for dewatering the overburden, or for meeting operational needs, may reduce surface water base flow, spring discharges, and water levels in nearby wells.

Streamflow could be affected by both water withdrawal and wastewater discharge (after water treatment). The streamflow would be reduced in areas downstream of water intakes and increased in areas downstream from discharge outfalls. The change of the streamflow can trigger the deposition or erosion of sediments along a stream channel.

Because of the large openings created in underground mining operations, the hydrologic properties of the geologic material in the mine are permanently altered. Abandoned mine shafts, as well as partially refilled (by spent shale) mines, will enhance vertical and lateral groundwater movement in the mined area after dewatering ceases and groundwater levels are reestablished. Enhanced leaching of formation rocks fractured during mining operations and spent shale backfill could result in poor-quality groundwater. The discharge of this groundwater through springs or seeps feeding water bodies located downgradient of the mine could negatively impact surface water quality.

At sites with a dewatered surface mine or in situ operations, groundwater levels would begin to recover after dewatering activities cease. As groundwater regains its original water level, surface water previously depleted by the dewatering would be replenished by seeps and springs, and the stream flow would eventually return to predevelopment patterns.

For in situ processes, after kerogen as well as some soluble minerals are removed from the source rock, rock porosity and permeability increase. The thermal fractures and fractures created by steam, water, or $CO_2$ in the source rock could potentially enhance the groundwater flow within aquifers and potentially increase the vertical hydraulic conductivities of aquitards after the retorted areas are refilled by groundwater. In other words, the flow system in the subsurface may be modified, as will be the groundwater discharge to the surface water bodies.

In the case of natural drainage channels that are rerouted or modified, the surface runoff would be altered, affecting existing downstream flow. Whether the water is derived from a surface water body with or without the use of a reservoir, the downstream flow would be reduced, which could cause deposition of steam sediment and change the morphology of the steam. If a reservoir is built for regulating water supply, sediment would be trapped upstream of the dam. The flow pattern of the stream could change depending on the discharge of the reservoir. The degradation (erosion of streambed) and deposition along the stream channel would adjust to the new stream flows. Losses due to evaporation and seepage in the reservoir would affect the amount of water available (Keefer and McQuivey 1979).

### 4.5.2 Water Budget for Individual Oil Shale Projects

In Table 4.5.2-1, a possible scenario of water demand and consumptive use for individual oil shale development projects is estimated and compared with the remaining available amounts of Upper Colorado River water, both from 2000 and projected to 2030 for Colorado and Wyoming, and to 2050 for Utah.[4] These are estimated potentially available volumes from the

[4] See Section 3.4.1.4 for details on the amount of water projected to be available. In this section, the water availability is projected to different years on the basis of the availability of projection data from the three states.

**TABLE 4.5.2-1 Water Budget for Oil Shale Development Projects[a]**

| | Technology and Water Resources | Supporting Information and Assumptions | Estimated Budget Components[b] | |
|---|---|---|---|---|
| ***Colorado*** | **Technology** | Assumption | Demand (1,000 ac-ft/yr) | Consumption (1,000 ac-ft/yr) |
| | In situ project at 150,000–200,000 bbl/day | 1–3 bbl of water/bbl oil produced per 200,000-bbl/day plant[c] | 9.2–36.9 | 7.0–28[d] |
| | Sanitary and potable use for in situ projects | 4,440 in-migrants at 135 gal/day/person | 0.67 | 0.23[e] |
| | Underground mine/surface retort (UM/SR) project at 50,000 bbl/day | 2.6–4 bbl of water/bbl oil produced per 50,000-bbl/day plant[c] | 8–12.3 | 6.08–9.35 |
| | Sanitary and potable use for UM/SR project | 6,512 in-migrants at 135 gal/day/person | 0.98 | 0.34 |
| | Coal-fired power plant[f] associated with Shell ICP-type in situ project | 13,000 ac-ft/yr | | 13 (for in situ only) |
| | | Total for each in situ project (includes power production) | | 20.23–41.23 |
| | | Total for each UM/SR project | | 6.42–9.69 |
| | **Water Resource** | | | |
| | State Water Allocation (1,000 ac-ft/yr) | Locations | | |
| | Projected remaining available surface water[g] | Upper Colorado Basin projected from 2000 to 2030 for Colorado state (see Table 3.4.1-2) | | 340 in 2000; 268–412 in 2030 |
| | Water Resources (1,000 ac-ft/yr) | Locations | Flow or recharge rate | |
| | Major streamflow | White River (where the targeted oil shale basin is located) average flow at Meeker (58-yr record) (see Section 3.4.2.2) | 460 | |
| | Estimated natural groundwater recharge | Piceance Basin (Taylor 1982) | 35 | |
| | Groundwater storage | Locations | Storage (1,000 ac-ft)[h] | |
| | Groundwater in storage (excluding alluvial aquifers) | Northern province of Piceance Basin (Czyzewski 2000) | up to 25,000 | |
| ***Utah*** | **Technology** | Assumption | Demand (1,000 ac-ft/yr) | Consumption (1,000 ac-ft/yr) |
| | In situ project at 150,000–200,000 bbl/day | 1–3 bbl of water/bbl oil produced for a 200,000-bbl/day plant | 9.2–36.9 | 7.0–28 |

**TABLE 4.5.2-1 (Cont.)**

| | Technology and Water Resources | Supporting Information and Assumptions | Estimated Budget Components[b] | |
|---|---|---|---|---|
| ***Utah*** (Cont.) | Sanitary and potable use for in situ projects | 4,736 in-migrants at 135 gal/day/ person | 0.72 | 0.38[i] |
| | UM/SR or surface mine/surface retort (SM/SR) project at 50,000 bbl/day | 2.6–4 bbl of water/bbl oil produced for a 50,000-bbl/day plant | 8–12.3 | 6.08–9.35 |
| | Sanitary and potable use for UM/SR projects | 5,328 in-migrants at 135 gal/day/ person | 0.81 | 0.43 |
| | Sanitary and potable use for SM/SR projects | 6,808 in-migrants at 135 gal/day/ person | 1.03 | 0.55 |
| | Coal-fired power plant | 13,000 ac-ft/yr | | 13 (for in situ only) |
| | | Total for each in situ project (includes power production) | | 21.18–41.38 |
| | | Total for each UM/SR project | | 6.51–9.78 |
| | | Total for each SM/SR project | | 6.63–9.90 |
| | **Water Resource** | | | |
| | State Water Allocation (1,000 ac-ft/yr)[g] | Locations | | |
| | Projected remaining available surface water | Upper Colorado Basin projected from 2000 to 2050 for Utah state (see Table 3.4.1-3) | | 396 in 2000; 193 in 2050 |
| | Water Resources (1,000 ac-ft/yr) | Locations | Flow or recharge rate | |
| | Major streamflow | Average flow of Green River at Ouray (combined flow of the White, Duchesne, and Green Rivers), based on 1965–1979 records (see Section 3.4.3.2) | 4,270 | |
| | | Average flow of Duchesne River near Randlett, based on 50-yr records (see Section 3.4.3.2) | 460 | |
| | Estimated practical limit of groundwater withdrawal other than alluvial aquifer in Uinta Basin | | No information available | |

**TABLE 4.5.2-1 (Cont.)**

| | Technology and Water Resources | Supporting Information and Assumptions | Estimated Budget Components[b] | |
|---|---|---|---|---|
| ***Wyoming*** | **Technology** | Assumption | Demand (1,000 ac-ft/yr) | Consumption (1,000 ac-ft/yr) |
| | In situ project at 150,000–200,000 bbl/day | 1–3 bbl of water/bbl oil produced for a 200,000-bbl/day plant | 9.2–36.9 | 7.0–28 |
| | Sanitary and potable for in situ projects | 3,848 people at 135 gal/day/person | 0.58 | 0.31[i] |
| | UM/SR or SM/SR project at 50,000 bbl/day | 2.6–4 bbl of water/bbl oil produced for a 50,000-bbl/day plant | 8–12.3 | 6.08–9.35 |
| | Sanitary and potable for UM/SR projects | 4,440 people at 135 gal/day/person | 0.67 | 0.36 |
| | Sanitary and potable for SM/SR projects | 4,292 people at 135 gal/day/person | 0.65 | 0.34 |
| | Coal-fired power plant | 13,000 ac-ft/yr | | 13 (for in situ only) |
| | | Total for each in situ project (1,000 ac-ft/yr) | | 20.31–41.31 |
| | | Total for each UM/SR project (1,000 ac-ft/yr) | | 6.44–9.71 |
| | | Total for each SM/SR project (1,000 ac-ft/yr) | | 6.42–9.69 |
| | **Water Resource** | | | |
| | State Water Allocation (1,000 ac-ft/yr)[g] | Locations | | |
| | Projected remaining available surface water | Upper Colorado Basin projected from 2000 to 2030 for Wyoming state (see Table 3.4.1-4) | | 226 in 2000; 80–202 in 2030 |
| | Water Resources (1,000 ac-ft/yr) | Locations | Flow or recharge rate | |
| | Major streamflow | Green River below the Fontenelle Reservoir (see Section 3.4.4.2) | 1,290 | |

**TABLE 4.5.2-1 (Cont.)**

| Technology and Water Resources | Supporting Information and Assumptions | Estimated Budget Components[b] |
|---|---|---|
| Groundwater yield (estimate for Tertiary-age aquifer); no information available on groundwater storage. | Green River and Washakie basins where the targeted oil shale deposits are located (States West Water Resources Corporation 2001) | 50–100[j] |

[a] The water uses of refineries are not included because refineries' needs are not known.

[b] Demand indicates total surface water and/or groundwater extraction; consumption indicates the net water use, assuming water treatment and return to the original source.

[c] bbl = barrel; 1 barrel water = 55 gal, 1 barrel oil = 42 gal.

[d] To convert the demand to consumption for oil shale water use, a factor of 0.76 (based on self-supplied industries in northwestern Colorado) was used.

[e] To convert the demand to consumption for sanitary and potable water use in Colorado, a conversion factor of 0.35 was used.

[f] New power plants are only assumed to be needed to support in situ oil shale facilities (see Section 4.1). For these plants, a hybrid cooling system is assumed; therefore, the water use is assumed to be consumptive.

[g] Based on Colorado's Statewide Water Supply Initiative 2004 (CWCB 2004); Utah State Water Plan — Southeast Colorado River Basin (UDNR 2000a); Utah State Water Plan — Uinta Basin (UDNR 1999); Utah State Water Plan — Western Colorado River Basin (UDNR 2000b); Utah's Water Resources, Planning for the Future for Utah (UNDR 2001); Green River Basin Water Plan, Basin Water Use Profile — Agricultural (SWWRC 2001a); and Green River Basin, Water Planning Process for Wyoming (SWWRC 2001b). Water rights may already have been allocated and may require purchasing for oil shale development.

[h] The estimates of groundwater in storage represent volumes. They do not indicate sustainable aquifer yield.

[i] To convert the demand to consumption for sanitary and potable water use in Utah and Wyoming, a conversion factor of 0.53 was used (based on state data for Uinta Basin).

[j] The yield was estimated from an area about five times the size of the basins studied in this PEIS.

Colorado River for use in oil shale development and other uses in the three states. Although a certain amount of water is calculated to be available on the basis of current and projected consumptive use and Upper Colorado River Compact allocations (see Section 3.4.1.4), this calculation does not imply that the water is readily or physically available for oil shale development. Whether enough water is available for the development depends on the results of negotiations between various parties, including water rights owners, state and federal agencies, and municipal water providers, as well as developers. Recurrence of severe drought conditions and higher temperatures are likely to occur in the Colorado Basin (National Research Council 2007). The latter would increase evaporation and, therefore, reduce runoff and streamflows (National Research Council 2007), which would reduce the water availability shown in Table 4.5.2-1. In addition, the Recovery Program for endangered Colorado River fishes has identified flow recommendations for major rivers in the Colorado River Basin, and these recommended flows could reduce the availability of water for oil shale as well as for other development projects.

The sustainable groundwater usage in the oil shale basins was estimated on the basis of groundwater recharge rate or practical yield. Withdrawal of the groundwater for oil shale development could reduce groundwater discharge to downgradient seeps, springs, or surface water bodies that are hydrologically connected to the groundwater. Finally, the estimated amount of groundwater in storage and the stream flows of major rivers in the area are also presented for reference purposes. Table 4.5.2-1 gives a summary of the above estimates.

This assessment assumes that additional power plants may be constructed to support in situ facilities (especially those using electric heating of the oil shale formation). It is assumed that underground mine/surface retort and surface mine/surface retort facilities could obtain adequate power from existing facilities.

#### 4.5.2.1 Colorado

For the in situ processing sites, the amount of water required is estimated to be 1 to 3 bbl of water per barrel of shale oil produced (Wilson et al. 2006). Assuming water conservation measures are practiced, the consumption of water for a 200,000-bbl/day project would be about 20,000 to 41,000 ac-ft/yr (this estimate includes an assumed new power plant, which would be required to provide adequate power). Water consumption for a projected 50,000 bbl/day underground mine with surface retort project would be about 6,400 to 9,700 ac-ft water/yr, which assumes 2.6 to 4 bbl of water needed for each barrel of oil produced but does not assume any new power plants (see Section 4.1 for details on these assumptions).

The remaining available water from the Colorado River in Colorado is projected to be 340,000 ac-ft/yr in 2000 and in the range of 268,000 to 412,000 ac-ft/yr in 2030.[5] With a range of 6,100 to 41,000 ac-ft/yr required for individual oil shale development projects, the possible water requirements represent 2 to 13% of the currently available water and would be 2 to 15% of the water available in 2030 (assuming the lower end of the projected range is available). This

[5] The upper end of the range assumes that water will be released from agricultural use in the future.

projection also assumes that the available water is stored and/or transported to the oil shale areas from various other water basins. Also, there could be an additional 35,000 ac-ft/yr from natural groundwater recharge in the Piceance Basin (Table 4.5.2-1), while the total groundwater storage in the northern province of the Piceance Basin is estimated to be 2.5 million ac-ft. Because this recharge is distributed over a large geographical area, only a limited portion of this groundwater would be available in the vicinity of an individual project site. It is expected that both the surface water and groundwater could be needed for oil shale development.

Wilson et al. (2006) analyzed surface water availability of the White River (where the principal Colorado oil shale basin is located) with consideration of climate variability, minimum streamflow, and existing uses. They estimated that the river should be able to support a new water demand of 100 cubic foot per second (cfs) (or 72,000 ac-ft/yr), if an additional 16,000 ac-ft of reservoir capacity is built. The White River drains to the Green River, a tributary of the Colorado River, in Utah. Withdrawal of water from the White River would reduce the flow in the Green River in Utah as well as the Colorado River downstream.

Within the White River hydrologic basin, Piceance Creek is a major regional groundwater discharge stream in the Piceance Basin (BLM 2006d). A groundwater discharge stream obtains a percentage of its surface flow from groundwater contributions that enter the stream channel. Yellow Creek is also a groundwater discharge stream, but to a lesser degree. Both of these streams are located in close proximity to the Colorado RD&D project sites. Dewatering operations in the vicinity of these streams could lower the local groundwater potentiometric surface to a depth of as much as 1,600 ft (see Appendix A), and thus reduce groundwater discharge to local springs or streams that are hydraulically connected to the groundwater. However, Shell's in situ conversion process (ICP) technology involving a freeze wall could contain the extent of the groundwater cone of depression to within the freeze wall, resulting in less impact on connected systems.

#### 4.5.2.2 Utah

For a 200,000-bbl/day in situ project in Utah, the amount of water consumption is estimated to be 21,000 to 41,000 ac-ft/yr (Table 4.5.2-1). A 50,000-bbl/day underground mine with surface retort project or surface mine with surface retort project is estimated to have a water consumption rate of 6,500 to 9,900 ac-ft/yr, assuming 2.6 to 4 bbl of water needed for each barrel of oil produced.

The remaining available water from the Colorado River in Utah is expected to decline from 396,000 ac-ft/yr in 2000 to 193,000 ac-ft/yr in 2050 (Table 4.5.2-1). With a range of 6,500 to 41,400 ac-ft/yr required for individual oil shale development projects, the water requirements represent 1.6 to 10.5% of the currently available water and would be 3.4 to 21.5% of the water available in 2050.

#### 4.5.2.3 Wyoming

For a 200,000-bbl/day in situ project in Wyoming, the amount of water consumption is estimated to be 20,300 to 41,300 ac-ft/yr (Table 4.5.2-1). Underground mine with surface retort or surface mine with surface retort projects at 50,000 bbl/day are estimated to consume 6,400 to 9,700 ac-ft/yr of water (Table 4.5.2-1).

The remaining available water from the Colorado River in Wyoming is expected to decline from 226,000 ac-ft/yr in 2000 to a range of 80,000 to 202,000 ac-ft/yr in 2030. With a range of 6,400 to 41,300 ac-ft/yr required for individual oil shale development projects, the water requirements represent 3 to 18.3% of the currently available water, and would be 3 to 52% of the water available in 2030.

### 4.5.3 Mitigation Measures

The potential impacts on water resources are closely related to the technologies used to mine, extract, process, and upgrade the shale oil from the source rocks. At the programmatic level, the impacts can be reduced tremendously starting from the planning stage. Local hydrologic conditions, including those of surface water and groundwater and the interactive relationship between them, should be characterized and considered in selecting areas for developmental sites, access roads, pipelines, transmission lines, and/or reservoirs. Sensitive areas should be avoided or receive special attention in oil shale development activities. Important factors include but are not limited to:

- Highly erodible geologic material;
- Steep terrain prone to soil erosion;
- Highly saline soils; and
- Groundwater discharge and recharge areas.

In selecting the technologies to develop oil shale, the technologies that would minimize potential contaminant sources should be considered. Several important factors to reduce impacts on water resources include technologies that:

- Result in minimum footprint of disturbed areas;
- Minimize total water consumption;
- Can use wastewater or brackish water in processing source rocks;
- Minimize disturbance between groundwater flow regimes to avoid cross flows between aquifers; and

- Have highest recovery of shale oil or bitumen, leaving spent material with the least amount of contaminants to be leached.

Mitigation measures that the BLM might consider requiring if warranted by the result of the lease-stage or plan of development-stage NEPA analyses are related to engineering practices, as follows:

- Water should be treated and recycled as much as possible.

- The size of cleared and disturbed lands should be minimized as much as possible and reclaim disturbed areas as quickly as possible.

- Erosion controls that comply with county, state, and federal standards and BLM guidelines (Fogg and Hadley 2007, USFS Region 2 2000) should be applied.

- Existing roads and borrow pits should be used as much as possible.

- Earth material would not be excavated from, nor would excavated material be stored in, any stream, swale, lake, or wetland.

- Vegetated buffers would be maintained near streams and wetlands. Silt fences could be used along edges of streams and wetlands to prevent erosion and transport of disturbed soil, including spoil piles.

- Earth dikes, swales, and lined ditches could be used to divert work-site runoff that would otherwise enter streams.

- Topsoil removed during construction should be stockpiled and reapplied during reclamation. Practices such as installing jute netting, silt fences, and check dams should be applied near disturbed areas.

- Operators should identify unstable slopes and local factors that can induce slope instability (such as groundwater conditions, precipitation, earthquake potential, slope angles, and dip angles of geologic strata). Operators also should avoid creating excessive slopes during excavation and blasting operations. Special construction techniques should be used where applicable in areas of steep slopes, erodible soil, and stream channel or wash crossings.

- Existing drainage systems should not be altered, especially in sensitive areas such as erodible soils or steep slopes. Culverts of adequate size to accommodate the runoff of a 25- and 100-year storm for temporary and permanent roads, respectively, should be used when constructing stream or wash crossings. Potential soil erosion should be controlled at culvert outlets with appropriate structures. Catch basins, roadway ditches, and culverts should be cleaned and maintained regularly.

- Runoff controls should be applied to disconnect new pollutant sources from surface water and groundwater.

- Foundations and trenches should be backfilled with originally excavated material as much as possible. Excess excavated material should be disposed of only in approved areas.

- Pesticides and herbicides should be used with the goal of minimizing unintended impacts on soil and surface water bodies. Common practices include but would not be limited to (1) minimizing the use of pesticides and herbicides in areas with sandy soils near sensitive areas; (2) minimizing their use in areas with high soil mobility; (3) maintaining the buffer between herbicide and pesticide treatment areas and water bodies; (4) considering the climate, soil type, slope, and vegetation type in determining the risk of herbicide and pesticide contamination; and (5) evaluating soil characteristics prior to pesticide and herbicide application, to assess the likelihood of their transport in soil.

- Pesticide use should be limited to nonpersistent, immobile pesticides and should only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.

- Vehicle service and fuel areas, chemical storage and use areas, and waste dumps and areas are to be located on gentle upland sites. Mixing, loading, and cleaning should be conducted on upland sites with gentle slopes. Chemicals and containers would be disposed of in state-certified disposal areas.

- Contour berms and trenches could be installed around vehicle service and refueling areas, chemical storage and use areas, and waste dumps to fully contain spills. Liners could be used as needed to prevent seepage into groundwater.

- An erosion and sedimentation control plan, as well as a Stormwater Pollution Prevention Plan (SWPPP), should be prepared in accordance with federal and state regulations.

## 4.6 AIR QUALITY AND CLIMATE

### 4.6.1 Common Impacts

The potential for air quality impacts from commercial oil shale development, including ancillary facilities such as access roads, upgraded facilities, gas pipelines, and compressors, is directly related to the amount of land disturbance, drilling and mining operations, processing methods, and the quantity of oil and gas equivalent produced. Indirect effects, such as impacts

resulting from the need for additional electrical generation and increased secondary population growth, are also considered.

Impacts on air quality from oil shale development would occur in several ways, as described below:

- Temporary, localized impacts (primarily PM and $SO_2$, with some CO and $NO_x$ emissions) would result from the clearing of the project area; grading, excavation, and construction of facilities and associated infrastructure; and mining (extraction) or drilling of the oil shale resource.

- Long-term, regional impacts (primarily CO and $NO_x$, with lesser amounts of PM, $SO_2$, and VOCs) would result from oil shale processing, upgrading, and transport (pipelines). Depending on site-specific locations, meteorology, and topography, $NO_x$ and $SO_2$ emissions could cause regional visibility impacts (through the formation of secondary aerosols) and contribute to regional nitrogen and sulfur deposition. In turn, atmospheric deposition could cause changes in sensitive (especially alpine) lake chemistry. In addition, depending on the amounts and locations of $NO_x$ and VOC emissions, photochemical production of $O_3$ (a very reactive oxidant) is possible, with potential impacts on human health and vegetation. Similar impacts could also occur from the additional coal-fired power plants that would be needed to supply electricity for in situ oil shale extraction. Localized impacts due to emissions of hazardous air pollutants (HAPs) (particularly benzene, toluene, ethylbenzene, xylene, and formaldehyde) and diesel PM could also present health risks to workers and nearby residences.

It is not possible to predict site-specific air quality impacts until actual oil shale projects are proposed and designed. Once such a proposal is presented, impacts on these resources would be further considered in project-specific NEPA evaluations and through consultations with the BLM prior to actual development.

Although oil shale is found in the states of Colorado, Utah, and Wyoming, there are two high-yield areas of the Piceance Basin in western Colorado with the greatest potential for development. Table 4.6.1-1 identifies those counties where direct and indirect air pollutant emissions could result from oil shale leasing.

Impacts on air quality would be limited by applicable local, state, Tribal, and federal regulations, standards, and implementation plans established under the CAA and administered by the applicable air quality regulatory agency, with EPA oversight. These agencies include, but are not limited to, the Colorado Department of Public Health and Environment–Air Pollution Control Division (CDPHE-APCD), the Utah Department of Environmental Quality–Division of Air Quality (UTDEQ-DAQ), and the Wyoming Department of Environmental Quality–Division of Air Quality (WYDEQ-DAQ). Air quality regulations require that proposed new or modified existing air pollutant emission sources undergo a permitting review before their construction can begin. Therefore, these state agencies have the primary authority and responsibility to review

**TABLE 4.6.1-1 Counties within the Study Area That Could Be Affected by Air Pollutant Emissions**

| State | County | Land Area ($mi^2$) | Population (July 1, 2001, estimate) | Population (July 1, 2005, estimate) |
|---|---|---|---|---|
| Colorado | Garfield | 2,947 | 45,545 | 49,810 |
| | Moffat | 4,742 | 13,213 | 13,417 |
| | Rio Blanco | 3,221 | 5,878 | 5,973 |
| | Subtotal | 10,910 | 64,636 | 69,200 |
| Utah | Carbon | 1,478 | 19,768 | 19,437 |
| | Duchesne | 3,238 | 14,563 | 15,354 |
| | Emery | 4,452 | 10,751 | 10,711 |
| | Garfield | 5,174 | 4,691 | 4,470 |
| | Grand | 3,682 | 8,490 | 8,743 |
| | San Juan | 7,820 | 13,607 | 14,104 |
| | Uintah | 4,477 | 25,773 | 26,995 |
| | Utah | 1,998 | 389,866 | 443,738 |
| | Wasatch | 1,177 | 16,172 | 18,974 |
| | Wayne | 2,460 | 2,529 | 2,450 |
| | Subtotal | 35,956 | 506,210 | 564,976 |
| Wyoming | Lincoln | 4,069 | 14,736 | 15,999 |
| | Sublette | 4,883 | 5,936 | 6,926 |
| | Sweetwater | 10,425 | 36,766 | 37,975 |
| | Uinta | 2,082 | 19,537 | 19,939 |
| | Subtotal | 21,459 | 76,975 | 80,839 |
| Regional | Total | 68,325 | 647,821 | 715,015 |

Source: USCB (2007a,b).

permit applications and to require emission permits, fees, and control devices prior to construction and/or operation. The U.S. Congress (through CAA Section 116) authorized local, state, and Tribal air quality regulatory agencies to establish air pollution control requirements more (but not less) stringent than federal requirements.

In addition, under the CAA and FLPMA, federal agencies cannot authorize any activity that does not conform to all applicable local, state, Tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans.

Before oil shale development could occur, additional project-specific NEPA analyses would be performed, subject to public and agency review and comment. The applicable air quality regulatory agencies (including the states and EPA) would also review site-specific preconstruction permit applications to examine potential projectwide air quality impacts. As part of these permits (depending on source size), the air quality regulatory agencies could require additional air quality impact analyses or mitigation measures. Those evaluations would take into

consideration the specific project features being proposed (e.g., specific air pollutant emissions and control technologies) and the locations of project facilities (including terrain, meteorology, and spatial relationships to sensitive receptors.) Project-specific NEPA assessments would predict site-specific impacts, and these detailed assessments (along with BLM consultations) would result in the required actions by the applicant to avoid or mitigate significant impacts. Under no circumstances can the BLM conduct or authorize activities that would not comply with all applicable local, state, Tribal, or federal air quality laws, regulations, standards, or implementation plans.

Ongoing scientific research has identified the potential effects of so-called "greenhouse gas" (GHG) emissions (including $CO_2$, methane, $NO_x$, water vapor; and several trace gases) on global climate. Recent industrialization and burning of fossil carbon sources have caused $CO_2$ concentrations to increase dramatically and are likely to contribute to overall climatic changes. Increasing $CO_2$ concentrations also leads to preferential fertilization and growth of specific plant species. The assessment of GHG emissions and climate change is in its formative phase, and it is not yet possible to know with confidence the net impact on climate. However, the IPCC (2007) recently concluded that "warming of the climate system is unequivocal" and "most of the observed increase in globally average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic [man-made] greenhouse gas concentrations."

Global mean surface temperatures have increased nearly 1.0°C (1.8°F) from 1890 to 2006 (Goddard Institute for Space Studies 2007). However, the northern latitudes (above 24°N — which includes all of the United States) have exhibited temperature increases of nearly 1.2°C (2.1°F) since 1900, with nearly a 1.0°C (1.8°F) increase since 1970 alone. Without additional meteorological monitoring systems, it is difficult to determine the spatial and temporal variability and change of climatic conditions, but increasing concentrations of GHG, however, are likely to accelerate the rate of climate change. The direct emissions of climate change air pollutants from oil shale development facilities are likely to be a small fraction of global emissions.

#### 4.6.1.1 Impacts from Emissions Sources for Oil Shale Facilities

To estimate total potential air pollutant emissions, emission factors for a specific activity must be identified and then multiplied by activity levels and engineering control efficiencies. The emission factors from proposed project activities would be estimated in future NEPA analyses by using appropriate equipment manufacturer's specifications, testing information, EPA AP-42 emission factor references (EPA 1995), and other relevant references. Anticipated levels of operational activities (e.g., load factors, hours of operation per year, and vehicle miles traveled) would be computed. Emission inventories would be made for selected years during the assumed plant life (including construction, operation, maintenance, and reclamation).

**4.6.1.1.1 Construction.** Mining and surface process technologies may include construction of a surface or underground mine and mine bench, with primary crushing facilities, processing and upgrading facilities, spent material disposal areas, and reservoirs for flood control

and a catchment dam below the disposal pile. For thermally conductive in situ conversion processes, considerable construction and preproduction development work include extensive drilling, placement of heating elements, construction of upgrading/refining facilities, power plants, and possibly cryogenic (freeze wall) plants.

Irrespective of surface or in situ technologies, additional construction activities include access roads, power supply and distribution systems, pipelines, water storage and supply facilities, construction staging areas, hazardous materials handling facilities, housing, and auxiliary buildings.

Impacts on air quality associated with these construction activities include fugitive dust emissions and engine exhaust emissions of heavy equipment, as well as commuting and delivery vehicles on paved and/or unpaved roads. Another emission source affecting air quality is wind erosion of soil disturbed by construction activities or from soil stockpiles.

**4.6.1.1.2 Production.** Emissions impacting air quality could result from surface operations, such as mining and crushing, processing (such as pyrolysis of the base material at high temperatures), upgrading the hydrocarbon products, support utilities, and disposing of waste products. Major processing steps for in situ processes would include heating the base material in place, extracting the liquid from the ground, and transporting it to an upgrading/refining facility. Because in situ processing does not involve mining, with limited waste material disposal, it does not permanently modify land surface topography and therefore produces fewer air pollutant emissions.

**4.6.1.1.3 Maintenance.** Maintenance activities primarily include access road maintenance and periodic visits to facilities and structures away from the main facilities. The primary emissions that could affect air quality would be fugitive dust and engine exhaust emissions.

**4.6.1.1.4 Reclamation.** During reclamation activities, which proceed continuously throughout the life of the project, waste material disposal piles would be smoothed and contoured by bulldozers. Topsoil would be placed on the graded spoils, and the land would be prepared for revegetation by furrowing, mulching, and the like. From the time an area is disturbed until the new vegetation emerges, all disturbed areas are subject to wind erosion. Fugitive dust and engine exhaust emissions from reclamation activities are similar to those from construction activities, although with a lower level of activity.

**4.6.1.1.5 Population Growth.** Population growth and related emission increases associated with potential development would include direct employment; other industry workers (such as those associated with additional power plants); workers from suppliers (e.g., related to equipment, materials, supplies, and services); consumer effects (e.g., related to additional retail stores); additional employment in federal, state, and local governments; and families.

**4.6.1.1.6 Mobile (onroad and nonroad).** Additional air pollutant emissions that could affect air quality would be associated with on-road mobile sources (e.g., cars, trucks, and buses), and nonroad mobile sources (e.g., graders and backhoes used in construction).

### 4.6.2 Mitigation Measures

Since all activities either conducted or approved through use authorizations by the BLM must comply with all applicable local, state, Tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans, it is unlikely that future oil shale development would cause significant adverse air quality impacts.

However, on a case-by-case basis, future individual leases and use authorizations could include specific measures to minimize potential air quality impacts. These mitigation measures could include but are not limited to (1) treating access roads with water or other surfactants to reduce fugitive dust from traffic; (2) reducing vehicle speeds on dirt roads to reduce fugitive dust from traffic; (3) specifying emission control devices on production equipment to reduce potential CO, $NO_x$, $PM_{2.5}$, $PM_{10}$, and VOC emissions; (4) specifying low-sulfur-content fuels to reduce potential $SO_2$ emissions; and/or (5) regulating the timing of emissions to reduce the formation of $O_3$ in the atmosphere from $NO_x$ and VOC emissions.

In addition, to ensure that BLM-authorized activities comply with applicable ambient air quality standards, as well as potential impacts on AQRVs (such as visibility, atmospheric deposition, noise, etc.), specific monitoring programs may be established.

Potential global warming impacts could be reduced if oil shale substitutes for the use of other fossil carbon-based energy sources, or if atmospheric loadings are reduced by emission controls or sequestration methods.

## 4.7 NOISE RESOURCES

Generic noise impacts of construction, operation, and reclamation of oil shale development facilities were estimated; however, detailed information on equipment types, schedules, layouts, and locations was not available at the programmatic level. When available, published estimates of noise impacts from technology assessments and EAs for facilities expected to be similar to those considered here were used as the basis for this assessment. Use of these existing studies required making reasonable assumptions and extrapolations. In addition, this lack of detailed information also precludes making quantitative estimates of the impacts of noise mitigation measures that might be applied, if warranted by the results of the lease-stage and/or plan of development-stage NEPA analyses.

The characteristics of the area around a noise source influence the impacts caused by that source. However, sources produce the same amount of noise independent of their location and, to a first approximation, noise propagates identically everywhere. At the programmatic level, information that could help differentiate between noise impacts in different locations is

unavailable as are estimates of the noise levels associated with some of the technologies. The approach taken here assesses the impacts of technologies. Noise levels are assumed to be independent of location. Thus, differences in impacts due solely to restrictions in areas available for leasing are not considered.

When published estimates for facilities were unavailable, simple noise modeling was used to estimate noise impacts (HMMH 1995). To predict an impact, the model requires that the noise level associated with the technology be assessed. Noise levels were not available for some technologies. In these cases, noise levels associated with similar technologies were used.

Published information was generally for a single-capacity facility. To use these data, their noise impacts were extrapolated by using a conservative approach equivalent to the 3-dBA rule of thumb.[6] For example, if noise levels were available for a reference facility of 20,000 bbl/day, the noise impact of a 40,000-bbl/day facility was assumed to be 3 dBA higher, an assumption equivalent to locating two 20,000-bbl/day facilities at the same point.

**Noise Modeling Parameters**

| | |
|---|---|
| All calculations: | |
| Ground type: | Soft |
| For calculating $L_{dn}$: | |
| Daytime background noise level: | 40 dBA (typical of rural areas) |
| Nighttime background noise level: | 30 dBA (typical of rural areas) |
| Daytime hours: | 15 hours from 7 a.m. to 10 p.m. |
| Nighttime hours: | 9 hours from 10 p.m. to 7 a.m. |

As is generally the practice, this PEIS uses the EPA guideline of 55 dBA ($L_{dn}$), deemed adequate to protect human health and welfare, as a significance criterion for assessing noise impacts (EPA 1974). However, oil shale development would occur mostly in remote rural locations. In these areas, background (already existing) noise levels are low (40 dBA during the day and 30 dBA during the night are representative levels), and an increase in noise levels to 55 dBA would be noticeable and annoying to both people and wildlife (Harris 1991). However, this guideline may not be appropriate for all wildlife impacts or for people seeking solitude or a natural, wilderness experience. Depending on ambient conditions, the activities being pursued by the receptors, and the nature of the sound, wildlife and human activities can be affected at levels below 55 dBA, but quantitative guidelines were unavailable. In addition, the NPS has determined that $L_{dn}$ and equivalent sound pressure level ($L_{eq}$) alone are not appropriate for determining impacts within National Parks and typically uses audibility metrics to characterize impacts on humans and wildlife. Site-specific impacts on resources administered by the NPS would be

6 A 3-dB change in sound level is considered barely noticeable based on individuals' responses to changes in sound levels (NWCC 1998; MPCA 1979).

assessed using audibility-based metrics and other appropriate data and methodologies. See Sections 4.8 and 4.9 for impacts on wildlife and human aesthetic experiences, respectively, that could occur as a result of increased levels of noise.

The Colorado noise regulation specifies maximum noise levels of 55 and 50 dBA for daytime and nighttime hours in residential areas, with excursions of up to 60 dBA for up to 15 minutes in an hour. These levels cannot be directly compared with the EPA guideline. Where appropriate, the Colorado limits are used as another significance criterion.

### 4.7.1 Common Impacts

Noise impacts from construction and reclamation of oil shale facilities would be largely independent of the type of facility being constructed and are discussed below. Noise impacts from associated on-road vehicular traffic would also be largely independent of the facility type. Deviations from these general discussions are noted in the discussions of specific technologies. The noise from electric transmission lines and the product pipelines associated with these facilities is also discussed.

#### 4.7.1.1 Construction

Construction would include a variety of activities, including building of access roads, grading, drilling, pouring concrete, trenching, laying pipe, cleanup, revegetation, and, perhaps, blasting. With the exception of blasting, construction equipment constitutes the largest noise source at construction sites. Table 4.7.1-1 presents noise levels for typical construction equipment. For a programmatic assessment of construction impacts, it can be assumed that the two noisiest pieces (derrick crane and truck) would operate simultaneously and in close proximity to each other. Together these would produce a noise level of 91 dBA. Assuming a 10-hour workday, noise levels would exceed the EPA guideline of 55 dBA ($L_{dn}$) up to about 850 ft from the location where the equipment was operating. The Colorado maximum hourly level of 50 dBA would be exceeded up to about 1,800 ft from this location. (The difference between the two distances is due largely to the 14 hours when construction equipment is not operating; hours when only low-level background noise is present are included in the calculation of $L_{dn}$ but do not affect the maximum hourly noise.) Construction impacts could last up to 2 years and could recur during the operational phase if additional processing facilities needed to be constructed.

If used, blasting would create a compressional wave with an audible noise portion. Potential impacts on the closest sensitive receptors could be determined; however, most sensitive receptors, at least human sensitive receptors, would probably be located at a considerable distance from the construction sites.

**TABLE 4.7.1-1 Noise Levels at Various Distances from Typical Construction Equipment**

| Construction Equipment | Noise Level $L_{eq(1\text{-}h)}$[a] at Distances (dB(A) | | | | | |
|---|---|---|---|---|---|---|
| | 50 ft | 250 ft | 500 ft | 1,000 ft | 2,500 ft | 5,000 ft |
| Bulldozer | 85 | 66 | 58 | 50 | 40 | 32 |
| Concrete mixer | 85 | 66 | 58 | 50 | 40 | 32 |
| Concrete pump | 82 | 63 | 55 | 47 | 37 | 29 |
| Crane, derrick | 88 | 69 | 61 | 53 | 43 | 35 |
| Crane, mobile | 83 | 64 | 56 | 48 | 38 | 30 |
| Front-end loader | 85 | 66 | 58 | 50 | 40 | 32 |
| Generator | 81 | 62 | 54 | 46 | 36 | 28 |
| Grader | 85 | 66 | 58 | 50 | 40 | 32 |
| Shovel | 82 | 63 | 55 | 47 | 37 | 29 |
| Truck | 88 | 69 | 61 | 53 | 43 | 35 |

[a] $L_{eq(1\text{-}h)}$ is the equivalent steady-state sound level that contains the same varying sound level during a 1-hour period.

Source: HMMH (1995).

### 4.7.1.2 Vehicular Traffic

Heavy-duty trucks produce most of the noise associated with vehicular traffic during construction.[7] Vehicular traffic includes hauling of materials, transport of equipment, delivery of water for fugitive dust control, and worker personal vehicles. Light-duty trucks, such as pickups and personal vehicles, produce less noise than heavy-duty trucks (10 passenger cars make about the same noise as a single heavy-duty truck on an $L_{eq}$ basis). Except for short time periods when workers are arriving and leaving the construction site, heavy truck traffic would dominate the vehicular traffic. Table 4.7.1-2 presents the noise impacts from heavy trucks estimated at various distances from a road for different hourly levels of truck traffic. In making these estimates, a peak pass-by noise level from a heavy-duty truck operating at 35 mph was based on Menge et al. (1998) and a 10-hour working day. Except for locations very close to the road or at high traffic levels, noise levels would exceed neither the EPA guideline level nor the Colorado daytime maximum level. At night, the Colorado nighttime maximum level (50 dBA) might be exceeded by lower levels of truck traffic. However, for 15 minutes in any hour, the Colorado standard permits noise levels (up to 60 dBA) not reached except very close to the road or at high traffic levels.

[7] The average noise of a passing car is about 15 dBA less than that from a passing truck (BLM 2006a).

**TABLE 4.7.1-2 Noise Levels at Various Distances from Heavy Truck Traffic**

| Hourly Number of Trucks | Noise Level $L_{dn}$ (dBA)[a] | | | | | |
|---|---|---|---|---|---|---|
| | 50 ft | 75 ft | 100 ft | 125 ft | 250 ft | 500 ft |
| 1 | 48 | 45 | 43 | 42 | 37 | 32 |
| 10 | 58 | 55 | 53 | 52 | 47 | 42 |
| 50 | 65 | 62 | 60 | 58 | 54 | 49 |
| 100 | 68 | 65 | 63 | 62 | 57 | 52 |

[a] Estimated assuming a 10-hour daytime shift and heavy trucks operating at 35 mph.

Source: Menge et al. (1998).

#### 4.7.1.3 Surface Mining with Surface Retort

This assessment relies on data on noise from a mine supporting a 20,000-bbl/day surface retort (Section 5.7), which would be equivalent to 61 dBA at 500 ft. This is almost identical to the noise level from the crusher and thus, even if the mine and crusher were co-located, noise levels with the surface mine would only be about 3 dBA higher than those with an underground mine. However, the surface mine must be considered separately during the site-specific NEPA analyses that should consider all major noise sources, including the surface mine, crushers, conveyors, on-site or nearby upgrading facilities, and pumps, and should consider the operating schedules detailed in operations plans. If high noise impacts are projected, noise-reduction equipment such as mufflers, blowdown mutes, pipe wrap, barriers, application of sound-absorbing material, and enclosures may be required (Daniels et al. 1981; Teplitzky et al. 1981). Planning for space buffers between the mine, crushers and conveyors, and sensitive receptors and the site boundary may be a feasible method of mitigating noise impacts from these sources.

#### 4.7.1.4 Underground Mining with Surface Retort

Underground mines with surface retorts are assumed to be commercial implementations of the OSEC RD&D technology (see Appendix A, Section A.5.3.4). For the OSEC underground mining and surface retort process, the design-basis capacity for the commercial facilities would be about 13 to 800 times larger than that of the RD&D facility. No information specific to noise from construction of the OSEC ATP was available. General construction noise is discussed in Section 4.7.1.1. However, for a large commercial facility, site-specific construction noise would need to be addressed during the NEPA analyses. These analyses should consider the detailed construction schedule, including the likely repetition of construction activities as different portions of the lease site are developed, and the proximity of these activities to off-site receptors.

Given that noise levels from the OSEC RD&D operation might exceed the EPA guideline beyond 1,000 ft from the crusher and conveyor operations, there could be off-site noise issues related to a commercial-scale facility. The number of crushing and conveyor operations is unknown but is likely to be small. During the NEPA analyses that would be conducted for approval of individual projects, operational noise levels must be analyzed in detail. These analyses should include the effects of all major noise sources, including crushers, conveyors, on-site or nearby upgrading facilities, and pumps, and should consider the operating schedules detailed in operations plans. If high noise impacts are projected, noise-reduction equipment may be required (Daniels et al. 1981; Teplitzky et al. 1981). Planning for space buffers between crushers and conveyors and sensitive receptors and the site boundary may be a feasible method of mitigating noise impacts from these sources.

#### 4.7.1.5 In Situ Process

In situ processes are assumed to be commercial implementations of the Chevron, Shell, and EGL RD&D technologies (see Appendix A, Section A.5.3). For the Chevron in situ process, the projected capacity of commercial facilities (i.e., 200,000 bbl/day) would be 3,000 to 10,000 times larger than that of the RD&D facility. Construction noise associated with the Chevron RD&D facility might exceed the EPA guideline level of 55 dBA out to about 1,500 ft. Construction of a larger commercial facility would be noisier. The overall impact, however, would depend on the details of the construction schedule, including the likely repetition of the construction activities as different portions of the lease site are developed, and on the proximity of construction activities to off-site receptors. These considerations are site-specific and should be addressed during the site-specific NEPA analyses.

It appears that pumps would be major contributors to overall noise levels and the number, size, and placement of pumps in relation to each other and to nearby receptors must be considered in assessing the overall noise impact. During the NEPA analyses that would be conducted for approval of individual projects, both construction and operational noise levels for the proposed project must be analyzed in detail. These analyses should include all major noise sources, including those associated with any on-site or nearby upgrading facility, and should consider the operating schedules detailed in the operations plans. If high noise impacts are projected, noise-reduction equipment may be required (Daniels et al. 1981; Teplitzky et al. 1981).

The projected capacity of commercial facilities would be 100 to 400 times larger than that of the Shell in situ RD&D facility. Construction of commercial-scale projects would require drilling hundreds of holes (e.g., 190 for the RD&D project). Noise associated with the Shell RD&D facility might exceed the EPA guideline level of 55 dBA out to about 1,300 ft. Drilling additional holes for a commercial-scale facility would probably cause higher noise levels. The overall impact would depend on the number of drill rigs operating simultaneously, the spacing between the rigs, their overall configuration, and the schedule for drilling, including the likely repetition of drilling activities as different portions of the lease site are developed, as well as the rigs' proximity to off-site receptors. These considerations are site-specific and should be addressed during the site-specific NEPA analyses.

During operation, the Shell RD&D facilities would employ pumps in the producer holes that would muffle noise. Aboveground pumps would be a major noise source. If commercial-scale facilities are designed to employ aboveground pumps, the noise impacts would need to be addressed in the site-specific NEPA analyses. The number, size, and placement of the pumps in relation to each other and nearby receptors and their interactions with on-site upgrading facilities would be key factors in these analyses. If high noise impacts are projected, noise-reduction equipment may be required (Daniels et al. 1981; Teplitzky et al. 1981).

In addition, the site-specific analyses would need to address transformer noise. The Shell ICPs use large amounts of electricity and would require the use of transformers, which could be a noise source. Their impact would depend upon their sizes, numbers, and locations in relation to the other large noise sources, and their relative importance would increase if underground pumps were retained in the commercial facilities. A transformer produces a constant low-frequency hum. The average A-weighted sound level at about 490 ft for a transformer of about 400 MW is about 49 dBA (Wood 1992). The number and size of the transformers are currently unknown, but a single transformer could exceed the EPA guideline at 500 ft. Transformer noise and mitigating measures must be addressed in the site-specific NEPA analyses, especially if underground pumps are used or the transformers are far removed from the locations of aboveground pumps.

Commercial-scale in situ technologies could require up to 2,400 MW in new coal-fired generating capacity (Section 4.1). Currently, a typical large power plant might be about 1,000 MW. The noisiest continuous sources at power plants are the steam boilers and turbine generators: about 89 dBA and 80 dBA at 50 ft, respectively, for a 500-MW boiler (Teplitzky et al. 1981). These sources would be enclosed in a building, and noise suppression could be included in the plant design. In addition, there are intermittent noise sources associated with coal car shaking, car dumping, coal crushing, conveyors, and transfer towers. Noise levels from dumping can exceed 90 dBA. The pollution control equipment associated with power plants also causes noise, and installation of this equipment has given rise to complaints from nearby residents. The noise levels associated with the generation of the electric power that may be needed by commercial-scale in situ technologies should be considered when the facilities are constructed. Table 4.7.1-3 presents approximate noise reductions achievable by noise-reduction techniques on the basis of experience at power plants (Teplitzky et al. 1981).

The projected capacity for commercial facilities would be about 200 to 800 times larger than that of the EGL RD&D facility. Drill rigs would constitute a major source of construction noise associated with the EGL RD&D facility. Drilling additional holes for a commercial-scale facility would probably cause higher noise levels. The overall impact would depend on the number of drill rigs operating simultaneously, the spacing between the rigs, their overall configuration, and the schedule for drilling, including the likely repetition of drilling activities as different portions of the lease site are developed, as well as the rigs' proximity to off-site receptors. These considerations are site-specific and should be addressed during the site-specific NEPA analyses.

Boilers may be a major noise-producing source. The number and size of the boilers associated with a commercial facility are unknown, as is the potential number of pumps. If large

pumps are used, they would constitute a major noise source. Although individual large boilers may be noisier than pumps, they would be located in a boiler house that would provide some noise reduction (Teplitzky et al. 1981). During the NEPA analyses that would be conducted for approval of individual projects, the number, size, and placement of the pumps and boilers in relation to each other and nearby receptors and their interactions with on-site upgrading facilities would be key factors in assessing noise levels. If high noise impacts are projected, noise-reduction equipment may be required (Daniels et al. 1981; Teplitzky et al. 1981).

**TABLE 4.7.1-3 Maximum Achievable Noise Reductions for Design Features**

| Feature | Achievable Noise Reduction (dBA) |
|---|---|
| Barrier | Up to 15 |
| Partial enclosure | Up to 10 |
| Complete enclosure | Up to 30 |
| Sound absorption material | Up to 10 |
| Mufflers | Up to 30 |
| Lagging | Up to 15 |
| Vibration damping | Up to 10 |
| Vibration isolation | Up to 10 |

Source: Teplitzky et al. (1981).

#### 4.7.1.6 On-Site Upgrading Operations

Noise levels from on-site upgrading operation could be substantial and should be accounted for in the site-specific NEPA analyses. No information specific to the noise associated with upgrading facilities was available. However, many of the operations employed in an upgrading facility would be the same as those in oil refineries. EPA (1971) presents results of noise field measurements taken around an oil refinery of unspecified capacity. The major sources are furnaces and their associated heat exchangers and compressor systems. The highest noise levels at the plant boundary (at unknown distances from the noise sources) range from 67 to 71 dBA depending on the time of day and day of the week. These levels would correspond to levels in excess of the EPA guideline level of 55 dBA ($L_{dn}$) and indicate that the on-site upgrading facility should be included in the site-specific noise analyses.

#### 4.7.1.7 Reclamation

In general, noise impacts from reclamation activities would be similar to but less than those associated with construction activities because the activity type and level would be similar but shorter in duration. Most reclamation would also occur during the day when noise is better tolerated by people, and noise levels would return to background levels during the night and would be intermittent in nature. Reclamation activities would last for a short period compared with the period of construction operations.

#### 4.7.1.8 Transmission Lines

General construction impacts are discussed in Section 4.7.1.1. During operation, the main sources of noise from the transmission line would be substation noise and corona discharge. Substation noise comes primarily from transformers and switchgear. A transformer produces a constant low-frequency hum. The average A-weighted sound level at about 490 ft for a

transformer of about 400 MW is about 49 dBA (Wood 1992). The number and size of transformers are currently unknown, but a single transformer could exceed the EPA guideline at 500 ft. Transformer noise and mitigating measures must be addressed if substations are required along the transmission lines. Switchgear noise is generated when a breaker opens, producing an impulsive sound, which is loud but of short duration. These occur infrequently, and the industry trend is toward breakers that generate significantly less noise. The potential impacts of switchgear noise would be temporary, infrequent, and minor.

Transmission lines generate corona discharge, which produces a noise having a hissing or crackling character. During dry weather, transmission line noise is generally indistinguishable from background noise at the edge of typical ROWs. During rainfall, the level would be less than 47 dBA at a distance of 100 ft from the center of a 500-kV transmission line (BPA 1996). This noise level is the level typical of a library (MPCA 1979). Even if several transmission lines of this capacity were required, the overall corona noise would be lost even in rural background noise within several hundred feet.

#### 4.7.1.9 Pipeline

General construction impacts are discussed in Section 4.7.1.1. Depending on the topography, a pipeline 55 mi long could require several pump stations. Pumps will generally be the noisiest equipment associated with a pump station. Large pumps would be needed to handle the assumed output of 200,000 bbl/day for in situ facilities. Contra Costa County (2003) gives a noise level of 94 dBA at 3 ft from a 400-hp pump but does not specify the throughput. Assuming three pumps, the EPA guideline would be exceeded out to about 260 ft from the pumps. Pumps are almost always located in structures for protection from the weather and for security. The enclosure would reduce noise levels. Because the pumps needed to move the assumed output may be larger and noisier than those assumed here, noise impacts would need to be assessed during planning for the actual pump stations.

### 4.7.2 Mitigation Measures

Regulatory requirements regarding noise already largely address the mitigation of impacts. To reinforce those regulatory requirements, mitigation measures will be required and could include the following:

#### 4.7.2.1 Preconstruction Planning

- Developers should conduct a preconstruction noise survey to identify nearby sensitive receptors (e.g., residences, schools, child care facilities, hospitals, livestock, ecological receptors of critical concern, and areas valued for solitude and quiet) and establish baseline noise levels along the site boundary and at the identified sensitive receptors.

- On the basis of site-specific considerations identified through the preconstruction noise survey, proponents should develop a noise management plan to mitigate noise impacts on the sensitive receptors. The plan would cover construction, operations, reclamation, and site restoration. The plan should ensure that the standards to be implemented reflect conditions specific to the lease site.

  This plan could provide for periodic noise monitoring at the facility boundary and at nearby sensitive receptors on a monthly or more frequent basis at a time when the facility is operating at normal or above-normal levels. Monitoring results could be used to identify the need for corrective actions in existing mitigation measures or the need for additional noise mitigation.

#### 4.7.2.2 Construction and Reclamation

Wherever there are sensitive receptors, as identified in the preconstruction survey, construction noise should be managed to the extent necessary to mitigate adverse impacts on the sensitive receptors. Efforts to mitigate these impacts could include the following measures:

- A noise complaint manager could be designated to receive any noise complaints from the public. This employee could have the responsibility and authority to convene a committee to investigate noise complaints, determine the causes of the noise leading to the complaints, and recommend mitigation measures.

- General construction activities could be limited to daytime hours between 7 a.m. and 7 p.m. On the basis of the results of the baseline noise survey, these hours could be extended to between 7 a.m. and 10 p.m. in areas remote from sensitive receptors.

- Particularly noisy activities, such as pile driving, blasting, and hauling by heavy trucks, could be limited to daytime hours between 8 a.m. and 5 p.m. on weekdays and prohibited on weekends and state and federal holidays. The noise management plan could identify alternate methods for conducting noisy activities and available mitigation methods. The least noisy of these could be chosen for use during construction unless its use is precluded by site-specific characteristics.

- When feasible, different particularly noisy activities could be scheduled to occur at the same time, since additional sources of noise generally do not add significantly to the perceived noise level. That is, less frequent noisy activities may be less annoying than frequent less noisy activities.

- If blasting or other impulsive noisy activities are required, nearby sensitive human receptors could be notified in advance.

- All construction equipment should have sound control devices no less effective than those provided on the original equipment. Construction equipment and the equipment's sound control devices could be required to be well tuned, in good working order, and maintained in accordance with the manufacturer's specifications. Appropriate record keeping of these maintenance activities could be required.

- Where possible, construction traffic could be routed to minimize disruption to sensitive receptors.

- Temporary barriers could be erected around areas where construction noise could disturb sensitive receptors.

- To the extent possible, stationary noisy equipment (such as compressors, pumps, and generators) could be located as far as practicable from sensitive receptors.

#### 4.7.2.3 Operation

Wherever there are sensitive receptors, as identified in the preconstruction survey, noise from operations should be managed to the extent necessary to mitigate adverse impacts on the sensitive receptors. Efforts to mitigate these impacts could include the following measures:

- A noise complaint manager could be designated to handle noise complaints from the public. This employee could have the responsibility and authority to convene a committee to investigate noise complaints, determine the causes of the noise leading to the complaints, and recommend mitigation measures.

- Noisy equipment (such as compressors, pumps, and generators) could be required to incorporate noise-reduction features such as acoustic enclosures, mufflers, silencers, and intake noise suppression.

- Facilities could be required to demonstrate compliance with the EPA's 55-dBA guideline at the nearest human sensitive receptor. Sensitive ecological receptors and appropriate associated lower noise levels could also be considered. In special areas where quiet and solitude have been identified as a value of concern, a demonstration that a lower noise level would be attained might be required. Such demonstrations might require use of additional or different criteria such as audibility.

- Based on the specific site, maintenance of off-site noise at suitable levels might require establishment of an activity-free buffer inside the fence line.

- Facility design could include all feasible noise-reduction methods, including, but not limited to, the mounting of equipment on shock absorbers; use of

mufflers or silencers on air intakes, exhausts, blowdowns, and vents; noise barriers; noise-reducing enclosures; use of noise-reducing doors and windows; sound-reducing pipe lagging; and low-noise ventilation systems.

- Where feasible, facility design could be required to incorporate low-noise systems such as ventilation systems, pumps, generators, compressors, and fans.

## 4.8 ECOLOGICAL RESOURCES

### 4.8.1 Common Impacts

#### 4.8.1.1 Aquatic Resources

Impacts on aquatic resources from the operation of oil shale projects could occur because of (1) direct disturbance of aquatic habitats within the footprint of construction or operation activities; (2) sedimentation of nearby aquatic habitats as a consequence of soil erosion from operational areas; (3) changes in water quantity or water quality as a result of construction (e.g., grading that affects surface runoff patterns), operations (e.g., depletions or discharges of water into nearby aquatic habitats), or releases of chemical contaminants into nearby aquatic systems. These impacts could occur to some degree during the construction period and throughout the operational life of the projects. In addition, some impacts could continue to occur beyond the operational life of the project.

Depending on the characteristics of specific development projects, new aquatic habitats could be formed after site development. For example, over time, drainage patterns associated with sediment control ponds that caught runoff from disturbed surfaces could create habitats that would support aquatic plants and invertebrates as well as fish. Although the development of such habitats could be beneficial in some instances, their ecological value would depend on the amount of habitat created and the types and numbers of species supported. In general, it is anticipated that the ecological value of these created habitats would be limited. Habitats that promote the survival and expansion of non-native aquatic species that compete with or prey upon native species could have negative ecological impacts on existing aquatic habitats.

Turbidity and sedimentation from erosion are part of the natural cycle of physical processes in water bodies, and most populations of aquatic organisms have adapted to short-term changes in these parameters. However, if sediment loads were unusually high or lasted longer than they would under natural conditions, adverse impacts could occur (Waters 1995). Increased sediment loads could suffocate aquatic vegetation, invertebrates, and fish; decrease the rate of photosynthesis in plants and phytoplankton; decrease fish feeding efficiency; decrease the levels of invertebrate prey; reduce fish spawning success; and adversely affect the survival of incubating fish eggs, larvae, and fry (Waters 1995). Fish adapted to living in clearer waters (e.g., cutthroat trout and mountain whitefish) are more sensitive to increased sediment loads than

species that are adapted to higher-turbidity conditions (e.g., humpback chub, Colorado pikeminnow, flannelmouth sucker). The level of effects from increased sediment loads would also depend on the natural condition of the receiving waters and the timing of sediment inputs. Although most aquatic systems might be affected if increases in the levels of suspended and deposited sediments were large, if the increases in suspended sediment loads were small to moderate, aquatic habitats that normally have turbid water might be less sensitive than those that normally have clear water. In a similar fashion, increased sedimentation might have less impact on aquatic biota during periods of the year when sediment levels were naturally elevated (e.g., wet periods) than when the levels were lower.

The potential for soil erosion and sediment loading of nearby aquatic habitats is proportional to the amount of surface disturbance, the condition of disturbed areas at any given time, and the proximity to aquatic habitats. It is anticipated that areas being actively disturbed during construction or operations would have a higher erosion potential than areas that are undergoing reclamation activities, and that reclamation areas become less prone to erosion over time because of completion of site grading and reestablishment of vegetated cover. Assuming that reclamation activities are successful, restored areas should eventually become similar to natural areas in terms of erosion potential. In addition to areas directly affected by construction and operations, surface disturbance could occur as a result of the development of access roads, utility corridors, and employer-provided housing. Implementation of measures to control erosion and runoff into aquatic habitats (e.g., silt fences, retention ponds, runoff-control structures, and earthen berms) would reduce the potential for impacts from increased sedimentation.

Contaminants could enter aquatic habitats as a result of leachate runoff from exposed oil shale; the accidental release of fuels, lubricants, or pesticides; or spills from pipelines. Spent shale remaining on the surface could become a chronic source of contaminated runoff unless adequate containment measures are implemented or unless it is transported offsite for disposal. Chronic exposure to the leachate from spent oil shale has been shown to reduce the survival of some fish and invertebrate species if the concentrations are high enough (Woodward et al. 1997). Because the resulting concentrations in aquatic habitats would depend largely on the dilution capability, and, therefore, the flow of the receiving waters, impacts would be more likely if runoff entered small perennial streams than if it entered larger streams.

Toxic materials (e.g., fuel, lubricants, and herbicides) could also be accidentally introduced into waterways during construction and maintenance activities or as a result of leaks from pipelines. The level of impacts from releases of toxicants would depend on the type and volume of chemicals entering the waterway, the location of the release, the nature of the water body (e.g., size, volume, and flow rates), and the types and life stages of organisms present in the waterway. In general, lubricants and fuel would not be expected to enter waterways as long as heavy machinery is not used in or near waterways, fueling locations for construction and maintenance equipment are situated away from the waterway, and measures are taken to control potential spills.

In areas where access roads, pipelines, or utility corridors cross streams, obstructions to fish movement could occur if culverts, low-water crossings, or buried pipelines are not properly installed, sized, or maintained. During periods of low water, vehicular traffic can result in rutting

and accumulation of cobbles in some crossings that can interfere with fish movements. In streams with low flows, flow could become discontinuous if disturbance of the streambed during construction activities results in increased porosity or if alteration of the channel spreads flows across a wider area. Restrictions on fish movement would likely be most severe if they occur in streams that support species that need to move to specific areas in order to reproduce.

In addition to the potential for the direct impacts identified above, indirect impacts on fisheries could occur as a result of increased public access to remote areas via newly constructed access roads and utility corridors. Fisheries could be impacted by increased fishing pressure, and other human activities (e.g., OHV use) could disturb riparian vegetation and soils, resulting in erosion and sediment-related impacts on water bodies, as discussed above. Such impacts would be smaller in locations where existing access roads or utility corridors that already provide access to waterways would be utilized.

#### 4.8.1.2 Plant Communities and Habitats

Potential impacts on terrestrial and wetland plant communities and habitats from activities associated with oil shale development would include direct and indirect impacts. Impacts would be incurred during initial site preparation and continue throughout the life of the project, extending over a period of several decades. Some impacts may also continue beyond the termination of shale oil production.

Direct impacts would include the destruction of habitat during initial land clearing on the lease site, as well as habitat losses resulting from the construction of ancillary facilities such as access roads, pipelines, transmission lines, and employer-provided housing, as well as the construction of new power plants for in situ facilities. Land clearing on the site would be required for construction of processing facilities, storage areas for soil and spent shale, and excavation areas. Land clearing would also occur incrementally throughout the life of the project, resulting in continued losses of habitat. Native vegetation communities present in project areas would be destroyed and may include rare communities and remnant vegetation associations. Storage of woody vegetation cleared from project areas would impact additional areas of vegetation. Impacts on jurisdictional wetlands (those under the regulatory jurisdiction of the CWA, Section 404, and the USACE) on or near the project site or locations of ancillary facilities would be avoided or mitigated. Preconstruction surveys would identify wetland locations and boundaries, and the permitting process would be initiated with the USACE for unavoidable impacts.

Reclamation of impacted areas would include reestablishment of vegetation on restored soils. Although revegetation of disturbed soils may successfully establish a productive vegetation cover, with biomass and species richness similar to local native communities, the resulting plant community may be quite different from native communities in terms of species composition and the representation of particular vegetation types, such as shrubs (Newman and Redente 2001). Revegetation of spent shale covered with a topsoil layer may also potentially result in a productive species-rich native plant community (Sydnor and Redente 2000). Community composition of revegetated areas would likely be greatly influenced by the species that are

initially seeded, particularly perennial grasses, and colonization by species from nearby native communities may be slow (Paschke et al. 2005; Newman and Redente 2001; Sydnor and Redente 2000). The establishment of mature native plant communities may require decades. Successful reestablishment of some vegetation types, such as shrubland communities or stabilized sand dunes, may be difficult and would require considerable periods of time, likely more than 20 years (BLM 2004a). Restoration of plant communities in areas with arid climates (generally averaging less than 9 in. of annual precipitation), such as the Uinta Basin Floor ecoregion in Utah and portions of the Rolling Sagebrush Steppe and Salt Desert Shrub Basins ecoregions in Wyoming, would be especially difficult (Monsen et al. 2004) and may be unsuccessful. The loss of intact native plant communities could result in increased habitat fragmentation, even with the reclamation of impacted areas.

Disturbed soils may provide an opportunity for the introduction and establishment of non-native invasive species. Seeds or other propagules of invasive species may be inadvertently brought to a project site from infested areas by heavy equipment or other vehicles used at the site. Invasive species may also colonize disturbed soils from established populations in nearby areas. Important invasive species on disturbed lands include Russian thistle (*Salsola kali*), Russian knapweed (*Centaurea repens*), cheatgrass (*Bromus tectorum*), halogeton (*Halogeton glomeratus*), and Canada thistle (*Cirsium arvense*). The establishment of invasive species may greatly reduce the success of establishment of native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. In addition, the planting of non-native species in reclamation areas may result in the introduction of those species into nearby natural areas.

Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. Impacts on surface water and groundwater systems, which subsequently affect terrestrial plant communities, wetlands, and riparian areas, are described in Section 4.5. Deposition of fugitive dust, including associated salts, generated during clearing and grading, construction, and use of access roads, or resulting from wind erosion of exposed soils, could reduce photosynthesis and productivity in plants near project areas, and could result in foliar damage. Plant community composition could subsequently be altered, resulting in habitat degradation. In addition, pollinator species could be affected by fugitive dust (Section 4.8.1.3), potentially reducing pollinator populations in the vicinity of an oil shale project. Temporary, localized effects on plant populations and communities could occur if seed production in some plant species is reduced. Soil compaction could reduce the infiltration of precipitation or snowmelt and, along with reduced vegetation cover, result in increased runoff and subsequent erosion and sedimentation. Reduced infiltration and altered surface runoff and drainage characteristics could result in changes in soil moisture characteristics, reduced recharge of shallow groundwater systems, and changes in the hydrologic regimes of downgradient streams and associated wetlands and riparian areas. Soils on steep slopes could be particularly susceptible to increased erosion resulting from changes in stormwater flow patterns.

Erosion and reductions in soil moisture could alter affected terrestrial plant communities adjacent to project activities, resulting in reduced growth and reproduction. Altered hydrologic regimes—particularly reductions in the duration, frequency, or extent of inundation or soil

saturation, potentially resulting from elimination of ephemeral or intermittent streams — could result in species or structural changes in wetland or riparian communities, changes in distribution, or reduction in community extent. Increased volume or velocities of flows could impact wetland and riparian habitats, removing fine soil components, organic materials, and shallow rooted plants. Large-scale surface disturbance that reduces infiltration may increase flow fluctuations, reduce base flows, and increase flood flows, resulting in impacts on wetland and riparian community composition and extent. Sedimentation, and associated increases in dissolved salts, could degrade wetland and riparian plant communities. Effects may include reduced growth or mortality of plants, altered species composition, reduced biodiversity, or, in areas of heavy sediment accumulation, a reduction in the extent of wetland or riparian communities. Disturbance-tolerant species may become dominant in communities impacted by these changes in hydrology and water quality. Increased sedimentation, turbidity, or other changes in water quality may provide conditions conducive to the establishment of invasive species.

Alterations of groundwater flow or quality in project areas, such as during shale extraction, may impact wetlands and riparian areas that directly receive groundwater discharge, such as at springs or seeps, or occur in streams with flows maintained by groundwater. Wetlands and riparian communities miles downgradient from shale extraction or retorting activities may be affected by reduced flows or reduced water quality. Flow reductions in alluvial aquifers from shale extraction, water withdrawals, or pipeline installation may also result in reductions in wetland or riparian communities associated with streams receiving alluvial aquifer discharge or in changes in community composition. Water withdrawals from surface water features, such as rivers and streams, may reduce flows and water quality downstream. Reduced flows and water quality may reduce the extent or distribution of wetlands and riparian areas along these water bodies or degrade these plant communities. The construction of reservoirs may also impact downstream wetlands and riparian areas by reducing flows and sediment transport and increasing salt loading.

Plant communities and habitats could be adversely affected by impacts on water quality, resulting in plant mortality or reduced growth, with subsequent changes in community composition and structure, and declines in habitat quality. Leachate from spent shale or overburdened stockpiles may adversely affect terrestrial, riparian, or wetland plant communities as a result of impacts on surface water or groundwater quality. Produced water from shale retorting or saline water pumped from lower aquifers, if discharged on the land surface, may result in impacts on terrestrial, riparian, or wetland communities because of reduced water quality. Herbicides used in ROW maintenance could be carried to wetland and riparian areas by surface runoff or may be carried to nearby terrestrial communities by air currents. Impacts on surface water quality from deposition of atmospheric dust or pollutants from equipment exhaust or power plant operation could degrade terrestrial, wetland, and riparian habitats. Accidental spills of chemicals, fuels, or oil would adversely impact plant communities. Direct contact with contaminants could result in mortality of plants or degradation of habitats. Spills could impact shallow groundwater quality and indirectly affect terrestrial plants contacting shallow groundwater.

#### 4.8.1.3 Wildlife

All oil shale leasing projects that would be constructed and operated have the potential to affect wildlife, including wild horses (*Equus caballus*) and burros (*E. asinus*), over a period of several decades. Reclamation that would occur after extraction activities are completed would serve to reduce or eliminate ongoing impacts by recreating habitats and ecological conditions that could be suitable to wildlife species. The effectiveness of any reclamation activities would depend on the specific actions taken; the best results, however, would occur where original site topography, hydrology, soils, and vegetation patterns could be reestablished.

The following discussion provides an overview of the potential impacts on wildlife that could occur from the construction and operation of an oil shale project. The use of mitigation measures and SOPs (e.g., predisturbance surveys, erosion and dust suppression control practices, establishment of buffer areas, reclamation of disturbed areas using native species, and netting of on-site ponds) would minimize impacts on wildlife species and their habitats. The specifics of these practices would be established through consultations with federal and state agencies and other stakeholders.

Impacts on wildlife from oil shale projects could occur in a number of ways and are related to (1) habitat loss, alteration, or fragmentation; (2) disturbance and displacement; (3) mortality; and (4) increase in human access. These impacts can result in changes in habitat use; changes in behavior; collisions with structures or vehicles; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminants.

Wildlife may also be affected by human activities that are not directly associated with the oil shale project or its workforce but that are instead associated with the potentially increased access to BLM-administered lands that had previously received little use. The construction of new access roads or improvements to old access roads may lead to increased human access into the area. Potential impacts associated with increased access include (1) the disturbance of wildlife from human activities, including an increase in legal and illegal take and an increase of invasive vegetation, (2) an increase in the incidence of fires, and (3) increased runoff that could adversely affect riparian or other wetland areas that are important to wildlife.

Wildlife impacts from the impacting factors discussed below are summarized in Table 4.8.1-1. The potential magnitude of the impacts that could result from oil shale development is presented for representative wildlife species types. Impacts are designated as small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of the local population (less than 10%), and does not result in a measurable change in carrying capacity or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of the local population, and result in a measurable but moderate change (less than 50%) in carrying capacity or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 50% of a local population, and result in a large measurable change (50% or more) in carrying capacity or population size in the affected area.

**TABLE 4.8.1-1 Potential Impacts on Wildlife Species Resulting from Commercial Oil Shale Development**

| | Potential Magnitude of Impacts According to Species Type[a] | | | | | | |
|---|---|---|---|---|---|---|---|
| Impact Category | Amphibians and Reptiles | Shorebirds and Waterfowl | Landbirds | Raptors | Small Game and Nongame Mammals | Big Game Mammals | Wild Horses and Burros |
| Vegetation clearing | Large | Small | Large | Large | Large | Large | Large |
| Habitat fragmentation | Moderate | Small | Moderate | Moderate | Moderate | Moderate | Moderate |
| Movement/dispersal blockage | Moderate | Small | Small | Small | Moderate | Moderate | Moderate |
| Alteration of topography | Small | Small | Small | Small | Small | Small | Small |
| Erosion and sedimentation | Small | Small | Small | Small | Small | Small | Small |
| Contaminant spills | Small | Small | Small | Small | Small | Small | Small |
| Fugitive dust | Small | Small | Small | Small | Small | Small | Small |
| Injury or mortality | Moderate | Moderate | Large | Moderate | Large | Large | Moderate |
| Collection | Moderate | Small | Small | Small | Small | Small | Small |
| Human disturbance/harassment | Small | Moderate | Large | Large | Large | Large | Large |
| Increases in predation rates | Moderate | Moderate | Moderate | Small | Moderate | Moderate | Small |
| Noise | Small | Large | Large | Large | Large | Large | Large |
| Spread of invasive plant species | Small | Small | Moderate | Small | Moderate | Small | Small |
| Air pollution | Small | Small | Small | Small | Small | Small | Small |
| Fire | Small | Small | Moderate | Small | Moderate | Small | Small |

[a] Potential impact magnitude (without mitigation) is presented as small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of the local population (less than 10%), and does not result in a measurable change in carrying capacity or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of the local population, and result in a measurable but moderate change (less than 50%) in carrying capacity or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 50% of a local population, and result in a large measurable change (50% or more) in carrying capacity or population size in the affected area.

**4.8.1.3.1 Habitat Disturbance.** The reduction, alteration, or fragmentation of habitat would result in a major impact on wildlife. Habitats within the construction footprint of the projects, utility ROWs, access roads, and other infrastructure would be destroyed or disturbed. The amount of habitat impacted would be a function of the current degree of disturbance already present in the project site area. With certain exceptions, areas lacking vegetation (e.g., operational areas, access roads, active portions of oil shale mining) provide minimal habitat. The construction of the projects would not only result in the direct reduction or alteration of wildlife habitat within the project footprint but could also affect the diversity and abundance of area wildlife through habitat fragmentation. Habitat fragmentation causes both a loss of habitat and habitat isolation. Wildlife species least impacted by habitat fragmentation include those that can inhabit a variety of habitats, that have the ability to colonize and reproduce in the habitat patches created by management actions, and that are relatively abundant (e.g., rodents and migratory birds) (Lehmkuhl 2005).

A decline in wildlife use near roads or other facilities would be considered an indirect habitat loss. Avoidance of habitat associated with roads has been reported to be 2.5 to 3.5 times as great as the actual habitat loss associated with the road's footprint (Reed et al. 1996). Mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) may avoid areas up to 0.25 mi from a project area (BLM 2006b). Similarly, bird nesting may be disrupted within 0.25 mi of construction activities during the nesting and brooding periods (e.g., February 1 to August 25) (BLM 2006f). Road avoidance by wildlife could be greater in open landscapes compared with forested landscapes (Thomson et al. 2005). Mule deer use declined within 2.7 to 3.7 km of gas well pads, suggesting that indirect habitat loss can be larger than direct habitat loss (Sawyer et al. 2006). Density of sagebrush obligates, particularly Brewer's sparrow (*Spizella breweri*) and sage sparrow (*Amphispiza belli*), was reduced 39 to 60% within a 100-m buffer around dirt roads with low traffic volumes. The declines may have been due to a combination of traffic, edge effects, habitat fragmentation, and increases in other passerine species along road corridors. Thus, declines may persist until roads are fully reclaimed (Ingelfinger and Anderson 2004). Those individuals that make use of areas within or adjacent to project areas could be subjected to increased physiological stress. This combination of avoidance and stress reduces the capability of wildlife to use habitat effectively (WGFD 2004). As noise and human presence are reduced (e.g., as may occur from the switch from construction to operation), wildlife may increase their use of otherwise suitable habitats, although probably not at the same levels as before disturbance initially began (BLM 2006d).

Some species such as the common raven (*Corvus corax*) are more abundant along roads because of automobile-generated carrion, whereas ravens and other raptors are more common along transmission lines because of the presence of perch and nest sites (Knight and Kawashima 1993).

Displaced animals would likely have lower reproductive success because nearby areas are typically already occupied by other individuals of the species that would be displaced (Riffell et al. 1996). Increasing the concentration of wildlife in an area may result in a number of adverse effects, including potential mortality of the displaced animals from depletion of food sources, increased vulnerability to predators, increased potential for the propagation of diseases and parasites, increased intra- and interspecies competition, and increased potential for poaching.

Long-term displacement of elk, mule deer, pronghorn (*Antilocapra americana*), or other species from critical (crucial) habitat because of habitat disturbance would be considered significant (BLM 2004a). For example, activities around parturition areas have the potential to decrease the usability of these areas for calving and fawning. An oil shale project located within a crucial winter area could directly reduce the amount of habitat available to the local population. This placement could force the individuals to use suboptimal habitat, which could lead to debilitating stress. Habitat loss and associated decrease in raptor prey base could increase the foraging area necessary to support an individual and/or decrease the number of foraging raptors an area could support (BLM 2006d). With decreasing availability of forbs and grasses, greater sage-grouse (*Centrocercus urophasianus*) broods could move longer distances and expend more energy to find forage. Increased movement, in addition to decreased vegetative cover, could expose chicks to greater risk of predation (BLM 2006d). More detailed information about how greater sage-grouse may be impacted by oil shale development, including information about possible measures to mitigate impacts, is provided in the text box on page 4-70.

Potential impacts on waterfowl and shorebirds could primarily occur from impacts on habitat or changes in habitat. Construction could cause short-term changes in water quality resulting from increases in siltation and sedimentation related to ground disturbance. Long-term impacts could result from habitat alterations (i.e., changing forested wetlands to scrub-shrub and emergent wetlands within the ROWs). This alteration could have a slight beneficial impact on most waterfowl and shorebird species.

The presence of an oil shale project and associated facilities could disrupt movements of wildlife, particularly during migration. Migrating birds would be expected to simply fly over the project and continue their migratory movement. However, herd animals, such as elk, deer, and pronghorn, could potentially be affected if the corridor segments transect migration paths between winter and summer ranges or in calving areas. The utility corridor segments would be maintained as areas of low vegetation that may hinder or prevent movements of some wildlife species. It is foreseeable that utility corridor segments may be used for travel routes by big game if they lead in the direction of their normal migrations.

Migration corridors are vulnerable, particularly at pinch points where physiographic constrictions force herds through relatively narrow corridors (Berger 2004). Loss of habitat continuity along migration routes would severely restrict the seasonal movements necessary to maintain healthy big game populations (Sawyer and Lindsay 2001; Thomson et al. 2005). Any activity or landscape modification that prevents the use of migration corridor constrictions (migration bottlenecks or pinch points) could effectively reduce the use of habitats either above or below the constriction (BLM 2004b). As summarized by Strittholt et al. (2000), roads have been shown to impede the movements of invertebrates, reptiles, and small and large mammals. For large mammals, blockages of a route between foraging or bedding areas and watering areas could cause the animals to abandon a larger habitat area altogether (BLM 2004b). High snow embankments as a result of plowing can greatly influence the mobility of wildlife such as moose (*Alces alces*) (WGFD 2004). Barriers to movement that prevent snakes from accessing wintering dens or that isolate amphibian breeding pools from feeding areas could affect or even eliminate a population (BLM 2004b).

**Compatibility of Oil Shale Leasing and the Greater Sage-Grouse**

Most concerns about the effects of oil shale development on greater sage-grouse (*Centrocercus urophasianus*) have focused on potential impacts associated with the reduction, fragmentation, and modification of grassland and shrubland habitats.

Populations of greater sage-grouse can vary from nonmigratory to migratory (having either one-stage or two-stage migrations) and can occupy an area that exceeds 1,040 $mi^2$ on an annual basis. The distance between leks (strutting grounds) and nesting sites can exceed 12 mi (Connelly et al. 2000; Bird and Schenk 2005). Nonmigratory populations can move 5 to 6 mi between seasonal habitats and have home ranges of up to 40 $mi^2$. The distance between summer and winter ranges for one-stage migrants can be 9 to 30 mi apart. Two-stage migrant populations make movements among breeding habitat, summer range, and winter range. Their annual movements can exceed 60 mi. The migratory populations can have home ranges that exceed 580 $mi^2$ (Bird and Schenk 2005). However, the greater sage-grouse has a high fidelity to a seasonal range. They also return to the same nesting areas annually (Connelly et al. 2000, 2004).

The greater sage-grouse needs contiguous, undisturbed areas of high-quality habitat during its four distinct seasonal periods: (1) breeding, (2) summer-late brooding and rearing, (3) fall, and (4) winter (Connelly et al. 2000). The greater sage-grouse occurs at elevations ranging from 4,000 to 9,000 ft. It is omnivorous and consumes primarily sagebrush and insects. More than 99% of its diet in winter consists of sagebrush leaves and buds. Sagebrush is also important as roosting cover, and the greater sage-grouse cannot survive where sagebrush does not exist (USFWS 2004).

Leks are generally areas supported by low, sparse vegetation or open areas surrounded by sagebrush that provide escape, feeding, and cover. They can range in size from small areas of 0.1 to 10 acres to areas of 100 acres or more (Connelly et al. 2000). The lek/breeding period occurs March through May, with peak breeding occurring from early to mid-April. Nesting generally occurs 1 to 4 mi from lek sites, although it may range up to 11 mi (BLM 2004a). The nesting/early brood-rearing period occurs from March through July. Sagebrush at nesting/early brood-rearing habitat is 12 to 32 in. above ground, with 15 to 25% canopy cover. Tall, dense grass combined with tall shrubs at nest sites decreases the likelihood of nest depredation. Hens have a strong year-to-year fidelity to nesting areas (BLM 2004a). The late brood-rearing period occurs from July through October. Sagebrush at late brood-rearing habitat is 12 to 32 in. tall, with a canopy cover of 10 to 25% (BLM 2004a). The greater sage-grouse occupies winter habitat from November through March. Suitable winter habitat requires sagebrush 10 to 14 in. above snow level with a canopy cover ranging from 10 to 30%. Wintering grounds are potentially the most limiting seasonal habitat for greater sage-grouse (BLM 2004a).

While no single or combination of factors has been proven to have caused the decline in greater sage-grouse numbers over the past half-century, the decline in greater sage-grouse populations is thought to be caused by a number of factors, including drought, oil and gas wells and their associated infrastructure, power lines, predators, and a decline in the quality and quantity of sagebrush habitat (due to livestock grazing, range management treatments, and development activities) (Connelly et al. 2000; Crawford et al. 2004). West Nile virus is also a significant stressor of the greater sage-grouse (Naugle et al. 2004).

Loud, unusual sounds and noise from construction and human activities disturb greater sage-grouse, cause birds to avoid traditional use areas, and reduce their use of leks (Young 2003). Disturbance at leks appears to limit reproductive opportunities and may result in regional population declines. Most observed nest abandonment is related to human activity (NatureServe 2006). Thus, site construction, operation, and site-maintenance activities could be a source of auditory and visual disturbance to the greater sage-grouse.

Oil shale lease area facilities, transmission lines, pipelines, access roads, and employer-provided housing may adversely affect important greater sage-grouse habitats by causing fragmentation, reducing habitat value, or reducing the amount of habitat available (Braun 1998). Transmission lines, aboveground portions of pipelines,

**Continued on next page.**

and other structures can also provide perches and nesting areas for raptors and ravens that may prey upon the greater sage-grouse.

Measures that have been suggested for management of greater sage-grouse and their habitats (e.g., Paige and Ritter 1999; Connelly et al. 2000; WGFD 2003) that have pertinence to oil shale projects and associated facilities include the following:

- Identify and avoid both local (daily) and seasonal migration routes.
- Consider sage-grouse and sage habitat when designing, constructing, and utilizing project access roads and trails.
- Avoid, when possible, siting energy developments in breeding habitats.
- Adjust the timing of activities to minimize disturbance to sage grouse during critical periods.
- When possible, locate energy-related facilities away from active leks or near other sage-grouse habitat.
- When possible, restrict noise levels to 10 dB above background noise levels at lek sites.
- Minimize nearby human activities when birds are near or on leks.
- As practicable, do not conduct surface-use activities within crucial sage-grouse wintering areas from December 1 through March 15.
- Maintain sagebrush communities on a landscape scale.
- Provide compensatory habitat restoration for impacted sagebrush habitat.
- Avoid the use of pesticides at sage-grouse breeding habitat during the brood-rearing season.
- Develop and implement appropriate measures to prevent the introduction or dispersal of noxious weeds.
- Avoid creating attractions for raptors and mammalian predators in sage-grouse habitat.
- Consider measures to mitigate impacts at off-site locations to offset unavoidable sage-grouse habitat alteration and reduction at the project site.
- When possible, avoid establishing artificial water bodies (e.g., stormwater and liquid industrial wastewater ponds) that could serve as breeding habitat for mosquitoes.

The BLM manages more habitats for greater sage-grouse than any other entity; therefore, it has developed a National Sage-Grouse Habitat Conservation Strategy for BLM-administered public lands to manage public lands in a manner that will maintain, enhance, and restore greater sage-grouse habitat while providing for multiple uses of BLM-administered public lands (BLM 2004c). The strategy is consistent with the individual state sage grouse conservation planning efforts. The purpose of this strategy is to set goals and objectives, assemble guidance and resource materials, and provide more uniform management directions for the BLM's contributions to the multistate sage grouse conservation effort being led by state wildlife agencies (BLM 2004c). The BLM strategy includes guidance for (1) addressing sagebrush habitat conservation in BLM land use plans, and (2) managing sagebrush plant communities for sage grouse conservation. This guidance is designed to support and promote the rangewide conservation of sagebrush habitats for sage grouse and other sagebrush-obligate wildlife species on public lands administered by the BLM and presents a number of suggested management practices (SMPs). These SMPs include management or reclamation activities, restrictions, or treatments that are designed to enhance or restore sagebrush habitats. The SMPs are divided into two categories: (1) those that will help maintain sagebrush habitats (e.g., practices or treatments to minimize unwanted disturbances while maintaining the integrity of the sagebrush communities), and (2) those that will enhance sagebrush habitat components that have been reduced or altered (BLM 2004c).

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SMPs that are or may be pertinent to energy transmission facilities include the following:

- Development of monitoring programs and adaptive management strategies.
- Control of invasive species.
- Prohibition or restriction of OHV activity.
- Consideration of sage-grouse habitat needs when developing reclamation plans.
- Avoidance of placing facilities in or next to sensitive habitats such as leks and wintering habitat.
- Location or construction of facilities so that facility noise does not disturb grouse activities or leks.
- Consolidation of facilities as much as possible.
- Initiation of reclamation practices as quickly as possible following land disturbance.
- Installation of antiperching devices on existing or new power lines in occupied sage-grouse habitat.
- Design of facilities to reduce habitat fragmentations and mortality to sage grouse.

In addition to the BLM's national sage grouse habitat conservation strategy, the Western Association of Fish and Wildlife Agencies has produced two documents that together comprise a Conservation Assessment for Greater Sage-Grouse. The first is the *Conservation Assessment of Greater Sage-Grouse and Sagebrush Habitats* (Connelly et al. 2004). The second document is the *Greater Sage-Grouse Comprehensive Conservation Strategy* (Stiver et al. 2006).

Larger and/or more mobile wildlife, such as medium-sized or large mammals and birds, would be most likely to leave an area that experiences habitat disturbance. Nevertheless, development of the site would represent a loss of habitat for these species and potentially a reduction in carrying capacity in the area. A species affected by habitat disturbance may be able to shift its habitat use for a short period. For example, the density of several forest-dwelling bird species has been found to increase within a forest stand soon after the onset of fragmentation as a result of displaced individuals moving into remaining habitat (Hagan et al. 1996). However, it is generally presumed that the habitat into which displaced individuals move would be unable to sustain the same level of use over the long term (BLM 2004b). The subsequent competition for resources in adjacent habitats would likely preclude the incorporation of the displaced individual into the resident populations. If it is assumed that areas used by wildlife before development were preferred habitat, then an observed shift in distribution because of development would be toward less preferred and presumably less suitable habitats (Sawyer et al. 2006). Overcrowding of species such as mule deer in winter ranges can cause density-dependent effects such as increased fawn mortality (Sawyer et al. 2006).

Rather than being displaced, smaller animals such as small mammals, reptiles, and amphibians may be killed during clearing and construction activities. If land clearing and construction activities occurred during the spring and summer, bird nests and eggs or nestlings could be destroyed. Fossorial species could be crushed or buried by construction equipment.

The creation of edge habitat along the boundary between two habitats can (1) increase predation and parasitism of vulnerable forest or sagebrush interior animals in the vicinity of

edges; (2) have negative consequences for wildlife by modifying their distribution and dispersal patterns; (3) be detrimental to species requiring large undisturbed areas, because increases in edge are generally associated with concomitant reductions in habitat size and possible isolation of habitat patches and corridors (habitat fragmentation); or (4) increase local wildlife diversity and abundance. Species that could benefit from the proposed utility or access road ROWs include those that prefer or require some open areas, edge habitat, and/or shrubs and small trees. Access roads through forested areas have been found to be positively correlated with bat activity since these areas can provide productive foraging areas and/or travel corridors (Zimmerman and Glanz 2000).

The utility and access road ROWs may hinder or prevent movements of some small mammals. In particular, species preferring heavy cover in forested areas may be adversely affected (Oxley et al. 1974; Forman and Alexander 1998). The degree to which roads serve as barriers to wildlife movement depends on traffic volume and speed, roadside vegetation, traditional movement patterns, and environmental factors motivating animal movement (e.g., predator avoidance).

Periodic removal of woody vegetation to maintain the ROW, particularly in forested areas, would maintain those sections of the ROW in an early stage of plant community succession that could benefit small mammals that use such habitats (e.g., hares) and their predators (e.g., bobcat [*Lynx rufus*]). Temporary growth of willows and other trees following brush cutting could benefit moose and other ungulates that use browse. Conversely, habitat maintenance would have localized adverse effects on species such as the red squirrel (*Tamiasciurus hudsonicus*), southern red-backed vole (*Myodes gapperi*), and American marten (*Martes americana*), which prefer late-successional or forested habitats (BLM 2002). Except where annual vegetation maintenance may be required over the pipelines to facilitate periodic corrosion and leak surveys, routine vegetation maintenance within a ROW segment conducted once every few years would lessen impacts on migratory bird species and other wildlife species that may make permanent use of the ROW segments. As ROWs become more densely vegetated toward the end of each maintenance cycle, bird species diversity would probably increase.

Overall, impacts on most wildlife would be proportional to the amount of habitat lost directly and indirectly and the duration of the loss (BLM 2006d). Project development within oil shale project areas could impact crucial winter and summer ranges for mule deer and elk; crucial lambing and rutting grounds and water sources for bighorn sheep (*Ovis canadensis*); substantial value habitat for pronghorn, black bear (*Ursus americanus*), and cougar (*Puma concolor*); portions of several wild horse and burro herds; yearlong, nesting, or strutting grounds for greater sage-grouse; and foraging habitat for raptors (BLM 1984a). Impacts on neotropical migrants that do not breed within the project area would be minor. Nonbreeders generally use riparian areas for feeding, and these areas would be minimally impacted by project construction and operation.

**4.8.1.3.2 Wildlife Disturbance.** Activities associated with construction and operation of an oil shale project may cause wildlife disturbance, including interference with behavioral activities. The response of wildlife to disturbance is highly variable and species specific. Intraspecific responses can also be affected by the physiological or reproductive condition of

individuals; distance from disturbance; and the type, intensity, and duration of disturbance. Wildlife can respond to disturbance in various ways, including attraction, habituation, and avoidance (Knight and Cole 1991). For example, wildlife may cease foraging, mating, or nesting or vacate active nest sites in areas where construction is occurring; some species may permanently abandon the disturbed areas and adjacent habitats. In contrast, wildlife such as bears, foxes, and squirrels readily habituate and may even be attracted to human activities, primarily when a food source is accidentally or deliberately made available. Human food wastes and other attractants in developed areas can increase the population of foxes, gulls, common ravens, and bears, which in turn prey on waterfowl and other birds.

Disturbance can reduce the relative habitat value for wildlife such as mule deer, especially during periods of heavy snow and cold temperatures. When wildlife are experiencing physiological stress, which requires higher levels of energy for survival and reproductive success, increased human presence can further increase energy expenditures that can lead to reduced survival or reproductive outcome. Furthermore, disturbance could prevent access to sufficient amounts of forage necessary to sustain individuals (BLM 2006e). Hobbs (1989) determined that mule deer doe mortality during a severe winter period could double if they were disturbed twice a day and caused to move a minimum of 1,500 ft per disturbance.

The average mean flush distance for several raptor species in winter was 118 m due to walk disturbance and 75 m due to vehicle disturbance (Holmes et al. 1993). Bighorn sheep have been reported to respond at a distance of 1,640 ft (500 m) from roads with more than one vehicle per day, while deer and elk response occurs at a distance of 3,280 ft (1,000 m) or more (Gaines et al. 2003). Snowmobile traffic was found to affect the behavior of moose located within 984 ft (300 m) of a trail and displaced them to less favorable habitats (Colescott and Gillingham 1998).

Mule deer will habituate to and ignore motorized traffic provided that the deer are not pursued (Yarmoloy et al. 1988). Harassment, an extreme type of disturbance caused by intentional actions to chase or frighten wildlife, generally causes the magnitude and duration of displacement to be greater. As a result, there is an increased potential for physical injury from fleeing and higher metabolic rates due to stress (BLM 2004b). Bears can be habituated to human activities, particularly moving vehicles, and these animals are more vulnerable to legal and illegal harvest (McLellan and Shackleton 1989). Wild horses and burros could also be impacted by increased encounters with vehicles. Noise and the presence of humans and vehicles could force herds to move to other areas. They would be most susceptible during spring foaling.

Disturbed wildlife can incur a physiological cost either through excitement (i.e., preparation for exertion) or locomotion. A fleeing or displaced animal incurs additional costs through loss of food intake and potential displacement to lower-quality habitat. If the disturbance becomes chronic or continuous, these costs can result in both reduced animal fitness and reproductive potential (BLM 2004b). Disturbance associated with a project would likely result in fewer nest initiations, increased nest abandonment and/or reproductive failure, and decreased productivity of successful nests (BLM 2006d). Factors that influence displacement distance include:

- Inherent species-specific characteristics,
- Seasonally changing threshold of sensitivity as a result of reproductive and nutritional status,
- Type of habitat (e.g., longer disturbance distances in open habitats),
- Specific experience of the individual or group,
- Weather (e.g., adverse weather such as wind or fog may decrease the disturbance),
- Time of day (e.g., animals are generally more tolerant during dawn and dusk), and
- Social structure of the animals (e.g., groups are generally more tolerant than solitary individuals) (BLM 2004b).

Regular or periodic disturbance could cause adjacent areas to be less attractive to wildlife and result in long-term reduction of wildlife use in areas exposed to a repeated variety of disturbances such as noise. Principal sources of noise would include vehicle traffic, operation of machinery, and blasting. The response of wildlife to noise would vary by species; physiological or reproductive condition; distance; and type, intensity, and duration of disturbance (BLM 2002). Wildlife response to noise can include avoidance, habituation, or attraction. Responses of birds to disturbance often involve activities that are energetically costly (e.g., flying) or affect their behavior in a way that might reduce food intake (e.g., shift away from a preferred feeding site) (Hockin et al. 1992). On the basis of a review of the literature by Hockin et al. (1992), the effects of disturbance on bird breeding and breeding success include reduced nest attendance, nest failures, reduced nest building, increased predation on eggs and nestlings, nest abandonment, inhibition of laying, increased absence from nest, reduced feeding and brooding, exposure of eggs and nestlings to heat or cold, retarded chick development, and lengthening of the incubation period. The most adverse impacts associated with noise could occur if critical life-cycle activities were disrupted (e.g., mating and nesting). For instance, disturbance of birds during the nesting season can result in nest or brood abandonment. The eggs and young of displaced birds would be more susceptible to cold or predators. Construction noise could cause a localized disruption to wild horses, particularly during the foaling season (BLM 2006b).

**4.8.1.3.3 Noise.** Much of the research on wildlife-related noise effects has focused on birds. This research has shown that noise may affect territory selection, territorial defense, dispersal, foraging success, fledging success, and song learning (e.g., Reijnen and Foppen 1994; Foppen and Reijnen 1994; Larkin 1996). Several studies have examined the effects of continuous noise on bird populations, including the effects of traffic noise, coronal discharge along electric transmission lines, and gas compressors. Some studies (e.g., Reijnen and Foppen 1994, 1995; Foppen and Reijnen 1994; Reijnen et al. 1995, 1996, 1997) have shown reduced densities of a number of species in forest (26 of 43 species) and grassland (7 of 12 species) habitats adjacent to

roads, with effects detectable from 66 to 11,581 ft from the roads. On the basis of these studies, Reijnen et al. (1996) identified a threshold effect sound level of 47 dBA for all species combined and 42 dBA for the most sensitive species; the observed reductions in population density were attributed to a reduction in habitat quality caused by elevated noise levels. This threshold sound level of 42 to 47 dBA (which is somewhat below the EPA-recommended limit for residential areas) is at or below the sound levels generated by truck traffic that would likely occur at distances of 250 ft or more from the construction area or access roads, or the levels generated by typical construction equipment at distances of 2,500 ft or more from the construction site.

Blast noise has been found to elicit a variety of effects on wildlife (Manci et al. 1988; Larkin 1996). Brattstrom and Bondello (1983) reported that peak sound pressure levels reaching 95 dB resulted in a temporary shift in hearing sensitivity in kangaroo rats, and that they required at least 3 weeks for the hearing thresholds to recover. The authors postulated that such hearing shifts could affect the ability of the kangaroo rat to avoid approaching predators. A variety of adverse effects of noise on raptors have been demonstrated, but in many cases, the effects were temporary, and the raptors became habituated to the noise (Andersen et al. 1989; Brown et al. 1999; Delaney et al. 1999).

**4.8.1.3.4 Mortality or Injury.** Construction, operation, maintenance, and reclamation activities would result in mortality of wildlife that are not mobile enough to avoid these activities (e.g., reptiles and amphibians, small mammals, and the young of other wildlife), that utilize burrows (e.g., ground squirrels and burrowing owls [*Athene cunicularia*]), or that are defending nest sites (such as ground-nesting birds). More mobile species of wildlife, such as deer and adult birds, may avoid direct impacts by moving into habitats in adjacent areas. However, it can be conservatively assumed that adjacent habitats are at carrying capacity for the species that live there and could not support additional biota from impacted areas. The subsequent competition for resources in adjacent habitats would likely preclude the incorporation of the displaced individual into the resident populations.

The presence of the oil shale and ancillary facilities (e.g., buildings, transmission lines, elevated portions of the pipelines, and other ancillary facilities) would create a physical hazard to some wildlife. In particular, birds may collide with transmission lines and buildings, while mammals may collide with fences. However, collisions with oil shale facilities would probably be infrequent, as human activity and project-related noise would discourage wildlife presence in the immediate project area. An open pipeline trench can trap small animals and injure larger wildlife trying to cross it, particularly at night. Artificial lighting can potentially affect birds by providing more feeding time (i.e., by allowing nocturnal feeding) and by causing direct mortality or disorientation (Hockin et al. 1992). Areas of standing water (e.g., stormwater and liquid industrial waste ponds) could potentially provide habitat for mosquitoes that are vectors of West Nile virus, which is a significant stressor on sage-grouse and probably other at-risk bird species (Naugle et al. 2004).

Direct mortality from vehicle collisions would be expected to occur along new access roads, while increases in road mortality would occur along existing roads because of increased traffic volumes (e.g., associated with increased numbers of construction and operational

personnel). Collision with vehicles can be a source of wildlife mortality, especially in wildlife concentration areas or travel corridors. When major roads cut across migration corridors, the effects can be dangerous for animals and humans. Between Kemmerer and Cokeville, Wyoming, hundreds of mule deer are killed during spring and fall migrations when they attempt to cross U.S. Highway 30 (Feeney et al. 2004). In unusual cases, mass casualties of wildlife occur from vehicular collision incidents, particularly in winter when animals may congregate near snow-free roads. Since 2003, there have been four vehicular incidents where 7 to 21 pronghorn were killed or injured per incident in Wyoming. There was also an incident where 41 pronghorn were killed by a train (Maffly 2007).

Being somewhat small and inconspicuous, amphibians are vulnerable to road mortality when they migrate between wetland and upland habitats, while reptiles are vulnerable because they will make use of roads for thermal cooling and heating. Greater sage-grouse are susceptible to road mortality in spring because they often fly to and from leks near ground level. They are also susceptible to vehicular collision along dirt roads because they are sometimes attracted to them to take dust baths (Strittholt et al. 2000). Utility ROWs and access roads increase use by recreationists and other public land users, which can increase the amount of human presence and the potential for harassment and legal or illegal harvesting of wildlife. This activity may include the collection of live animals, particularly reptiles and amphibians, for pets. Direct mortality from snowmobiles may occur because of crushing or suffocation of small mammals occupying subnivean spaces and from increased access to predators over compacted vehicular trails (Gaines et al. 2003).

No electrocution of raptors would be expected when they are perching on the transmission line structures because the spacing between the conductors and between a conductor and ground wire or other grounding structure would exceed the wing span of the largest raptors in the project area (i.e., bald and golden eagles [*Haliaeetus leucocephalus* and *Aquila chrysaetos*]). However, although a rare event, electrocution can occur to flocks of small birds that cross a line or when several roosting birds take off simultaneously because of current arcing. This occurrence is most likely in humid weather conditions (Bevanger 1998; BirdLife International 2003). Arcing can also occur by the excrement jet of large birds roosting on the crossarms above the insulators (BirdLife International 2003).

Electromagnetic field exposure can potentially alter the behavior, physiology, endocrine system, and the immune function of birds, which, in theory, could result in negative repercussions on their reproduction or development. However, the reproductive success of some wild bird species, such as ospreys (*Pandion haliaetus*), does not appear to be compromised by electromagnetic field conditions (Fernie and Reynolds 2005).

Any species of bird capable of flight can collide with power lines. Birds that migrate at night, fly in flocks, and/or are large and heavy with limited maneuverability are at particular risk (BirdLife International 2003). The potential for bird collisions with a transmission line depends on variables such as habitat, relation of the line to migratory flyways and feeding flight patterns, migratory and resident bird species, and structural characteristics of the line (Beaulaurier et al. 1984). Near wetlands, waterfowl, wading birds, shorebirds, and passerines are most vulnerable to colliding with transmission lines; while in habitats away from wetlands,

raptors and passerines are most susceptible (Faanes 1987). Highest concern for bird collisions is where lines span flight paths, including river valleys, wetland areas, lakes, areas between waterfowl feeding and roosting areas, and narrow corridors (e.g., passes that connect two valleys). A disturbance that leads to a panic flight can increase the risk of collision with transmission lines (BirdLife International 2003).

The shield wire is often the cause of bird losses involving higher voltage lines because birds fly over the more visible conductor bundles only to collide with the relatively invisible, thin shield wire (Faanes 1987; Thompson 1978). Young inexperienced birds, as well as migrants in unfamiliar terrain, appear to be more vulnerable to wire strikes than resident breeders. Also, many species appear to be most highly susceptible to collisions when alarmed, pursued, searching for food while flying, engaged in courtship, taking off, landing, when otherwise preoccupied and not paying attention to where they are going, and during night and inclement weather (Thompson 1978). Sage-grouse and other upland game birds are vulnerable to colliding with transmission lines because they lack good acuity and because they are generally poor flyers (Bevanger 1995).

Meyer and Lee (1981) concluded that while waterfowl (in Oregon and Washington) are especially susceptible to colliding with transmission lines, no adverse population or ecological results occurred because all species affected were common and because collisions occurred in fewer than 1% of all flight observations. A similar conclusion was reached by Stout and Cornwell (1976) who suggested that fewer than 0.1% of all nonhunting waterfowl mortality nationwide result from collisions with transmission lines. The potential for waterfowl and wading birds to collide with the transmission lines could be assumed to be related to the extent of preferred habitats crossed by the lines and the extent of other waterfowl and wading bird habitats within the immediate area.

Raptors have several attributes that decrease their susceptibility to collisions with transmission lines: (1) they have keen eyesight; (2) they soar or use relatively slow flapping flight; (3) they are generally maneuverable while in flight; (4) they learn to use utility poles and structures as hunting perches or nests and become conditioned to the presence of lines; and (5) they do not fly in groups (like waterfowl), so their position and altitude are not determined by other birds. Therefore, raptors are not as likely to collide with transmission lines unless distracted (e.g., while pursuing prey) or when other environmental factors (e.g., weather) contribute to increased susceptibility (Olendorff and Lehman 1986).

Some mortality resulting from bird collisions with transmission lines is considered unavoidable. However, anticipated mortality levels are not expected to result in long-term loss of population viability in any individual species or lead to a trend toward listing as a rare or endangered species, because mortality levels are anticipated to be low and spread over the life of the transmission lines. A variety of mitigation measures, such as those outlined in *Avian Protection Plan (APP) Guidelines* (APLIC and USFWS 2005) and *Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances* (Romin and Muck 1999) would minimize impacts on birds.

**4.8.1.3.5 Exposure to Contaminants.** Wildlife may be exposed to accidental spills or releases of product, fuel, herbicides, or other hazardous materials. Exposure to these materials could affect reproduction, growth, development, or survival. Potential impacts on wildlife would vary according to the type of material spilled, the volume of the spill, the media within which the spill occurs, the species exposed to the spilled material, and home range and density of the wildlife species. For example, as the size of a species' home range increases, the effects of a spill would generally decrease (Irons et al. 2000). Generally, small mammal species that have small home ranges and/or high densities per acre would be most affected by a land-based spill. A population-level adverse impact would only be expected if the spill was very large or contaminated a crucial habitat area where a large number of individual animals were concentrated. The potential for either event would be unlikely. Because the amounts of most fuels and other hazardous materials are expected to be small, an uncontained spill would affect only a limited area. In addition, wildlife use of the project area where contaminant spills may occur would be limited, thus greatly reducing the potential for exposure.

The potential effects on wildlife from a spill could occur from direct contamination of individual animals, contamination of habitats, and contamination of food resources. Acute (short-term) effects generally occur from direct contamination of animals; chronic (long-term) effects usually occur from such factors as accumulation of contaminants from food items and environmental media (Irons et al. 2000). Moderate to heavy contact with a contaminant is most often fatal to wildlife. In aquatic habitats, death occurs from hypothermia, shock, or drowning. In birds, chronic oil exposure can reduce reproduction, result in pathological conditions, reduce chick growth, and reduce hatching success (BLM 2002). Water quality contamination could reduce emergent vegetation and invertebrate biomass, which provide a food resource for wildlife such as waterfowl, amphibians, and bats. The reduction or contamination of food resources from a spill could also reduce survival and reproductive rates. Contaminant ingestion during preening or feeding may impair endocrine and liver functions, reduce breeding success, and reduce growth of offspring (BLM 2002).

A land-based spill would contaminate a limited area. Therefore, a spill would affect relatively few individual animals and a relatively limited portion of the habitat or food resources for large ranging species (e.g., moose, mule deer, pronghorn, elk, and black bear). It would be unlikely that a land-based spill would cause major impacts on movement (e.g., block migration) or foraging activities at the population (herd) level, largely because of the vast amount of surrounding habitat that would remain unaffected (BLM 2002).

Human presence and activities associated with response to spills would also disturb wildlife in the vicinity of the spill site and spill-response staging areas. In addition to displacing wildlife from areas undergoing contaminant cleanup activities, habitat damage could also occur from cleanup activities (BLM 2002). Avoidance of contaminated areas by wildlife during cleanup because of disturbance would minimize the potential for wildlife to be exposed to contaminants before site cleanup is completed.

Most herbicides used on BLM-administered lands pose little or no risk to wildlife or wild horses and burros unless they are exposed to accidental spills, direct spray, or herbicide drift, or they consume herbicide-treated vegetation. The licensed use of herbicides would not be expected

to adversely affect local wildlife populations. Applications of these materials would be conducted by following label directions and in accordance with applicable permits and licenses. Thus, any adverse toxicological threat from herbicides to wildlife is unlikely. The response of wildlife to herbicide use is attributable to habitat changes resulting from treatment rather than direct toxic effects of the applied herbicide on wildlife. However, accidental spills or releases of these materials could impact exposed wildlife. Effects could include death, organ damage, growth decrease, and decrease in reproductive output and condition of offspring (BLM 2005).

Herbicide treatment reduced structural and floral complexity of vegetation on clear-cuts in Maine, resulting in lower overall abundance of birds and small mammals because of a decrease in invertebrate and plant foods and cover associated with decreased habitat complexity (Santillo et al. 1989a,b). However, some researchers have found increases in small mammal numbers because of increases in species that use grassy habitats (particularly microtine rodents). Nevertheless, small mammal communities rapidly returned to pretreatment numbers (e.g., within a 2-year period) because of regrowth of vegetation damaged by herbicides (Anthony and Morrison 1985). Moose tended to avoid herbicide-treated areas of clear-cuts as browse was less available for 2 years post-treatment. When they did feed in treated clear-cuts, they fed heavily in areas that were inadvertently skipped by spraying (Santillo 1994; Eschholtz et al. 1996). Selective herbicide use (e.g., cut-stump treatments) encourages the development of shrub habitat without negatively impacting birds nesting in such habitats (Marshall and Vandruff 2002).

Wildlife can be exposed to herbicides by being directly sprayed, inhaling spray mist or vapors, drinking contaminated water, feeding on or otherwise coming in contact with treated vegetation or animals that have been contaminated, and directly consuming the chemical if it is applied in granular form (DOE 2000). Raptors, small herbivorous mammals, medium-sized omnivorous mammals, and birds that feed on insects are more susceptible to herbicide exposure since they either feed directly on vegetation that might have been treated or feed on animals that feed on the vegetation. The potential for toxic effects would depend on the toxicity of the herbicide and the amount of exposure to the chemical. Generally, smaller animals are more at risk as it takes less substance for them to be affected (DOE 2000).

Indirect adverse effects on wildlife from herbicides would include a reduction in availability of preferred forage, habitat, and breeding areas because of a decrease in plant diversity; decrease in wildlife population densities as a result of limited vegetation regeneration; habitat and range disruption because wildlife may avoid sprayed areas following treatment; and increase in predation of small mammals because of the loss of ground cover (BLM 2005). However, population-level impacts on unlisted wildlife species are unlikely because of the limited size and distribution of treated areas relative to those of the wildlife populations and the foraging area and the behavior of individual animals (BLM 2005).

Wildlife species that consume grass (e.g., deer, elk, rabbits and hares, quail, and geese) are at potentially higher risk from herbicides than species that eat other vegetation and seeds because herbicide residue tends to be higher on grass. However, harmful effects are not likely unless the animal forages exclusively within the treated area shortly after application. Similarly, bats, shrews, and numerous bird species that feed on herbicide-contaminated insects could be at risk (BLM 2005).

**4.8.1.3.6 Erosion and Runoff.** As described in Section 4.8.1.1, it is assumed that the potential for soil erosion and the resulting sediment loading of nearby aquatic or wetland habitats would be proportional to the amount of surface disturbance, the condition of disturbed lands at any given time, and the proximity to aquatic habitats. It is also assumed that areas being actively disturbed during mining or construction activities would have higher erosion potential than areas that are undergoing reclamation activities and that areas being restored become progressively less prone to erosion over time because of the completion of site grading and the reestablishment of vegetated cover. Erosion and runoff from freshly cleared and graded sites could reduce water quality in aquatic and wetland habitats that are used by amphibians, potentially affecting their reproduction, growth, and survival. Any impacts on amphibian populations would be localized to the surface waters receiving site runoff. Although the potential for runoff would be temporary, pending completion of construction activities and stabilization of disturbed areas with vegetative cover, erosion could result in significant impacts on local amphibian populations if an entire recruitment class is eliminated (e.g., complete recruitment failure for a given year because of siltation of eggs or mortality of aquatic larvae). Implementation of measures to control erosion and runoff into aquatic and wetland habitats would reduce the potential for impacts from increased turbidity and sedimentation. Assuming that reclamation activities are successful, restored areas should eventually become similar to natural areas in terms of erosion potential.

**4.8.1.3.7 Fugitive Dust.** Little information is available regarding the effects of fugitive dust on wildlife; however, if exposure is of sufficient magnitude and duration, the effects may be similar to the respiratory effects identified for humans (e.g., breathing and respiratory symptoms). A more probable effect would be from the dusting of plants that could make forage less palatable. Fugitive dust that settles on forage may render it unpalatable for wildlife and wild horses, which could increase competition for remaining forage. Highest dust deposition would generally occur within the area where wildlife and wild horses would be disturbed by human activities (BLM 2004b). Fugitive dust generation during construction activities is expected to be short term and localized to the immediate construction area and is not expected to result in any long-term individual or population-level effects. Dusting impacts would be potentially more pervasive along unpaved access roads.

**4.8.1.3.8 Invasive Vegetation.** Utility corridors and access roads can facilitate the dispersal of invasive species by altering existing habitat conditions, stressing or removing native species, and allowing easier movement by wild or human vectors (Trombulak and Frissell 2000). Wildlife habitat could be impacted if invasive vegetation becomes established in the construction-disturbed areas and adjacent off-site habitats. The establishment of invasive vegetation could reduce habitat quality for wildlife and affect wildlife occurrence and abundance locally. The introduction or spread of non-native plants would be detrimental to wildlife such as neotropical migrants and sage-grouse by reducing or fragmenting habitat, increasing soil erosion, or reducing forage (BLM 2006a).

**4.8.1.3.9 Fires.** Increased human activity can increase the potential for fires. In general, short-term and long-term effects of fire on wildlife are related to fire impacts on vegetation,

which in turn affect habitat quality and quantity, including the availability of forage shelter (Groves and Steenhof 1988; Sharpe and Van Horne 1998; Lyon et al. 2000b; USDA 2002a,b,c; Hedlund and Rickard 1981; Knick and Dyer 1996; Watts and Knick 1996; Schooley et al. 1996).

While individuals caught in a fire could incur increased mortality, depending on how quickly the fire spreads, most wildlife would be expected to escape by either outrunning the fire or seeking underground or aboveground refuge within the fire (Ford et al. 1999; Lyon et al. 2000a). However, some mortality of burrowing mammals from asphyxiation in their burrows during fire has been reported (Erwin and Stasiak 1979).

In the absence of long-term vegetation changes, rodents in grasslands usually show a decrease in density after a fire; they often recover, however, to achieve densities similar to or greater than those of preburn levels (Beck and Vogel 1972; Lyon et al. 2000b; USDA 2002d). Long-term changes in vegetation from a fire (such as loss of sagebrush or the invasion or increase of non-native annual grasses) may affect food availability and quality and habitat availability for wildlife; the changes could also increase the risk from predation for some species (Hedlund and Rickard 1981; Groves and Steenhof 1988; Knick and Dyer 1997; Watts and Knick 1996; Schooley et al. 1996; Lyon et al. 2000b; USDA 2002b,c).

Raptor populations generally are unaffected by, or respond favorably to, burned habitat (Lyon et al. 2000b). Fires may benefit raptors by reducing cover and exposing prey; raptors may also benefit if prey species increase in response to post-fire increases in forage (Lyon et al. 2000b; USDA 2002d). Direct mortality of raptors from fire is rare (Lehman and Allendorf 1989), although fire-related mortality of burrowing owls has been documented (USDA 2002d). Most adult birds can be expected to escape fire, while fire during nesting (prior to fledging) may kill young birds, especially of ground-nesting species (USDA 2002d).

#### 4.8.1.4 Threatened and Endangered Species

The evaluation in this PEIS presents the potential for impacts on federally or state-listed threatened or endangered species, BLM-designated sensitive species, or species that are proposed or candidates for listing if development occurs. Project-specific NEPA assessments, ESA consultations, and coordination with state natural resource agencies will address project-specific impacts more thoroughly. These assessments and consultations will result in required actions to avoid or mitigate impacts on protected species.

The potential for impacts on threatened, endangered, and sensitive species of commercial oil shale development, including ancillary facilities such as access roads, power plants, and transmission systems, is directly related to the amount of land disturbance, the duration and timing of construction and operation periods, and the habitats affected by development (i.e., the location of the project). Indirect effects such as impacts resulting from the erosion of disturbed land surfaces and disturbance and harassment of animal species are also considered, but their magnitude also is considered proportional to the amount of land disturbance.

Impacts on threatened and endangered species are fundamentally similar to or the same as those described for impacts on aquatic resources; plant communities and habitats; and wildlife in Sections 4.8.1.1, 4.8.1.2, and 4.8.1.3, respectively. The most important difference from these impacts is the potential consequence of the impacts. Because of low population sizes, threatened and endangered species are far more vulnerable to impacts than more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development.

The potential magnitude of the impacts that could result from oil shale development is presented for different species types in Table 4.8.1-2. Unlike some projects where there are discrete construction and operation phases with different associated impacts, oil shale development projects include facility construction and extraction activities that would have similar types of impacts throughout the life of the project. Project construction and extraction activities would occur over a period of several decades. Reclamation that would occur after extraction activities are complete would serve to reduce or eliminate ongoing impacts by recreating habitats and ecological conditions that could be suitable for threatened, endangered, and sensitive species. The effectiveness of any reclamation activities would depend on the specific actions taken, but the best results would occur if site topography, hydrology, soils, and vegetation patterns were reestablished.

Post-lease land clearing and construction activities could remove potentially suitable habitat for threatened, endangered, and sensitive plant and animal species. Any plants present within the project areas would be destroyed, and plants adjacent to project areas could be affected by runoff from the site either through erosion or sedimentation and burial of individual plants or habitats. In addition, fugitive dust from site activities could accumulate in adjacent areas occupied by listed plants. Dust that accumulates on leaf surfaces can reduce photosynthesis and subsequently affect plant vigor. Disturbed areas could be colonized by non-native invasive plant species.

Larger, more mobile animals such as birds and medium-sized or large mammals would be most likely to leave the project area during site preparation, construction, and other project activities. Development of the site would represent a loss of habitat for these species and potentially a reduction in carrying capacity in the area. Smaller animals, such as small mammals, lizards, snakes, and amphibians, are more likely to be killed during clearing and construction activities. If land clearing and construction activities occurred during the spring and summer, bird nests and nestlings in the project area could be destroyed.

Operations could affect protected plants and animals as well. Animals in and adjacent to project areas would be disturbed by human activities and would tend to avoid the area while activities were occurring. Site lighting and operational noise from equipment would affect animals on and off the site, resulting in avoidance or reduction in use of an area larger than the project footprint. Runoff from the site during site operations could result in erosion and

**TABLE 4.8.1-2 Potential Impacts on Threatened, Endangered, and Sensitive Species Resulting from Commercial Oil Shale Development**

| | Potential Magnitude of Impacts According to Species Type[a] | | | | | | |
|---|---|---|---|---|---|---|---|
| Impact Category | Upland Plants | Wetland and Riparian Plants | Aquatic and Wetland Animals[b] | Terrestrial Invertebrates | Terrestrial Amphibians and Reptiles | Terrestrial Birds | Terrestrial Mammals |
| Vegetation clearing | Large | Large | Large | Large | Large | Large | Large |
| Habitat fragmentation | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate |
| Movement/dispersal blockage | Moderate | Moderate | Large | Small | Moderate | Small | Moderate |
| Alteration of topography | Moderate | Large | Large | Small | Small | Small | Small |
| Changes in drainage patterns | Moderate | Large | Large | Small | Small | Small | Small |
| Erosion | Large | Large | Large | Small | Small | Small | Small |
| Sedimentation from runoff | Large | Large | Large | Small | Small | Small | Small |
| Oil and contaminant spills | Moderate | Large | Large | Small | Large | Small | Small |
| Fugitive dust | Moderate | Moderate | Small | Small | Small | Small | Small |
| Injury or mortality of individuals | Large | Large | Large | Large | Large | Large | Large |
| Human collection | Moderate | Moderate | Small | Small | Moderate | Small | Small |
| Human disturbance/harassment | None | None | Large | None | Small | Large | Large |
| Increased human access | Moderate | Moderate | Moderate | Moderate | Moderate | Large | Large |
| Increases in predation rates | None | None | None | None | Moderate | Moderate | Moderate |
| Noise | None | None | None | None | Small | Large | Large |
| Spread of invasive plant species | Large | Large | Moderate | Moderate | Small | Small | Small |
| Air pollution | Moderate | Moderate | Small | Small | Small | Small | Small |
| Disruption of groundwater flow patterns | Small | Moderate | Moderate | Small | Small | Small | Small |
| Temperature increases in water bodies | None | None | Moderate | None | None | None | None |

[a] Potential impact magnitude (without mitigation) is presented as none, small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of the local population (less than 10%), and does not result in a measurable change in carrying capacity or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of the local population, and result in a measurable but moderate change (less than 50%) in carrying capacity or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 50% of a local population, and result in a large measurable change (50% or more) in carrying capacity or population size in the affected area.

[b] Aquatic and wetland animals include invertebrates (mollusks and arthropods), fish, amphibians, reptiles, birds, and mammals.

sedimentation of adjacent habitats. Fugitive dust during operations could affect adjacent plant populations.

For all potential impacts, the use of mitigation measures, possibly including predisturbance surveys to locate protected plant and animal populations in the area, erosion control practices, dust suppression techniques, establishment of buffer areas around protected populations, and reclamation of disturbed areas using native species upon project completion, would greatly reduce or eliminate the potential for effects on protected species. The specifics of these practices should be established in project-specific consultations with the appropriate federal and state agencies. ESA Section 7 consultations between the BLM and the USFWS would be required for all projects that have the potential to affect listed species before leased areas could be developed. Those consultations would identify conservation measures, allowable levels of incidental take, and other requirements to protect listed species. Potential conservation measures for oil shale development have been developed jointly by the BLM and USFWS to avoid and minimize impacts of commercial oil shale development on federally listed threatened and endangered species (Appendix F) and could be applied, if deemed appropriate, and in consultation with the USFWS, at the lease or development stage of potential future projects.

There is a potential for commercial oil shale development projects to adversely affect most of the threatened, endangered, and sensitive species that occur in the counties where development could occur (Tables 4.8.1-3 and 4.8.1-4). This potential for adverse effects results from a lack of specificity on the locations of lease areas and the often incomplete information on species distributions. The Barneby ridge-cress and whooping crane are the only federally listed species in project area counties that are not expected to be affected by development. The Barneby ridge-cress is not likely to be adversely affected because known population distributions are clearly outside of the potential lease areas. The whooping crane is a rare migrant through the area, and the population that could migrate through the area is considered experimental and nonessential.

Federally listed plant species that could occur in project areas and that could be affected by project activities include clay reed-mustard, Dudley Bluffs bladderpod, Dudley Bluffs twinpod, shrubby reed-mustard, Uinta Basin hookless cactus, and Ute ladies'-tresses (Table 4.8.1-4). All but the Ute ladies'-tresses are upland species that could be affected by a variety of impacting factors, including vegetation clearing, habitat fragmentation, dispersal blockage, alteration of topography, changes in drainage patterns, erosion, sedimentation from runoff, oil and contaminant spills, fugitive dust, injury or mortality of individuals, human collection, increased human access, spread of invasive plant species, and air pollution (Table 4.8.1-2). Clay-reed mustard, Dudley Bluffs bladderpod, Dudley Bluffs twinpod, and shrubby reed-mustard are all found on shale-derived soils and are therefore more likely to occur in potential development areas. Three ACECs in the Piceance Basin of Colorado (Duck Creek, Ryan Gulch, and Dudley Bluffs) were established to protect known populations of the Dudley Bluffs twinpod and Dudley Bluffs bladderpod. These areas would not be available for leasing, and, therefore, would be protected from the direct effects of oil shale development. This action reduces the potential for impact on these species but does not necessarily eliminate it, as individuals could occur outside of the ACECs in suitable habitat.

**TABLE 4.8.1-3 Potential Effects on State-Listed Threatened and Endangered Species and Species of Special Concern, Federal Candidates for Listing, and BLM-Designated Sensitive Species**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Plants*** | | | | |
| Adobe thistle | *Cirsium perplexans* | BLM-S | CO-Garfield | **Potential for negative impact.** Possible occurrence in Colorado project areas. |
| Beaver Rim phlox | *Phlox pungens* | BLM-S; WY-SC | WY-Lincoln, Sublette | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Blue elderberry | *Sambucus cerulea* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Caespitose cat's-eye | *Cryptantha caespitosa* | BLM-S | CO-Rio Blanco; UT-Duchesne, Uintah | **Potential for negative impact.** Possible occurrence in Colorado and Utah project areas. |
| Cedar Mountain Easter-daisy | *Townsendia microcephala* | BLM-S; WY-SC | WY-Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Cedar Rim thistle | *Cirsium aridum* | BLM-S; WY-SC | WY-Sublette, Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Colorado bedstraw | *Galium coloradoense* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Crandall's rockcress | *Boechera crandallii* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Crisp-leaf wild buckwheat | *Eriogonum corymbosum* var. *corymbosum* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Debeque milkvetch | *Astragalus debequaeus* | BLM-S | CO-Garfield | **Potential for negative impact.** Possible occurrence in Colorado project areas. |
| Debeque phacelia | *Phacelia scopulina* var. *submutica* | ESA-C | CO-Garfield | **Potential for negative impact.** Possible occurrence in Colorado project areas. |
| Debris milkvetch | *Astragalus detritalis* | BLM-S | CO-Rio Blanco; UT-Duchesne, Uintah | **Potential for negative impact.** Possible occurrence in Colorado and Utah project areas. |
| Deep Creek cinquefoil | *Potentilla multisecta* | WY-SC | WY-Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |

**TABLE 4.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Plants (Cont.)*** | | | | |
| Desert glandular phacelia | *Phacelia glandulosa* var. *deserta* | WY-SC | WY-Lincoln, Sublette, Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Divergent wild buckwheat | *Eriogonum divaricatum* | WY-SC | WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Dorn's twinpod | *Physaria dornii* | BLM-S; WY-SC | WY-Lincoln, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Douglas' campion | *Silene douglasii* | WY-SC | WY-Lincoln | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Dwarf mountain mahogany | *Cercocarpus ledifolius* var. *intricatus* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Dwarf ninebark | *Physocarpus alternans* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Dwarf woolly-heads | *Psilocarphus brevissimus* | WY-SC | WY-Sublette | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Entire-leaved peppergrass | *Lepidium integrifolium* var. *integrifolium* | BLM-S; WY-SC | WY-Lincoln, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Ephedra buckwheat | *Eriogonum ephedroides* | BLM-S | CO-Rio Blanco; UT-Uintah | **Potential for negative impact.** Possible occurrence in Colorado and Utah project areas. |
| Ferron milkvetch | *Astragalus musiniensis* | BLM-S | CO-Garfield | **Potential for negative impact.** Possible occurrence in Colorado project areas. |
| Fremont cottonwood | *Populus deltoides* var. *wislizeni* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Fullstem | *Chamaechaen-actis scaposa* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Garrett's beardtongue | *Penstemon scariosus* var. *garrettii* | WY-SC | WY-Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Gibbens' beardtongue | *Penstemon gibbensii* | BLM-S; WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |

**TABLE 4.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Plants (Cont.)*** | | | | |
| Grand buckwheat | *Eriogonum contortum* | BLM-S | CO-Garfield | **Potential for negative impact.** Possible occurrence in Colorado project areas. |
| Great Basin downingia | *Downingia laeta* | WY-SC | WY-Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Green Mormon tea | *Ephedra viridis* var. *viridis* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Greene rabbitbrush | *Chrysothamnus greenei* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Harrington beardtongue | *Penstemon harringtonii* | BLM-S | CO-Garfield | **Potential for negative impact.** Possible occurrence in Colorado project areas. |
| Hayden's milkvetch | *Astragalus bisulcatus* var. *haydenianus* | WY-SC | WY-Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Hooker wild buckwheat | *Eriogonum hookeri* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Intermountain phacelia | *Phacelia demissa* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Jones blue star | *Amsonia jonesii* | BLM-S | UT-Uintah | **Potential for negative impact.** Possible occurrence in Utah project areas. |
| Juniper prickly-pear | *Opuntia polyacantha* var. *juniperina* | WY-SC | WY-Sublette, Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| King's milkvetch | *Astragalus calycosus* var. *calycosus* | WY-SC | WY-Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Large-flower collomia | *Collomia grandiflora* | WY-SC | WY-Lincoln | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Large-fruited bladderpod | *Lesquerella macrocarpa* | BLM-S; WY-SC | WY-Lincoln, Sublette, Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Ligulate feverfew | *Parthenium ligulatum* | BLM-S | CO-Rio Blanco | **Potential for negative impact.** Possible occurrence in Colorado project areas. |
| Little-leaf mock-orange | *Philadelphus microphyllus* var. *occidentalis* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |

**TABLE 4.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Plants (Cont.)*** | | | | |
| Little-leaved brickell-bush | *Brickellia microphylla* var. *scabra* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Long-awned alkali wild-rye | *Elymus simplex* var. *luxurians* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Many-headed broom groundsel | *Senecio spartioides* var. *multicapitatus* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Maybell locoweed | *Oxytropis besseyi* var. *obnapiformis* | WY-SC | WY-Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Moab milkvetch | *Astragalus coltonii* var. *moabensis* | WY-SC | WY-Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Mystery wormwood | *Artemisia biennis* var. *diffusa* | BLM-S; WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Narrow-leaved bladderpod | *Lesquerella parvula* | WY-SC | WY-Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Narrow-stem gilia | *Gilia stenothyrsa* | BLM-S | CO-Rio Blanco; UT-Carbon, Duchesne, Emery, Uintah | **Potential for negative impact.** Possible occurrence in Colorado and Utah project areas. |
| Naturita milkvetch | *Astragalus naturitensis* | BLM-S | CO-Garfield | **Potential for negative impact.** Possible occurrence in Colorado project areas. |
| Nelson phacelia | *Phacelia salina* | WY-SC | WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Nevada sweetpea | *Lathyrus lanszwertii* var. *lanszwertii* | WY-SC | WY-Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Northern twayblade | *Listera borealis* | BLM-S | CO-Garfield; UT-Duchesne, San Juan; WY-Sublette | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| Nuttall sandwort | *Minuartia nuttallii* | BLM-S | UT-Duchesne, WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Utah and Wyoming project areas. |

**TABLE 4.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Plants (Cont.)*** | | | | |
| Ownbey's thistle | *Cirsium ownbeyi* | BLM-S; WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Parachute beardtongue | *Penstemon debilis* | ESA-C | CO-Garfield | **Potential for negative impact.** Possible occurrence in Colorado project areas. |
| Payson's tansy mustard | *Descurainia pinnata* var. *paysonii* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Persistent sepal yellowcress | *Rorippa calycina* | BLM-S; WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Piceance bladderpod | *Lesquerella parviflora* | BLM-S | CO-Garfield, Rio Blanco | **Potential for negative impact.** Possible occurrence in Colorado project areas. |
| Precocious milkvetch | *Astragalus proimanthus* | BLM-S; WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Prostrate bladderpod | *Lesquerella prostrate* | WY-SC | WY-Lincoln, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Red poverty-weed | *Monolepis pusilla* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Rollins' cat's-eye | *Cryptantha rollinsii* | BLM-S; WY-SC | CO-Rio Blanco; UT-Uintah; WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| Rufous-spine prickly-pear | *Opuntia polyacantha* var. *rufispina* | WY-SC | WY-Lincoln, Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Saffron groundsel | *Packera crocata* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| San Rafael daisy | *Erigeron compactus* var. *consimilis* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Selby's rockcress | *Boechera selbyi* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Sickle saltbush | *Atriplex falcata* | WY-SC | WY-Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Slender cryptantha | *Cryptantha gracilis* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |

**TABLE 4.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Plants (Cont.)*** | | | | |
| Sodaville milkvetch | *Astragalus lentiginosus* var. *salinus* | WY-SC | WY-Lincoln, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Stemless beardtongue | *Penstemon acaulis* var. *acaulis* | BLM-S; WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Strigose Easter-daisy | *Townsendia strigosa* | BLM-S | UT-Duchesne, Uintah | **Potential for negative impact.** Possible occurrence in Utah project areas. |
| Swallen mountain-ricegrass | *Achnatherum swallenii* | WY-SC | WY-Lincoln, Sublette | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Ternate desert-parsley | *Lomatium triternatum* var. *anomalum* | WY-SC | WY-Lincoln | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Tiny phacelia | *Phacelia tetramera* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Tree-like oxytheca | *Oxytheca dendroidea* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Trelease's racemose milkvetch | *Astragalus racemosus* var. *treleasei* | BLM-S; WY-SC | WY-Sublette, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Tufted twinpod | *Physaria condensata* | BLM-S; WY-SC | WY-Lincoln, Sublette, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Uinta Basin spring-parsley | *Cymopterus duchesnensis* | BLM-S | CO-Rio Blanco; UT-Uintah | **Potential for negative impact.** Possible occurrence in Colorado and Utah project areas. |
| Uinta draba | *Draba juniperina* | WY-SC | WY-Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Uinta greenthread | *Thelesperma pubescens* | BLM-S; WY-SC | WY-Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Utah gentian | *Gentianella tortuosa* | BLM-S | CO-Rio Blanco; UT-Duchesne, Uintah | **Potential for negative impact.** Possible occurrence in Colorado and Utah project areas. |

**TABLE 4.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Plants (Cont.)*** | | | | |
| Utah greasebush | *Glossopetalon spinescens* var. *meionandrum* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Utah mountain lilac | *Ceanothus martinii* | WY-SC | WY-Lincoln, Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Western phacelia | *Phacelia incana* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| White beardtongue | *Penstemon laricifolius* ssp. *exilifolius* | WY-SC | WY-Sublette | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| White fir | *Abies concolor* | WY-SC | WY-Sweetwater | **No impact.** Only known record from Little Mountain outside of project area. |
| White River beardtongue | *Penstemon scariosus* var. *albifluvis* | ESA-C | CO-Rio Blanco; UT-Uintah | **Potential for negative impact.** Possible occurrence in Utah project areas. Not found in Piceance Basin. |
| White-margined phlox | *Phlox albomarginata* | WY-SC | WY-Lincoln | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Wilcox eriastrum | *Eriastrum wilcoxii* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Wolf's orache | *Atriplex wolfii* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Yellow water-crowfoot | *Ranunculus flabellaris* | WY-SC | WY-Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| ***Invertebrates*** | | | | |
| Eureka mountainsnail | *Oreohelix eurekensis* | UT-SC | UT-Duchesne | **No impact.** Populations occur outside of project areas. |
| Great Basin silverspot butterfly | *Speyeria nokomis nokomis* | BLM-S | UT-Duchesne, Uintah | **Potential for negative impact.** Possible occurrence in Utah project areas. |
| ***Fish*** | | | | |
| Bluehead sucker | *Catostomus discobolus* | BLM-S; WY-SC | WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |

**TABLE 4.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Fish (Cont.)*** | | | | |
| Bonneville cutthroat trout | *Oncorhynchus clarkii utah* | BLM-S; WY-SC | WY-Lincoln, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Colorado River cutthroat trout | *Oncorhynchus clarkii pleuriticus* | BLM-S; CO-SC; WY-SC | CO-Garfield, Rio Blanco; UT-Duchesne, Uintah; WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| Flannelmouth sucker | *Catostomus latipinnis* | BLM-S; WY-SC | UT-Duchesne, Uintah; WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Utah and Wyoming project areas. |
| Leatherside chub | *Gila copei* | BLM-S; UT-SC; WY-SC | UT-Uintah; WY-Lincoln, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. Populations occur outside of project areas in Utah. |
| Roundtail chub | *Gila robusta* | BLM-S; CO-SC; WY-SC | CO-Garfield, Rio Blanco; UT-Duchesne, Uintah; WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| ***Amphibians*** | | | | |
| Boreal toad | *Bufo boreas* | BLM-S; CO-E; WY-SC; UT-SC | CO-Garfield, Rio Blanco; UT-Duchesne, Uintah; WY-Lincoln, Sublette, Uinta | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| Columbia spotted frog | *Rana luteiventris* | BLM-S; WY-SC | WY-Lincoln, Sublette | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Great basin spadefoot | *Spea intermontana* | BLM-S; WY-SC | CO-Garfield, Rio Blanco; UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne; WY-Lincoln, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |

**TABLE 4.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Amphibians (Cont.)*** | | | | |
| Northern leopard frog | *Rana pipiens* | BLM-S; CO-SC; WY-SC | CO-Garfield; UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne; WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| ***Reptiles*** | | | | |
| Longnose leopard lizard | *Gambelia wislizenii* | BLM-S; CO-SC | CO-Garfield, Rio Blanco | **Potential for negative impact.** Possible occurrence in Colorado project areas. |
| Midget faded rattlesnake | *Crotalus oreganus concolor* | BLM-S; CO-SC | CO-Garfield, Rio Blanco; WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Colorado and Wyoming project areas. |
| Smooth greensnake | *Liochlorophis vernalis* | UT-SC | UT-Duchesne, Uintah | **Potential for negative impact.** Possible occurrence in Utah project areas. |
| ***Birds*** | | | | |
| American bittern | *Botaurus lentiginosus* | WY-SC | WY-Lincoln, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| American peregrine falcon | *Falco peregrinus anatum* | BLM-S; CO-SC | CO-Garfield, Rio Blanco; UT-Carbon, Duchesne, Emery, Garfield, Grand, San Jan, Uintah, Wayne; WY-Sublette, Sweetwater | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| American white pelican | *Pelecanus erythrorhynchos* | BLM-S; UT-SC | CO-Garfield; UT-Uintah | **Potential for negative impact.** Possible occurrence in Colorado and Utah project areas. |
| Bald eagle | *Haliaeetus leucocephalus* | CO-T, WY-SC | CO-Garfield, Rio Blanco; WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Colorado and Wyoming project areas. |
| Barrow's goldeneye | *Bucephala islandica* | BLM-S | CO-Garfield, Rio Blanco | **Potential for negative impact.** Possible occurrence in Colorado project areas. |

**TABLE 4.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Birds (Cont.)*** | | | | |
| Black swift | *Cypseloides niger* | CO-SC; UT-SC | CO-Garfield, Rio Blanco; UT-Duchesne, Uintah | **Potential for negative impact.** Possible occurrence in Colorado and Utah project areas. |
| Black-backed woodpecker | *Picoides arcticus* | WY-SC | WY-Lincoln | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Bobolink | *Dolichonyx oryzivorus* | UT-SC | UT-Uintah | **Potential for negative impact.** Possible occurrence in Utah project areas. |
| Boreal owl | *Aegolius funereus* | WY-SC | CO-Garfield, Rio Blanco; WY-Lincoln, Uinta | **Potential for negative impact.** Possible occurrence in Colorado and Wyoming project areas. |
| Burrowing owl | *Athene cunicularia* | BLM-S; CO-T; UT-SC; WY-SC | CO-Garfield, Rio Blanco; UT-Duchesne, Uintah; WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| Bushtit | *Psaltriparus minimus* | WY-SC | WY-Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Caspian tern | *Sterna caspia* | WY-SC | WY-Lincoln | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Clark's grebe | *Aechmophorus clarkii* | WY-SC | WY-Lincoln | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Columbian sharp-tailed grouse | *Tympanuchus phasianellus columbianus* | BLM-S; CO-SC | CO-Garfield | **Potential for negative impact.** Possible occurrence in Colorado project areas. |
| Common loon | *Gavia immer* | WY-SC | WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Ferruginous hawk | *Buteo regalis* | BLM-S; CO-SC; UT-SC; WY-SC | CO-Garfield, Rio Blanco; UT-Duchesne, Uintah; WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| Forster's tern | *Sterna forsteri* | WY-SC | WY-Lincoln | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Greater sandhill crane | *Grus canadensis tabida* | CO-SC | CO-Garfield, Rio Blanco | **Potential for negative impact.** Possible occurrence in Colorado project areas. |

**TABLE 4.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Birds (Cont.)*** | | | | |
| Juniper titmouse | *Baeolophus ridgwayi* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Lewis's woodpecker | *Melanerpes lewis* | UT-SC; WY-SC | UT-Duchesne, Uintah; WY-Uinta | **Potential for negative impact.** Possible occurrence in Utah and Wyoming project areas. |
| Loggerhead shrike | *Lanius ludovicianus* | WY-SC | WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Long-billed curlew | *Numenius americanus* | BLM-S; CO-SC; UT-SC; WY-SC | CO-Garfield, Rio Blanco; UT-Uintah; WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| McCown's longspur | *Calcarius mccownii* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Mountain plover | *Charadrius montanus* | BLM-S; CO-SC; WY-SC | CO-Rio Blanco; WY-Lincoln, Sublette, Sweetwater | **Potential for negative impact.** Possible occurrence in Colorado and Wyoming project areas. |
| Northern goshawk | *Accipiter gentilis* | BLM-S; WY-SC | CO-Garfield, Rio Blanco; UT-Duchesne, Uintah; WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| Pygmy nuthatch | *Sitta pygmaea* | WY-SC | WY-Lincoln, Sublette | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Sage grouse | *Centrocercus urophasianus* | BLM-S; CO-SC; UT-SC | CO-Garfield, Rio Blanco; UT-Duchesne, Uintah; WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| Sage sparrow | *Amphispiza belli* | BLM-S | WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Scott's oriole | *Icterus parisorum* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Short-eared owl | *Asio flammeus* | UT-SC | UT-Duchesne, Uintah | **Potential for negative impact.** Possible occurrence in Utah project areas. |
| Three-toed woodpecker | *Picoides tridactylus* | UT-SC | UT-Duchesne, Uintah | **Potential for negative impact.** Possible occurrence in Utah project areas. |

**TABLE 4.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Birds (Cont.)*** | | | | |
| Trumpeter swan | *Cygnus buccinator* | WY-SC | WY-Lincoln, Sublette, Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Western scrub-jay | *Aphelocoma californica* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Western yellow-billed cuckoo | *Coccyzus americanus occidentalis* | ESA-C; BLM-S; WY-SC | CO-Garfield; UT-Duchesne, Uintah; WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| White-faced ibis | *Plegadis chihi* | BLM-S; WY-SC | CO-Garfield, Rio Blanco; WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Colorado and Wyoming project areas. |
| ***Mammals*** | | | | |
| Big free-tailed bat | *Nyctinomops macrotis* | BLM-S; UT-SC | CO-Garfield; UT-Uintah | **Potential for negative impact.** Possible occurrence in Colorado and Utah project areas. |
| Canyon mouse | *Peromyscus crinitus* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Cliff chipmunk | *Tamias dorsalis utahensis* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Fringed myotis | *Myotis thysanodes* | BLM-S; UT-SC; WY-SC | CO-Garfield, Rio Blanco; UT-Duchesne, Uintah; WY-Sublette | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| Idaho pocket gopher | *Thomomys idahoensis* | BLM-S; WY-SC | WY-Lincoln, Sublette, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Kit fox | *Vulpes macrotis* | CO-E; UT-SC | CO-Garfield, Rio Blanco; UT-Duchesne, Uintah | **Potential for negative impact.** Possible occurrence in Colorado and Utah project areas. |
| Long-eared myotis | *Myotis evotis* | BLM-S | WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Pallid bat | *Antrozous pallidus* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Pinon mouse | *Peromyscus truei* | WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Preble's shrew | *Sorex preblei* | WY-SC | WY-Lincoln, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |

**TABLE 4.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Mammals (Cont.)*** | | | | |
| Pygmy rabbit | *Brachylagus idahoensis* | BLM-S; UT-SC; WY-SC | WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Spotted bat | *Euderma maculatum* | BLM-S; UT-SC; WY-SC | CO-Garfield, Rio Blanco; UT-Duchesne, Uintah; WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| Swift fox | *Vulpes velox* | BLM-S; WY-SC | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| Townsend's big-eared bat | *Corynorhinus townsendii pallescens* | BLM-S; CO-SC; UT-SC; WY-SC | CO-Garfield, Rio Blanco; UT-Duchesne, Uintah; WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |
| Water vole | *Microtus richardsoni* | WY-SC | WY-Lincoln, Sublette, Uinta | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |
| White-tailed prairie dog | *Cynomys leucurus* | BLM-S; UT-SC; WY-SC | UT-Duchesne, Uintah; WY-Lincoln, Sublette, Sweetwater, Uinta | **Potential for negative impact.** Possible occurrence in Utah and Wyoming project areas. |
| Wolverine | *Gulo gulo* | CO-E; WY-SC | CO-Garfield, Rio Blanco; WY-Lincoln, Sublette | **Potential for negative impact.** Possible occurrence in Colorado and Wyoming project areas. |
| Wyoming pocket gopher | *Thomomys clusius* | BLM-S | WY-Sweetwater | **Potential for negative impact.** Possible occurrence in Wyoming project areas. |

[a] Status categories: BLM-S = listed by the BLM as sensitive; CO = Colorado; E = listed as endangered; ESA-C = candidate for listing under the Endangered Species Act; SC = listed as species of special concern; T = listed as threatened; UT = Utah; WY = Wyoming.

The Ute ladies'-tresses could occur in Utah project areas in wetland habitats and along the Green River or White River. This species is dependent on a high water table and, in addition to the factors affecting upland plants, could be adversely affected by any water depletions from the Green River or White River basins associated with oil shale development in Utah.

Impacts on the endangered Colorado River fishes (bonytail, Colorado pikeminnow, humpback chub, and razorback sucker) could result from oil shale developments in the Green River and White River basins. On the basis of proximity of populations and critical habitat to potential lease areas, the greatest potential for impacts on these species is related to development in Utah, where the Green River and White River flow through oil shale areas, although areas

**TABLE 4.8.1-4 Potential Effects on Federally Listed Threatened, Endangered, and Proposed Species**

| Common Name | Scientific Name | Status [a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Plants*** | | | | |
| Barneby ridge-cress | *Lepidium barnebyanum* | E | UT-Duchesne | **Not likely to affect.** Species occurs outside of project area. |
| Clay reed-mustard | *Schoenocrambe argillacea* | T | UT-Uintah | **Potential adverse affect.** Possible occurrence in Utah project areas. |
| Dudley Bluffs bladderpod | *Lesquerella congesta* | T | CO-Rio Blanco | **Potential adverse affect.** Possible occurrence in Colorado project areas. |
| Dudley Bluffs twinpod | *Physaria obcordata* | T | CO-Rio Blanco | **Potential adverse affect.** Possible occurrence in Colorado project areas. |
| Shrubby reed-mustard | *Schoenocrambe suffrutescens* | E | UT-Duchesne, Uintah | **Potential adverse affect.** Possible occurrence in Utah project areas. |
| Uinta Basin hookless cactus | *Sclerocactus glaucus* | T | CO-Garfield; UT-Duchesne, Uintah | **Potential adverse affect.** Possible occurrence in Colorado and Utah project areas. |
| Ute ladies'-tresses | *Spiranthes diluvialis* | T | UT-Duchesne, Uintah | **Potential adverse affect.** Possible occurrence in Utah project areas. |
| ***Fish*** | | | | |
| Bonytail | *Gila elegans* | E | UT-Duchesne, Uintah | **Potential adverse affect.** Possible occurrence in Utah project areas. Depletions from the Colorado River Basin are considered an adverse effect. |
| Colorado pikeminnow | *Ptychocheilus lucius* | E | CO-Rio Blanco (XN); UT-Duchesne, Uintah | **Potential adverse affect.** Possible occurrence in Colorado and Utah project areas. Depletions from the Colorado River Basin are considered an adverse effect. |
| Humpback chub | *Gila cypha* | E | UT-Uintah | **Potential adverse affect.** Although occurrence in Utah project areas is unlikely, depletions from the Colorado River Basin are considered an adverse effect. |

**TABLE 4.8.1-4 (Cont.)**

| Common Name | Scientific Name | Status [a] | States and Counties in Project Area Where Species Occur | Potential Effect |
|---|---|---|---|---|
| ***Fish (Cont.)*** | | | | |
| Razorback sucker | *Xyrauchen texanus* | E | CO-Garfield, Rio Blanco; UT-Uintah | **Potential adverse affect.** Possible occurrence in Colorado and Utah project areas. Depletions from the Colorado River Basin are considered an adverse effect. |
| ***Birds*** | | | | |
| Mexican spotted owl | *Strix occidentalis lucida* | T | UT-Uintah | **Potential adverse affect.** Possible occurrence in Utah project areas. |
| Southwestern willow flycatcher | *Empidonax traillii extimus* | E | CO-Garfield, Rio Blanco; UT-Uintah | **Potential adverse affect.** Possible occurrence in Colorado and Utah project areas. |
| Whooping crane | *Grus americana* | XN | CO-Garfield, Rio Blanco | **Not likely to affect.** Rare migrant through Colorado. |
| ***Mammals*** | | | | |
| Black-footed ferret | *Mustela nigripes* | E | CO-Rio Blanco (XN); UT-Duchesne, Uintah | **Potential adverse affect.** Possible occurrence in Colorado and Utah project areas. |
| Canada lynx | *Lynx canadensis* | T | CO-Garfield, Rio Blanco; UT-Uintah; WY-Lincoln, Sublette, Uinta | **Potential adverse affect.** Possible occurrence in Colorado, Utah, and Wyoming project areas. |

[a] Status categories: E = listed under the ESA as endangered; T = listed under the ESA as threatened; XN = experimental, nonessential population.

immediately adjacent to these rivers are not available for leasing because they are either designated as ACECs (Lower Green River) or have been proposed as ACECs (Four Mile Wash and White River). In Colorado, the White River is outside potential lease areas (the closest distance is about 5 km [3 mi]), but tributaries to the White River (e.g., Yellow Creek and Piceance Creek) flow through potential lease areas. Potential factors associated with oil shale development that could affect these species include alteration of topography, changes in drainage patterns, erosion, sedimentation from runoff, and oil and contaminant spills.

Any water depletions from the upper Colorado River Basin are considered an adverse effect on endangered Colorado River fishes. Commercial oil shale development could affect

these species if they resulted in water depletions in the basin. Water depletions for individual projects could be quite large and represent a significant adverse impact on these riverine fish.

Listed bird species that could be affected by commercial oil shale development include the Mexican spotted owl and southwestern willow flycatcher (Table 4.8.1-4). The Mexican spotted owl could occur year-round in steep forested canyons in Utah and could be affected if these types of habitats are disturbed during oil shale development. Impacts on individual owls could result from injury or mortality (e.g., collisions with transmission lines), human disturbance or harassment, increased human access to occupied areas, increases in predation rates, and noise from facilities.

The southwestern willow flycatcher is most commonly found in riparian areas, especially along large rivers (e.g., Green River, White River). Direct impacts on these habitats are not anticipated because they occur within designated ACECs or potential ACECs. However, these riparian habitats could be affected indirectly by activities in their watersheds that resulted in alteration of topography, changes in drainage patterns, erosion, sedimentation from runoff, and oil and contaminant spills. In addition, impacts on riparian habitats that support these species could result if the habitats were crossed by project transmission lines or roads. Impacts on individual birds could result from injury or mortality (e.g., collisions with transmission lines), human disturbance or harassment, increased human access to occupied areas, increases in predation rates, and noise from facilities.

Listed mammals that could be affected by oil shale development include the black-footed ferret and Canada lynx (Table 4.8.1-4). The black-footed ferret occurs in grassland and shrublands that support active prairie dog towns and potentially occurs in both Utah and Colorado project areas. The Canada lynx occurs in coniferous forests and potentially occurs in project areas in all three states. Impacts on these species could result from impacts on habitat (including vegetation clearing, habitat fragmentation, and movement-dispersal blockage) and individuals (injury or mortality [e.g., collisions with vehicles], human disturbance or harassment, increased human access to occupied areas, increases in predation rates, and noise from facilities).

### 4.8.2 Mitigation Measures for Ecological Resources

Various mitigation measures would be required to reduce the impact of oil shale development on ecological resources during construction, operations, and reclamation. Existing guidance, recommendations, and requirements related to management practices are described in detail in the BLM Gold Book (DOI and USDA 2006), and BLM field office RMPs. The BLM has also developed a guidance document, *Hydraulic Considerations for Pipeline Crossing Stream Channels*, for construction of pipeline crossings of perennial, intermittent, and ephemeral stream channels. This guidance can be found at: http://www.blm.gov/nstc/library/techno2.htm. BLM Handbook 6840—*Special Status Species Management* describes BLM policy to protect species identified by the BLM as sensitive.

In addition to the actions described in these guidance documents, the mitigation actions below could be used to reduce the potential for impacts on various ecological resources. Other mitigation measures may be identified by the BLM or USFWS prior to project development.

#### 4.8.2.1 Aquatic Resources

- Protect wetlands, springs, seeps, ephemeral streams, and riparian areas on or adjacent to development areas either through avoidance (if possible) or mitigation. This objective would be accomplished by conducting predisturbance surveys in all areas proposed for development following accepted protocols established by the USACE, the BLM, or state regulatory agencies, as appropriate. If any wetlands, springs, seeps, or riparian areas are found, plans to avoid (if possible) or mitigate impacts would be developed in consultation with those agencies and the local BLM field office prior to the initiation of ground disturbance. Examples of potential protective measures include (1) establishing buffer zones adjacent to these habitats in which development activities would be excluded or modified, (2) using erosion control techniques to prevent sediment runoff into these habitats, (3) using runoff control devices to prevent surface water runoff into these areas, and (4) identifying and implementing spill prevention technologies that would prevent or reduce the potential for oil or other contaminants from entering these habitats.

- Avoid (if possible) or mitigate changes in the function of the 100-year floodplain or flood storage capacity. To achieve this, either no activities or limited activities within floodplains would be allowed and floodplain contours could be restored to predisturbance conditions following short-term disturbances. The effectiveness of mitigation measures would be evaluated and modified, if necessary.

- Avoid (if possible) or mitigate water quality degradation (e.g., chemical contamination, increased salinity, increased temperature, decreased dissolved oxygen, and increased sediment loads) that could result from construction and operation. Water quality in areas adjacent to or downstream of development areas would be monitored during the life of the project to ensure water quality in aquatic habitats is protected.

- Avoid (if possible) or mitigate the impacts on aquatic habitats (including springs, seeps, and ephemeral streams), wetlands, and riparian areas that could result from changes to surface or groundwater flows. Hydrologically connected areas would be monitored for changes in flow that are development related.

#### 4.8.2.2 Plant Communities and Habitats

- Avoid (if possible) or mitigate impacts on rare natural communities and remnant vegetation associations. Predisturbance surveys would be used to identify these communities in and adjacent to development areas. Examples of potential protective measures include (1) establishing buffer zones adjacent to these habitats and excluding or modifying development activities within those areas, (2) using erosion control techniques to prevent sediment runoff into these habitats, (3) using runoff control devices to prevent surface water runoff into these areas, and (4) identifying and implementing spill prevention technologies that would prevent or reduce the potential for oil or other contaminants from entering these habitats. Mitigation could also include reclamation or establishment of similar habitats elsewhere as compensation.

- Reclaim excavated areas and disturbed areas following backfilling operations. Spent shale returned to mined areas would be covered with subsoil and then topsoil. Exposed soils would be seeded and revegetated as directed under applicable BLM requirements. Only locally native plant species would be used for the reclamation of disturbed areas to reestablish native plant communities.

- Prevent the establishment and spread of invasive species and noxious weeds, thus protecting developing plant communities on the project site from colonization by these species and increasing the potential for the successful development of diverse, mature native habitats in disturbed areas. Degradation of nearby habitats by invasive species colonization from project areas would also be avoided.

- Protect plant communities and habitats near all project areas from the effects of fugitive dust. This objective could be achieved by implementing dust abatement practices (e.g., mulching, water application, paving roads, and plantings) that would be applied to all areas of regular traffic or areas of exposed erodible soils.

#### 4.8.2.3 Wildlife (including Wild Horses and Burros)

- Identify important, unique, or high-value wildlife habitats in the vicinity of the project, and design the project to avoid (if possible) or mitigate impacts on these habitats. For example, project facilities, access roads, and other ancillary facilities could be located in the least environmentally sensitive areas (i.e., away from riparian habitats, streams, wetlands, drainages, and critical or crucial wildlife habitats). The lessee would consult with the BLM and state agencies to discuss important wildlife use areas in order to assist in the determination of facility design and location that would avoid or minimize impacts on wildlife species and their habitats to the fullest extent practicable.

Where habitat impacts cannot be avoided, these losses could be mitigated by habitat enhancement or compensatory habitat mitigation of in-kind, high-value habitat areas developed in coordination with the USFWS and state fish and game departments.

- Evaluate the project site for avian use (particularly by raptors, greater sage-grouse, neotropical migrants, and birds of conservation concern), and design the project to avoid (if possible) or mitigate the potential for adverse impacts on birds and their habitat. Conduct predisturbance surveys for raptor nesting in all areas proposed for development following accepted protocols and in consultation with the USFWS and state natural resource agencies. If raptor nests are found, an appropriate course of action would be formulated to avoid (if possible) or mitigate impacts, as appropriate. For example, impacts could be reduced if project design avoided locating transmission lines in landscape features known to attract raptors. The lessee would also, at a minimum, follow guidance provided in the APP Guidelines prepared by the Avian Power Line Interaction Committee (APLIC) and USFWS (APLIC and USFWS 2005).

- Design facilities to discourage their use as perching or nesting sites by birds and minimize avian electrocutions.

- Avoid (to the fullest extent practicable) the creation of open surface water bodies (including wastewater pits). Any surface water body created for projects would be netted and fenced to prevent use by all wildlife.

- Avoid (if possible) or mitigate wildlife mortality from vehicle collisions. To achieve this objective, important wildlife habitats could be mapped and activities within them avoided (if possible) or mitigated. Education programs could be implemented to ensure that employees are aware of wildlife impacts associated with vehicular use. Carpooling, busing, or other means to limit traffic (and vehicle collisions with wildlife) would be emphasized.

- Develop a habitat restoration plan for disturbed project areas that includes the establishment of native vegetation communities consisting of locally native plant species. The plan would identify revegetation, soil stabilization, and erosion reduction measures that would be implemented to ensure that all disturbed areas are restored. Restoration would be implemented as soon as possible after completion of activities to reduce the amount of habitat converted at any one time and to hasten the recovery to natural habitats.

- Minimize habitat loss and fragmentation due to project development. For example, habitat fragmentation could be reduced by consolidating facilities (e.g., access roads and utilities would share common ROWs, where feasible), reducing access roads to the minimum number required, and, where possible, locating facilities in areas where habitat disturbance has already occurred.

Transportation management planning can be used as an effective tool to minimize habitat fragmentation to meet this performance goal.

- Protect wildlife from the negative effects of fugitive dust. Dust abatement practices include measures such as mulching, water application, road paving, and plantings.

- Avoid (to the extent practicable) human interactions with wildlife (and wild horses and burros). To achieve this objective, the following measures could be implemented: (1) instruct all personnel to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons; (2) make personnel aware of the potential for wildlife interactions around facility structures; (3) ensure that food refuse and other garbage are not available to scavengers (e.g., by use of covered dumpsters); and (4) restrict pets from project sites.

- Avoid (if possible) or mitigate noise impacts on wildlife during construction and operation. This objective could be accomplished by limiting the use of explosives to specific times and at specified distances from sensitive wildlife areas, as established by the BLM or other federal and state agencies. Operators would ensure that all construction equipment was adequately muffled and maintained to minimize disturbance to wildlife.

- Protect wildlife from chronic and acute pesticide exposure. This objective could be accomplished by measures such as using pesticides of low toxicity, minimizing application areas where possible, and by using timing and/or spatial restrictions (e.g., do not use pesticide treatments in critical staging areas). All pesticides would be applied consistent with their label requirements and in accordance with guidance provided in the *Final Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement* (BLM 2007b).

- Construct wildlife- and wild-horse-friendly cattleguards for all new roads or improve existing ways and trails that require passing through existing fences, fence line gates, or new gates, in addition to standard wire gates alongside them.

- Construct fencing (as practicable) to exclude livestock, wild horses, or wildlife from all project facilities, including all water sites built for the development of facilities and roadways.

- Avoid (if possible) or mitigate existing water sources used by wildlife or wild horses in the vicinity of the project if adversely impacted during project construction or operation.

- Protect important big game winter habitat by prohibiting activities or surface use from November 15 to April 30 within certain areas encompassed by the authorization. The same criteria apply to defined big game birthing areas from May 1 to June 30. Application of this limitation to operation and maintenance of a developed project must be based on environmental analysis of the operational or production aspects. Exception, waiver, or modification of this limitation in any year may be approved in writing, including documented supporting analysis, by the authorized officer.

#### 4.8.2.4 Threatened and Endangered Species

At the outset of the development of this PEIS, when the BLM planned to issue leases on the basis of the analyses conducted here, the BLM began the process of consultation with the USFWS pursuant to its obligations under Section 7 of the ESA. During this preliminary consultation, the BLM and USFWS jointly developed conservation measures to support conservation of species listed under the ESA. Because the proposed action (land use plan amendments setting out allocation of areas that will be available for application for leases) has been altered, the BLM has determined that the proposed action will result in no effect to listed species. Please see Section 6.3 for discussion of compliance with ESA. The conservation measures developed in this initial consultation with USFWS, then, will not necessarily be applied, unless warranted by the results of the consultation that will take place at the time the BLM prepares to issue leases. These measures are described in brief here, however, and more fully in Appendix F, in order to provide some general understanding of the kinds of measures that might be applicable to commercial oil shale development leases.

For purposes of the PEIS, these conservation measures are assumed to be generally consistent with existing conservation agreements, recovery plans, and completed consultations. It is the intent of the BLM and USFWS to ensure that the conservation measures are consistent with those currently applied to other land management actions where associated impacts are similar. However, it is presumed that potential impacts from development described in the PEIS are likely to vary in scale and intensity when compared to land management actions previously considered (e.g., oil and gas exploration and production, surface mining, and underground mining). Hence, final conservation measures would be developed for individual projects prior to leasing and ground-disturbing activities and will be consistent with agency policies. Current BLM guidance on similar actions (e.g., fluid mineral resources) requires that the least restrictive stipulation that effectively accomplishes the resource objectives or resource uses for a given alternative should be used while remaining in compliance with the ESA. Mitigation measures, generally applicable to all listed species, are presented below. Species-specific measures are listed in Appendix F.

- Protect federally listed and state-listed threatened and endangered species and BLM sensitive species through siting and development decisions to avoid impacts. Conduct predisturbance surveys in all areas proposed for development following accepted protocols and in consultation with the USFWS and/or state agencies. If any federally listed species are found, and it

is determined that the proposed development "may affect" the listed species or their critical habitat, the USFWS will be consulted as required by Section 7 of the ESA and an appropriate course of action developed to avoid (if possible) or mitigate impacts and address any potential incidental take from the activity. If any state-listed or BLM sensitive species are found, plans to avoid or mitigate impacts will be developed prior to construction consistent with guidance provided in BLM Handbook 6840.

- Avoid (if possible) or mitigate harassment or disturbance of federally listed threatened and endangered animals, BLM sensitive animal species, and state-listed threatened and endangered animals and their habitats in or adjacent to project areas. This objective can be accomplished by identifying sensitive areas and implementing necessary protection measures based upon consultation with the USFWS (Section 7 of the ESA). Education programs could be developed to ensure employees are aware of protected species and requirements to protect them. Prohibition of nonpermitted access and gating could be used to restrict access to sensitive areas.

- Avoid (if possible) or mitigate impacts on federally listed and state-listed threatened and endangered species and BLM sensitive species and their habitats during construction and operations. If deemed appropriate by the USFWS, activities and their effects on these species will be monitored throughout the duration of the project. To ensure that impacts are avoided, the effectiveness of mitigation measures will be evaluated and, if necessary, Section 7 consultation will be reinitiated.

- Protect federally listed and state-listed threatened and endangered species and BLM sensitive species (especially plants) and their habitats from the adverse effects of fugitive dust. This objective could be achieved by implementing dust abatement practices near threatened and endangered species' habitats or other special habitats of importance (to be determined at the local Field Office level). Dust abatement practices (e.g., mulching, water application, paving roads, and plantings) could be applied to all areas of regular traffic or areas of exposed erodible soils, especially in areas near occupied habitats.

- Avoid the release of oil to aquatic habitats in quantities that could result in subsequent adverse impacts on federally listed and state-listed threatened and endangered species and BLM sensitive species. This objective could be accomplished by applying spill prevention technology to all oil pipelines that cross or are in close proximity to rivers or streams with threatened or endangered aquatic species. For example, pipelines crossing rivers with listed aquatic species could have remotely actuated block or check valves on both sides of the river; pipelines could be double-walled pipe at river crossings; and pipelines could have a spill/leak contingency plan which includes timely notification of the USFWS and/or state agencies.

## 4.9 VISUAL RESOURCES

Because of the subjective and experiential nature of visual resources, the human response to visual changes in the landscape cannot be quantified, even though the visual changes associated with a proposed development can be described (Hankinson 1999). There is, however, some commonality in individuals' experiences of visual resources, and while it may not be possible to quantify subjective experience and values, it is possible to systematically examine and characterize commonly held visual values and to reach general consensus about visual impacts and their trade-offs. The BLM's VRM procedures provide a means of describing visual impacts systematically and of evaluating their impact on the scenic qualities of affected landscapes so that defensible decisions about the relative worth and disposition of visual resources relative to competing resource demands can be made (BLM 1984b). The following text box describes the factors that influence individuals' perceptions of visual impacts and that are considered within the BLM's VRM system.

The BLM's VRM system defines visual impact as the contrast perceived by observers between existing landscapes and proposed projects and activities. Contrasts between an existing landscape and a proposed project or activity are expressed in terms of the landscape elements of form, line, color, and texture. These basic design elements are routinely used by landscape designers to describe and evaluate landscape aesthetics. They have been incorporated into the BLM's VRM system to lend objectivity, integrity, and consistency to the process of assessing visual impacts of proposed projects and activities on BLM-administered lands (BLM 1986b).

Visual impacts can be either positive or negative, depending on the type and degree of visual contrasts introduced to an existing landscape. Where modifications repeat the general forms, lines, colors, and textures of the existing landscape, the degree of visual contrast is lower, and the impacts are generally perceived less negatively. Where modification introduces pronounced changes in form, line, color, and texture, the degree of contrast is greater, and impacts are often perceived more negatively.

Visual changes associated with oil shale development can be produced through a range of direct and indirect actions or activities, including:

1. Vegetation and landform alterations;

2. Additions of structures;

3. Additions or upgrades to roads;

4. Additions or upgrades to utilities and/or ROWs, for example, expansion of ROW width, addition of electric transmission lines or pipelines, or upgrading of transmission voltage or pipeline size;

5. Vehicular and worker activity;

**Factors That Influence an Individual's Perception of Visual Impacts**

**Visibility Factors:** Circumstances or activities that eliminate views of the impact area or impacting feature will reduce the level of perceived visual impact. Intervening topography, vegetation, or structures that effectively screen views can greatly reduce impacts of even large visual changes. Conversely, projects placed at higher elevations relative to viewers, particularly along ridgelines, may be conspicuously visible over larger areas, and thus have greater visual impact. Viewer elevation and aspect can also affect impact visibility by increasing or decreasing the viewable area and reducing or increasing screening effectiveness.

**View Duration:** Impacts that are viewed for a long period of time are generally judged to be more severe than those viewed briefly. For example, a transmission line that closely parallels a hiking trail may be in continuous view of hikers for several hours and would have a greater perceived visual impacts than the same transmission line crossed by a perpendicular highway, which would be viewed relatively briefly by drivers and would have a smaller perceived visual impact.

**Viewer Distance and Angle:** Viewer distance from the impacted area is a key factor in determining the level of impact. The BLM's VRM system defines distance zones — foreground-middleground (less than 3–5 mi), background (5–15 mi), and seldom seen (beyond 15 mi) — with perceived impact diminishing as distance between the viewer and the impact increases (BLM 1986a). Viewer angle relative to the impact may also affect perceived visual impact; when people view landscapes from angles approaching 90° (e.g., views of canyon walls or steep mountain slopes), the landscapes may be scrutinized more closely than those viewed from low angles (e.g., views of plains and other low-relief areas).

**Landscape Setting:** Landscape setting provides the context for judging the degree of contrast in form, line, color, and texture between the proposed project and the existing landscape, as well as the appropriateness of the project to the landscape. Because of their physical properties, some landscapes are perceived by most viewers to have intrinsically higher scenic value than other landscapes, and physical landscape properties also determine the visual absorption capacity of the landscape (i.e., the degree to which the landscape can absorb visual impacts without serious degradation in perceived scenic quality). Scenic integrity describes the degree of "intactness" of a landscape, which is related to the existing amount of visual disturbance present. Landscapes with higher scenic integrity are generally regarded as more sensitive to visual disturbances. A development project in a pristine, high-value scenic landscape with low visual absorption capacity will typically be more conspicuous and perceived as having greater visual impact than if that same project were present in an industrialized landscape of low scenic value where similar projects were already visible. Special landscapes (also called special areas) have special meanings to some viewers because of unique scenic, cultural, or ecological values, and are, therefore, perceived as being more sensitive to visual disturbances. Other landscapes are regarded as more sensitive to visual disturbances because they are near or adjacent to high-value landscapes, such as national parks or historic trails. Rarity of the landscape setting may also affect visual impact assessment; impacts on landscape settings that are relatively rare within a given region may be of greater concern than impacts on a landscape setting that is regionally very common.

**Continued on next page.**

**Seasonal and Lighting Conditions:** Seasonal and lighting conditions that affect contrast may affect perceived visual impact. The presence of snow cover, fall-winter coloration of foliage, and leaf drop may drastically alter color and texture properties of vegetation and soil, thereby altering visual contrasts between a proposed project and the landscape. Sun angle that changes by season and time of day affects shadow casting and color saturation, which, in turn, affect both perceived scenic beauty and contrast.

**Number of Viewers:** The BLM's VRM system considers impacts to be generally more acceptable in areas that are seldom seen, and conversely, less acceptable in areas that are heavily used and/or viewed.

**Viewer Activity, Sensitivity, and Cultural Factors:** The type of activity a viewer is engaged in when viewing a visual impact may affect his or her perception of impact level. Recreationists, particularly hikers and others who may visit an area with the specific goal of scenic appreciation, are generally more sensitive to visual impacts than workers, for example, oil and gas workers. Some individuals and groups are also inherently more sensitive to visual impacts than others, as a result of educational and social background, life experiences, and other cultural factors.

Sources: BLM (1984b, 1986a,b); USFS (1995).

6. Dust and other visible emissions; and

7. Light pollution.

Site-specific impact assessment is needed to systematically and thoroughly assess visual impact levels for a particular project. Without precise information about the location of a project, a relatively complete and accurate description of its major components and their layout, and information about the number and types of viewers, it is not possible to assess the visual impacts associated with the facility precisely. However, if the general nature of the facility is known, as well as the general possible location of facilities, a more generalized but still useful assessment of the possible visual impacts can be made by describing the range of expected visual changes and discussing contrasts typically associated with these changes. In addition, a general analysis can be used to identify sensitive resources that may be at risk if a future project is sited in a particular area.

The impact analysis for this PEIS makes use of distance zones specified by the BLM's VRM system to identify potentially sensitive visual resources that might be impacted if they are within view of an oil shale project. The distance between the viewer and the project elements that are the source of visual contrast is a critical element in determining the level of perceived impact. The BLM's VRM system specifies three distance zones in its visual resource inventory process:

- *Foreground-middleground* (0–5 mi). This zone includes areas where management activities can be seen in detail. This zone has the highest visibility; visual changes are more noticeable than at farther distances and are more likely to trigger public concern.

- *Background* (5–15 mi). This zone includes the area beyond the foreground/middleground up to 15 mi and includes the area where some detail beyond the form or outline of the project is visible.

- *Seldom Seen* (beyond 15 mi). This zone includes areas beyond 15 mi or where only the form or outline of the project can be seen or the project cannot be seen at all (BLM 1986a).

The GIS-based impact analysis used for this PEIS identifies potentially sensitive visual resource areas for which some portions are either within the potential leasing area under an alternative examined in the PEIS, within the 5-mi foreground-middleground distance from the potential leasing area, or within the 15-mi background distance from the leasing area. Assuming an unobstructed view of the project, viewers in these areas would be likely to perceive some level of visual impact from the project, with impacts expected to be greater for resources within the foreground-middleground distance, and lesser for those areas within the background distance. Beyond the background distance, the project might be visible but would likely occupy a very small visual angle and create low levels of visual contrast such that impacts would be minor to negligible.

The impact analysis did not account for topography; in many cases, intervening terrain might obstruct all or part of the view of a project from a given location, for example, a canyon or river bottom. The analysis shows areas that might be affected, but the actual number of affected areas is likely less than that indicated by the analysis. A more precise visibility analysis could be conducted when a site-specific environmental analysis is performed for a particular project, at which point more precise spatial data would be available. This analysis is limited to data that were available in GIS format at the time of analysis; it is recognized that additional scenic resources exist at the national, state, and local levels. While the GIS is capable of extremely high spatial accuracy, it is limited by the accuracy of the data used in the analysis, which were obtained from many sources and subject to error.

Because of a lack of data in a usable GIS format, the analysis did not include examination of BLM VRM classes for all lands potentially affected by the oil shale projects analyzed in the PEIS; however, general statements about the compatibility of visual impacts associated with oil shale facilities with BLM VRM classes can be made. These statements would apply to locations where projects and their associated facilities are located, and in some cases to adjacent lands from which the project would be visible.

The BLM's VRM system specifies the degree of contrast resulting from a project or management activity that is permissible for a given VRM classification. BLM activities must conform to the VRM objectives that apply to the project area, as established in the RMP process. The management objectives for the VRM classes are as follows:

- *Class I Objective.* To preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention.

- *Class II Objective.* To retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but must not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural landscape features.

- *Class III Objective.* To partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements of form, line, color, and texture found in the predominant natural landscape features.

- *Class IV Objective.* To provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high.

Regardless of the technologies employed for oil shale extraction and processing, commercial production of oil shale at the scales projected for analysis in the PEIS would entail industrial processes eventually requiring more than 5,000 acres of land disturbance and the presence and operation of large-scale industrial facilities, and equipment that would introduce major visual changes into nonindustrialized landscapes and would create strong visual contrasts in line, form, color, and texture. These processes also would involve constant, noticeable human and vehicle activity during operation, and particularly during construction. Where visible to observers within the foreground-middleground distance, facilities would normally be expected to attract attention, and in many cases would be expected to dominate the view. While mitigation measures, such as painting the facilities in earth tones and using nonreflective surfaces, might reduce color contrasts, the strong, complex, regular geometry of the structures, combined with the large sizes of the facilities, would preclude repeating of the basic elements of form, line, color, and texture found in the predominant natural landscape features found in a nonindustrialized landscape. While some of the lesser elements of an oil shale project might be compatible with VRM Class III or Class II objectives, the siting of the major facility elements would be expected to be compatible with Class IV objectives only, unless careful siting hid them from view. VRM Class II or Class III areas in close proximity to the major facilities where open lines of sight existed between the Class II or Class III lands and the major facilities would in some cases be expected to be subject to visual impacts from the strong visual contrasts that would result, particularly if the distance was within the foreground-middleground range, but possibly farther in some cases. These impacts might be incompatible with the VRM objectives for these areas.

The following impact analysis provides a general description of the visual changes that are likely to occur as a result of the construction, operation, and reclamation of oil shale projects (and associated facilities).

While visual impacts associated with the construction, operation, and reclamation of oil shale projects considered in the PEIS differ in some important aspects on the basis of the oil shale extraction and processing technologies employed, there are many impacts that are common

to the development approaches. Direct visual impacts associated with construction, operation, and reclamation of commercial oil shale projects can be divided into generally temporary impacts associated with activities that occur during the construction and reclamation phases of the projects, and longer-term impacts that result from the presence of and operation of the facilities themselves. Impacts are presented below by oil shale extraction and processing technology approach.

While mitigation measures (see Section 4.9.2) might lessen some visual impacts associated with these projects, in large part the visual impacts associated with commercial oil shale projects could not be effectively mitigated.

## 4.9.1 Common Impacts

### 4.9.1.1 Surface Mining with Surface Retorting

**4.9.1.1.1 Construction and Reclamation.** Major construction activities associated with the development of an oil shale project utilizing surface mining and surface retorting would include vegetation clearing, recontouring of landforms, road building and/or upgrading, and pad and utility ROW construction. Buildings and structures associated with mining and processing (e.g., ore crushing facilities) and upgrading would be constructed (e.g., multiple liquid storage tanks). Other construction activities would include digging of drilling reserve pits and possibly retention ponds, construction of berms around some tanks, and the addition of fencing around some or all of the lease site. Employer-provided housing would also be constructed off-lease to house workers and their families during the construction phase. (See Section 4.9.1.4 for discussion of impacts associated with electric transmission lines, pipelines, and employer-provided housing.)

The various construction activities described above would require work crews, vehicles, and equipment that would add to visual impacts during construction. Small-vehicle traffic for worker access and large-equipment (trucks, graders, excavators, and cranes) traffic for road construction, site preparation, and tower-pipeline installation would be expected. Both would produce visible activity and dust from disturbance of dry soils. Suspension and visibility of dust would be influenced by vehicle speeds, road surface materials, and weather conditions. Temporary parking for vehicles would be needed at or near work locations. Unplanned and unmonitored parking could likely expand these areas, producing visual contrast by suspended dust and loss of vegetation. Piles of building materials would be visible at times, as well as brush piles and soil piles. Construction equipment might produce emissions and visible exhaust plumes.

Construction would introduce contrasts in form, line, color, and texture, as well as a relatively high degree of human activity into what are generally natural appearing existing landscapes with generally low levels of human activity. In general, visual impacts associated directly with construction activities would be temporary in nature, but because of the “rolling

footprint" approach to mining, recovery, and upgrading during the operations phase of the project, some construction activities would occur several times during the course of the project, giving rise to brief periods of intense construction activity (and associated visual impacts) followed by periods of inactivity.

During reclamation, visual impacts would be similar to those encountered during construction but likely of shorter duration. These impacts probably would include road redevelopment, removal of aboveground structures and equipment, and the presence of idle or dismantled equipment, if allowed to remain on-site. Reclamation activities would involve heavy equipment, support facilities, and lighting. The associated visual impacts would be substantially the same as those in the construction phase. Reclamation likely would be an intermittent or phased activity persisting over extended periods of time and would include the presence of workers, vehicles, and temporary fencing at the work site.

Restoring a site to preproject conditions would also entail recontouring, grading, scarifying, seeding, and planting, and perhaps stabilizing disturbed surfaces, although obtaining the preproject state might not be possible in all cases (i.e., the contours of restored areas might not always be identical to preproject conditions). Newly disturbed soils might create visual contrasts that could persist for several seasons before revegetation would begin to disguise past activity. Invasive species might colonize reclaimed areas, likely producing contrasts of color and texture.

**4.9.1.1.2 Operation.** Oil shale projects utilizing surface mining and surface retorting technologies could utilize pit or strip mines, depending on site characteristics and applicable BLM policies. A pit mining approach would likely involve one or more mine pits, while a strip mining approach would involve rolling footprint activities whereby small sections of the site would be worked in succession, with equipment, crews, and some structures moving from section to section throughout the life of the project. Under the rolling footprint scenario, some buildings and structures and activities would be centrally located and thus have a permanent presence and associated visual impact, while others would "follow" the rolling footprint, and thus the associated visual impacts might change on the basis of viewing conditions.

Some amount of restoration/remediation of the site would commence soon after a given section was worked. This pattern of activities would create the appearance of construction, operation, and reclamation activities occurring simultaneously on some portion or portions of the site throughout the operational life of the project.

Visual impacts from the operation of a commercial oil shale project employing surface mining and retorting would be generated by vegetation clearing, the presence of the mine pit or strip; mining, retorting, upgrading, and support facilities; utilities and other infrastructure; and the presence and activities of workers, vehicles, and equipment. These impacts would occur in some degree throughout the operational life of the projects, and some impacts might occur beyond the operational life of the project.

Visible project components and activities that would likely result in visual impacts include:

- *Vegetation clearing* (eventually involving approximately 5,760 acres per site) with associated debris. For a pit mine, much of the site might be cleared at the beginning of the project. If a rolling footprint approach is utilized, clearing would not take place all at once; rather, it would be progressive and would likely involve repeated clearing of sections of several hundred acres. Vegetation clearing could result in strong visual contrasts in color, line, and texture between cleared and uncleared areas, depending on viewing conditions. Invasive species might colonize cleared areas if revegetation and other control activities are not completely successful. These species might be introduced naturally or in seeds, plants, or soils introduced for intermediate restoration, or by vehicles.

- *The mine pit or strip.* For a pit mining project, the mine pit would have the appearance of a large depression, possibly several hundred to one thousand acres in size at a given time, and possibly up to 500 ft deep, depending on site characteristics and applicable regulations. The pit would be permanent over the life of the project and might change in size and depth over time; some spent shale would likely be returned to the pit as the project progresses. For a strip mining project, the depression would likely be smaller in area (at a given time) and would move across the site over time. It is projected that surface mining projects in Utah would have 600 to 1,200 acres of surface disturbance at any one time, while surface mines in Wyoming could have 1,000 to 2,000 acres of surface disturbance at any one time. It is projected that the total lease area would be affected over a 20-year project life, but that mine area and spent shale disposal areas would be reclaimed on an ongoing basis much like many surface coal mines currently are. In both cases, the mine pit or strip would introduce strong visual contrasts in form, line, color, and texture (where visible) to the existing landscape, and because of the large size of the pit or strip, these strong visual contrasts could be conspicuous to viewers within several miles of the project, depending on visibility and viewing conditions.

- *Recontouring of landforms.* The creation of the mine pit or strip, retention ponds, soil and shale piles, roads and pads for facilities, and restoration activities would require extensive recontouring of land throughout the lifetime of the project. Soil scars, exposed slope faces, eroded areas, and areas of compacted soil that could result from recontouring could introduce noticeable color contrasts, depending on soil type, as well as contrasts in form, line, and texture. Color and texture contrasts might be mitigated by revegetation activities over time.

- *New or upgraded roads.* Both new road construction and upgrading of existing roads would be required for site access, materials hauling, and general transport within the site. The presence of new roads could introduce

contrasts in line, color, and texture to existing landscapes, while the upgrading of existing roads could increase contrasts in color and texture, depending on treatment, and may increase the visible area if the road is widened. The process of road building and upgrading would likely continue to some degree throughout the life of the project as new sections are worked, particularly for strip mining projects.

- *Pads for structures and/or equipment.* A variety of paved or gravel pads would be required for building and equipment sites, wells, and other activities such as vehicle parking. The presence of pads would introduce contrasts in line, color, and texture into existing landscapes and could introduce contrasts in form if substantial recontouring is required.

- *Buildings, retorts, ore crushing and processing buildings and structures, and other buildings and structures.* The mining, ore handling, retorting, and upgrading processes all require a variety of buildings and built structures, for example, storage tanks, pipelines, flare and smoke stacks, and wells. In addition, a variety of support buildings and structures would be constructed, such as administration buildings, work trailers, guardhouses, storage structures, fences, etc. In general, these buildings and structures would contrast strongly in form, line, color, and texture with existing, generally natural-appearing landscapes because of the built structures' rectilinear geometry, symmetry, and surface characteristics. In particular, those buildings and structures associated with oil shale extraction, ore processing, retorting, upgrading, storage, and transport would have a "heavy industry" look, similar in appearance to an oil refinery. For the larger operations, buildings and structures would likely cover 100 acres. While color contrasts might be partially mitigated by painting buildings and structures in earth tones and using nonreflective coatings, in general the buildings and structures would be visually prominent for any nearby viewers. To varying degrees (depending on the mining technology and other project-specific factors), the buildings and structures would be found in multiple locations and might be moved periodically to follow the mining activities across the site. Flare and smoke stacks could be as tall as 300 ft and could be visible for several miles in daylight, and farther at night.

- *Utilities.* Electric transmission lines, pipelines, and communication data lines and towers (with associated ROWs and structures) would be required. New utilities could be located within and/or outside the lease boundaries. Where visible, these generally linear features would introduce contrasts in line to existing landscapes, while cleared ROWs and structures associated with utilities could introduce contrasts in form, line, color, and texture (Figures 4.9.1-1 and 4.9.1-2).

**FIGURE 4.9.1-1 ATP Processor Retort Technology at Stuart Oil Shale Facility, Queensland, Australia (This is a demonstration-scale [4,800-bbl/day] oil shale facility. A portion of the oil shale mining area is visible in background. Photo courtesy of Queensland Energy Resources Limited, Queensland, Australia, and UMATAC Industrial Processes, Calgary, Alberta, Canada. Reprinted with permission.)**

**FIGURE 4.9.1-2 Stuart Oil Shale Facility, Queensland, Australia (This is a demonstration-scale [4,800 bbl/day] aboveground oil shale retorting and processing facility. Photo courtesy of Queensland Energy Resources Limited, Queensland, Australia, and UMATAC Industrial Processes, Calgary, Alberta, Canada. Reprinted with permission.)**

- *Retention ponds, runoff-control structures, and earthen berms.* Retention ponds would likely be required to control runoff on the project site and to store various liquids used for oil shale processing or reclamation; other runoff control structures such as earthen berms might also be constructed. Earthen berms would likely also be constructed around many of the storage tanks that would be present on the project site. Retention ponds and berms would introduce contrasts in form, line, and texture into existing natural-appearing landscapes. Depending on their size and on visibility and viewing conditions, retention ponds in particular might be visible at long distances.

- *Mounds of stored soil and raw and spent shale.* Depending on the amount of overburden present at the project site, millions of tons of soil could be removed from on top of the oil shale deposits. This soil would be stored in mounds on-site for use in reclamation. If the project involved strip mining, the soil would be used in reclamation immediately after a section was worked, and the total amount visible in storage mounds would be significantly smaller than if the project involved pit mining. In either case, the soil mounds would be vegetated to reduce visual impacts and erosion, but revegetation would require a number of years before texture and color contrasts would be reduced. The mounds would likely be visible for several miles where clear lines of sight existed, and could introduce strong contrasts in form to existing landscapes. Invasive species might colonize disturbed and stockpiled soils and compacted areas. In addition to soil, an estimated 17 to 23 million tons of spent shale would be produced each year for each retort (multiple retorts would be utilized for a given project) and would be stored on-site in large mounds, although a significant amount of the spent shale would be returned to the mine cavity eventually. Because of the expansion of oil shale during heating, much of the spent shale would remain on the surface and would constitute a permanent visual impact unless it was transported off-site. Smaller, but still substantial, mounds of raw shale could be present while awaiting crushing and retorting.

- *Vehicular equipment and worker presence and activity.* The large size of the project, the number of operations being conducted simultaneously (e.g., mining, ore processing, retorting, and upgrading), and the operating schedule of 24 hours per day, 7 days per week, would require that a substantial amount of equipment and a significant number of workers and vehicles be active on the site at most times throughout the life of the project. Small-vehicle traffic for worker access and nearly constant large-equipment traffic for raw and spent shale hauling and other activities would be expected. Both would produce visible activity and dust in dry soils, and some of the large-vehicle traffic would likely generate visible exhaust plumes. Suspension and visibility of dust would be influenced by vehicle speeds, road surface materials, and weather conditions, but might be at least partially controlled by dust-suppression measures. The presence of workers could also result in litter

and debris that could create negative visual impacts within and around the project site.

- *Dust and emissions.* Large equipment used to mine and crush oil shale would likely create large amounts of dust, which, if uncontrolled, could produce visible dust plumes, particularly for projects located on ridges or other exposed locations. Equipment and vehicles would also produce dust and emissions, as would explosives used in the mining process. Retort smokestacks, up to 300 ft (approximately 100 m) or more in height would likely generate visible plumes under certain atmospheric conditions that could be visible for great distances (Commission on Geosciences, Environment and Resources 1993). Smaller stacks associated with other activities might also create visible emission plumes. In addition to their direct visibility, dust and emissions could also contribute to atmospheric haze in the region that could decrease landscape visibility, especially for long-distance views.

- *Light pollution.* Because the projects would operate "around the clock," they would generate light pollution from a variety of sources such as flare stacks, navigation warning lights on smokestacks, operations and security lighting, and vehicles. Lighting needs for operations would be substantial. This operational state could result in skyglow (an increase in brightness in the night sky) above and around the project area, depending on viewing and atmospheric conditions, and could also result in direct illumination of the facilities where lines of sight exist.

#### 4.9.1.2 Underground Mining with Surface Retorting

While still introducing major visual changes to natural-appearing existing landscapes and creating strong visual contrasts in line, form, color, and texture that in large part could not be mitigated, commercial production of oil shale involving underground mining and surface retorting would involve fewer and less severe visual impacts compared with oil shale projects utilizing surface mines (see Section 4.9.1.1), primarily because of reduced surface disturbance from mining and related activities. Visual impacts associated with reclamation would also likely be less than for projects utilizing surface mines, because of the greatly reduced level of ground disturbance.

**4.9.1.2.1 Construction and Reclamation.** Construction and reclamation of commercial oil shale projects utilizing underground mining and surface retorting would generate visual impacts similar in nature to those generated by projects utilizing surface mines. A rolling footprint development approach would not be utilized; however, a large mine pit would not be developed during operation either, so that ultimately, far less surface would need reclamation after operations, and, therefore, reclamation activities would be less extensive, take less time, and thus would generate fewer visual impacts than reclamation activities for surface mines. A larger pile of spent shale would remain on the surface after operations; this material could require

increased duration and intensity of reclamation activities for the affected portion of the site, which could increase associated visual impacts.

It is assumed that there would be one connecting transmission line and ROW and one pipeline and ROW serving each project site. Employer-provided housing also would be constructed off-lease to house workers and their families during the construction phase (see Section 4.9.1.4 for discussion of impacts associated with electric transmission, pipeline, and housing construction).

**4.9.1.2.2 Operation.** Visual impacts associated with commercial oil shale production using underground mines are generally similar in nature to impacts associated with projects using surface mines; however, some major visual impacts associated with surface mining are absent or greatly diminished. Although mine adits and some ancillary facilities would be present, the associated visual impacts would be small, relative to either a pit or strip mine. In addition, because the adits would be created at permanent locations and the rolling footprint development approach would not be utilized, far less vegetation clearing, recontouring, and road building would be required, thereby greatly reducing the visual impacts relative to projects involving surface mines. It is expected that an area of approximately 150 acres would have a highly industrialized appearance with a core area of buildings, ore processing facilities, tank farms, up to eight retorts, and other ancillary structures and equipment. Because of the reduced level of land disturbance, there would likely be less need for retention ponds and other erosion-water control structures relative to surface mining operations. Because much of the activity associated with mining would take place underground, there likely would also be fewer and less severe visual impacts associated with worker and equipment presence and activity, and likely reduced dust and emissions as well.

Impacts associated with surface retorting, upgrading, and materials storage and transport would likely be similar to those described for projects utilizing surface mines (see Section 4.9.1.1). There would likely be slightly less light pollution because mining activity would be moved underground. Because most of the mined shale could not be disposed of in the mine, much larger amounts of spent shale would be present on the surface, and visual impacts associated with spent shale piles would be proportionally larger. Depending on the disposal areas chosen within the lease area, spent shale disposal areas may eventually cover approximately 1,500 acres at a depth of material up to 250 ft. Disposal areas would be revegetated as an ongoing part of the operation. The increased impact from spent shale piles would be partially offset by the absence of soil mounds associated with overburden removal.

#### 4.9.1.3 In Situ Processing

Similarly to projects utilizing surface or underground mining, commercial oil shale projects utilizing in situ processing are large-scale industrial concerns that would introduce major visual changes to natural-appearing existing landscapes. During the life of the project, in large part these visual impacts could not be effectively mitigated; however, in situ processing would likely generate the lowest total visual impacts of the three technical approaches, primarily

because it does not require mining, ore processing, or retorting, and there would be no spent shale pile. After successful remediation, many visual impacts associated with in situ oil shale development could likely be eliminated or substantially attenuated.

**4.9.1.3.1 Construction and Reclamation.** In general, construction and reclamation of commercial oil shale projects utilizing in situ processing would utilize a rolling footprint development approach, with the appearance of continual construction and reclamation throughout the life of the project. Construction and reclamation impacts for in situ projects would likely be lower than for oil shale projects utilizing mines and surface retorting because of the relatively low level of recontouring and the absence of spent shale and soil mounds.

It is assumed that there would be one connecting transmission line and ROW and one pipeline and ROW serving each project site. Employer-provided housing also would be constructed off-lease to house workers and their families during the construction phase (see Section 4.9.1.4 for discussion of impacts associated with electric transmission, pipeline, and housing construction).

**4.9.1.3.2 Operation.** Many visual impacts associated with commercial production of oil shale using in situ processing are generally similar in nature to impacts associated with projects using mining and surface retorting. The major visual impacts associated with mining and retorting are absent, however, and the overall visual impact would likely be substantially lower because of the absence of mines, ore processing facilities, retorts and ancillary facilities, spent-raw shale piles, and retention ponds and water-erosion control structures. Relatively little recontouring would be required. There likely would also be, on average, less activity visible on the site because there would be no mining or shale-hauling activities. There would likely be a lower level of visual impacts from dust and emissions because there would be no ore crushing, and there would be less traffic and equipment activity on the site. There would, however, be extensive clearing of vegetation in each section and large numbers of wells and well pads in areas where shale oil was being extracted as it was worked, in accordance with the rolling footprint development process that would be employed. For projects in Colorado and Utah, between 150 and 600 acres are likely to be disturbed at a given time, and for projects in Wyoming, 1,000 to 2,000 acres would likely be disturbed at a given time. It is projected that the total lease area of up to 5,760 acres would be affected over a 20-year project life. Buildings and structures would be associated with pumping shale oil and coolant for freeze-wall maintenance, as well as facilities for upgrading, storage, and transport of shale oil. Because of the large demand for power to heat and cool underground formations, more structures associated with power generation, transmission, and distribution would likely be required, which would increase visual impacts. These permanent facilities are estimated to occupy approximately 200 acres. Other visual impacts (for infrastructure, employee-provided housing, and roads) would likely be similar to those described for oil shale projects utilizing surface mines.

Oil shale projects utilizing in situ processes are expected to have electric power requirements that would necessitate construction of new power plants to supply the required electricity. It is expected that the new power plants would be conventional 1,500-MW coal-fired

plants. Visual impacts associated with the construction and operation of the new power plants are discussed in Section 4.9.1.4.2.

#### 4.9.1.4 Other Associated Oil Shale Project Facilities

While many visual impacts expected from commercial oil shale development projects under consideration in the PEIS are site- or technology-specific, the oil shale projects have some common elements that would be expected to create similar visual impacts regardless of location or the oil shale extraction and processing technologies employed. These elements include transmission lines and pipelines (required for all commercial oil shale projects), employer-provided housing (required for all commercial oil shale projects), and new power generation facilities (required for commercial oil shale projects utilizing in situ processing). The elements and related visual impacts are discussed here separately from impacts associated with specific oil shale extraction and processing technologies.

**4.9.1.4.1 Electric Transmission Lines and Pipelines.** Construction and operation of electric transmission lines and oil pipelines could be required for commercial oil shale development. However, the projected linear extent of the facilities varies by project type and technology employed. Visual impacts associated with construction, operation, and reclamation of the electric transmission and pipeline facilities include temporary impacts associated with activities that occur during the construction and reclamation phases of the projects, and longer-term impacts that result from construction and operation of the facilities themselves. For a given oil shale project, up to 150 mi of transmission line ROW might be required, and up to 55 mi of pipeline ROW might be required.

Potential visual impacts that could result from construction activities include ROW clearing with associated debris; trenching (for pipelines); road building and upgrading; construction and use of staging areas and laydown areas; mainline and support facility construction; blasting of rock faces and other cavities; vehicular, equipment, and worker presence and activity; and associated vegetation and ground disturbances, dust, and emissions. Pipeline construction may also involve pipeline bridge construction for crossings of rivers and canyons. During reclamation, visual impacts would be similar to those encountered during construction, but likely of shorter duration, and generally occurring in reverse order from construction impacts.

Construction of a ROW requires clearing of vegetation, large rocks, and other objects. Vegetation clearing and topographic grading would be required for construction of access roads, maintenance roads, and roads to support facilities (e.g., electric substations or pump stations). Vegetation clearing activities can cause visual impacts by creating contrasts in form, line, color, and texture with existing natural landscapes, depending on site-specific factors, such as existing vegetation. Road development may introduce strong visual contrasts in the landscape depending on the route relative to surface contours, and the width, length, and surface treatment of the roads. Construction access roads would be reclaimed after construction ended, but some visual impacts (e.g., vegetation disturbance) associated with them might be evident for some years

afterwards, gradually diminishing over time. Staging areas and laydown areas would be required for stockpiling and storage of equipment and materials needed during construction. These areas may require vegetation clearing, may cover 2 to 30 acres, and be placed at intervals of several miles along a ROW.

Transmission line construction activities include clearing, leveling, and excavation at tower sites, as well as assembly and erection of towers followed by cable pulling. Pipeline mainline construction activities include clearing, leveling, trenching, and laying of pipe. Both electric and pipeline mainline construction activities would potentially have substantial but temporary visual impacts. Because both types of facilities are linear, construction activities would generally proceed as a "rolling assembly line," with a work crew gradually moving through an area at varying rates depending on circumstances.

The operation and maintenance of electric transmission lines or pipelines and their associated facilities, roads, and ROWs would potentially have substantial long-term visual effects. Some impacts are common to both types of structures; however, the mainline structures are fundamentally different in terms of visual impacts. Electric transmission lines generally involve stronger visual contrasts than pipelines. In the following discussion, impacts similar for both types of projects are discussed, while impacts that are significantly different are discussed separately.

The width of cleared area for the permanent ROW for a given project would be determined at a project-specific level, but in general would be expected to be substantially wider for electric transmission line projects than for pipelines. Cleared ROWs might open up landscape views, especially down the length of the ROW, and introduce potentially significant changes in form, line, color, and texture. While the opening of views for viewers close to a cleared ROW might in some circumstances be a positive visual impact, the introduction of strong linear and color contrasts from clearing of ROWs in mid-ground and background views could create negative visual impacts, particularly in forested areas where either the viewer or the ROW is elevated such that long stretches of the ROW are visible. Viewing angle could also be an important factor in determining the perceived visual impact in these settings. In some situations, the impacts could be visible for many miles.

Where visible, electric transmission and distribution towers could create strong visual contrasts. The tower structures, conductors, insulators, aeronautical safety markings, and lights would all create visual impacts. Electric transmission towers would create vertical lines in the landscape, and the conductors would create horizontal lines that would be visible depending on viewing distance and lighting conditions. In the open landscapes present in much of the West and under favorable viewing conditions, the towers and conductors might be easily visible for several miles, especially if skylined, that is, placed along ridgelines. A variety of mitigation measures could be used to reduce impacts from these structures, but because of their size, in many circumstances it is difficult to avoid some level of visual impact except at very long distances. A transmission line's visual presence would last from construction throughout the life of the project.

Oil pipelines in the United States are generally buried several feet below the surface, except at valves, compressor stations, pigging stations, city gate stations, metering facilities, some river crossings, or where very steep topography, bedrock, or other subsurface conditions preclude burial. Visual impacts are therefore typically less for buried portions of a pipeline than for aboveground portions and are limited primarily to those impacts associated with ROW clearing. Aboveground pipeline would generally introduce a strong, generally horizontal line into natural landscapes and might introduce significant color contrast as well, depending on surface treatment. Pipeline bridges might be conspicuously visible at some river or canyon crossings.

Both electric transmission projects and pipelines have associated ancillary structures that would contribute to perceived visual impacts. Electrical substations are located at the start and end points of transmission lines and may be required at locations where line voltage is changed. Substations may be several acres in size and include a variety of visually complex structures, conductors, fencing, lighting, and other features that result in an "industrial" appearance. The industrial look of a typical substation, together with the substantial height of its structures (up to 40 ft or more) and its large areal extent, may result in negatively perceived visual impacts for nearby viewers.

Pipeline systems include aboveground structures, including valves, compressor and pump stations, metering stations, and pig launch and recovery facilities. Valves may occupy a few hundred square feet, while pump stations may exceed 25 acres in size and include several buildings and sections of aboveground pipeline. All of these facilities are industrial in appearance, with visually complex and generally rectilinear geometry, and the facilities typically introduce strong visual contrasts in line, form, texture, and color where they are located in nonindustrial surroundings, particularly for nearby viewers.

**4.9.1.4.2 Power Generation Facilities.** New conventional coal-fired power plants or expansion of existing plants are projected to be required to supply electricity for certain commercial oil shale projects utilizing in situ processing. The power plants would be major industrial facilities occupying a total of approximately 4,800 acres during construction and operations. The location of new plants is not likely to occur on public lands. Direct visual impacts associated with construction, operation, and reclamation of the required power plants can be divided into generally temporary impacts associated with activities that occur during the construction and reclamation phases of the projects, and longer-term impacts that result from construction and operation of the facilities themselves.

Major construction activities associated with the new power plants would include vegetation clearing; recontouring of landforms; road building and/or upgrading; and pad, parking lot, and building construction, as well as construction of other structures such as smokestacks or cooling towers. Other construction activities could include laying of railroad track; construction of berms, ditches and/or ponds; and the addition of fencing around some or all of the facility site. Transmission towers and lines would be constructed to transmit the generated electricity off-site (impacts associated with electric transmission ROW construction and operation are discussed separately above).

These construction activities would require work crews, vehicles, and equipment that would add to visual impacts during construction. During reclamation, visual impacts would be similar to those encountered during construction, but they would likely be of shorter duration and generally occur in reverse order from construction impacts.

Visual impacts from the operation of the power plants would be primarily caused by visual contrasts associated with vegetation removal and the presence of buildings and other structures with strong geometric lines, spatial symmetry, and flat, monochromatic surfaces. These man-made industrial facilities would draw visual attention because of their size, color, and shape. The presence and activities of workers, vehicles, and equipment also would cause visual impacts. In addition, emission plumes would be expected to be visible in some atmospheric conditions, and the plumes could be visible for long distances. The emissions from the plants could contribute to atmospheric haze that would reduce visibility over long distances, thereby impacting scenic quality. The facilities also would be expected to contribute to local light pollution at night. These impacts would occur throughout the operational life of the power plants, and some impacts might occur beyond the operational life of the project.

Expected impacts associated with the construction and operation of a conventional coal-fired power plant would differ to some degree depending on the specific site location, the technologies employed, and the configuration of the facility. Regardless of these factors, the presence and operation of industrial-appearing power plant facilities and equipment would introduce major visual changes to natural-appearing existing landscapes by creating strong visual contrasts in line, form, color, and texture. While mitigation measures might lessen some visual impacts associated with the power plants, in large part the visual impacts associated with the power plants could not be effectively mitigated. If the new power plants were sited adjacent to existing power plants or similar industrial facilities, the impacts could be significantly smaller, because the addition of an industrial facility to an already industrial-appearing landscape would involve a lower degree of visual contrast between the new plant and its surroundings.

**4.9.1.4.3 Employer-Provided Housing.** Employer-provided housing would be constructed for each project; the locations are unknown, but not likely to be located on public lands. Employer-provided housing would likely consist of clusters of prefabricated buildings or trailer homes used for worker housing, and some common buildings (e.g., recreation centers, stores, schools, and medical facilities). The size of the housing development would vary depending on the type of project and project phase (see Section 4.1), ranging from 7 to 63 acres in size. Employer-provided housing developments might be fenced around the perimeter, and street and/or security lighting would likely be provided. Paved or gravel pads might be constructed under the buildings/trailer homes. Visual impacts associated with the employer-provided housing would include contrasts in form, line, color, and texture caused by the introduction of buildings, fences, pads, possible land forming to level the area, and vegetation clearing; the addition of utilities such as electric transmission and distribution lines, telephone lines, etc.; the addition of roads both within and outside of the development; and the presence of workers, their families, their vehicles, and litter and other debris associated with the presence of humans. Light pollution would be generated at night from buildings, vehicles, and outdoor lighting. The extent and exact nature of the visual contrasts created would depend on site-

specific factors but might be very noticeable for nearby viewers with unobstructed views of the housing area.

Visual impacts associated with employer-provided housing would first occur during construction of the housing and would normally continue throughout the life of the oil shale project. However, employer-provided housing needs are predicted to be smaller during facility operation than during facility construction, and the unneeded housing would be removed after facility construction is completed. When the oil shale project is decommissioned, the remaining employer-provided housing and associated structures and facilities would likely be removed, and the area remediated to preconstruction conditions. Primarily because of the length of time required for vegetation restoration, some visual impacts associated with employer-provided housing might last for many years after removal of the housing.

### 4.9.2 Mitigation Measures

Development activities will implement visual impact mitigation measures to the extent applicable and practicable. Potential mitigation measures that may be applied to siting, development, and operation of oil shale leases, as warranted by the result of the lease-stage or plan of development-stage NEPA analyses include the following. However, it should be noted that while mitigation measures might lessen some visual impacts associated with oil shale development, in large part the visual impacts associated with commercial oil shale projects could not be mitigated.

- Siting projects outside of the viewsheds of key observation points (KOPs), or if this cannot be avoided, as far away as possible.
- Siting projects to take advantage of both topography and vegetation as screening devices to restrict views of projects from visually sensitive areas.
- Siting facilities away from and not adjacent to prominent landscape features (e.g., knobs and waterfalls).
- Avoiding placement of facilities on ridgelines, summits, or other locations such that they will be silhouetted against the sky from important viewing locations.
- Co-locating facilities to the extent possible to utilize existing and shared ROWs, existing and shared access and maintenance roads, and other infrastructure in order to reduce visual impacts associated with new construction.
- Siting linear facilities so that generally they do not bisect ridge tops or run down the center of valley bottoms.

- Siting linear features (above-ground pipelines, ROWs, and roads) to follow natural land contours rather than straight lines (particularly up slopes) when possible. Fall-line cuts should be avoided.

- Siting facilities, especially linear facilities, to take advantage of natural topographic breaks (i.e., pronounced changes in slope) to avoid siting facilities on steep side slopes.

- Where possible, siting linear features such as ROWs and roads to follow the edges of clearings (where they will be less conspicuous) rather than passing through the centers of clearings.

- Siting facilities to take advantage of existing clearings to reduce vegetation clearing and ground disturbance, where possible.

- Choosing locations for ROWs and other linear feature crossings of roads, streams, and other linear features to avoid KOP viewsheds and other visually sensitive areas and minimize disturbance to vegetation and landform.

- Siting linear features (e.g., trails, roads, rivers) to cross other linear features at right angles whenever possible to minimize viewing area and duration.

- Minimizing the number of structures required.

- Constructing low-profile structures whenever possible to reduce structure visibility.

- Siting and designing structures and roads to minimize and balance cuts and fills and to preserve existing rocks, vegetation, and drainage patterns to the maximum extent possible.

- Selecting and designing materials and surface treatments in order to repeat and/or blend with existing form, line, color, and texture of the landscape.

- Using appropriately colored materials for structures, or appropriate stains/coatings, to blend with the project's backdrop.

- Using nonreflective or low-reflectivity materials, coatings, or paints whenever possible.

- Painting grouped structures the same color to reduce visual complexity and color contrast.

- Designing and installing facility lighting so that the minimum amount of lighting required for safety and security is provided but not exceeded and that upward light scattering (light pollution) is minimized.

- Siting construction staging areas and laydown areas outside of the viewsheds of KOPs and visually sensitive areas, where possible, including siting in swales, around bends, and behind ridges and vegetative screens.

- Developing a site reclamation plan and implementing it as soon as possible after construction begins.

- Discussing visual impact mitigation objectives and activities with equipment operators prior to commencement of construction activities.

- Mulching slash from vegetation removal and spreading it to cover fresh soil disturbances or, if not possible, burying slash.

- If slash piles are necessary, staging them out of sight of sensitive viewing areas.

- Avoiding installation of gravel and pavement where possible to reduce color and texture contrasts with existing landscape.

- Using excess fill to fill uphill-side swales resulting from road construction in order to reduce unnatural-appearing slope interruption and to reduce fill piles.

- Avoiding downslope wasting of excess fill material.

- Rounding road-cut slopes, varying cut and fill pitch to reduce contrasts in form and line, and varying slope to preserve specimen trees and nonhazardous rock outcroppings.

- Leaving planting pockets on slopes where feasible.

- Providing benches in rock cuts to accent natural strata.

- Using split-face rock blasting to minimize unnatural form and texture resulting from blasting.

- Segregating topsoil from cut and fill activities and spreading it on freshly disturbed areas to reduce color contrast and aid rapid revegetation.

- If topsoil piles are necessary, staging them out of sight of sensitive viewing areas.

- Where feasible, removing excess cut and fill from the site to minimize ground disturbance and impacts from fill piles.

- Burying utility cables where feasible.

- Minimizing signage and painting or coating reverse sides of signs and mounts to reduce color contrast with existing landscape.

- Prohibiting trash burning during construction, operation, and reclamation; storing trash in containers to be hauled off-site for disposal.

- Controlling litter and noxious weeds and removing them regularly during construction, operation, and reclamation.

- Implementing dust abatement measures to minimize the impacts of vehicular and pedestrian traffic, construction, and wind on exposed surface soils during construction, operation, and reclamation.

- Undertaking interim restoration during the operating life of the project as soon as possible after disturbances.

- During road maintenance activities, avoiding the blading of existing forbs and grasses in ditches and along roads.

- Recontouring soil borrow areas, cut-and-fill slopes, berms, waterbars, and other disturbed areas to approximate naturally occurring slopes during reclamation.

- Randomly scarifying cut slopes to reduce texture contrast with existing landscape and to aid in revegetation.

- Covering disturbed areas with stockpiled topsoil or mulch, and revegetating with a mix of native species selected for visual compatibility with existing vegetation.

- Removing or burying gravel and other surface treatments.

- Restoring rocks, brush, and forest debris whenever possible to approximate preexisting visual conditions.

To mitigate visual impacts on high-value scenic resources in lands outside of, but adjacent to or near oil shale leasing areas, the following mitigation measures should be applied to siting, development, and operation of oil shale leases, as warranted by the result of the lease-stage or plan of development-stage NEPA analyses.

- Oil shale-related development and operation activities within 5 mi of National Scenic Highways, All-American Roads, state-designated scenic highways, WSRs, and river segments designated as eligible for wild and scenic river status should conform to VRM Class II management objectives, with respect to impacts visible from the roadway/river. Beyond 5 mi but less than 15 mi

from the roadway/river, development activities should conform to VRM Class III objectives.

- Development activities within 15 mi of high-potential sites and segments of National Trails, National Historic Trails, and National Scenic Trails should conform to VRM Class II management objectives, with respect to impacts visible from the adjacent trail high-potential sites and segments. Beyond 15 mi, development activities should conform to VRM Class III objectives.

- Development activities on BLM-managed public lands within 15 mi of KOPs (e.g., scenic overlooks, rest stops, and scenic highway segments) in National Parks, National Monuments, NRAs, and ACECs with outstandingly remarkable values for scenery should conform to VRM Class II management objectives, with respect to impacts visible from the KOPs. Beyond 15 mi, development activities will conform to VRM Class III objectives. KOPs for non-BLM-managed lands should be determined in consultation with the managing federal agency.

## 4.10 CULTURAL RESOURCES

### 4.10.1 Common Impacts

Significant cultural resources, listed or eligible for listing on the NRHP, could be affected by commercial oil shale leasing and development.

The potential for impacts on cultural resources from commercial oil shale development, including ancillary facilities such as access roads, transmission lines, pipelines, employer-provided housing, and construction of possible new power plants, is directly related to the amount of land disturbance and the location of the project. Indirect effects, such as impacts on the cultural landscape resulting from the erosion of disturbed land surfaces and resulting from increased accessibility to possible site locations, are also considered. Leasing itself has the potential to impact cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development to cultural properties.

Impacts on cultural resources could result in several ways as described below.

- *Complete site destruction* could result from the clearing of the project area, grading, excavation, and construction of facilities and associated infrastructure if sites are located within the footprint of the project.

- *Site degradation and/or destruction* could result from the alteration of topography; alteration of hydrologic patterns; removal of soils; erosion of soils; runoff into and sedimentation of adjacent areas; and oil or other

contaminant spills if sites are located on or near the project area. Such degradation could occur both within the project footprint and in areas downslope or downstream. While the erosion of soils could negatively impact sites downstream of the project area by potentially eroding away materials and portions of sites, the accumulation of sediment could serve to protect some sites by increasing the amount of protective cover. Contaminants could affect the ability to conduct analysis of material present at the site and thus the ability to interpret site components.

- *Increases in human access* and subsequent disturbance (e.g., looting, vandalism, and trampling) of cultural resources could result from the establishment of corridors or facilities in otherwise intact and inaccessible areas. Increased human access (including OHV use) exposes archaeological sites and historic structures and features to greater probability of impact from a variety of stressors.

- *Visual degradation of setting* associated with significant cultural resources could result from the presence of commercial oil shale development and associated land disturbances and ancillary facilities. This could affect significant cultural resources for which visual integrity is a component of the sites' significance, such as sacred sites and landscapes, historic trails, and historic landscapes.

Cultural resources are nonrenewable, and, once damaged or destroyed, they are not recoverable. Therefore, if a cultural resource is damaged or destroyed during oil shale development, it would constitute an irretrievable commitment of this particular cultural location or object. For cultural resources that are significant for their scientific value, data recovery is one way in which some information may be salvaged should a cultural resource site be adversely impacted by development activity. Certain contextual data are invariably lost, but new cultural resources information is made available to the scientific community. Loss of value for education, heritage tourism, or traditional uses is less easily mitigated.

### 4.10.2 Mitigation Measures

For all potential impacts, the application of mitigation measures developed in consultation under Section 106 of the NHPA will avoid, reduce, or mitigate the potential for adverse impacts on significant cultural resources. Section 106 consultations between the BLM and the SHPOs, appropriate Tribes, and other consulting parties would be required at the lease stage and at the plan of development stage. The use of BMPs, such as training/education programs, could reduce occurrences of human-related disturbances to nearby cultural sites. The specifics of these BMPs would be established in project-specific consultations between the applicant and the BLM, as well as with the SHPO and Tribes, as appropriate.

An ethnohistory and cultural resources overview were completed for the project area (Bengston 2007 and O'Rourke et al. 2007, respectively). The overviews synthesized existing

information on cultural resources that had been previously identified. Also, tribal consultation was initiated to further identify significant cultural resources. This phase of analysis did not identify geographical areas that will preclude moving areas forward for leasing. During the leasing phase, the overviews and ongoing tribal consultation will be reviewed to help determine areas of sensitivity and appropriate survey and mitigation needs.

The BLM will conduct a phased approach to meet the agency's obligations under Section 106 of the NHPA. This approach is necessary for identification and evaluation efforts where alternatives under consideration consist of large land areas across a multistate region and when effects on historic properties cannot be fully determined prior to approval of leasing. Each phase of development will require an appropriate level of Section 106 analysis. The Section 106 analysis will be tiered to the PEIS. Oil shale and tar sands leasing may require additional consultation and information gathering prior to the lease sale. The final phase is that the lessee will then submit a plan of development for a site-specific project. Additional site-specific NEPA analyses will be conducted on these individual project plans of development. The BLM will complete comprehensive identification (e.g., field inventory), evaluation, protection, and mitigation following the policies and procedures contained within the 1997 BLM National Programmatic Agreement and State Protocols. Also, the BLM will continue to implement government-to-government consultation with Tribes and with other consulting parties on a case-by-case basis for plans of development.

The BLM does not approve any ground-disturbing activities that may affect any historic properties, sacred landscapes, and/or resources protected under the NHPA, American Indian Religious Freedom Act, Native American Graves Protection and Repatriation Act (NAGPRA), E.O. 13007 (U.S. President 1996), or other statutes and Executive Orders until it completes its obligations under applicable requirements of the NHPA and other authorities. The BLM may require modification to exploration or development proposals to protect such properties, or disapprove any activity that is likely to result in adverse effects that cannot be successfully avoided, minimized, or mitigated. The BLM attaches this language to all lease parcels.

In some instances, additional special stipulations to the leases may be required for protection of specific cultural resources on the basis of the Ethnohistoric Overview and Class I Cultural Resource Overview (Bengston 2007 and O'Rourke et al. 2007, respectively) and on information received from Tribal consultations, if it will not be possible to adequately avoid, minimize, or mitigate such resources under existing statute, regulation, or BLM policy subsequent to lease issuance.

The BLM develops specific mitigation measures to implement the lease stipulations on a project-by-project basis. Mitigation for adverse effects to the most common resource type, archaeological sites significant for their scientific value, is data recovery. To protect portions of historic trails that are potentially eligible for listing on the NRHP from visual intrusion and to maintain the integrity of the historic cultural setting, the BLM would require that surface disturbance be restricted or prohibited within the viewshed of the trail along those portions of the trail for which eligibility is based on the viewshed.

## 4.11 SOCIOECONOMICS

The analysis of the socioeconomic impacts of oil shale developments in Colorado, Utah, and Wyoming consists of two interdependent parts. The analysis of *economic impacts* estimates the impacts of oil shale facilities and associated facilities (e.g., power plants and coal mines)[8] on employment and personal income in an ROI in which oil shale resources are located in each state. Because of the relative economic importance of oil shale developments in small rural economies and the lack of available local labor and economic infrastructure, large-scale oil shale developments are likely to cause a large influx of temporary population. As population increases are likely to be rapid, local communities may be unable to quickly absorb new residents, resulting in impacts on local finances and public service infrastructure. Social and psychological disruption may also occur, together with the undermining of established community social structures. Given these considerations, the analysis of *social impacts* assesses the potential impacts of oil shale developments on population, housing, public service employment, and community public finances in the ROI in each of the three states. The analysis also assesses the potential impact of oil shale projects on social disruption that may be associated with rapid population growth in small rural communities hosting large resource development projects.

The assessment of the socioeconomic impacts of oil shale developments was based on a number of key assumptions:

- *Material and equipment procurement.* Many of the industries that would likely provide the appropriate materials, equipment, and other supplies in sufficient quantity for construction and operation of oil shale facilities and the associated power plants and coal mines are presently located outside the ROI in each state; thus, it was assumed that the majority of these resources would be purchased outside each ROI and shipped to the relevant oil shale, power plant, and coal mine facility locations. Specifically, for each ROI it was assumed that 15% of materials and equipment during the construction phase were purchased in each local economy, with 20% purchased locally during the operations phase. Given the more likely local availability of materials and services for housing construction, it was assumed that 25% of materials required for the construction of temporary employer-provided housing and housing provided in local communities would come from each ROI.

- *Wages and salary spending.* Since oil shale, power plant, and coal mine construction workers would reside in the ROI in each state for extended periods of time, it was assumed that 75% of wages and salaries paid to these workers would be spent in the ROI in each state, with 25% of income used to cover existing expenses, such as housing payments, in locations outside each

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8 The impact of coal mining to support coal-fired power plants that are projected to be required for in situ projects is only addressed for socioeconomics and environmental justice in this PEIS. Although impacts from coal mining may be important factors for the socioeconomic analysis, the need for additional coal mining is speculative. Future site-specific NEPA analyses would be needed to address the full range of socioeconomic concerns for a development project.

ROI. As it was assumed that all oil shale, power plant, and coal mine operations workers would move permanently into the ROI in each state, 100% of wages and salary spending by these workers was assumed to occur within the ROI in each state. It was assumed that 50% of housing construction workers would reside in the ROI in each state and would spend their wages and salaries locally and that housing construction workers not residing in the ROI would commute from elsewhere, with no wage-spending impacts associated with commuting workers.

- *Worker in-migration.* Because of the relatively small local labor force and fairly low unemployment rates in each ROI (see Section 3.10.1), it was assumed that the entire construction and operations labor force for oil shale facilities and the associated power plants and coal mines would come from outside the ROI in each state. It was also assumed that 33% of oil shale facility, power plant, and coal mine workers (direct and indirect) during construction and operations would be accompanied by their families and would be accommodated in temporary employer-provided housing or in housing provided by local communities. The national average household size of 2.59 (USCB 2007c) was used to calculate the number of additional family members per worker. It was assumed that, given the presence of workers in the relevant occupations in each ROI, 50% of the workers required for temporary housing construction would already reside in local ROI communities. The remainder would commute from outside the ROI on a daily basis or use temporary accommodations (rental housing, hotels, campsites, etc.).

- *Worker housing.* Given the size of the potential demand for housing by the in-migrating oil shale facility, power plant, and coal mine workers and families compared with the number of housing units projected to be available in each ROI, it was assumed that all temporary housing required would be new construction. Based on population density, the relative remoteness of rural communities, and likely driving distances to oil shale facilities, it was assumed that a relatively large percentage of oil shale and power plant workers and families would be housed in employer-provided housing, the location of which is unknown at this time, but which is not expected to be on public lands (Table 4.11-1). The remainder would be accommodated in temporary housing of similar quality built in local communities in each ROI. A small number (15%) would be accommodated in rental housing and motels in the ROI. Indirect workers producing goods and services needed as a result of increased local demand associated with oil shale, power plant, and coal mine worker wage and salary spending would also be partially accommodated in employer-provided housing (Table 4.11-1). It was assumed that temporary housing built for direct and indirect workers and family members during project construction would be occupied by direct and indirect workers during operations, meaning that no new worker housing would be required during facility operating phases.

Planned temporary housing developments of employer-provided housing for oil shale workers could be the most effective means of minimizing the impacts of rapid population growth on local housing, local community fiscal resources, and local public services funded locally. Since these temporary housing developments could have adequate food service, security, health, and recreational facilities, these facilities might also help avoid social and psychological disruption that might occur as a result of conflicts between the permanent and temporary populations and the potential consequent impact on established community social structures.

**TABLE 4.11-1 Temporary Housing Location Assumptions**

| | Employer-Provided Housing (%) | Local Communities (%) |
|---|---|---|
| ***Colorado*** | | |
| Construction | | |
| Direct workers | 60 | 40 |
| Indirect workers | 10 | 90 |
| Operations | | |
| Direct workers | 25 | 75 |
| Indirect workers | 10 | 90 |
| ***Utah*** | | |
| Construction | | |
| Direct workers | 80 | 20 |
| Indirect workers | 35 | 65 |
| Operations | | |
| Direct workers | 50 | 50 |
| Indirect workers | 25 | 75 |
| ***Wyoming*** | | |
| Construction | | |
| Direct workers | 70 | 30 |
| Indirect workers | 30 | 70 |
| Operations | | |
| Direct workers | 30 | 70 |
| Indirect workers | 15 | 85 |

Source: Thompson (2006a).

- *Power plants and coal mines.* As stated in Section 4.1, employment in a 2,400-MW power plant would range from 1,900 to 2,400 during construction, with 240 employees during operations. If needed, coal production to support power plants was assumed to come from an underground mine in both Colorado and Utah; each mine would employ 753 during construction and between 529 and 635 during operations. If a power plant were needed in Wyoming, it was assumed to be a surface mine, which would employ 135 workers during both construction and operation (Hill and Assoc. 2007). An additional coal-fired power plant is only projected to be needed for certain in situ projects, depending on technologies used and production levels.

- *Peak construction year and first year of operations.* Although the exact schedule that would be used for construction and operation of oil shale facilities is not known, in order to assess the magnitude of the impacts of facilities on the economic and social baseline in each ROI, specific years were used for each project phase for each facility. For the peak construction year, 2022 was assumed for an in situ facility and 2027 for a surface and underground mine. The first year of operation of an in situ facility was assumed to occur in 2027, while operations of a surface and underground mine were assumed to occur beyond the end of the planning period

2008–2027. Peak construction of a power plant and coal mine was assumed to occur in 2013, with operation of both facilities beginning in 2017. The peak year of construction for housing required for oil shale, power plant, and coal mine construction workers was assumed to occur in the year immediately preceding the peak construction year for each facility.

## 4.11.1 Common Impacts

### 4.11.1.1 Economic Impacts

***Methods.*** The economic impacts of each facility on ROI employment and personal income are presented. To estimate economic impacts, the assessment used representative data from a number of NEPA assessments covering the potential impacts of large energy resource development projects (DOI 1973b; BLM 1980, 1983a,b, 1984; DOE 1982a). These data included direct workforce projections for project construction and operation for various oil shale technologies, different sizes of operations, and temporary housing requirements. Employment data for proposed oil shale developments and for the associated power plants and coal mines were provided by the BLM (Thompson 2006b,c,d), from DOE (2007a,b,c), and industry sources (Hill and Assoc. 2007). IMPLAN® economic data were then used to calculate the indirect impacts associated with oil shale project wage and salary spending, material procurement spending, and the construction of temporary employer-provided housing and housing provided by local communities in each ROI (Minnesota IMPLAN Group, Inc. 2007). Details of this methodology are presented in Appendix G. Underlying employment numbers are also presented in Appendix G.

A gravity model was used to assign oil shale workers and their families not accommodated in temporary employer-provided housing to specific ROI communities (see Section 3.10). Gravity models mathematically estimate the interaction between pairs of points (the number of construction and operations workers and family members associated with each technology, nominally located at the oil shale resource centroid in a state, and the population of each community in a state ROI) weighted by the linear distance between each pair of points. Worker and family population data associated with each technology were used to calculate the number of housing units required and the impact on vacant housing, as well as, in association with existing levels of service, the number of local government employees (policemen, firemen, general government workers, and teachers) and the relative impact on local government finances. A qualitative assessment of the potential impact of a large number of in-migrants on social disruption in small rural communities was made on the basis of evidence from a large literature in sociology on potential social problems associated with boomtown energy development.

In the following sections, impacts are presented for a variety of facilities relevant to the development of oil shale resources in each state ROI. Impacts associated with construction of adequate temporary employer-provided housing and housing provided by the local community for each oil shale facility for each ROI are also discussed, together with an assessment of the

impact of power plant and coal mine construction and operation and the associated employer-provided housing and housing provided in local communities.

Although there are a wide range of restrictions governing the potential location of oil shale developments and associated facilities on public lands, these are not reflected in the analysis of socioeconomic impacts. Direct and indirect employment associated with oil shale developments would lead to population in-migration into each ROI and increases in housing, public service employment, and expenditures and may lead to changes in quality of life and social change in local communities, regardless of the proposed locations of each facility within each ROI.

In order to assess the magnitude of the impacts resulting from project construction on the baseline in each ROI, the percentage change in a number of key economic (peak construction employment) and social (population, vacant housing, and local government expenditures) variables in specific years was used. For any variable, impacts would be small if the percentage change compared to the baseline is less than 5%, moderate if the percentage change is between 5 and 10%, and large if the percentage change compared to the baseline is more than 10%.

***Impacts.*** Construction and operation of oil shale facilities and the associated temporary employer-provided housing and housing constructed in local communities in the ROI for oil shale facility, power plant, and coal mine workers and family members would impact the economy of each ROI. Oil shale technologies and the associated energy production facilities and housing would create significant new sources of employment and income at each facility. Wages and salaries spent by facility workers and by housing construction workers would create demand for a range of durable and nondurable goods and services sold by ROI retailers, which, together with the purchase of equipment, materials, and supplies required during energy project and housing construction and project operation in each ROI, would provide significant new sources of indirect employment and income to ROI residents.

Surface mining with surface retorting would produce about 2,200 total (direct plus indirect) jobs in the two ROIs in the peak year of construction and between $110 million and $131 million in income (Table 4.11.1-1). Project operations would produce between 2,900 and 3,000 jobs and between $145 million and $173 million in income. Underground mining would create between 2,200 and 2,600 jobs and between $112 million and $159 million in personal income, with between 2,900 and 3,300 jobs created during the operating period. Construction of an in situ processing facility would create between 2,300 and 2,900 jobs and between $116 million and $169 million in personal income, producing between 780 and 950 jobs and between $38 million and $56 million in income during the operating period. Construction employment for each facility would represent an increase of between 1.5% and 4.7% over the projected employment baseline in the three ROIs in the peak construction year.

Construction of power plants in association with in situ facilities would produce between 2,700 and 2,900 total jobs in the three ROIs during the peak construction year and between $151 million and $210 million in income (Table 4.11.1-2). During plant operations, between 300 and 330 employees would be required in the ROIs, producing between $17 million and

**TABLE 4.11.1-1 ROI Economic Impacts of Oil Shale Developments[a]**

| | Housing Construction | | Oil Shale Development: Construction | | Oil Shale Development: Operation | |
|---|---|---|---|---|---|---|
| | Employment | Income ($ million) | Employment | Income ($ million) | Employment | Income ($ million) |
| Surface mining with surface retorting | | | | | | |
| Direct | 467–496 | 8.2–8.4 | 1,443 | 95.2–114.6 | 1,923 | 126.8–152.8 |
| Indirect | 112 | 2.5 | 724–789 | 14.7–16.2 | 975–1,038 | 18.5–19.9 |
| Total | 578–608 | 10.7–10.8 | 2,167–2,232 | 109.8–130.8 | 2,898–2,960 | 145.3–172.7 |
| Underground mining with surface retorting | | | | | | |
| Direct | 439–505 | 8.3–10.4 | 1,470 | 97.0–130.7 | 1,910 | 126.0–169.8 |
| Indirect | 114–145 | 2.5–4.1 | 738–1,083 | 15.0–28.4 | 969–1,391 | 18.4–34.8 |
| Total | 584–619[b] | 10.9–14.5 | 2,208–2,553 | 111.9–159.1 | 2,879–3,301 | 144.4–204.6 |
| In situ processing | | | | | | |
| Direct | 476–526 | 8.8–11.3 | 1,500 | 98.9–133.4 | 500 | 33.0–44.5 |
| Indirect | 118–157 | 2.6–4.4 | 814–1,360 | 16.6–35.7 | 275–449 | 5.2–11.3 |
| Total | 625–644 | 11.5–15.7 | 2,314–2,860 | 115.6–169.0 | 775–949 | 38.2–55.8 |

[a] The direct employment data presented in this table for the construction and operation of commercial surface and underground mining projects are based on data provided in DOI (1973b). Some of these data were extrapolated from data presented for construction and operation of an underground mine with a capacity of 50,000 bbl/day and 100,000 bbl/day, and a surface mine with a capacity of 100,000 bbl/day. In situ facility data are from Thompson (2006b), with data for Colorado multiplicative of a single facility with a capacity of 200,000 bbl/day. Direct employment numbers and multiplier data from the IMPLAN model were used to calculate indirect employment and income numbers for housing and each technology.

[b] Direct and indirect employment and income numbers in each range do not necessarily add to the corresponding totals. Across the ROIs, for housing construction and any given technology, power plant, and coal mine, variations in the size of indirect impacts do not necessarily correspond to variations in the size of direct impacts.

$23 million in income. Construction employment for the power plants would represent an increase of between 2.4 and 5.9% over the projected employment baseline in the three ROIs in the peak year. Coal mine development in each ROI would produce between 200 and 1,300 jobs in the ROI during construction and between $12 million and $79 million in income in the ROIs (Table 4.11.1-2). Plant operations would require between 200 and 940 employees in the ROIs, producing between $12 million and $56 million in income. Construction employment for the coal mines would represent an increase of between 0.4% and 2.4% over the projected peak year employment baseline in the three ROIs.

In addition to oil shale, power, and coal production facilities, employer-provided temporary housing and housing constructed in local communities would also produce

**TABLE 4.11.1-2 ROI Economic Impacts of Power Plant and Coal Mine Development[a]**

| | Housing Construction | | Construction | | Operation | |
|---|---|---|---|---|---|---|
| | Employment | Income ($ million) | Employment | Income ($ million) | Employment | Income ($ million) |
| Power Plant | | | | | | |
| Direct | 571–666 | 10.8–13.6 | 2,150 | 141.8–191.1 | 240 | 19.1–21.3 |
| Indirect | 148–188 | 3.3–5.3 | 632–929 | 13.2–24.9 | 61–91 | 1.2–2.3 |
| Total | 759–816[b] | 14.1–18.9 | 2,782–3,079 | 155.1–216.0 | 301–331 | 16.8–23.4 |
| Coal Mine | | | | | | |
| Direct | 44–259 | 0.8–5.4 | 135–753 | 10.7–66.9 | 135–635 | 10.7–47.0 |
| Indirect | 10–74 | 0.2–2.1 | 74–555 | 1.5–14.6 | 73–384 | 1.4–9.6 |
| Total | 54–317 | 1.0–7.4 | 209–1,308 | 12.2–81.5 | 203–941 | 11.9–55.8 |

[a] The direct employment data presented in this table are based on data provided in Thompson (2006c,d). Direct employment numbers and multiplier data from the IMPLAN model were used to calculate indirect employment and income numbers for housing and each technology.

[b] Direct and indirect employment and income numbers in each range do not necessarily add to the corresponding totals. Across the ROIs, for housing construction and any given technology, power plant, and coal mine, variations in the size of indirect impacts do not necessarily correspond to variations in the size of direct impacts.

employment and income in each ROI. Housing provided for surface mine workers and their families would create between 580 and 610 jobs and approximately $11 million in income in the ROIs (Table 4.11.1-1). Construction of housing for underground mine workers and families would produce between 580 and 620 jobs and between $11 million and $15 million in income in the ROIs. Construction of housing for in situ project workers and their families would produce employment of between 625 and 640 jobs and between $12 million and $16 million in income in the ROIs. Construction of temporary housing for power plant workers and families in the ROI would create between 760 and 820 jobs, while housing for mine workers would produce between 50 and 320 jobs. Between $14 million and $19 million in income would be produced during construction of housing for power plant workers and between $1 million and $7 million during construction of coal mine worker housing (Table 4.11.1-2).

#### 4.11.1.2 Social Impacts

Worker in-migration to local communities in each ROI during construction and operation of oil shale facilities and the associated power plants and coal mines would impact population in each ROI. In the absence of temporary accommodations in local communities for oil shale workers during project construction and operation, the influx of oil shale workers and family members would have a relatively large impact on the housing market in each ROI. The new residential population associated with the project construction and operation would also require the hiring of additional local public service employees (police officers, fire personnel, local government employees, and teachers) in each ROI. Increases in ROI public service employment

would also require increases in local revenues and expenditures to meet the necessary additional local public service provision.

During the peak year of construction of a surface mine facility, between 1,158 and 1,502 new residents are expected in the ROIs, with between 2,581 and 3,397 relocating to the ROIs during operations (Table 4.11.1-3). Construction of an underground mine would mean between 1,180 and 2,383 new residents in the ROI during the peak construction year, with between 2,564 and 4,093 expected during operations. Construction of an in situ facility would mean between 1,264 and 2,781 new residents during the peak construction year, with between 695 and 1,189 workers and their families required during facility operations. Population increases associated with the construction of an underground mine project would represent an increase of between 0.6% and 1.4% over the baseline population in the three ROIs during construction and between 1% and 3.2% during operations, with similar increases expected for a surface mine.

Construction of a power plant would bring between 1,282 and 2,587 new residents to the ROIs during the peak construction year, with between 253 and 400 workers and their families required during facility operations (Table 4.11.1-4). Coal mine construction would mean between 140 and 1,220 new residents during construction and between 238 and 1,132 in-migrants during operations. Population increases associated with the construction of power plants would represent increases of between 0.8% and 1.7% in the population baseline in the three ROIs during construction and between 0.1% and 0.3% during operations. Coal mine construction would increase baseline population in the three ROIs by between 0.1% and 0.4%, with operations adding between 0.2% and 0.3% to the baseline population in the three ROIs.

Population increases associated with construction of a surface mine project would require between 334 and 443 housing units in the ROIs, absorbing between 2.9 and 5.3% of vacant housing units (Table 4.11.1-3). For an underground mine, between 340 and 687 housing units, or between 3.0 and 5.4% of the vacant housing stock in the three ROIs, would be required. For an

**TABLE 4.11.1-3 ROI Demographic and Housing Impacts of Oil Shale Development**

| | In-Migration to Local Communities | | Housing Demand in Local Communities | |
|---|---|---|---|---|
| | Construction | Operation | Number of Units | Percent Vacant |
| Surface mining with surface retorting | 1,158–1,502 | 2,581–3,397 | 334–443 | 2.9–5.3 |
| Underground mining with surface retorting | 1,180–2,383 | 2,564–4,093 | 340–687 | 3.0–5.4 |
| In situ processing | 1,264–2,781 | 695–1,189 | 365–802 | 3.4–6.2 |

**TABLE 4.11.1-4 ROI Demographic and Housing Impacts of Power Plant and Coal Mine Development**

| | In-Migration to Local Communities | | Housing Demand in Local Communities | |
|---|---|---|---|---|
| | Construction | Operation | Number of Units | Percent Vacant |
| Power Plant | 1,282–2,587 | 253–400 | 370–746 | 3.8–6.4 |
| Coal Mine | 140–1,220 | 238–1,132 | 40–352 | 0.5–2.9 |

in situ facility, population increases associated with project construction would require between 365 and 802 housing units, or between 3.4% and 6.2% of the vacant housing stock in the three ROIs. For a power plant, population increases associated with project construction would require between 370 and 746 housing units, or between 3.8% and 6.4% of the vacant housing stock in the three ROIs, while coal mine development would require between 40 and 352 housing units, between 0.5% and 2.9% of vacant units in the ROIs (Table 4.11.1-4).

Construction of a surface mine facility would require between 28 and 48 new local government employees in the three ROIs during construction and between 63 and 109 employees during operations (Table 4.11.1-5). The additional local public service provision during the peak construction year would require an increase of between 1.1% and 1.7% in local expenditures in the three ROIs, with increases of between 2.5% and 3.8% during operations. Construction of an underground mine would require between 29 and 60 local government employees during construction, and between 63 and 110 during operations. The increase in local public service provision would represent an increase of between 1.0% and 1.7% in expenditures in the three ROIs during construction and between 1.8% and 3.9% during operations. Construction of an in situ facility would require between 31 and 73 local government employees during construction and between 17 and 31 during operations, with the increase in local public service provision requiring an increase of between 1.2% and 1.9% in expenditures during construction and between 0.5% and 1.1% during operations. Construction of a power plant would require between 25 and 71 local government employees in the three ROIs during construction and between 4 and 11 during operations, with the increase in local public service provision requiring an increase of between 1.1% and 1.9% in expenditures in the three ROIs during construction and between 0.2% and 0.4% during operations (Table 4.11.1-6). Coal mine development would require between 2 and 33 local government employees in the three ROIs during construction, requiring an increase of between 0.2% and 0.6% in local government expenditures in the three ROIs, and between 3 and 31 during operations, which necessitate an increase in local government expenditures of between 0.3% and 0.5%.

Financing needed to support increases in local public expenditures that would be required to facilitate expansion in local public services, education, and local infrastructure impacted by oil shale and associated facilities might come from a number of sources. In communities impacted

**TABLE 4.11.1-5 ROI Community Impacts of Oil Shale Development**

| | Government Employees | | Change in Local Government Expenditures (%) | |
|---|---|---|---|---|
| | Construction | Operation | Construction | Operation |
| Surface mining with surface retorting (one 50,000-bbl/day project) | 28–48 | 63–109 | 1.1–1.7 | 2.5–3.8 |
| Underground mining with surface retorting (one 50,000-bbl/day project) | 29–60 | 63–110 | 1.0–1.7 | 1.8–3.9 |
| In situ processing (one 200,000-bbl/day project) | 31–73 | 17–31 | 1.2–1.9 | 0.5–1.1 |

**TABLE 4.11.1-6 ROI Community Impacts of Power Plant and Coal Mine Development**

| | Government Employees | | Change in Local Government Expenditures (%) | |
|---|---|---|---|---|
| | Construction | Operation | Construction | Operation |
| Power Plant | 25–71 | 4–11 | 1.1–1.9 | 0.2–0.4 |
| Coal Mine | 2–33 | 3–31 | 0.2–0.6 | 0.3–0.5 |

by the oil and gas industry, increases in property tax revenues resulting from increases in assessed valuations with increased demand for employee housing have often provided local communities with funds to support local finances in each ROI and have often occurred without the need to increases property tax rates (see Section 3.10.2). In addition, revenues from oil and gas severance taxes are currently distributed by state authorities to local communities to support local public service and infrastructure development using a range of different mechanisms, while payments-in lieu-of-taxes are often made by federal agencies to support local community responses to energy developments on public land. Royalty bonus payments have also been provided to local communities with the leasing of public lands for energy development. Some communities might also receive increased sales tax revenues resulting from local energy development and consequent increases in economic activity that could be used to support local government expenditures.

#### 4.11.1.3 Social Disruption Impacts

Although it is likely that social and psychological disruption would occur during the boom phase of the development of oil shale facilities in small rural communities, the precise relationship between development projects and particular forms of social disruption and social change are difficult to predict. It has been suggested, for example, that social disruption is likely to occur once an arbitrary population growth rate associated with oil shale development has been reached, with an annual rate of between 5 and 10% growth in population assumed to result in a breakdown in social structures, with a consequent increase in alcoholism, depression, suicide, social conflict, divorce, delinquency, and deterioration in levels of community satisfaction (BLM 1980, 1983a,b).

The review of the literature assessing the relationship between social disruption and the rapid development of various energy projects in small rural communities suggests that there is insufficient evidence to predict the extent to which specific communities are likely to experience social disruption, which population groups within each community are likely to be most affected, and the extent to which social disruption is likely to persist beyond the end of the boom period. However, the number of new residents from outside the producing regions and the pace of population growth associated with the commercial development of oil shale resources, which would include large-scale production facilities and ancillary power plants, coal mines, and housing developments, are likely to lead to substantial demographic and social change in small rural communities. Communities hosting these developments are likely to be required to adapt to a different quality of life, with a transition away from a more traditional lifestyle involving ranching and taking place in small, isolated, close-knit, homogenous communities with a strong orientation toward personal and family relationships, toward a more urban lifestyle, with increasing cultural and ethnic diversity and increasing dependence on formal social relationships within the community.

#### 4.11.1.4 Impacts on Agriculture

As it is likely that oil shale technologies will require large quantities of water, water transfers from other industries may be required in each ROI. To facilitate new oil and gas development, historic water rights have often been purchased from agricultural landowners, primarily ranchers (see Section 3.10.2.2). Although the transfer of water rights to energy companies has not always meant that agricultural land is lost, the loss of water rights has meant usually that irrigated agriculture is no longer possible and has led to conversion of each ROI to dryland farming/ranching activities. At higher levels of oil shale development, it is possible that water may be transferred into each ROI from other areas, which may limit the impact of reduced access by agriculture to water resources in some areas of each ROI. In many cases, however, the conversion of historic water rights to support oil shale development would change the character of agriculture in each ROI.

The impacts of substantial conversion of agricultural water rights could have large impacts on the economy of each ROI, the extent to which would depend on the amount of agricultural production lost, the extent of local employment in agriculture, the reliance of other

industries in each ROI on agricultural production, the extent of local procurement of equipment and supplies by agriculture, and the local impact of spending of wage and salaries by farmers, ranchers, and farm workers. The impact of losses in revenues and income from a reduction in agriculture likely would be more than offset by increases in revenues coming from oil shale development but would likely change the character of community life in each ROI. Changes in economic activity such as these would also likely produce social impacts associated with the loss of traditional quality of life and the adoption of a more urban lifestyle.

#### 4.11.1.5 Recreation Impacts

Estimating the impact of oil shale development and the associated power plant and coal mine facilities on recreation is problematic, as it is not clear how activities under each alternative in each ROI would impact recreational visitation. While it is clear that some federal land in each state ROI would no longer be accessible for recreation, the majority of popular wilderness locations would be precluded from oil shale development. It is also possible that oil shale developments and associated transmission lines and transportation infrastructure elsewhere in each ROI would be visible from popular recreation locations (see Section 4.9), reducing visitation and consequently impacting the economy of each ROI.

Because the impact of each oil shale technology and alternative on visitation is not known, this section presents two simple scenarios to indicate the magnitude of the economic impact of oil shale development on recreation: the impact of a 10% and a 20% reduction in ROI recreation employment in each state ROI. Impacts include the direct loss of recreation employment in the recreation sectors in each ROI, and the indirect effects, which represent the impact on the remainder of the economy in each ROI as a result of a declining recreation employee wage and salary spending, and expenditures by the recreation sector on materials, equipment, and services. Impacts were estimated by using IMPLAN data for each ROI (Minnesota IMPLAN Group, Inc. 2007). IMPLAN is an input-output modeling framework designed to capture spending flows among all economic sectors and households in each ROI economy.

In the Colorado ROI, the total (direct plus indirect) impacts of oil shale development on recreation would be the loss of 1,415 jobs with a 10% reduction in recreation employment, and 2,830 jobs if recreation employment were to decline 20% (Table 4.11.1-7). Income lost as a result of the 10% decrease in recreational employment would be $18.3 million, with $36.5 lost for the 20% loss in employment. In the Utah ROI, 388 jobs and $3.2 million in income would be lost in the ROI as a whole as a result of a 10% reduction in recreation employment, and 776 jobs and $6.3 million in income would be lost with the 20% reduction. In the Wyoming ROI, 1,360 jobs and $7.2 million in income would be lost under the 10% scenario, with 2,719 jobs and $14.4 in income lost if 20% of recreation-related employment were lost in the ROI.

**TABLE 4.11.1-7 Total ROI[a] Impacts of Reductions in Recreation Sector[b] Employment Resulting from Oil Shale and Tar Sands Development**

| | 10% Reduction | | 20% Reduction | |
|---|---|---|---|---|
| ROI | Employment | Income ($ million) | Employment | Income ($ million) |
| Colorado | 1,415 | 18.3 | 2,830 | 36.5 |
| Utah | 388 | 3.2 | 776 | 6.3 |
| Wyoming | 1,360 | 7.2 | 2,719 | 14.4 |

[a] The Colorado ROI includes Delta, Garfield, Mesa, Moffat, and Rio Blanco Counties; the Utah ROI includes Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, and Wayne Counties; the Wyoming ROI includes Carbon, Lincoln, Sweetwater, and Uinta Counties.

[b] The recreation sector includes amusement and recreation services, automotive rental, eating and drinking establishments, hotels and lodging facilities, museums and historic sites, RV parks and campsites, scenic tours, and sporting goods retailers.

#### 4.11.1.6 Impacts on Property Values

There is concern that oil shale developments and their associated power plants, transmission lines, and coal mines might affect property values in ROI communities located nearby. Property values might decline in some locations as a result of the deterioration in aesthetic quality, increases in noise, real or perceived health effects, congestion, or social disruption. In other locations, property values might increase resulting from their access to employment opportunities associated with oil shale developments.

In general, potentially hazardous facilities can directly affect property values in two ways (Clark et al. 1997; Clark and Allison 1999). First, negative imagery associated with these facilities could reduce property values if potential buyers believed that any given facility might produce an adverse environmental impact. Negative imagery could be based on individual perceptions of risk associated with proximity to these facilities or on perceptions at the community level that the presence of such a facility might adversely affect local economic development prospects. Even though a potential buyer might not personally fear a potentially hazardous facility, the buyer might still offer less for a property in the vicinity of a facility if there was fear that the facility would reduce the rate of appreciation of housing in the area. Second, there could be a positive influence on property values associated with accessibility to the workplace for workers at the facility, with workers offering more for property close to the facility to minimize commuting times. Workers directly associated with the facility would probably also have much less fear of the technology and operations at the facility than would the population as a whole. The importance of this influence on property values would likely vary with the size of the workforce involved.

Although there is no evidence of the impact of oil shale facilities on local property values, there is limited evidence of the impact of gas drilling on property values in western Colorado. In communities adjacent to drilling activities, property values declined with the announcement of drilling, and during the first stages of extraction, the values rebounded, at least partly, once production was fully underway (BBC Research and Consulting 2006). Other studies have assessed the impact of other potentially hazardous facilities — such as nuclear power plants and waste facilities (Clark and Nieves 1994; Clark et al. 1997; Clark and Allison 1999) and hazardous material and municipal waste incinerators and landfills (Kohlhase 1991; Kiel and McClain 1995) — on, for example, local property markets. Many of these studies used a hedonic modeling approach to take into account the wide range of spatial influences — including noxious facilities, crime (Thaler 1978), fiscal factors (Stull and Stull 1991), and noise and air quality (Nelson 1979) — on property values.

The general conclusion from these studies is that while there may be a small negative effect on property values in the immediate vicinity of noxious facilities (i.e., less than 1 mi), this effect is often temporary and often associated with announcements related to specific project phases, such as site selection, the start of construction, or the start of operations. At larger distances, over longer project durations, no significant, enduring, negative property value effects have been found. Depending on the importance of the employment effect associated with the development of the various activities analyzed in these studies, a positive impact on property values was found to be associated with increases in demand for local housing.

Under conditions of moderate population growth and housing demand, it appears that property values could increase with the expansion in local employment opportunities resulting from oil shale development. However, with multiple oil shale technologies under construction in each ROI (particularly toward the end of the planning period), increases in population and the associated congestion — in the absence of adequate private sector real estate investment and appropriate local community planning — might have adverse impacts on property values. It has also been suggested that once the annual growth in population was between 5% and 15% in smaller rural communities, a breakdown in social structures would occur, with a consequent increase in alcoholism, depression, suicide, social conflict, divorce, and delinquency and a deterioration in levels of community satisfaction (BLM 1980, 1983b, 1996), with the resulting deterioration in local quality of life adversely affecting property values.

Energy transmission lines could also affect property values in communities located on land adjacent to oil shale developments, primarily as a result of the visibility of electricity transmission structures; the health and safety issues (in particular, electric and magnetic field [EMF]), noise, and traffic congestion associated with transmission lines would likely be less important. Although various studies have attempted to measure the impact of transmission lines on property values, significant data and methodological problems are associated with many of the studies, and the results are often inconclusive (Kroll and Priestley 1992; Grover, Elliot and Company 2005).

### 4.11.2 Mitigation Measures

Mitigation measures to reduce socioeconomic impacts will be required and could include work with state and local agencies by the BLM to identify potential socioeconomic impacts and develop mitigation measures. In doing so, a suite of potential measures could be implemented, including but not limited to the following actions:

- Operators could be required to provide housing and basic services for all direct project hires and their families in order to minimize potential (1) social disruption associated with large numbers of in-migrants locating in small rural communities, (2) short-term adverse impacts on regional housing markets and overnight accommodation facilities, (3) adverse impacts on regional consumer products' availability and price, and (4) adverse impacts on public services provided by local communities in the surrounding region.

- Operators could work with state and local agencies to develop community monitoring programs that will be sufficient to identify and evaluate socioeconomic impacts resulting from commercial development. Monitoring programs should collect data reflecting economic, fiscal, and social impacts of the development at both the state and local level. Parameters to be evaluated could include impacts on local labor and housing markets, local consumer product prices and availability, local public services (police, fire, and public health), and educational services. Programs also could monitor indicators of social disruption (e.g., crime, alcoholism, drug use, and mental health) and the effectiveness of community welfare programs in addressing these problems.

Operators could work with state and local agencies to develop community outreach programs that would help communities adjust to changes triggered by commercial development. Such programs could include any of the following activities:

- Establish vocational training programs for the local workforce to promote development of skills required by the commercial development industries. Develop instructional materials for use in area schools to educate the local communities on the commercial development industries.

- Support community health screenings, especially those addressing potential health impacts related to commercial development activities.

- Provide financial support to local libraries for development of information repositories on commercial development and processing, including materials on the hazards and benefits of commercial development. Electronic repositories established by the operators could also be of great value.

## 4.12 ENVIRONMENTAL JUSTICE

Construction and operation of oil shale developments and associated power plants and housing could impact environmental justice if any adverse health and environmental impacts resulting from either phase of development are significantly high and if these impacts would disproportionately affect minority and low-income populations. If health and environmental impacts are not significant, there can be no disproportionate impacts on minority and low-income populations. If the impacts are significant, disproportionality is determined by comparing the proximity of high and adverse impacts with the location of low-income and minority populations. Details of the methodology for assessing environmental justice issues are presented in Appendix G. For each of the alternatives, the following sections describe impacts on various resources located in the oil shale resource areas within the three-state study area that would be impacted by oil shale development. Local demographic and social disruption impacts, property value impacts, land use, air and water quality and use, and visual impacts are described. This discussion is followed by a determination of the extent to which impacts of oil shale development would have a disproportionate effect on low-income and minority groups on the basis of the location of low-income and minority populations.

### 4.12.1 Common Impacts

#### 4.12.1.1 Impact-Producing Factors

Rapid population growth in small rural communities hosting large oil shale development projects may produce social and psychological disruption, together with the undermining of established community social structures. Various studies have suggested that social disruption may occur in small rural communities when annual population increases are between 5 and 15% (see Section 4.11.1.3).

Property value impacts on private land in the vicinity of oil shale development projects and associated transmission lines may affect minority and low-income populations. These impacts would depend on the range of alternate uses of specific land parcels to landowners, current property values, and the perceived value of costs (e.g., visual impacts, traffic congestion, noise and dust pollution, air quality impacts, and EMF effects) and benefits (e.g., infrastructure upgrades, employment opportunities, local tax revenues) from proximity to oil shale-related facilities to potential real estate purchasers of property owned by minority and low-income individuals in local communities.

Construction activities would produce fugitive dust emissions and engine exhaust emissions from heavy equipment, as well as from commuting and delivery vehicles on paved and/or unpaved roads, and wind erosion of soil disturbed by construction activities or from soil stockpiles. Emissions associated with these activities would consist primarily of particulate matter ($PM_{2.5}$ and $PM_{10}$), and criteria pollutants, VOCs, $CO_2$, and certain HAPs released from heavy construction equipment and vehicle exhaust. Emissions during oil shale facility operations would consist of CO, $NO_2$, $PM_{2.5}$, $PM_{10}$, and $SO_2$. Construction of transmission lines and access

roads required for the delivery of equipment and materials to project sites would produce fugitive dust impacts, the magnitude of which would depend, in part, on the terrain and road length, and the length of time that they would be used for construction traffic.

Water consumption and quality impacts on land in the vicinity of oil shale development projects and associated transmission lines might affect minority and low-income populations, both in terms of water used for domestic consumption and water that may be used to support wildlife populations used for subsistence agriculture and for cultural and religious purposes. The impact on water resources during construction would consist primarily of increases in surface runoff, and, consequently, in dissolved solids and in the volumetric flow of nearby streams near the project sites. The amount of water used during the operation of oil shale development projects is expected to be large at higher levels of facility production and could potentially impact minority and low-income populations if there are shortages of drinking water or water that might be used for agriculture.

Construction and operation of oil shale and supporting facilities, power plants, housing, and transmission lines would produce noise impacts, and operation of transmission lines may lead to EMF effects.

Oil shale facilities and associated transmission towers may potentially alter the scenic quality in areas of traditional or cultural significance to minority and low-income populations, depending on the facility's size and location. Construction would introduce contrasts in form, line, color, and texture, as well as a relatively high degree of human activity into existing landscapes with generally low levels of human activity.

Land used for oil shale facilities might impact certain animals or vegetation types that may be of cultural or religious significance to certain population groups or that form the basis for subsistence agriculture. Similarly, land used for facilities that has additional economic uses might affect access to resources by low-income and minority population groups.

#### 4.12.1.2 General Population

Population in-migration would occur in each year of oil shale resource development. Workers would be required to move into each state during construction and operation of oil shale and power plant facilities and to facilitate the demand for goods and services resulting from the spending of oil shale, power plant, and housing construction worker wages and salaries. In-migration in the peak year of construction of a power plant would increase population in the three-state study area by up to 1.7%. During the period in which an underground mine would be operated in the study area, and also the period during which power plants and coal mines would be operating, population in the three-state study area is projected to increase by 3.2%. In-migration associated with oil shale development would also require additional housing to be constructed in the three-state study area, with up to 6.4% of vacant housing units required during the peak year for power plant construction, and up to 6.2% of vacant units required during the peak year of coal mine construction.

Because oil shale development projects and the associated power plant and housing developments would lead to rapid population growth in many of the communities in each ROI, particularly in situ projects in Colorado, and given evidence presented in the literature (see Section 3.10.2.2), it is highly possible that some degree of social disruption would accompany these developments. In the absence of appropriate levels of local and regional planning, rapid demographic change may lead to the undermining of local community social structures with contrasting beliefs and value systems among the local population and in-migrants, and consequently, to a range of changes in social and community life, including increases in crime, alcoholism, drug use, etc.

The precise nature of the impact of oil shale facility construction and operation on property values was not evaluated for this PEIS. The impact would depend on the range of alternate uses of specific land parcels by landowners, current property values, and the perceived value of costs (visual impacts, traffic congestion, noise and dust pollution, air quality impacts, and EMF effects) and benefits (infrastructure upgrades, employment opportunities, and local tax revenues) from proximity to oil shale-related facilities to potential real estate purchasers of property owned by minority and low-income individuals in local communities.

Emissions associated with construction activities would consist primarily of particulate matter ($PM_{2.5}$ and $PM_{10}$), criteria pollutants, VOCs, $CO_2$, and certain HAPs released from heavy construction equipment and vehicle exhaust. Since all activities either conducted or approved by the BLM through use authorizations must comply with all applicable local, state, Tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans, it is unlikely that future oil shale and/or tar sands development would cause significant adverse air quality impacts.

Because of the limited surface water and groundwater, the amount of water needed in Colorado for the project sites, power plant, coal mine, and associated population growth would mean that additional water resources would be needed. In Utah, water from the Colorado River plus the estimated sustainable groundwater yield is likely to be sufficient to support the amount of water needed for oil shale and tar sands developments, ancillary power and coal facilities, and associated population growth. It should be noted that prolonged drought conditions may occur and constrain water availability in Utah. Similarly in Wyoming, water from the Colorado River in Utah plus the estimated sustainable groundwater yield would be sufficient to support development of oil shale in Wyoming. Although discharges could have significant impacts on water quality if not properly controlled, water quality impacts of oil shale development are expected to be temporary and local, provided that mitigation measures are implemented, in part because of the dry climate where the sites are located. However, steep slopes in some areas may channel surface runoff and result in localized soil erosion.

Oil shale facilities might impact certain animals or vegetation types that may be of cultural or religious significance to certain population groups, or that form the basis for subsistence agriculture. Similarly, land used for these facilities that has additional economic uses might affect access to resources by low-income and minority population groups.

Surface mine and surface retorting would involve the most surface disturbance, and visible activity (including dust and emissions) would be expected to generate the largest visual impacts relative to the other projects of similar size but utilizing underground mining or in situ processes. Underground mining and surface retorting projects would involve fewer and less severe visual impacts compared with oil shale projects utilizing surface mines, primarily because of reduced surface disturbance from mining and related activities. Visual impacts associated with reclamation also would likely be less than for projects utilizing surface mines because of the greatly reduced level of ground disturbance. Projects utilizing in situ technologies would likely generate the smallest levels of visual impacts because of the absence of spent shale piles, shale-crushing facilities, and other mining-related facilities and activities. These projects also would likely have the smallest reclamation impacts because of reduced surface disturbance and the absence of spent shale piles.

#### 4.12.1.3 Environmental Justice Populations

Construction and operation of oil shale developments could impact environmental justice if the adverse health and environmental impacts resulting from either phase of development identified in the previous sections are significantly high, and if these impacts would disproportionately affect minority and low-income populations. Where impacts are significant, disproportionality is determined by comparing the proximity of high and adverse impacts with the location of low-income and minority populations.

A number of census block groups have low-income and minority populations, where the minority population exceeds 50% of the total population in each block group. There are four block groups where the minority share of total block group population exceeds the state average by more than 20 percentage points in each of the three states potentially hosting oil shale and tar sands development (see Section 3.11). Within 50 mi of the oil shale area in Colorado, there is one census block group with a low-income population; it is located to the east of the oil shale area in Carbondale; two census block groups are located in Grand Junction. In Utah, the minority population is located in the northeastern part of the state in the immediate vicinity of the oil shale resource area itself, in the southeastern portion of the Uintah and Ouray Indian Reservation, and in the north central part of the state, to the east of Springville. The low-income population is centered in roughly the same area as the minority population, with five block groups in the southeastern portion of the Uintah and Ouray Indian Reservation and one located in the vicinity of Price. In Wyoming, the minority population is located in the Wind River Indian Reservation, also the location of the low-income population.

Given the location of environmental justice populations in each state, construction and operation of oil shale facilities, power plants, and employee housing required for the operation of oil shale development projects would produce impacts that would be experienced disproportionately by minority and low-income populations. Of particular importance would be social disruption impacts of large increases in population in small rural communities, the undermining of local community social structures, and the resulting deterioration in quality of life. The impacts of facility operations on air and water quality and on the demand for water in the region would also be important. Depending on their locations, impacts on low-income and

minority populations may also occur with the development of transmission lines associated with power development and the supply of power to oil shale facilities in each state. Land use and visual impacts might be significant depending on the location of land parcels impacted by oil shale projects and the associated power plant and housing facilities, their importance for subsistence, their cultural and religious significance, and alternate economic uses.

### 4.12.2 Mitigation Measures

Various procedures might be used to protect low-income and minority groups from high and adverse impacts of oil shale development and associated facilities. Most important of these would be to develop and implement focused public information campaigns to provide technical and environmental health information directly to low-income and minority groups or to local agencies and representative groups. Included in these campaigns would be descriptions of existing air and groundwater monitoring programs; the nature, extent, and likelihood of existing and future airborne or groundwater releases from oil shale facilities; and the likely characteristics of environmental and health impacts. Key information would include the extent of any likely impact on air quality, drinking water supplies, subsistence resources, and the relevant preventative measures that may be taken.

Rapid population growth following the in-migration of the construction and operations workers associated with oil shale development and ancillary facilities into communities with low-income and minority populations could lead to the undermining of local community social structures as beliefs and value systems among the local population and in-migrants contrast and, consequently, could lead to a range of changes in social and community life, including increases in crime, alcoholism, drug use, etc. In anticipation of these impacts, key information on the scale and timeline of oil shale developments, and on the experience of other communities that have followed the same energy development path, could be made available to low-income and minority populations, together with information on planning activities that may be initiated to provide local infrastructure, public services, education and housing.

## 4.13 HAZARDOUS MATERIALS AND WASTE MANAGEMENT

### 4.13.1 Common Impacts

Impacts related to hazardous materials and wastes are generally independent of location. Such impacts would be derivatives of the technologies employed for resource recovery and for the subsequent processing of recovered products rather than of the locations at which these activities occur.

Hazardous materials and wastes are unique to the technology combinations used for oil shale development. However, hazardous materials and waste impacts are common for some of the ancillary support activities that would be required for development of any oil shale facility

regardless of the technology used. These activities include the impacts from development or expansion of support facilities, such as employer-provided housing and power plants.

Hazardous materials impacts associated with construction or expansion of off-site support facilities would be minimal and limited only to the hazardous materials typically utilized in construction of such facilities, including hazardous materials required to support construction equipment and vehicles (fuels, other vehicle and equipment fluids such as lubricating oils, hydraulic fluids, and glycol-based coolants) and miscellaneous hazardous materials typically associated with construction such as solvents, adhesives, and corrosion control coatings. Construction-related wastes would include landscape wastes from clearing and grading of the construction sites and other wastes typically associated with construction, none of which are expected to be hazardous and all of which, except for landscape wastes, are expected to be disposed of in permitted sanitary landfills. Landscape wastes are expected either to be burned on-site or delivered to permitted off-site facilities for disposal or composting.

Once these support facilities become functional, different hazardous materials and waste impacts would result. It is expected that virtually no hazardous materials would be associated with employer-provided housing. However, wastes would include nonhazardous solid wastes and sanitary wastewaters. Solid wastes are expected to be containerized and hauled to permitted sanitary landfills or other appropriate waste disposal facilities. As conditions permit, sanitary waste waters are expected to be treated on-site through such technologies as septic systems or active biological treatment; all such activities would be controlled by permits issued to state or local authorities. Depending on the location of the employer-provided housing and other circumstantial factors, it is also possible that sanitary wastewaters would be delivered by truck or sewer to existing or expanded municipal treatment works for treatment.

Hazardous materials associated with power plant operation would include that complement of hazardous materials typically used to support the maintenance and repair of mechanical equipment. The most notable waste stream associated with power plant operation would be coal combustion waste (CCW), primarily a mixture of fly ash and bottom ash. CCW is expected to be disposed of at the power plant site under state or local permits, or alternatively, delivered back to the mine site to support reclamation.

Commercial oil shale development activities may include surface mining and/or underground mining with surface retort or in situ technologies. As production rates and resulting associated waste volumes increase, different waste management schemes are likely to be implemented, potentially including more on-site treatment, storage, and disposal. For example, larger volumes of wastewaters from industrial activities and contaminated pyrolysis water are likely to dictate on-site treatment (under the auspices of permits issued by state or local regulatory authorities) because containerization and transport to off-site treatment facilities could become prohibitively expensive. Similarly, at commercial production levels, the expansion in the workforce would likely result in the installation of on-site treatment facilities for sanitary wastewaters. Except for spent shale, nonhazardous solid wastes, whether from industrial activities or from support of the workforce (e.g., kitchen wastes) would increase in proportion to production and workforce levels but is expected still to be managed by collection and delivery to established off-site sanitary landfills, regardless of the volume increases that result. For those

projects involving surface retorting, spent shale would be the largest volume solid waste stream and is likely to be disposed of on-site (under a permit issued by state or local authorities). Likewise, industrial hazardous wastes would increase proportionally to production and upgrading activities (where they occur), but in all instances, are expected to be managed by containerization, brief periods of on-site storage, and ultimate delivery to permitted hazardous waste treatment, storage, and disposal facilities (TSDFs). No treatment of hazardous waste is expected to occur on-site, except as may be necessary to stabilize extremely unstable waste for transport or to neutralize free acidity, both actions that can occur without benefit of a permit.

One of the by-products of surface retorting is water (sometimes referred to as pyrolysis water). Pyrolysis water is also created in all in situ retorting technologies and recovered from production wells, together with hydrocarbon pyrolysis products. This water will often contain hydrocarbon pyrolysis products that have enough polar character to be water soluble; however, the quality of pyrolysis water will vary. The water would likely be collected in lined ponds and treated before release. Pyrolysis water with little to no contamination (e.g., hydrocarbon, heavy metals) can be put to beneficial uses on the site, such as for fugitive dust control on on-site roads or as a wetting agent for the spent shale to promote adequate compaction). It can also be reinjected downgradient of the retort zone to help the groundwater contours reequilibrate. Contaminated pyrolysis water would require treatment before discharge, either to surface water or to groundwater downgradient of the retort zone.

Some amount of upgrading of the shale oil product may be necessary before it would be attractive to refineries as a replacement for conventional crude oil feedstocks, especially for shale oil produced from mining and surface retorting. Upgrading would dramatically increase the amount and type of hazardous materials present, such as additional commercial fuels to provide the necessary energy and hydrogen for hydrocracking and hydrotreating reactions. In all likelihood, the hydrogen would be produced on-site through steam reforming of commercially available natural gas. It is also likely that the hydrogen would generally be produced as needed and that no large amounts of hydrogen would be kept in storage. The products of such upgrading, synthetic crudes, would themselves exhibit some hazardous properties (e.g., flammability). Prudent engineering design suggests that on-site storage capacity for synthetic crudes would represent at least 2 to 3 days of production capacity. By-products of synthetic crude production would include some additional light-weight fuel gases (C-1 through C-4) that are likely to be used on-site to augment commercial fuels in external combustion sources such as boilers and steam generators, and ammonia ($NH_3$) and $H_2S$, both of which are expected to be treated or incinerated as they are produced. Other wastes associated with upgrading would be spent catalysts, some of which might require management as hazardous waste, and sludge accumulating in reaction vessels and storage tanks that would be removed periodically according to cleaning and maintenance schedules.

#### 4.13.1.1 Surface Mining

Hazardous materials needed to support surface mining activities primarily include diesel fuel, lubricating oils, hydraulic fluids, coolants, and other chemicals associated with the fueling, operation, maintenance, and repair of mining-related vehicles and equipment. Because of their

large size, maintenance and repair activities for these machines would likely occur on-site. Other hazardous materials potentially include cleaning solvents, welding gases, corrosion control coatings, and herbicides (for vegetation clearing and control). The amount of hazardous waste generated from these activities is expected to be small and would likely be containerized for temporary on-site storage and then shipped by licensed haulers to permitted off-site facilities.

Some locations may use explosives (typically, ammonium nitrate and fuel oil [ANFO] mixtures) to facilitate oil shale extraction. Explosives management plans are expected to be implemented at these sites.

The amount of solid waste resulting from surface mining activities is expected to be minimal. Sources include removed vegetation (e.g., tree stumps), items associated with the maintenance and repair of mining vehicles and equipment, putrescible solid wastes from kitchen activities, solid wastes associated with administrative activities, and shale fines too small for retorting. Landscape waste may be used to create wildlife shelters sold for commercial purposes or composted on-site. Other solid waste would be containerized on-site and shipped to appropriate permitted off-site disposal facilities. The shale fines are likely to be returned to the mine site or disposed of with spent shale from the surface retort.

Disturbance of the ground surface that occurs with surface mining can potentially contaminate surface water runoff, resulting primarily in increased levels of suspended particulates. However, SWPPPs are expected to mitigate such surface water contamination. Any contaminated surface water runoff is likely to be diverted to holding ponds until it can be treated and released. Stormwater runoff from stockpiled overburden is a wastewater unique to surface mining operations. Such runoff may need to be captured and treated (e.g., filtered to remove suspended solids) before being released to surface waters.

As is the case for underground mining, surface mining would require a larger workforce than in situ operations. Consequently, nonhazardous solid wastes and wastewaters related to workforce support activities would be greater in volume. Regardless of the volumes produced, solid wastes are expected to be containerized and hauled to off-site permitted sanitary landfills for disposal. Sanitary wastewaters would likely undergo treatment on-site through septic systems (when conditions allow) or active biological treatment under the auspices of appropriate permits issued by state or local authorities. Depending on the locations of the developments, some sanitary wastes might be delivered to nearby municipal treatment facilities (either by truck or by sewer). Pyrolysis water would result from retorting. Depending on the degree of contamination of this water (by polar hydrocarbons and/or heavy metals), this water could be used for beneficial purposes (fugitive dust control or wetting of spent shale prior to disposal) or would require treatment before release to surface or groundwater systems. Such treatment, when necessary, would likely occur in on-site facilities.

The only other wastewater that would result from surface mining operations would be the glycol-based coolants that would be periodically removed from mining equipment and vehicles during maintenance. Sanitary wastewater is likely to be treated and disposed of on-site according to permits issued by state or local regulatory authorities.

Potential adverse health and environmental impacts associated with the improper management of hazardous materials and waste streams associated with surface mining activities could be significant. However, if hazardous materials are stored, used, and disposed of according to all applicable regulations, impacts are expected to be minimal to nonexistent. Similarly, if solid waste and wastewater are handled appropriately, no adverse impacts are expected.

#### 4.13.1.2 Surface Retorting and Subsequent Upgrading

During the 1970s and 1980s, when extensive research and development of oil shale retorting processes were undertaken, a number of agencies prepared environmental impact analyses of commercial-scale operations (BLM 1973, 1977; DOE 1982b, 1983, 1988; EPA 1977, 1979; OTA 1980a,b; Stevens et al. 1984). Engineering projections were made for a number of surface retorts, including the Paraho Direct-Burn Retort, TOSCO II Indirect Burn Retort, and ATP. Each of these technologies is discussed in Appendix A. For the purposes of this impact analysis, it is assumed that the commercial-scale surface retort technologies would be equivalent to these three types of surface retorts with respect to associated hazardous materials and waste streams. Because some amount of upgrading is likely to be required for products recovered from surface retorts, this discussion also addresses typical upgrading activities. In addition, because upgrading is always conducted in conjunction with aboveground retorting, the impacts of such upgrading on hazardous materials and wastes are also addressed.

Hazardous materials associated with surface retorting and upgrading include the flammable fuel gases that are produced during retorting (typically, molecules in the C-1 through C-4 size range), as well as the crude shale oil and its subsequent upgraded products. Some of the fuel gas is expected to be used on-site to augment commercial fuels. The remainder would be stored on-site pending transport to off-site refining facilities. Upgrading would include the use of flammable hydrogen gas, which could be produced on-site or purchased from commercial sources. Upgrading would also likely result in the production of elemental sulfur and anhydrous ammonia, both of which would likely undergo minimal purification and be stored on-site until they are transported to respective markets. Solid wastes from upgrading activities may have to be characterized as hazardous wastes primarily because of the presence of certain catalysts, as well as toxic heavy metals (e.g., arsenic and selenium) that could accumulate in reaction vessel sludge or residues. Sludge from the treatment of process water may also exhibit hazardous characteristics because of the presence of heavy metals. Hazardous wastes would be containerized and shipped to a permitted disposal facility following applicable regulations.

The operation of surface retorts results in the largest volumes of solid wastes of any oil shale development step. These include spent shale, raw shale fines created during the shale crushing operations but unsuitable for retorting, spent shale fines recovered from crude shale oils, and shale wastes unsuitable for retorting. The specific retorting technology will influence both the volume and character of the spent shale wastes (see Appendix A for more details.)

Other sources of solid wastes result from the subsequent crude shale oil upgrading activities (spent catalysts, and tank and reaction vessel residues and sediments) and associated water treatment activities (boiler blowdown, water softening salts, and sludges from treatment of

industrial or sanitary wastewaters or domestic sewage). Relatively small amounts of nonindustrial solids wastes are anticipated. These include landscape waste and domestic solid wastes such as food, kitchen scraps, and office waste.

Nonhazardous solid wastes can be disposed of in landfill cells specifically created for that purpose or disposed of in the mined out portions of strip mines or subsurface mines. For the purposes of analysis, this assessment assumes that no more than 30% of the entire volume of spent shale produced could be disposed of within former mine footprints. Consequently, a substantial volume of spent shale (roughly equal to the volume of oil shale mined) would need to be disposed of in surface areas within the oil shale facility's boundary.

Disposal techniques might also include permanent storage in a nearby canyon or valley or temporary surface storage until final placement within the mine footprint is possible (DOE 1988). Landfill disposal outside the mine footprint would require permits for construction, operation, and closure in most jurisdictions. Disposal of spent shale within the mine footprint would also need disposal permits and would have to be compatible with closure and reclamation plans established for the mine.

Disposal of spent shale back into a subsurface mine presents various logistical issues that may prevent or limit such disposal. For example, mine development design may prevent convenient access to retired portions of the mine. Also, leaching as a result of the interaction of groundwater must be anticipated. Nevertheless, disposal in retired subsurface mines can effectively diminish the potential for future surface settling (which can affect, for example, surface drainage patterns) and incurs no additional labor-intensive surface reclamation requirements.

Water intrusion controls and waste pile cover designs can limit the potential for leaching or erosion of the spent shale to create contaminated surface water effluents. Such controls are expected to be developed within the context of a SWPPP. However, the principal method for erosion control (establishing a vegetative cover) may be difficult in relatively arid regions.

Regardless of the disposal option selected, a number of issues would need to be addressed, including the character of the leachates from spent shale, the structural integrity of the emplaced spent shale, and the increase in volume (decrease in density) of spent shale over the raw shale as a result of retorting (see Appendix A for details).

Impacts on the quality of surface waters can occur from the generation, management, and release of water produced during retorting (pyrolysis water) and upgrading, industrial wastewaters from ancillary activities (e.g., well drilling fluids, steam condensates, and boiler blowdown water), and sanitary and domestic wastewaters resulting from activities related to supporting the on-site workforce. Because of the presence of various contaminants, wastewater effluents would require treatment before use, discharge, or recycling (see Appendix A for details). Some pyrolysis water free of hydrocarbon or heavy metal contamination can be put to beneficial use such as for control of fugitive dust on on-site roads or for wetting spent shale to ensure proper compaction.

Surface retorting and upgrading activities could cause potentially significant environmental and health impacts if appropriate safety measures are not used in the handling and storage of hazardous materials and in the management of hazardous, solid, and wastewater waste streams. However, if applicable regulations governing the use, storage, and disposal of hazardous materials and of wastes are followed, the impacts are expected to be minimal. Likewise, appropriate engineering features and operational controls for spent shale disposal sites can successfully preempt or mitigate anticipated adverse environmental impacts.

#### 4.13.1.3 Underground Mining with Surface Retorting

The complement of hazardous materials required to support underground mining would be virtually the same as that used in surface mining and would primarily involve equipment and vehicle fuels and fluids, and, on some occasions, explosives (that are likely only to be brought to the site on the occasions of their use rather than being stored on-site in any significant quantity). Cleaning solvents, welding gases, and corrosion control coatings would also be used, all in limited volumes.

Surface and underground mining projects are projected to produce similar wastes, both resulting in solid industrial wastes associated with the maintenance and repair of vehicles and mining equipment, the majority of which would not be capable of traveling public roads to off-site maintenance and repair facilities. Wastes associated with equipment support would include primarily waste engine fluids (lubricating oils, hydraulic fluids, and glycol-based coolants) but may also result in small amounts of asbestos-containing wastes from gasket and brake component replacements and small amounts of refrigerants from air-conditioning system maintenance.

Some degree of surface disturbance would occur with underground mining; the amount of contaminated surface water effluents, however, would be minimized by properly designed and implemented SWPPPs. Mine dewatering is expected to occur for the duration of the subsurface mining operation. Recovered groundwater is expected to be free of contamination and eligible for reinjection into a near-surface aquifer in downgradient locations. It is also expected to be used for fugitive dust control and to moisten spent shale from the surface retorts to facilitate its handling and disposal. Mine dewatering waters are known to have elevated levels of chlorine, sodium, fluorine, sulfur, and boron (DOE 1988).

Section 4.13.1.2 provided details on the hazardous materials and wastes associated with surface retorting and subsequent upgrading. Regardless of whether underground or surface mining techniques are employed to recover the resource, the hazardous materials and waste impacts from the subsequent surface retorting and upgrading activities are virtually identical.

#### 4.13.1.4 In Situ Processes

Proponents of in situ technologies believe that products recovered will be able to be forwarded directly to off-site refining facilities. Consequently, the hazardous materials that

would be present on-site to support surface upgrading reactions would not be needed. The retorting products themselves would, however, be hazardous. These would include the primary products (flammable gases, volatile and flammable organic liquids, and heavier molecular weight organic compounds) as well as by-products such as $NH_3$ and $H_2S$ (in some cases, further converted to elemental sulfur). It is reasonable to expect that facilities operating at commercial scale would arrange for transport of primary products to refineries for further processing and by-products to permitted off-site facilities for treatment or disposal. It is also reasonable to expect that prudent facility engineering designs would include provisions for temporary storage of substantial volumes of products between production and transport off-site. Storage of flammable gases is not expected because such materials would be introduced into interstate pipelines, diverted for immediate use in external combustion sources on-site, or destroyed by incineration stacks. Hazardous materials needed to support ancillary functions as well as on-site vehicles and equipment would also be present.

Some technologies may require subsurface refrigeration to retard or preempt the flow of groundwater into the zone undergoing retorting. Such refrigeration is likely to be provided by commercial-scale systems using refrigerants such as anhydrous or aqueous ammonia. The EGL system anticipates using a critical fluid to sweep the formation to enhance recovery of petroleum products (see Appendix A, Section A.5.3). One of the fluids cited is $CO_2$. In the concentrated form in which it would be used as a flushing agent, the $CO_2$ is both an asphyxiant and toxic.

In situ and aboveground retorting scenarios have dramatically different solid waste profiles. Most significantly, the largest solid waste stream from aboveground retorting (spent shale) is virtually eliminated in true in situ retorting. If future technology enhancements reduce or eliminate the need for additional upgrading at the surface, substantial or even total elimination of solid wastes associated with typical upgrading activities can be expected. In addition, such in situ upgrading can be expected to result in reductions in solid wastes associated with sanitary and domestic wastewater treatment or workforce support activities, since the number of workers for such a facility may be dramatically reduced.

The quality and sources of water effluents are dramatically different for in situ and aboveground retorting scenarios. Surface runoff effluents associated with aboveground retorting are effectively eliminated or greatly reduced by in situ processes. In their place are waters from dewatering operations (formation water), waters created during kerogen pyrolysis (retort water), and waters formed during subsequent in situ upgrading reactions. Also, groundwater's subsequent interactions with retorted zones may result in additional effluents after resource extraction has ended. However, additional wastewaters would be produced from surface support facilities such as boilers and steam generators. Both would produce blowdown wastewaters and sludge from treatment of condensates that would necessarily be part of water recycling.[9]

There are limited field data on observed impacts of in situ retorting on groundwater quality, and most involve modified in situ rather than true in situ technologies. Information

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9 Hazardous materials in the form of water treatment chemicals would also be introduced at those projects where steam or hot water is used in industrial applications.

regarding studies that looked at the impacts on groundwater from in situ technologies can be found in Appendix A.

Potential adverse health and environmental impacts associated with the improper management of hazardous materials and waste streams associated with in situ processes could be significant. However, if regulations regarding handling of hazardous materials and management of various waste streams are followed, no adverse impacts are expected. In comparison with surface retorting processes, in situ retorting nearly eliminates the generation of spent shale.

It is possible for some waste streams to be eliminated or reduced in volume or hazardous character as a result of efforts to substitute nonhazardous materials into the waste-producing process, or as a result of the identification and installation of waste recycling management strategies. However, given the relative newness of oil shale development technologies, identification of such waste elimination and waste recycling opportunities may not result until substantial volumes of field experiences are assembled. Finally, it is also possible that as the refinery industry continues to make adjustments to refining processes to accommodate the heavier crude oil feedstocks that are becoming more prevalent in the market, such modifications may relax the quality factors for feedstocks such as synthetic crude oils, thus reducing the degree of mine site upgrading that may be required. If that were to occur, reductions in the amounts and types of hazardous materials and waste streams associated with mine site upgrading may occur, and upgrading-related wastes would become less voluminous and less hazardous in character.

### 4.13.2 Mitigation Measures

Hazardous wastes would be present at an oil shale facility throughout construction, operation, and reclamation. During construction, hazardous wastes will be limited in both variety and volume, consisting mostly of wastes from the maintenance of construction equipment and the field applications of protective coatings. During operation, a greater variety of hazardous wastes can be expected, with volumes generally proportional to the scale of the operation. Although facility owners/operators may elect to treat and even dispose of their hazardous wastes at the oil shale facility (with appropriate state-issued permits in place), it is reasonable to expect that most would adopt a strategy that minimizes the times and volumes of on-site storage of hazardous wastes, with expeditious transport to off-site, properly permitted TSDFs. Elementary neutralizations of strongly corrosive wastes, as well as preliminary treatment of wastes to stabilize them for storage and transport, might occur on-site but only to the extent that is minimally necessary.

Regulatory requirements to address hazardous materials and waste management already largely address the mitigation of impacts. To reinforce the regulatory requirements, additional mitigation measures and management plans could include the following:

- An individual, written management strategy for each hazardous waste anticipated;

- Written procedures for waste evaluations, containerization, on-site storage, and off-site disposal;

- Inspection procedures for hazardous material transportation vehicles and storage areas;

- Storage requirements for each hazardous material, including container type, required design elements and engineering controls for storage and handling areas (e.g., secondary containment for liquids, fire protection for areas where flammables are used), and chemical incompatibilities;

- Dedicated, restricted access areas for hazardous waste storage, including adequate separations of chemically incompatible wastes;

- Formal, routine, inspections of hazardous waste storage and handling areas;

- In addition to hazardous communication (HAZCOM) training required for workers who handle hazardous materials, awareness training for all facility personnel, including an identification of explicit roles and responsibilities for each individual;

- Limiting access to hazardous material storage and use areas to authorized personnel;

- A comprehensive inventory of all hazardous materials at the facility, including notations of incompatibilities;

- Formal, written standard operating procedures addressing “cradle-to-grave” management, including receipt, containerization, storage, use, emergency response, and management and disposal of spent materials for each hazardous material at the facility;

- “Just-In-Time” purchasing strategies to limit the amounts of hazardous materials present at the facility to just those quantities immediately needed to continue operations;

- Preventative maintenance on all equipment and storage vessels containing hazardous materials;

- Aggressive pollution prevention programs to identify less hazardous alternatives and other waste minimization opportunities;

- Establishment of comprehensive in-house emergency response capabilities to ensure expeditious response to accidental releases; and

- Documentation of all accidental releases of hazardous materials and corrective actions taken; conduct of root cause analyses; determination of the adequacy of response actions (making changes to response capabilities as necessary); assessment of long- and short-term impacts on the environment and public health; initiation of necessary remedial actions; and identification of policy or procedural changes that will prevent reoccurrence.

## 4.14 HEALTH AND SAFETY

Potential health and safety impacts from recovering oil from oil shale can be associated with the following activities: (1) mining of the oil shale (if processing is not in situ); (2) the obtaining and upgrading of the crude oil, either through surface retorting or in situ processing; (3) transport of construction and raw materials to the upgrading facility and transport of product from the facility; and (4) exposure to water and air contamination associated with oil shale development. Hazards from oil shale development are summarized in Table 4.14-1.

**TABLE 4.14-1 Potential Health Impacts Associated with Oil Shale Development[a]**

| Process or Product | Possible Hazard |
|---|---|
| Mining | Pneumoconiosis and/or increased cancer risk from inhalation of rock dust, shale particles, and/or diesel exhaust; physical hazards, including explosions; heat stress; noise. |
| Retorting | Inhalation of or dermal exposure to fumes or particles; noise; inhalation or dermal exposure to contaminants in wastewater (e.g., hydrocarbons, phenols, trace elements, salts, suspended solids, oil, sulfides, ammonia, polycyclic aromatic hydrocarbons [PAHs], and radionuclides). |
| In situ processing | Physical hazards associated with well drilling, use of explosives, noise, and use of steam at high temperature and pressure; inhalation of or dermal contact with fumes or particles in product, recovered process water, or process chemicals. |
| Raw and spent shale storage | Exposure to contaminants in drinking water; concentration of contaminants in edible aquatic organisms; inhalation of airborne particulates. |
| Shale oil products | Potential cancers from dermal contact with or inhalation of volatile products. |
| Combustion products | Inhalation of HAPs from emissions of chemicals (e.g., criteria pollutants, trace elements, sulfur and nitrogen compounds, PAHs, radionuclides). |
| All | Increased physical hazards and exposure risks from transportation of raw materials and products to and from the facility. |

[a] Adapted from DOE (1988) and Brown (1979).

For mining and upgrading activities, the primary health and safety impacts are on facility workers. These worker impacts include physical hazards from accidents (including asphyxiation, heat stress or stroke, explosion, or injuries related to working with large, moving equipment); health risks from chemical exposures (usually inhalation or dermal) to hazardous substances present in oil shale, the oil product, other process chemicals, and wastes; and loss of hearing because of potentially high on-the-job noise levels. This section primarily addresses worker physical hazards and worker chemical exposure risks. Noise risks are discussed in Section 4.7. Potential water and air contamination, which could lead to exposures of the general public, are discussed in Sections 4.5 and 4.6, respectively. Since, in general, water and air standards are set to be protective of public health, the discussion in those sections addresses potential health impacts on the public.

A potential safety impact on the local off-site population that must be considered is risk that arises from an increased volume of vehicular traffic. The presence of construction and product transport trucks on narrow, two-lane roads could create unique hazards for children waiting at the roadside for their school buses. Such hazards would extend, for example, to exposure to particulate dusts created by the large trucks, as well as the increased potential for accidents. Transport of shale oil and other by-products is expected to occur by tractor trailer or by pipeline. Traffic accidents involving those movements or accidents involving the pipelines could also impact public safety.[10]

Several types of potential worker health and safety issues associated with oil shale development were assessed in the early 1980s. One study looked at the potential health effects associated with a 1-million bbl/day oil shale industry employing 41,000 workers (IWG Corp. 1984; Gratt et al. 1984). The health impacts estimated for workers and the general public in that study are summarized in Table 4.14-2 and include uncertainty ranges. The highest number of potential worker deaths is predicted to occur as a result of lung disease caused by inhalation exposures to dusts, although the uncertainty ranges for these estimates are quite large. It was found that the highest number of deaths would occur in the mining population of workers, which represented 50% of the assumed workforce but accounted for 70% of the expected fatalities (Gratt et al. 1984).

A small number of premature deaths and cancer deaths were also predicted to occur in the general public population, again subject to considerable uncertainty. The uncertainties are in large measure due to the inability to accurately predict actual exposures that would occur. If exposures were limited through emission controls and worker safety precautions, the actual number of deaths from dust inhalation would decrease substantially.

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[10] Spent shale would be generated in large quantities in any surface processing technology. However, it is expected that disposal of these tailings would occur on the leased site. Consequently, little if any spent shale would be transported to disposal areas over public roadways. However, other chemical wastes associated with the operation may not be acceptable for on-site disposal and would, therefore, be transported by truck to permitted treatment or disposal facilities.

**TABLE 4.14-2 Estimated Health Effects Associated with a Hypothetical One Million-bbl/day Oil Shale Industry[a]**

| Health Effect | Exposure[b] | Risk per year (Uncertainty Range) Cases | Deaths |
|---|---|---|---|
| Workers | | | |
| Injuries | Accident with days lost | 2,400 (1,700–3,700) | 13 (9–22) |
| Injury | Accident without days lost | 1,500 (1,200–2,200) | NA[c] |
| Cancers | Hydrocarbons, radiation, As | 26 (0–300) | 4 (0–49) |
| Silicosis | Dust | 232 (0–1,070) | 76 (0–387) |
| Pneumoconiosis | Dust | 100 (33–310) | 17 (9–98) |
| Chronic bronchitis | Dust | 41 (13–130) | 17 (9–98) |
| Airway obstruction | Dust | 10 (3–36) | 5 (1–17) |
| High-frequency hearing loss | Noise | 3 (0–8) | NA |
| Public | | | |
| Premature death | Particulate air pollution | NA | 6 (0–47) |
| Internal cancers | As, Cd, Cr, Ni, Radiation, PAHs | NA | 6 (0–47) |

[a] The type of production assumed was 13 facilities using underground mining with aboveground retorting and one facility using a modified in situ technology. The total number of workers assumed was 41,000 (14,200 mining, 6,200 crushing, 9,400 retorting/upgrading, 3,300 construction, 5,600 refining, and 2,200 transportation).

[b] As = arsenic; Cd = cadmium; Cr = chromium, Ni = nickel.

[c] NA = not available.

Source: IWG Corp. (1984).

Rom et al. (1981) summarized health studies conducted for Scottish and Estonian oil shale workers; both countries have had commercial oil shale industries for lengthy time periods (e.g., Scotland from the mid-1800s until the 1960s; Estonia from the mid-1950s to the present). The carcinogenicity of oil shales was first noted in the Scottish workers at the end of the nineteenth century; oil shales produced at higher temperature were found to produce more PAHs, and hydrotreating the shale oil was shown to reduce its carcinogenicity (Twort and Twort 1930). In the Estonian workers, it was also found that the carcinogenicity was highest for the oil shale fractions retorted at the highest temperatures, and that there was no general pattern between the irritant and general toxic and carcinogenic effects of shale oils (Bogovski 1962). A significant excess of skin cancer has also been observed in long-term oil shale workers in comparison with an urban control group (Purde and Etlin 1980). In the United States, several underground oil shale mines and one aboveground retort existed near Rifle, Colorado, from 1946 to 1978. However, studies of these workers have been inconclusive with respect to health impacts.

### 4.14.1 Common Impacts

#### 4.14.1.1 Surface Mining

The hazards associated with surface mining would be similar to those associated with surface mining of other materials. These include the following (Bhatt and Mark 2000; Daniels et al. 1981):

- Injuries from highwall-spoilbank failures;
- Hazards associated with the storage, handling, and detonation of explosives;
- Accidents and injuries from working in close proximity to large equipment (such as shovels, trucks, and loaders) and equipment with moving parts;
- Injury hazards from lifting, stooping, and shoveling; exposure to climate extremes and sun while working outside;
- Inhalation of dust and particulates, possibly containing oil shale; inhalation of exhaust fumes from mining equipment; and
- Elevated noise levels (discussed in Section 4.7).

Highwall failures are very dangerous, often resulting in fatalities when the falling material hits workers. Mine Safety and Health Administration (MSHA) statistics show that there were 428 accidents caused by highwall instability in active coal and nonmetal surface mines from 1988 to 1997; 28 fatalities were recorded (Bhatt and Mark 2000). About one-half of the injuries occurred when the workers were hit directly with the failed highwall material; the other injuries involved the material hitting heavy or miscellaneous equipment. More than one-half of the accidents resulted in lost workdays.

Deaths and injuries from accidental ignition of explosives used to blast the formations and allow removal of the oil shale are a serious hazard of mining operations. Injuries and fatalities may also occur because of the high physical demands of surface mining. Although in some cases large machinery (e.g., draglines and loading machines) could be used to remove the oil shale, a truck-and-shovel approach might also be used. This approach can be more efficient, but it also requires a larger number of employees to conduct the work. It is most likely that excavated oil shale would be trucked to the retorting facility. The degree of mechanization in the surface mining processes used would greatly influence the number of worker injuries. In general, more mechanization would be expected to result in a lower number of worker injuries, because fewer workers would be needed to conduct the mining (although the number of machinery-related injuries would increase).

Injury and fatality incidence from oil shale surface mining is likely to be lower than that from the mining industry generally, since the latter also includes the more hazardous

underground mining accidents. However, as an indicator, the recent statistics for the mining industry as a whole are provided here. Statistics for work-related injuries and deaths show that mining is one of the most hazardous occupations, with approximately 28.3 deaths per 100,000 mine workers in the United States in 2004 (NSC 2006). Because of improved safety practices and the use of more advanced machinery, mining deaths have decreased since the 1970s. For example, the death rate in 1970 was 200 per 100,000 workers; the rate has decreased to about 30 deaths per 100,000 in recent years (DOL 2006). The number of work-related injuries for miners was 3.8 nonfatal injuries per 100 mine workers annually in 2004 (NSC 2006).

Inhalation of dusts generated during the mining process can cause disease. If these are oil shale dusts, they will likely contain polycyclic aromatic hydrocarbons (PAHs),[11] a carcinogenic component of the shale (further discussed in Section 4.14.1.2 below). Chronic inhalation of irritants such as mineral or metal particles causes pneumoconiosis or miner's lung, a condition characterized by nodular fibrotic lung tissue changes. Prolonged inhalation of silica dusts causes a form of pneumoconiosis termed silicosis, which is a severe fibrosis of the lungs that results in shortness of breath. Both conditions can be fatal. Although concentrations of these dusts are lower for surface mining in comparison with underground mining, additive exposures may nonetheless result in these diseases.

#### 4.14.1.2 Surface Retorting

Oil shales are fine-grained sedimentary rocks containing relatively large amounts of organic matter (kerogen) that can yield petroleum when the shale is heated. Oil shales have a wide range of organic and mineral composition. Retorting technologies can potentially allow exposures to gaseous and liquid organic compounds from the crude shale oil formed during kerogen pyrolysis, volatile and gaseous end products (e.g., low molecular weight organic compounds such as methane, ethane, or propane; or by-products such as $H_2S$ and $NH_3$), as well as exposures to dusts and fumes from material handling operations. Also of concern is the potential for exposure to char, the organic residue remaining on the spent shale.

Retorting conditions determine the precise composition of the organic compounds that are produced as gases, which are present in the crude shale oil liquid or present in the solid char residues. It can generally be expected that many of the compounds in the char will be members of the chemical family known as PAHs, exposures to which may result in various health impacts, including carcinogenic effects (ATSDR 1995; EPA 2006; IARC 1983).

The International Agency for Research on Cancer (IARC) has published a monograph on PAHs (IARC 1983), a monograph on shale oils (IARC 1985), and a supplement to that monograph (IARC 1987). Concerns were expressed in the 1985 IARC Monograph about the potential for workers at oil shale development facilities to be exposed to crystalline silica, inorganic gases and vapors (including CO and $H_2S$), and gases and vapors of organic compounds, including low levels of PAHs.

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[11] Also known as polynuclear aromatic hydrocarbons or polynuclear aromatic compounds.

Studies on which the 1985 IARC Monograph were based included testing the carcinogenicity of crude shale oils and other by-products and wastes resulting from retorting of oil shales from various parts of the world, including the Green River Formation. The majority of the tests supporting the 1985 IARC Monograph were conducted on laboratory animals. However, human exposure data also were reviewed. While there were subtle differences between oil shale samples, the general conclusions of the report applied to all of the samples investigated. Salient results of the studies reported on in the 1985 IARC Monograph include the following:

- Dermal exposures of laboratory rats to crude shale oils resulting from retorting of Green River Formation oil shale resulted in the induction of benign and malignant skin tumors.

- Lung tumors in mice were also caused by exposures to crude shale oil from the Green River Formation.

- Spent oil shale samples also were investigated. Dusts from a retorted Green River Formation spent oil shale sample caused lung tumors in rats that experienced inhalation exposures.

- Samples analogous to wastes, by-products, and intermediates of crude shale oil upgrading also were investigated. A “pot residue” from distillation of Green River Formation crude oil shale was carcinogenic to mouse skin after dermal exposures. This pot residue was presumed to be equivalent to the shale oil coke residues that would be produced on-site during crude shale oil upgrading.

- Water recovered from retorts (pyrolysis waters) was found to elicit DNA damage and mutations in bacteria and in cultured mammalian cells following metabolic or photoinduced activations.

Primarily on the basis of the above results and positive results in some mutation assays, the IARC concluded that “there is sufficient evidence for the carcinogenicity in experimental animals of high-temperature crude shale-oils, low-temperature crude shale-oils, fractions of high-temperature shale-oil, crude shale-oil distillation fractions, shale-oil bitumens, and commercial blends of shale-oils” (IARC 1985). The monograph went on to conclude that there was insufficient evidence for similar carcinogenic effects from raw oil shale, spent oil shale, and a residue of shale-oil distillation, and that “there is sufficient evidence that shale-oils are carcinogenic in humans.” The 1987 IARC Supplement reaffirmed the conclusions regarding carcinogenic properties of raw oil shale, crude shale oil, and derivatives obtained through upgrading activities that were contained in the original 1985 IARC Monograph. The Supplement also indicated that no data were available on the genetic and related effects of shale oils in humans (IARC 1987).

Retorting technologies that use open-flame impingement on oil shale (in either aboveground or in situ retorting circumstances) can be expected to result in the evolution of gases of nitrogen, sulfur, and carbon oxides, all of which produce health effects from inhalation

exposure). Exposure to PAHs may be further increased for those retorting technologies that purposefully combust the char to recover latent heat energy.

Crude shale oil contains higher concentrations of nitrogen-bearing compounds than conventional crude oils. Not only does the presence of these compounds introduce complexity into the upgrading or refining of the crude shale oil, they also represent additional exposure hazards to retort and upgrade workers since many of the chemicals exhibit toxic properties. Routson et al. (1979) has summarized the individual nitrogen-bearing compounds that have been identified as being present in typical condensable liquids from kerogen pyrolysis. Researchers have found that the nitrogen content of whole shale oils (i.e., before any upgrading) ranges from 1 to 20% by weight, depending on the source and retorting process used, with the majority of these compounds being in the pyridine family.

Many oil shales contain significant amounts of arsenic. The fate of this arsenic as a result of typical surface retorting often involves the formation of organo-arsenical compounds in crude shale oil. Upgrading activities will commonly include the removal of arsenic compounds through the use of a caustic wash or by adsorption on suitable materials. Both actions result in a solid waste stream or sludge with predictably high concentrations of arsenic. Exposure to these arsenic-bearing wastes can cause toxicity in upgrade facility workers through multiple exposure pathways.

Finally, it is important to note that other technology permutations may introduce additional chemical exposure potentials. For example, chemically assisted techniques for enhanced oil recovery may be used. Substantial quantities of chemicals may be brought to a facility to implement these chemically assisted techniques. Also, in addition to the array of organic chemicals that would be produced during shale oil recovery and processing, other chemicals, including caustic agents, would be present for treatment of steam condensates and raw water to allow for recycling of steam that would most likely be necessary to control costs. Evaluation of the hazards posed by storage and use of these chemicals would be included in required site-specific documentation for facilities using these techniques.

Physical hazards to facility workers during retorting can be associated with equipment and systems. These hazards include potential contact with hot pipes, fluids, and vapors; exposure to ruptured pipes and their contents; accidents from maintenance operations; and physical contact with chemical agents. Comprehensive facility safety plans and worker safety training can minimize these hazards.

#### 4.14.1.3 Underground Mining

The greatest concern for chemical hazards associated with underground mining centers on potential inhalation of airborne dusts (including silica dusts), inorganic gases (e.g., CO and $H_2S$) and organic gases (e.g., methane) by workers. Chronic inhalation of irritants such as mineral or metal particles causes pneumoconiosis or miner’s lung, a condition characterized by nodular fibrotic lung tissue changes. Prolonged inhalation of silica dusts causes a form of pneumoconiosis termed silicosis, which is a severe fibrosis of the lungs that results in shortness

of breath. Both conditions can be fatal. Underground mining activities also present potential inhalation hazards from exhaust fumes from diesel-powered equipment, including diesel fuel vapors and criteria pollutants.

In conventional methods to date, deep oil shale deposits have generally been extracted by drilling and blasting (room and pillar mining). Experimental mine and laboratory tests have shown that, given the proper predispersed concentrations, particle size, and kerogen or sulfur content, oil shale and sulfide ore dust can be ignited and cause an explosion (DOI 1995). When fine particles of a combustible dust (oil shale, sulfide oil, etc.) are suspended in an atmosphere that contains sufficient oxygen to support combustion, a dust explosion can occur.

Physical hazards associated with oil shale mining are similar to those from coal mining and include possible injuries or deaths from cave-ins, asphyxiation, or machinery malfunctions; hearing loss; and heat stress. As stated in Section 4.14.1.1, mining in general (both surface and underground) is one of the most hazardous occupations; there were approximately 28.3 deaths per 100,000 mine workers and 3.8 nonfatal injuries per 100 mine workers in the United States in 2004 (NSC 2006).

#### 4.14.1.4 In Situ Processing

The hazards for steam injection in situ processes are similar to those for thermal retorting, although there is much less potential for exposure to the spent shale, since the shale would remain underground. Steam injection can occur without prior modification to the formation or could be preceded by explosive or hydraulic fracturing of the formation to enhance shale oil recovery. Occupational hazards particularly associated with in situ steam injection processes include the following:

- Physical hazards associated with the high-pressure steam boilers and pumps and compressors used for injection;
- Hazards associated with the storage, handling, and detonation of explosives for modified in situ processes employing explosives to cause or enhance reservoir fracturing;
- Physical hazards associated with well drilling; and
- Exposures to hazardous substances in the recovered shale oil, in recovered process water, and in chemicals used to treat and recycle recovered water.

The hazards associated with the use of explosives are discussed in Section 4.14.1.1. A hazard associated with in situ processes that is not applicable to mined oil shale is well drilling, in order to pump the mobilized shale oil to the surface. The phases of drilling wells include site preparation, drilling, well completion, servicing, and abandonment; each is associated with unique physical hazards (e.g., falling from heights, being struck by swinging equipment or falling tools, and burns from cutting and welding equipment or steam).

In comparison with aboveground retorting, many exposure pathways are more limited for in situ retorting technologies although not completely eliminated. Exposures to char are expected to be greatly minimized if not eliminated, except when purposeful burning of the char for additional heat recovery is practiced. Formation waters and pyrolysis waters recovered from in situ retorting are likely to contain contaminants such as chlorine, carbonates, sulfates, mercury, selenium, arsenic, and various organic compounds such as phenols and carboxylic acids (Walsh 1981). Gaseous and liquid retort products produced in situ will ultimately be recovered to the surface or may dissolve in formation and/or pyrolysis waters that also would be recovered to the surface and handled, treated, or disposed of. Worker dermal and ingestion exposures to pyrolysis waters would be limited through facility safety procedures; however, workers could inhale substances volatilizing from these waste waters.

### 4.14.2 Mitigation Measures

Regulatory requirements to address occupational health and safety issues already largely address the mitigation of impacts. For example, Occupational Safety and Health Administration (OSHA) standards under 29 CFR Parts 1910 and 1926 (1910.109 is specific for explosives) and MSHA standards under 30 CFR Parts 1–99. Also, electrical systems must be designed to meet applicable safety standards (e.g., National Electric Code [NEC] and International Electrochemical Commission [IEC]). To reinforce the regulatory requirements, additional mitigation measures could include the following:

- To address traffic safety, installation of appropriate highway signage and warnings to alert the populace of increased traffic and to alert vehicle operators to road hazards and pedestrian traffic. Construction of safe bus stops for children waiting for school buses; these stops should be located well away from the roadway.

- Recommended mitigation measures to avoid highwall-spoilbank failure include benching, using blasting patterns specifically designed for each mine site, adequate compacting of spoilbanks, and adequate miner training allowing for recognition and remediation of hazardous conditions (Bhatt and Mark 2000).

- The use of appropriate personal protective equipment (PPE) can minimize some safety and exposure hazards.

- Safety assessments for oil shale facilities should be conducted to describe potential safety issues and the means that could be taken to mitigate them.

- A comprehensive facility health and safety program for all project phases should be developed. The program should identify all applicable federal and state occupational safety standards, establish safe work practices for each task, establish fire safety evacuation procedures, and define safety performance standards.

- A comprehensive training program and HAZCOM program should be developed for workers, including documentation of training and a mechanism for reporting serious accidents or injuries to appropriate agencies.

- Secure facility access control should be established and maintained for all oil shale project facilities. Site boundaries should be defined with physical barriers and site access restricted to only qualified personnel.

- Low incendive explosives, coupled with good blasting procedures, should be used in underground mining as a means of greatly reducing the occurrences of dust and/or gas ignitions following blasting operations. Also, general safety measures (e.g., good housekeeping for explosives storage areas; requiring safety training for all workers using explosives) should be followed.

- Hazards from well drilling may be mitigated through use of measures recommended by OSHA (2007).

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# 5 EFFECTS OF TAR SANDS TECHNOLOGIES

In the NOI announcing the preparation of this PEIS (70 FR 73791–73792), the BLM indicated its intent to amend land use plans to allow for leasing of oil shale and tar sands resources in Colorado, Utah, and Wyoming. Through a public scoping process, the BLM solicited comments on the proposed PEIS and undertook additional analysis and consultation as part of the PEIS process. After preparation and analysis of an internal draft PEIS and discussion with its cooperating agencies, the BLM has modified its proposed action and, therefore, the scope of analysis for this PEIS. For tar sands, rather than amending plans to support immediate issuance of leases for commercial development of these resources without further NEPA analysis, the BLM proposes to amend land use plans to (1) identify lands within the designated STSAs that will be open to commercial leasing, exploration, and development; (2) stipulate requirements for future NEPA analyses and consultation activities; and (3) specify that the BLM will consider and give priority to the use of land exchanges to facilitate commercial tar sands development pursuant to Section 369(n) of the Energy Policy Act of 2005. Specific land use plan amendments are provided in Appendix C. (See Chapter 4 for the discussion of oil shale resources.) In the case of both oil shale and tar sands, additional NEPA analysis will be conducted prior to the issuance of leases.

Although the proposal analyzed in this PEIS has now shifted away from supporting issuance of commercial leases of oil shale and tar sands resources, substantial information was identified regarding current and emerging development technologies that will still be useful for decision makers and the public with respect to the proposal to amend the land use plans. Chapter 5 of this PEIS contains summary information on tar sands technologies and their potential environmental and socioeconomic impacts. Also included in this chapter is a brief description of mitigation measures that the BLM may consider using if warranted by the results of NEPA analysis undertaken prior to issuance of site-specific tar sands commercial leases and/or approval of detailed plans of development for facilities. Use of the mitigation measures will be evaluated at that time.

It is important to understand that information on the technologies presented here is provided for the purpose of general understanding and does not necessarily define the range of possible technologies and issues that may develop in the coming years. Prior to approval of future commercial leases, additional NEPA analyses would be completed that would consider site- and project-specific factors for proposed development activities. The magnitude of impacts and the applicability and effectiveness of the mitigation measures would need to be evaluated on a project-by-project basis in consideration of site-specific factors (e.g., existing land use, presence of paleontological and cultural resources, proximity to surface water, groundwater conditions, existing ecological resources, proximity to visual resources) and project-specific factors (e.g., which technologies would be used, magnitude of operations, water consumption and wastewater generation, air emissions, number of employees, development time lines).

## 5.1 ASSUMPTIONS AND IMPACT-PRODUCING FACTORS FOR INDIVIDUAL FACILITIES BY COMMERCIAL TAR SANDS TECHNOLOGY

Although no tar sands development is currently taking place on public lands in Utah, for the purposes of analysis in this PEIS, it is assumed that development is possible in any of the 11 STSAs listed in Table 2.3-1. This section summarizes some of the assumptions and potential impact-producing factors related to the different commercial tar sands technologies being considered, as well as the potential impacts associated with establishing transmission line and crude oil pipeline ROWs and building employer-provided housing. Impact-producing factors are defined as activities or processes that cause impacts on the environmental or socioeconomic setting, such as surface disturbance, water use, numbers of employees hired, and generation of solid and liquid waste. Specifically, this section identifies the data used and assumptions made to define potential impact-producing factors for hypothetical individual tar sands development facilities. The information presented here is summarized, in part, from more detailed discussions contained in Appendix B (the tar sands development background and technology overview), as well as previous environmental documents. In those instances where specific data are not available to define a potential impact-producing factor, best professional judgments have been made to establish reasonable assumptions. Discussions relating to air emissions are not included in this section but instead are presented in Section 5.6.

The technologies considered in this PEIS for tar sands development include surface mines with surface retorts or solvent extraction, and in situ facilities using steam injection or combustion. The application of underground mining technologies for commercial tar sands development was not considered because, at this time, they do not appear to be commercially viable. Available information on impact-producing factors that would be applicable to Utah tar sands development is very limited. Many of the assumptions used to estimate tar sands development impacts in this PEIS are based on published information for a proposed 20,000-bbl/day-capacity plant designed for recovery of oil from a diatomaceous earth tar sands deposit in California (Daniels et al. 1981), or on the Utah Combined Hydrocarbon Leasing Regional Final EIS (BLM 1984)[1]. Future production levels are unknown at this time; for purposes of analysis in this PEIS, to provide a range of impacts, these data were scaled to a production rate of 100,000 bbl/day. However, values for some variables (e.g., acres disturbed, water use, and employment levels) were not considered to have a direct linear relationship to production levels. Alternate assumptions for these variables are discussed, where applicable, in Sections 5.1.1 and 5.1.2. Also, for purposes of analysis, this assessment looks at the potential impacts from a single facility, although the actual level of development that could occur in the future is not known. Subsequent NEPA analysis will occur prior to leasing when more information on specific technologies and production levels is available.

A key assumption is that all applicable federal, state, and local regulatory requirements will be met (see Section 2.2 and Appendix D of the PEIS). Within the following text, specific assumptions that have been made for each technology or major activity that could occur during

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[1] Although more recent data exist from tar sands development ongoing in Canada, those data are not applicable to Utah tar sands because of the different chemical characteristics of the tar sands (i.e., the Canadian tar sands have an aqueous layer between the sand and the bitumen, making separation easier).

commercial operations have been identified. In most instances, these assumptions represent good engineering practice or reflect the BLM's understanding of design or performance limitations of various tar sands development activities. In those instances where various options have equal standing as practicable within the industry, the option offering the greatest potential environmental impacts was selected so as not to inadvertently understate these impacts.

### 5.1.1 Surface Mine with Surface Retort or Solvent Extraction Projects

The information presented in Table 5.1.1-1 identifies the key assumptions associated with surface mining with surface retorting or solvent extraction of tar sands for a facility sized to support production levels of 20,000 bbl/day of oil. These data may be used to extrapolate assumptions for facilities with higher production levels (see Appendix B). Development is assumed to occur with a rolling footprint so that, at any given time, portions of the lease area would be (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing restoration after development; and (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. The mine area and spent tar sands disposal areas would be reclaimed on an ongoing basis. Spent tar sands may be disposed of by being returned to the mine as operations would permit; there also would be some spent tar sands disposal on other parts of the lease area. The amount of land used for spent tar sands disposal would vary from project to project but is expected to be encompassed within the estimated development area identified in Table 5.1.1-1.

Water sources for tar sands surface mine facilities would be varied but may include a combination of groundwater, surface water, and treated process water. Groundwater pumped from the mine or from dewatering wells would be of variable quality; the higher quality water would most likely be used for industrial processes, dust control, and revegetation. Water of lower quality would be reinjected or otherwise disposed of pursuant to state requirements.

Assumptions regarding surface mining, surface retorts, spent tar sands from surface retorting, and upgrading activities associated with surface retorting include the following.

#### Surface Mining

- Surface mining would occur only in areas where the overburden thickness is equal to or less than the thickness of the mined tar sands.
- Topsoil and subsoil removed as overburden would be separately stockpiled and vegetated to mitigate or eliminate erosion.
- When mine site dewatering is necessary, recovered water would be used for fugitive dust control, moisturizing spent tar sands, and other nonconsumptive uses, to the extent allowable given water quality considerations.

**TABLE 5.1.1-1 Assumptions Associated with a Surface Mine with Surface Retort or with Solvent Extraction for Production Levels of 20,000 bbl/day of Syncrude[a,b]**

| Impact-Producing Factor | Value Used in Impact Analyses |
|---|---|
| Footprint of development area (acres)[c] | 2,950 |
| Surface disturbance (acres)[c] | 5,760 |
| Water use for mining (bbl/day)[d] | 25,000 |
| Water use for retort (bbl/day)[d] | 12,000 |
| Water use for solvent extraction (bbl/day)[d] | 107,000 |
| Water use for upgrading (bbl/day)[d] | 386,000 |
| Noise at mine site (dBA at 500 ft) | 61[e] |
| Noise at retort, solvent extraction, or upgrading sites (dBA at 500 ft) | 73–88 |
| Spent (processed) sand (tons/day) | 52,000 |
| Direct employment for surface mining | |
| Construction | 1,200 |
| Operations | 480 |
| Total employment[f] | |
| Mine and retort/extraction facility construction | 1,800 |
| Mine and retort/extraction facility operations | 750 |

[a] Values based on a 20,000-bbl/day facility using a diatomaceous earth deposit (see Appendix B; Daniels et al. 1981), unless otherwise noted.

[b] bbl = barrel; 1 bbl syncrude = 42 gal, 1 bbl water = 55 gal.

[c] These acreages represent the assumed area of surface disturbance that could occur at any given time during the life of the project once commercial production levels are reached. Development is expected to occur with a rolling footprint so that, ultimately, the entire lease area would be developed and then restored. Assumed lease area of 5,760 acres is based on provisions of the MLA as revised by Section 369(j) of the Energy Policy Act of 2005.

[d] See Appendix B for sources for water use values. Approximately 3.5% of the process water used for mining, 100% of that used for a retort, and 22% of that used for solvent extraction would need to be fresh water (Daniels et al. 1981)

[e] Noise level for a 20,000-bbl/day facility is from Daniels et al. (1981).

[f] The total employment values include both direct and indirect jobs. The values are based on average data for both a surface mine and an in situ facility (BLM 1984). The methodology is discussed in Appendix G.

- Explosives would be used in the mining process to remove overburden and fracture the tar sands.

- Raw tar sands would be loaded by shovel into trucks for delivery to the crusher that would be adjacent to the retort and would feed the retort by conveyor belt.

- Strip mine development would provide for disposal of spent tar sands in previously mined areas of the mine, to the extent that the disposal can be accommodated by available capacity.

- Reclamation would be conducted contemporaneously with mining activities.

**Surface Retorts**

- In the absence of additional data, it is assumed the emissions from the surface retorts would be consistent with those from the Lurgi-Ruhrgas retort (see Appendix B).

- Surface retorts would be operated continuously for maximum energy efficiency, and mining and other processing activities that support the retorts would be scaled to provide a relatively constant supply of material to allow the retort to operate continuously at its rated capacity; multiple, simultaneous mining and crushing operations may therefore be required.

- Retorts would be positioned at or near the mine entrance, and tar sands would be delivered by truck to the crushing operation that would be adjacent to the retort and feed the retort by conveyor.

- Primary and secondary crushing would take place adjacent to the retort.

- Flammable gases from retorting would be captured, filtered to remove suspended solids, dewatered, and consumed on-site as supplemental fuel in external combustion devices.

- Condensable liquids would be filtered, dewatered, and delivered to the adjacent upgrading facility.

- Indirect heat sources for surface retort would be provided by external combustion sources fueled by natural gas delivered to the site by pipeline, propane stored in pressure tanks on-site, or diesel fuel provided by commercial suppliers and stored in on-site aboveground tanks. Each commercial fuel source would be supplemented by combustible gases recovered from the retort.

- Fuel for direct-burn surface retorts would be provided by natural gas, propane, or diesel fuel, each of which would be delivered to the site and stored as noted above and supplemented by combustible gases recovered from the retort.

**Upgrading Activities Associated with Surface Retorting**

- All bitumen recovered from the tar sands facilities would require some degree of upgrading.

- At a minimum, upgrading would consist of:

  – Dewatering;
  – Filtering of suspended solids;
  – Conversion of sulfur-bearing molecules to $H_2S$;
  – Removal of $H_2S$ and conversion to elemental sulfur by the use of a conventional Claus process or equivalent;
  – Conversion of nitrogen-bearing compounds to ammonia, recovery of ammonia gas, and temporary storage and sale of ammonia gas as fertilizer feedstock; and
  – Hydrogenation or hydrocracking of organic liquids only to the extent necessary to sufficiently change physical properties (API gravity, pour point) of the resulting syncrude to allow for conveyance from the mine site by conventional means (tanker truck and/or pipeline).

- Hydrogen used in upgrading would be supplied by a commercial vendor and stored temporarily in transport trailers (high-pressure tube trailers) before use in upgrading reactions; no long-term storage of hydrogen would take place on-site; no steam reforming of methane to produce hydrogen would be conducted on-site.

- Fuel for upgrading activities would be commercial natural gas, propane, or diesel, augmented to the greatest extent practical by flammable gases recovered from upgrading activities.

- Water for upgrading would be recovered from surface water bodies (including on-site stormwater retention ponds), mine dewatering operations, or on-site groundwater wells.

- Treatment of wastewaters from upgrading activities would occur on-site; water recycling would be practiced to the greatest extent practical.

**Solvent Extraction**

- Solvent extraction would occur after tar sands were recovered from a surface mine.

- Solvent extraction facilities would be located near the upgrading operations and could be at some distance from the surface mine.

- Preparation of mined sand, such as crushing or screening, would occur adjacent to the solvent extraction facility.

- Since the temperatures involved are not high (212ºF [100ºC] or less), solvent extraction units would not need to operate continuously but could do so to support upgrading operations.

- Solvent would be recycled after separation from the bitumen.

- Although other processes could be used, solvent recovery would be accomplished by steam stripping and evaporation followed by decanting to separate solvent from water.

- Solvent would be stored on-site in aboveground storage tanks.

- Makeup for lost solvent would be delivered to the site by commercial suppliers in tanker trucks.

- In addition to recovery of the dissolved bitumen, recycling would require, at a minimum:

  – Dewatering, particularly if hot or cold water solvent extraction were used (however, in some processes, some of the solvent/water mixture can be recycled without complete dewatering);
  – Removal of spent sand and suspended solids; and
  – Removal of any dissolved gases.

- Process heat and steam would be provided by external combustion sources fueled by natural gas delivered by pipeline, propane stored in pressurized tanks on-site, and/or diesel fuel stored on-site in aboveground tanks and delivered by commercial suppliers.

- Upgrading of the recovered bitumen would be required.

### 5.1.2 In Situ Facilities with Steam Injection or Combustion

The information presented in Table 5.1.2-1 identifies the key assumptions associated with in situ steam injection or combustion projects sized to support production levels of 20,000 bbl/day. These data may be used to extrapolate impacting factors for facilities with higher production levels (see Appendix B). Development is assumed to occur with a rolling footprint so that, at any given time, portions of the lease area would be (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing reclamation after development; and (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots.

**TABLE 5.1.2-1 Assumptions Associated with In Situ Facilities with Steam Injection or Combustion for Production Levels of 20,000 bbl/day of Syncrude[a]**

| Impact-Producing Factor | Value Used in Impact Analyses |
|---|---|
| Footprint of development area (acres)[b] | 80–200 |
| Surface disturbance (acres)[b] | 5,760 |
| Water use for steam injection (bbl/day)[c] | 100,000 |
| Water generated through combustion (bbl/day)[c] | (40,000) |
| Water use for upgrading (bbl/day)[c] | 386,000 |
| Noise at upgrading site (dBA at 500 ft)[d] | 73–88 |
| Direct employment for in situ | |
| Construction | 1,200 |
| Operations | 480 |
| Total employment[e] | |
| Steam injection or combustion facility construction | 1,830 |
| Steam injection or combustion facility operations | 750 |

[a] bbl = barrel; 1 bbl syncrude = 42 gal, 1 bbl water = 55 gal.

[b] These acreages represent the assumed area of surface disturbance that could occur at any given time during the life of the project once commercial production levels are reached. Development is expected to occur with a rolling footprint so that, ultimately, the entire lease area would be developed and then restored. Assumed lease area of 5,760 acres is based on provisions of the MLA as revised by Section 369(j) of the Energy Policy Act of 2005.

[c] See Appendix B for sources for water use values. For steam injection, they are based on an estimated 5 bbl of water use per bbl of syncrude produced; for combustion, the basis is 1 to 2 bbl of wastewater produced per bbl of syncrude. For upgrading, the water use represents evaporative losses from the coker unit.

[d] Noise level for a 20,000-bbl/day facility is from Daniels et al. (1981).

[e] The total employment values include both direct and indirect jobs. The values are based on average data for both a surface mine and an in situ facility (BLM 1984). The methodology is discussed in Appendix G.

Water for tar sands facilities using in situ production would come from wells, surface sources, and treated process water. Groundwater and process water would be of variable quality, with the higher quality water being used for industrial processes, dust control, and revegetation. Water of lower quality would be reinjected or otherwise disposed of pursuant to state requirements.

Additional assumptions regarding in situ combustion or steam injection include the following:

- Some degree of upgrading of the bitumen can be expected to occur within the formation, before product recovery occurs.

- Upgrading of recovered products would be required and is likely to include:
  - Dewatering;
  - Gas/liquid separations;
  - Filtering of suspended solids from both gaseous and liquid fractions;
  - Removal of $H_2S$ gas, treatment to elemental sulfur, temporary on-site storage, and sale;
  - Removal of ammonia gas, temporary on-site storage, and sale as fertilizer feedstock;
  - Hydrogenation/hydrotreating/hydrocracking performed on condensable liquids only if necessary to adjust API gravity and viscosity to allow for transport by conventional means (tanker truck transport and/or pipeline) to a conventional petroleum refinery;
  - Temporary storage of recovered and/or upgraded liquid products on-site in aboveground tanks before delivery to market or conventional petroleum refineries by tanker truck or pipeline; and
  - Dewatering of 100% of flammable gases recovered from the formation, then filtering of suspended solids, and consumption on-site as supplemental fuel in external combustion sources.

### 5.1.3 Transmission Line and Crude Oil Pipeline ROWs

Tar sands projects (except those at the Tar Sand Triangle STSA) would need to connect to the existing transmission grid (or to new regional transmission lines) to obtain electricity. The maximum distance from an existing 500-kV transmission line to any of the STSAs is approximately 140 mi. The maximum distance from an existing 230-kV transmission line to any of the STSAs is approximately 80 mi. The greater distance of 140 mi has been assumed for all hypothetical tar sands projects, although some projects would be located at shorter distances from existing transmission lines. Project economics would likely select for sites closest to existing infrastructure.

For the purposes of analyses, it is assumed that one connecting transmission line and ROW would serve any tar sands project and would be 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide (equivalent to a disturbed area of 1,700 acres during operations and 2,500 acres during construction). The 140-mi distance assumption and 100-ft ROW size represent probable maximum sizes. Power needs at the Tar Sand Triangle STSA would be expected to be met by on-site power generation because the remote location of this STSA would likely preclude extensive transmission line construction.

In addition, it is assumed that tar sands projects would need to connect to existing regional crude pipelines (or to new regional pipelines) through the installation of new feeder pipelines. It is assumed that one pipeline and ROW would serve each project. The maximum length from an existing pipeline to any tar sands resource is approximately 95 mi. For purposes of analysis, it is assumed that these pipeline ROWs would be 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (equivalent to a disturbed area of 570 acres

during operations and 1,200 acres during construction). The 95-mi distance assumption and 100-ft ROW size represent probable maximum sizes.

### 5.1.4 Workforce Operational Details and Employee Housing

A number of assumptions have been made regarding the operations schedule and housing for workers who move into the study area to support future commercial tar sands development. It is assumed that at commercial scale, all projects would operate 24 hours a day, 7 days a week. It is further assumed that about 30% of the construction and operations workers, including those hired directly to work on tar sands projects as well as those hired for jobs indirectly related to the development, would bring families with them, with an average family size of 2.6 (see Section 5.11). Some portion of these incoming people would live in housing provided by the operators. The locations of the employer-provided housing are unknown at this time; however, housing is not expected to be located on public lands. Employer-provided housing would be constructed as needed to house the workforce and provide facilities and infrastructure (e.g., groceries, basic medical care, schools, and recreation). A density of 35 people per acre is assumed for this employer-provided housing.

The BLM has made assumptions regarding what percentage of workers and their families would be housed in employer-provided housing, as opposed to those that would move into existing communities. Section 5.11 provides a more detailed discussion of these and related assumptions. Table 5.1.4-1 provides estimates of the number of people that would be housed in local communities versus employer-provided housing, and the number of acres that would be required to support the employer-provided housing by technology.

**TABLE 5.1.4-1 Estimated Housing Distribution of Incoming People, and Acres Impacted by Employer-Provided Housing for the Construction and Operations Phases of Commercial Tar Sands Development**

| Parameter | Construction | Operations |
|---|---|---|
| Total population (including families)[a] | | |
| Employer-provided housing | 1,700 | 450 |
| Local communities | 930 | 640 |
| Maximum size of employer-provided housing (acres)[b] | 49 | 13 |

[a] The total population, including families, is calculated on the basis of the total number of new direct and indirect workers that would move into the area, assuming that 30% of them would bring families with an average family size of 2.6 people.

[b] These estimates are based on an assumed density of 35 people per acre for employer-provided housing. This acreage is not expected to be on public lands.

### 5.1.5 Expansion of Electricity Generating Capacity

Given the limited amount of electrical power needed, power needs for commercial development projects at the STSAs would be met by anticipated expansion of existing coal-fired plants in Utah. Power needs for any projects at the Tar Sand Triangle STSA are expected to be met by on-site power generation because of the remote location of this STSA.

### 5.1.6 Refining Needs for Tar Sands Development Projects

Factors that would likely impact the incorporation of tar sands–derived crude into the refinery market are discussed in Attachment B1 to Appendix B. This attachment specifically examines the anticipated refinery market response to potential tar sands production over the 20-year timeframe assessed in this PEIS. It provides a brief overview of the U.S. petroleum refinery market and identifies some of the major factors that would influence decisions regarding construction or expansion of refineries and displacement of comparable volumes of crude. On the basis of the discussion in Attachment B1, it is concluded Utah tar sands–derived crude oil and/or asphalt that might be produced during the 20-year time frame evaluated in this PEIS (up to approximately 300,000 bbl/day) would not trigger significant expansions in either long-range crude transportation pipelines or refineries, either within the region or beyond. Therefore, additional refinery capacity is not considered to be necessary as a result of tar sands development and is not further considered in this PEIS. It is assumed that all processing required to upgrade the product(s) to render them suitable for pipeline transport and acceptance at refineries would be conducted on-site.

### 5.1.7 Additional Considerations and Time Lines

The above assumptions broadly describe the impact-producing factors for commercial tar sands development. Within these general facility and descriptions, many permutations are possible. For example, various surface retort designs exist, and each has a unique set of environmental impacts and resource demands. A detailed definition of each possible permutation and a subsequent analysis of its impacts would be impractical and speculative, because there is no means of identifying the precise development schemes that may be proposed by future developers. Furthermore, while it is likely that commercial development would be accompanied by the centralization or consolidation of some services (e.g., product storage, waste management, and equipment maintenance), it is not possible at this time to predict how this would evolve. This PEIS, therefore, provides an analysis of the range of impacts from each of the major technologies that might be deployed in the future, along with an analysis of the supporting services that would be required by each technology, but it does not analyze specific facility configurations or technology combinations. Efficiencies and economies that would be realized from integrated systems or centralized services are not considered. As a result, outcomes from this analysis could inadvertently overstate some impacts only if the resulting impacts are added together to accommodate multiple projects.

Although there are many unknowns with respect to time lines for construction and operations of commercial-scale tar sands production facilities, in general, it can be assumed that projects using in situ technologies would require about 3 years of construction and permitting before pilot testing, that pilot testing would last 6 years, and that additional construction to scale up to commercial levels would take 2 more years. It can be assumed that the permitting and construction phases for surface mines would take longer than such phases for in situ projects, such that construction and permitting before pilot testing would take about 7 years, pilot testing would last 6 years, and permitting and construction to scale up to commercial levels would take 5 more years. For all commercial tar sands projects, regardless of the technologies used, it can be assumed that maximum production levels would be reached after 3 to 5 years of commercial operations.

## 5.2 LAND USE

### 5.2.1 Common Impacts

As discussed in Section 3.1, lands within Utah where commercial tar sands development might occur are currently used for a wide variety of activities, including recreation, mining, hunting, oil and gas production, livestock grazing, wild horse and burro herd management, communication sites, and ROW corridors (e.g., roads, pipelines, and transmission lines). Commercial tar sands development activities would have a direct effect on these uses, displacing them from areas being developed to process tar sands.

Indirect impacts of tar sands development would be associated with changes in existing off-lease land uses, including the conversion of land in and around local communities from existing agricultural, open space, or other uses to provide services and housing for employees and families who move to the region in support of commercial tar sands development. Increases in traffic, increased access to previously remote areas, and development of tar sands facilities in currently undeveloped areas would continue changing the overall character of the landscape that had already begun as a result of oil and gas development. The value of private ranches/residences adjacent to tar sands developments or ROWs may be reduced because of perceived noise, human health, or aesthetic concerns.

Although transmission and pipeline ROWs associated with commercial tar sands development would not necessarily preclude other land uses, they would result in both direct and indirect impacts. Direct impacts (e.g., the loss of available lands to physical structures, maintenance of ROWs free of major vegetation, maintenance of service roads, and noise and visual impacts on recreational users along the ROW) would last as long as the transmission lines and pipelines were in place. Indirect impacts (e.g., the introduction of or increase in recreational use to the area due to improved access, avoidance of the area adjacent to public lands for residential or recreational use for aesthetic reasons, and increased traffic) could occur and be long-term.

The specific impacts on land use and their magnitude would depend on project location; project size and scale of operations; proximity to roads, transmission lines, and pipelines; and development technology. The following sections discuss the common impacts on different types of land uses and potential mitigation measures that may be applicable on a site-by-site basis.

#### 5.2.1.1 Other Mineral Development Activities

As discussed in Section 1.4.2, in October 2005, in response to Section 350 of the Energy Policy Act of 2005, the BLM issued an interim final rule on leasing in STSAs (70 FR 58610–58516). The interim rule replaced the CHL Program that was established in 43 CFR Part 3140 in 1983. Under the new interim rule, within the designated STSAs, the BLM is authorized to issue separate leases for tar sands development, separate leases for oil and gas development, and CHLs in any areas that contain tar sands and oil or gas resources. This rule paves the way for tar sands development to coincide with oil and gas development in the future, as deemed appropriate at the time of leasing. However, simultaneous development of tar sands and other mineral resources would require coordination of extraction technologies and schedules. As a result, commercial tar sands development might be incompatible in those portions of the STSAs that already are undergoing or leased for other mineral development activities and will likely preclude these activities, such as the development of oil and gas resources while oil shale development and production is ongoing. Areas with tar sands resources where there are existing oil and gas or other mineral leases may be precluded from development, because currently the leases that are first in time have priority. Without some accommodation being made between tar sands developers and prior lease holders, tar sands development may not be able to proceed. Conflicts between competing mineral resource uses would be resolved in the future at the leasing stage or plan of development stage.

In those areas where commercial tar sands leases would overlap with other existing leases, the right to develop under the primary lease (i.e., the lease issued first) would prevail unless the lease holders negotiated some other arrangement. In areas where no other mineral development lease was held, the issuance of a commercial tar sands lease would establish a primary right to development.

The authorization of ROWs for connecting transmission lines and oil pipelines supporting commercial tar sands projects would result in fewer impacts on other mineral development activities than would the commercial tar sands development projects. It is assumed that the ROWs could be located in a manner that would largely avoid impacts on mineral development activities by avoiding areas of mineral development or by being co-located in a manner that is consistent with planned resource development.

#### 5.2.1.2 Grazing Activities

Grazing activities would be precluded by commercial tar sands development in those portions of the lease area that were (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing restoration after development; or (4) occupied by

long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. Grazing might be possible in the remaining undeveloped portions of the lease area or on portions that were successfully restored after development. On the basis of assumptions discussed above regarding the amount of land that would be disturbed at any given time for different technologies, it is possible that 2,810 to 5,680 acres within a 5,760-acre lease area would remain available for grazing. Depending on conditions unique to the individual grazing allotment, temporary or long-term reductions in authorized grazing use may be necessary because of loss of a portion of the forage base.

Once established, transmission line and pipeline ROWs would not prevent the use of any land for grazing other than the areas physically occupied by aboveground facilities. The establishment of employer-provided housing might preclude grazing activities, depending on how the housing is developed and the location, although this development is not expected to occur on public lands.

#### 5.2.1.3 Recreational Land Use

Commercial tar sands development activities are largely incompatible with recreational land use (e.g., hiking, biking, fishing, hunting, bird watching, OHV use, and camping). As discussed in Section 5.2.1.2 regarding grazing activities, recreational land use could be precluded from those portions of the lease area, depending on the technology employed. While recreational use could be possible in undeveloped or restored portions of the lease area, the amount of land that would be available would vary from project to project. The change in the overall character of the undeveloped BLM-administered lands to a more industrialized, developed area would displace people seeking more primitive surroundings in which to hunt, camp, ride OHVs, etc. Many BLM field offices have designated lands as open, closed, or available for limited OHV use. Areas that would be open to application for commercial tar sands development may be currently available for some level of OHV use, and commercial tar sands development in these areas would displace this use. Even if access could be granted to portions of the lease area for recreational use, visitors might find the recreational experience to be compromised by the nearby development activities. Such impacts could also occur on recreational users of adjacent, off-lease lands. In addition, impacts on vegetation, development of roads, and displacement of big game could degrade the recreational experiences and hunting opportunities near commercial tar sands projects. To the extent that commercial developments might be clustered, the effect on recreation uses would be magnified by changing the overall character of a larger area and by dominating a larger portion of the landscape.

Once established, transmission line and pipeline ROWs would have fewer impacts on recreation users than would the actual commercial development projects. Access to the land in the ROWs would not be precluded; however, depending on the type of recreation, the overall recreational experience could be adversely affected by the visual disturbance to the landscape and potential noise impacts associated with overhead transmission lines. The establishment of employer-provided housing, although not likely to be located on public lands, would preclude recreational land use and might cause indirect impacts on recreational land use on adjacent lands, depending on how the housing is developed and the location.

#### 5.2.1.4 Specially Designated Areas, Potential ACECs, and Areas with Wildernesss Characteristics

As discussed in Section 1.2, the BLM has determined that certain designated areas are excluded from commercial tar sands leasing. These areas include all designated Wilderness Areas, WSAs, other areas that are part of the NLCS (e.g., National Monuments, NCAs, WSRs, and National Historic and Scenic Trails), and existing ACECs that are closed to mineral development. Because of these exclusions, these designated areas would not incur direct impacts associated with commercial tar sands development. They might, however, incur indirect impacts (e.g., dust and degraded viewshed) resulting from commercial tar sands development on adjacent lands or areas within the general vicinity. Section 5.9 discusses impacts on visual resources in greater detail.

Existing ACECs that are not closed to mineral development and potential ACECs that are currently under consideration for designation as part of ongoing land use planning efforts would be available for application for commercial leasing in the future. In general terms, commercial development in both existing and potential ACECs could result in direct or indirect loss of the R&I values that support either designation or identification of the areas leading to the removal/nondesignation of the ACECs. Decisions regarding either the designation of the potential ACECs or commitment of the areas to other uses would be made by local BLM Field Offices utilizing the BLM planning process and NEPA analyses.

Another category of lands are those that have been recognized by the BLM as having one or more wilderness characteristics yet are not eligible for formal recognition as a WSA. Lands that have been identified in this manner by BLM are discussed in Section 3.1. Commercial tar sands development activities and the development of transmission line and pipeline ROWs within these areas would cause a loss of the wilderness characteristics in and around the disturbed areas. Commercial development on adjacent lands or within the general vicinity of an area with wilderness characteristics could result in both direct and indirect impacts on the wilderness attributes. Decisions regarding either the protection and management of such wilderness characteristic areas or committing the areas to other uses would be made by local BLM Field Offices utilizing the BLM planning process and NEPA analyses.

All specially designated areas, potential ACECs, and areas with wilderness characteristics that are located in the vicinity of the STSAs are identified in Section 3.1.

#### 5.2.1.5 Wild Horse and Burro Herd Management Areas

As discussed in Section 3.1.1, the STSAs coincide with a number of designated Wild Horse and Wild Burro HMAs. Specifically, the following HMAs overlie the STSAs: the Muddy Creek, Sinbad, and Range Creek Wild Horse HMAs and the Sinbad Wild Burro HMA in the Price Field Office; the Canyon Lands Wild Burro HMA in the Richfield Field Office; and the Hill Creek Wild Horse HMA in the Vernal Field Office. At least some portion of each of these HMAs coincides with lands proposed to be available for application for leasing under the tar sands alternatives.

As discussed in Section 5.2.1.2 regarding grazing activities, the management of wild horse and burro herds is not compatible within those portions of commercial tar sands lease areas that are (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing reclamation after development; or (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. Animals would likely be displaced from the areas of commercial development, and, depending on the conditions in the individual HMA, it might be necessary to reduce herd numbers to match forage availability on the undisturbed portion(s) of the HMA. If horses emigrate out of HMA boundaries because of the disturbance within the HMA, they could be removed via the capture and adoption program. Transmission line and pipeline facilities would not prevent use of the land by horses or burros other than in the areas physically occupied by aboveground facilities, although they could be subject to disturbance or harassment from people using the ROWs for access. For more information about impacts on wild horses, see Section 5.8.1.3 and Table 5.8.1-1.

#### 5.2.1.6 Different Tar Sands Development Technologies

For the most part, impacts on land use would be the same regardless of the development technology used. However, the amount of potential land disturbance would vary by technology. Assuming a rolling footprint of development for in situ projects involving either steam injection or combustion, the acreage disturbed at any given time is expected to range from 80 to 200 acres. For surface mining projects coupled with either surface retorting or solvent extraction, the estimated area of disturbance at any given time is 2,950 acres.

### 5.2.2 Mitigation Measures

The direct and indirect impacts on land use described above could be mitigated to some extent by a number of actions, including, in some instances, application of specific engineering practices. The effectiveness of these potential mitigation measures and the extent to which they are applicable would vary from project to project and would need to be examined in detail in future NEPA reviews of project plans of development. Potential mitigation measures include these:

- Consulting with federal and state agencies, property owners, and other stakeholders as early as possible in the planning process to identify potentially significant land uses and issues, rules that govern commercial tar sands development locally, and land use concepts specific to the region;

- During the project design and planning phase, incorporating considerations regarding the use of lands in undeveloped or restored portions of the lease area to maximize their potential for other uses (e.g., grazing, recreational use, or wild horse or burro herd management);

- During the project design and planning phase, incorporating considerations regarding the use of adjacent lands to minimize direct and indirect off-lease land use impacts;

- During the project design and planning phase, providing for consolidation of infrastructure wherever possible to maximize efficient use of the land;

- During the design, siting, and planning phase for employer-provided housing, incorporating considerations regarding the use of adjacent lands to minimize direct and indirect off-lease land use impacts; and

- Developing and implementing effective land restoration plans to mitigate long-term land use impacts.

To address more specific impacts on land use, such as impacts on grazing, recreational use, and wild horse herd management, potential mitigation measures could also include the following:

- Coordinating the activities of commercial operators with livestock owners to ensure that impacts on livestock grazing on a portion of a lease area were minimized. Issues that would need to be addressed could include installation of fencing and access control, delineation of open range, traffic management (e.g., vehicle speeds), and location of livestock watering sources.

- Coordinating the activities of the commercial operators with the BLM and local authorities to ensure that adequate safety measures (e.g., access control and traffic management) were established for recreational visitors.

- Coordinating the activities of the commercial operators with the BLM to ensure that impacts on the wild horse herds and their management areas were minimized. Issues that would need to be addressed could include installation of fencing and access control, delineation of open range, traffic management (e.g., vehicle speeds), and access to water sources.

## 5.3 SOIL AND GEOLOGIC RESOURCES

### 5.3.1 Common Impacts

The potential impacts on soil and geologic resources would vary somewhat according to the four different technologies under consideration. There would also be some STSA-specific impacts. However, many of the impacts would be common to each technology and common to project phases. This section discusses the common impacts on soil resources and geologic resources, including phase-specific impacts.

#### 5.3.1.1 Soil Resources

Tar sands operations could have an impact on soil resources. A significant concern is increased soil erosion because of ground disturbance. This problem pertains to each technology considered in this PEIS.

Soil erosion varies with location within and among the STSAs, generally ranging from moderate to high, depending on local conditions of soil properties and slope. Individual project sites would need to be assessed to determine their erosion potential. The San Rafael STSA is the only STSA with a very high level of erosion over a significant portion of its land area. Cryptobiotic soils are present in some portions of Utah and may be present in the study area. The biological crusts, when intact, serve to reduce wind and water erosion of these soils.

Soil erosion can be increased in areas disturbed through construction activities. The maximum land area that is assumed to be disturbed for tar sands facilities is the entire leased area for surface mines and in situ facilities (up to 5,760 acres). The degree of the impact depends on factors such as soil properties, slope, vegetation, weather, and distance to surface water. Specific activities that could create soil erosion (and possibly increase turbidity in surface water) include removal and stockpiling of overburden for surface mining (and, to a lesser extent, for subsurface mining); traffic on unpaved roads; and erosional gullies formed on land regraded for in situ work areas, support facilities, roads, etc. Surface disturbance may include vegetation clearing, grading, and contouring that can affect the vegetation, soil structure, and biological crust, thereby increasing erosion potential. The drainage along roads may contribute additional soil erosion as surface runoff is channeled into the drainages. Compaction by vehicles or heavy equipment may reduce infiltration and promote surface runoff. Wind erosion would be enhanced though ground disturbance.

The construction or installation of other facilities in addition to buildings and of utilities would require disturbance of soil. These activities would include, but not be limited to, utility tower installation, telephone pole installation, parking area construction, buried utility installation (e.g., water mains, wastewater lines, and electrical or communication cables), drilling to prepare for in situ operations, drilling for resource evaluation, and drilling for groundwater monitoring well installation. Some of these activities, such as exploratory drilling and road grading, may also take place during preliminary site assessment.

ROWs for transmission lines would be built to connect all project sites with regional utilities except those located at the Tar Sand Triangle STSA, where power needs are expected to be met by on-site generation. These ROWs would cause up to 1,700 acres of longer-term disturbance and 2,500 acres of disturbance during construction (see Section 5.1.3). A pipeline ROW is also assumed to be constructed for each project site (up to 570 acres of longer-term disturbance and 1,200 acres disturbed during construction). Likewise, employer-provided housing would likely be built, which would have a limited longer-term disturbance (e.g., housing would occupy approximately 49 acres during construction of a commercial tar sands facility). The locations of employer-provided housing are unknown at this time; however, housing is not expected to be located on public lands.

Erosion rates are expected to be higher along ROWs and at construction sites, access roads, surface mines, and river banks. Site grading and drainage design would cause changes in the local hydrology and may result in increased runoff focused at certain discharge locations. This situation may cause increased erosion in creeks and drainages and on hill slopes, with subsequent increases in downstream sediment loads. Following site construction, soil conditions may stabilize, resulting in reduced erosion and sediment input to surface water. Localized erosion may continue to take place, requiring maintenance and remedial measures.

The pipelines associated with tar sands development would include those conveying hydrocarbons extracted from in situ retorting or from surface retorts or upgrading facilities, as well as possible pipelines for water or sanitary waste. Flood events have the potential to cause pipeline breakage and subsequent contamination of surface water.

Soil and geology impacts would differ during tar sands operations depending on the technological approach. All techniques would affect ongoing situations with soil erosion and runoff management in areas of disturbed soil (water and wind erosion, rutting, potential salinity impacts, etc.) as described above. All four technologies would result in widespread ground disturbance and associated problems related to erosion and increased sediment and salinity input to streams. The use of pesticides and herbicides and accidental spills or leaks of product, fuels, or chemicals could result in soil contamination. The potential soil contamination would be localized in extent and could be addressed with appropriate remediation measures.

The surface mining approach requires removing and stockpiling the overburden, source rock, and waste rock, thereby creating a potentially large source of sediment and salinity in site runoff. Up to 2,950 acres would be disturbed at any one time during commercial operations, with a total of 5,760 acres potentially disturbed. The various stockpiles are also susceptible to wind erosion. Much of the spent sands could be returned to the mine, but some overflow would be placed in disposal areas outside the excavation. Ongoing stabilization of the waste piles would likely be required.

In situ techniques would result in rolling operations areas, with continuous ground disturbance areas and reclamation areas. In situ techniques are estimated to result in smaller disturbed land areas than surface mining techniques, with 80 to 200 acres disturbed at any one time. A total of 5,760 acres would potentially be disturbed and subject to erosion and sediment runoff.

During reclamation, potential geologic and soil impacts would be similar to those during the construction phase. The replacement of stockpiled topsoil on former work or support areas, roads, or in reclaimed surface mines would require time for reestablishment with stabilizing vegetation, and these areas may be a source of erodable material depending on factors such as slope and weather conditions. Monitoring of soil reclamation areas for erosion and ecology are also part of a reclamation phase (DOI and USDA 2006).

Tar sands development may have a significant impact on surface water quality in the greater Colorado River Basin because of ground disturbance. As discussed in Section 5.5, soil erosion increases both the sediment load to streams and the salinity of runoff reaching these

streams. Increases in surface water salinity due to project site runoff could be high. The sensitivity of the surface water throughout the PEIS study area makes soil management a key factor in environmentally acceptable energy development. The infiltration of precipitation through stockpiled tar sands or through waste piles of spent material has the potential to impact surface water or shallow aquifers with leached hydrocarbons and salts.

#### 5.3.1.2 Geologic Resources

A variety of other geologic resources are present in the STSAs. Tar sands development could impact these resources, including contributing to the loss of resources. Sand and gravel and crushed stone supplies are widespread throughout the study areas, and their use at project sites (for construction, fill, etc.) would not be expected to impact their availability.

Oil and gas occur at P.R. Spring and Pariette STSAs, are likely at Hill Creek and Raven Ridge STSAs, and are possible at other STSAs. Significant oil shale is present stratigraphically above the tar sands along the northern edge of P.R. Spring, Hill Creek, Pariette, and Raven Ridge STSAs. Coal occurs at the Sunnyside STSA at a depth that would require underground mining. Coal is also possible at the Hill Creek, P.R. Spring, and Asphalt Ridge STSAs. Uranium may occur in localized areas at Circle Cliffs, Tar Sand Triangle, White Canyon, and San Rafael STSAs. Localized copper deposits are present at the San Rafael STSA.

### 5.3.2 Mitigation Measures

Various mitigation measures may be taken to reduce the impact of tar sands activities on soil and geologic resources during construction, operations, and reclamation. The subsequent effects on water quality may therefore be reduced (see Section 5.5).

- Guidance, recommendations, and requirements related to management practices are described in detail in the BLM Solid Minerals Reclamation Handbook (BLM 1992), the BLM Gold Book (DOI and USDA 2006), BLM pipeline crossing guidance (Fogg and Hadley 2007), and in BLM field office RMPs. These actions include, but are not limited to, minimizing the amount of disturbed land; stockpiling topsoil prior to construction or regrading; mulching and seeding in disturbed areas; covering loose materials with geotextiles; using silt fences to reduce sediment loading to surface water; using check dams to minimize the erosive power of drainages or creeks; and installing proper culvert outlets to minimize erosion in creeks.

- Surface pipeline crossings must be constructed above the highest anticipated flood stage, and subsurface crossings must be installed below the scouring depth. The BLM (Fogg and Hadley 2007) provides guidance on hydraulic analysis necessary for proper design of pipeline crossings.

- Mapping of highly erosive soils and soils with a high salt content should be performed in proposed project areas and on their connecting roads, so that site-specific information could be used to guide project planning. A proper road grading analysis should be performed to reduce the potential for problems such as erosion or cut slope failure (DOI and USDA 2006).

- The revegetation and restoration potential of soil, as was the case for many other soil factors described above, is site-specific and would be addressed in a project-level NEPA analysis. Mitigations involving soil erosion control, stabilization, and reseeding would limit the impact of soil erosion.

- Stockpiling of topsoil prior to the construction of roads, parking areas, buildings, work areas, or surface mining is a practice that should aid reclamation efforts following the completion of work activities in a certain area. During reclamation, replacement of the stockpiled topsoil would aid in a return to somewhat natural conditions for local vegetation.

- Detailed geotechnical analyses would be required to address the stability of quarry walls and slopes; these analyses would include an assessment of slope cuts for the creation of roads or work areas.

- Site-specific soil mapping would be necessary in assessing the condition of any proposed project site. Geologic resources may vary at the STSAs, and current information on exploration would be required to understand the potential for conflict between tar sands development and other energy or mineral development. Geologic hazards are expected to be similar among the STSAs, with varying potential for landslides.

## 5.4 PALEONTOLOGICAL RESOURCES

### 5.4.1 Common Impacts

Significant paleontological resources could be affected by commercial tar sands development. The potential for impacts on paleontological resources from commercial tar sands development, including ancillary facilities such as access roads, transmission lines, pipelines, and employer-provided housing, is directly related to the amount of land disturbance and the location of the project. Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces and from increased accessibility to possible site locations, are also considered.

Impacts on paleontological resources could result in several ways, as described below.

- Complete destruction of the resource could result from the clearing of the project area; grading, excavation, and construction of facilities and associated

infrastructure; and extraction of the tar sands resource, if paleontological resources are located within the development area.

- Degradation and/or destruction of near-surface resources could result from the alteration of topography; alteration of hydrologic patterns; removal of soils; erosion of soils; runoff into and sedimentation of adjacent areas; and oil or other contaminant spills if near-surface paleontological resources are located near the project area. Such degradation could occur both within the project footprint and in areas downslope or downstream. While the erosion of soils could negatively impact near-surface paleontological localities downstream of the project area by potentially eroding away materials and portions of sites, the accumulation of sediment could serve to protect some localities by increasing the amount of protective cover. Agents of erosion and sedimentation include wind, water, ice, downslope movements, and both human and wildlife activities.

- Increases in human access and subsequent disturbance (e.g., looting and vandalism) of near-surface paleontological resources would result from the establishment of corridors or facilities in otherwise intact and inaccessible areas. Increased human access (including OHV use) exposes paleontological sites to a greater probability of impact from a variety of stressors.

Paleontological resources are nonrenewable; once they are damaged or destroyed, they cannot be recovered. Therefore, if a paleontological resource was damaged or destroyed during tar sands development, it would constitute an irretrievable commitment of this scientific specimen. Data recovery and resource removal are ways in which at least some information can be salvaged should a paleontological site be developed, but certain contextual data are invariably lost. The discovery of otherwise unknown fossils would be beneficial to the scientific community, even if such resources were ultimately lost, but only if sufficient data were recorded prior to destruction or loss.

### 5.4.2 Mitigation Measures

For all potential impacts, the application of mitigation measures developed in consultation with the BLM could reduce or eliminate (if avoidance of the resource is chosen) the potential for adverse impacts on significant paleontological resources. Consultations between the operator and the BLM would be required for all projects before lease areas could be developed. The use of BMPs, such as training and education programs to reduce the amount of inadvertent destruction to paleontological sites, could also reduce the occurrences of human-related disturbances to nearby sites. The specifics of these BMPs would be established in project-specific consultations between the operator and the BLM.

A paleontological overview was completed for the project area (Murphey and Daitch 2007). The overview synthesized existing information and generated maps showing areas with the potential fossil yield classification and paleontological condition. This phase of the

analysis did not identify geographical areas that would preclude moving areas forward for leasing. During the leasing phase, the overview will be reviewed to help determine areas of sensitivity and appropriate survey and mitigation needs.

Mitigation measures to reduce impacts on paleontological resources would be required and could include the following:

- The sedimentary context of the project area and its potential to contain paleontological resources would be identified prior to development in consultation with the BLM. A records search of published and unpublished literature may be required for past paleontological finds in the area. Paleontological researchers working locally in potentially affected geographic areas and rock units may be consulted in order to obtain invaluable information and insights that should be taken into account when considering alternative actions and developing mitigation strategies. Depending on the extent of paleontological information, the BLM may require completion of a paleontological survey. If paleontological resources are present at the site, or if areas with a high potential to contain paleontological material have been identified, the development of a paleontological resources management plan may be required to define required mitigation measures (i.e., avoidance, removal, and monitoring) and the curation of any collected fossils.

- If an area has a high potential but no fossils are observed during the survey, monitoring by a qualified paleontologist may be required during all excavation and earthmoving in the area. Monitoring of high-potential areas during earthmoving activities would be conducted by a professional paleontologist, when required by the BLM. Development of a monitoring plan is recommended. An exception may be authorized by the BLM.

- If fossils are discovered during construction, the BLM will be notified immediately. If feasible (i.e., when safe to do so), work will be halted at the fossil site and continued elsewhere until a qualified paleontologist could visit the site and make site-specific recommendations for collection or (other) resource protection.

If these mitigation measures are implemented during the initial project design and planning phases and adhered to throughout the course of development, the potential impacts on paleontological resources discussed under the common impacts section would be mitigated to the fullest extent possible. Implementation of mitigation measures does not mean that there would be no impacts on paleontological resources. The exact nature and magnitude of the impacts would vary from project to project and would need to be examined in detail in future NEPA reviews of lease areas and project plans of development.

## 5.5 WATER RESOURCES

### 5.5.1 Common Impacts

Similar to oil shale development, tar sands development would impact water resources as a result of ground surface disturbance, water withdrawal and use, disposal of wastewater and potential contaminant sources, alteration of hydrologic flow systems for both surface water and groundwater, and the interaction between groundwater and surface water. These factors are interdependent and depend on the technologies used for tar sands development. In this section, the range of potential impacts of tar sands development on water resources is discussed. Because STSAs are located in areas where surface water resources are limited, water storage facilities and delivery systems are likely to be needed for water use at development sites. The construction or modification of storage facilities and new delivery systems may cause additional environmental impacts on water resources and additional competition among various water use sectors. The consequences could affect water quality and quantity in both groundwater and surface water on- and off-site.

Common impacts could include:

- Degradation of surface water quality caused by increased sediment load or contaminated runoff from project sites;
- Surface disturbance that may alter natural drainages by both diverting and concentrating natural runoff;
- Surface disturbance that becomes a non-point source of sediment and dissolved salt to surface water bodies;
- Withdrawal of water from a surface water body that reduces its flow and degrades the water quality of the stream downgradient from the point of the withdrawal;
- Withdrawals of groundwater from a shallow aquifer that produce a cone of depression and reduce groundwater discharge to surface water bodies or to the springs or seeps that are hydrologically connected to the groundwater;
- Construction of reservoirs that might alter natural streamflow patterns, alter local fisheries, temporarily increase salt loading, cause changes in stream profiles downstream, reduce natural sediment transport mechanisms, and increase evapotranspiration losses;
- Discharged water from a project site that could have a lower water quality than the intake water that is brought to a site;

- Spent tar sands that might be sources of contamination for salts, metals, and hydrocarbons for both surface and groundwater; and,

- Degradation of groundwater quality resulting from injection of lower quality water; from contributions of residual hydrocarbons or chemicals from retorted zones after recovery operations have ceased; and, from spent tar sands.

- Reduction or loss of flow in domestic water wells from dewatering operations or from production of water for industrial uses.

- Dewatering operations of a mine, or dewatering through wells that penetrate multiple aquifers, that could reduce groundwater discharge to seeps, springs, or surface water bodies if the surface water and the groundwater are connected.

The following sections place these common impacts in the context of specific operating parameters and also show that many of the impacts are interconnected with the multiple activities that could occur in a single operation. Indeed, it is necessary to understand the context of each of the above summary findings to clearly understand the impact dynamics and the rationale behind the mitigative measures that follow the impact analysis.

#### 5.5.1.1 Ground Surface Disturbance

Ground surface disturbance is unavoidable in tar sands development. The disturbance comes from mining, site development, material (including waste) handling, access road construction, supportive infrastructure construction (e.g., reservoir, pipelines for water and products, and transmission lines), reclamation activities, and on-road and off-road traffic. Specific actions may include:

- Clearing of vegetation and stripping of overburden;

- Stockpiling of topsoil and overburden;

- Drilling and blasting;

- Backfilling, grading, and contouring;

- On- and off-road traffic;

- Mining operations;

- Material handling of mined tar sands and disposal of tailings;

- Developing facilities to support mining operations, including pipelines, sewers and drainage facilities, water treatment plants, gas cleaning facilities, control

facilities, offices, housing, warehouses, evaporation and cooling ponds, boiler houses, electric generation facilities, electricity substations, pump houses, and storage tanks for fuels, chemicals, and products;

- Drainage construction; and

- Land reclamation from access roads, mines, spent tar sands storage areas, and facility sites.

These activities can affect surface water flows and surface water and groundwater quality in various ways. Disturbed lands are generally susceptible to soil erosion and affect surface water quality with increased salt, metals, and sediment loads until the disturbed areas are reclaimed and stabilized. Silt and potential contaminants from tar sands may be transported into surface water bodies by runoff. Leaching of stockpiles and overburden piles can also enhance the transport of organics, salts, and trace metals into the water courses and into shallow groundwater. Fallout of dust from access roads, mines, and material handling may affect surface waters. Diverted surface runoff from the disturbed areas can also adversely impact nearby water bodies.

#### 5.5.1.2 Water Use

The water use in tar sands development is closely related to the technologies used to extract the bitumen from the source rock and the conservation measures adopted in a site. Various water uses also depend on water quality. For example, the highest quality of fresh water is needed for human consumption. Poor-quality water, such as brackish groundwater, may be used for dust suppression or hydrotransport (transporting mined tar sands as a water slurry). A list of water uses for tar sands development follows:

- Consumptive use of surface water and/or groundwater for dust suppression (including the use of poor-quality water) in mines, access roads, stockpiles of source rock and spent tar sands, well drilling, equipment maintenance, and solid waste compaction;

- Consumptive use of surface water and/or groundwater in processes, boilers, coolers, and ancillary operations;

- Consumptive use of domestic water, including potable and nonpotable water; and

- Optional consumptive use for hydrotransport.

- If in-situ steam injection technology is used to extract bitumen, a large amount of good-quality water is needed to make steam. The steam mixed with bitumen and formation water can be recovered to at a degree of 90 to 95% and recycled for further use.

- If in-situ combustion technology is used to extract bitumen, water from combustion and source rock formation could be collected. Surplus water may be possible.

Water may be drawn from surface water bodies or underground aquifers, depending on water rights, project locations, water availability, and water quality. Withdrawal from a surface stream would reduce its flow and cause sediment deposition in the stream channel. In the case of streams receiving groundwater discharge (which generally has a higher dissolved salt content), the withdrawal can degrade the water quality of the stream downgradient from the point of withdrawal because the relative proportion of groundwater remaining in the stream would increase.

Groundwater withdrawals from a shallow aquifer would produce a cone of depression and could reduce groundwater discharge to surface water bodies or to the springs or seeps that are hydrologically connected to the groundwater. The withdrawal could reduce streamflows, and the effects would increase with the amount of water withdrawn.

The water quality of surface water bodies and shallow alluvial aquifers generally is higher than that of deeper aquifers. Therefore, surface water or shallow groundwater is generally preferred as a source of supply if it is available. Withdrawal of surface water would reduce streamflow downstream from the point of diversion. Because of the reduced flow, the stream's capacity for carrying sediment would also be reduced, and channel sediment deposition would be increased. The morphology of the stream channel would also adjust to the reduced flows. For stream segments where natural groundwater discharge into the stream occurs, the water withdrawal could increase the relative proportion of the groundwater contribution to the stream, thereby lowering the overall quality of the stream.

#### 5.5.1.3 Discharge, Waste Handling, and Contaminant Sources

The discharge of mine water (from dewatering operations), wastewater (after treatment), cooling water (for cooling equipment such as crushers, bearings, pumps, and compressors), and diverted surface runoff from a tar sands site can adversely impact nearby water bodies. The impacts are attributed to potential contaminants in the water and potential change of streamflow. In addition, contaminants released by non-point sources associated with the project (through access roads, air emissions, and groundwater discharge) could further degrade the surface water quality.

The water and potential contaminants associated with surface mining include:

- Dewatering operations and possible underground reinjection or discharge to surface water;
- Discharge of the surface runoff from project sites;
- Spills of fuels, chemicals, and products;

- Discharge of treated sanitary and domestic wastewaters; and
- Discharge of effluents from the treatment of process waters, such as sour water, hydrocarbon storage tanks condensate, boiler condensate, boiler water blowdown, and pump and compressor cooling water blowdown.

The water and potential contaminants associated with leachate include:

- Stockpiled mined or spent tar sands, and other stored materials;
- Drilling wastes;
- Sludges recovered from water treatment, wastewater treatment, blowdown from boilers, and solvent extraction;
- Fly ash and boiler bottom ash; and
- Tailings ponds, backfilled mined areas, or backfilled valleys or gullies.

Management of mine water, wastewater, and surface runoff could involve various forms of reuse or disposal. Deep groundwater or mine water in the region generally has a high dissolved solids content. This water, as well as wastewater with or without treatment, could be used to support facility operations, including dust suppression along access roads, at the project site, in the mine, or on stockpiles of source rocks or tailings.

Underground injection, as a means to dispose of low-quality water, especially brine water from a water treatment plant, could affect groundwater quality. The injection could take place at locations hydraulically downgradient of the mine. Injection would be governed by the EPA. If underground injection is used for the disposal of the produced water, the water may reappear at the surface at seeps or springs downgradient of the injection wells, providing that the aquifer receiving the injection is hydrologically connected to the surface water. Because injected water is generally not treated before injection, the reemergence of the injected water could adversely affect the quality of the surface water where the seeps or springs are located and increase the flow of the surface water body. Impacts of injected water on downgradient groundwater well users are also possible, depending on injection quantities, site-specific hydrogeologic factors, and the pumping rates of groundwater users.

Surface discharge of treated or nontreated surface runoff, wastewater, or mine water to a stream from the project site could potentially change the streamflow as well as the stream's water quality, especially during the low-flow season. The water to be discharged may come from domestic wastewater, industrial wastewater, tailing pond drainage, overland flow, and treated water from a leachate collection system. If discharge to a surface water body is selected, the water generally requires treatment and an NPDES permit. The permit specifies the quality and flow of the discharged water, thus limiting the impact on surface water quality. The discharges from a plant generally would have poorer water quality than the natural water of the surface water body. The discharge would increase streamflow at outfalls.

At mining sites after reclamation, the spent tar sands piles and mine tailings could be potential sources of contamination with salts, metals, and hydrocarbons. Leachate containing these contaminants may enter nearby surface water bodies or shallow aquifers and continue to degrade the surface water quality well after the reclamation phase.

For surface mining with surface retort technologies, if the direct coking process is used to upgrade bitumen, fly ash and boiler bottom ash would be produced as wastes. Leaching of the wastes might produce an additional potential source of contamination for surface water or groundwater. If hot water extraction or cold water extraction technology is used, the amounts of processed water and wastewater generated would be substantial. The impacts attributed to the disposal of wastewater are great for hot water or cold water extraction technologies if the wastewater is not treated and reused.

If a solvent (e.g., heptane, cyclohexane, or ethanol) extraction technology is used to extract the bitumen from the source rock, the spent tar sands (tailings) are expected to contain residual solvents after most are recovered for recycling. The waste could be subjected to leaching processes when it is disposed of in open areas. The leachate could potentially enter into surface water bodies or into shallow groundwater and pollute the resource unless sufficient controls, including leachate collection and treatment, are implemented. Solvent spills or leaks are other potential sources of impacts on surface water or shallow groundwater.

In situ combustion could produce large volumes of water from the underground burning and thermal cracking of bitumen, estimated to be 1 to 2 bbl of water for each barrel of oil produced. The produced water from in situ combustion may contain increased levels of potential contaminants such as TDS, chloride, hydrocarbons, and heavy metals.

Residual organic compounds are expected to be present in a formation following in situ processing. In a laboratory study, Raphaelian et al. (1981) analyzed water samples obtained from two in situ tar sands experiments. Water from the combustion experiment was found to contain cyclic cyclohexonyl compounds, acetophenones of ketones, alcohols, quinolines, pyridines, phenyl piperidines, pyrazoles, phenols, carboxylic acids, and lactones. The sample from the steam injection experiment contained alkenes, cyclohexanes, cyclic ketones, toluenes, quinolines, acridines, pyrazoles, pyridines, phenyl piperidines, piperidines, and phenols. Steam from injection can also dissolve organics and metals from source rocks, potentially contaminating groundwater. All of these potential contaminants could migrate with the groundwater to reach wells or discharge locations (i.e., springs, seeps, or surface water). The quality of the surface water could consequently be impacted.

Several of the STSAs are drained in part by state-classified Category 1 streams. These include Sunnyside, Argyle Creek, and Asphalt Ridge STSAs. According to the state, such streams are of “exceptional recreational or ecological significance or have been determined to be a State or National resource requiring protection, [and] shall be maintained at existing high quality through designation, by the Board after public hearing, as High Quality Waters - Category 1. New point source discharges of waste water, treated or otherwise, are prohibited in such segments” (BLM 2007a). For this reason, any point source or non-point-source releases from these STSAs could potentially degrade these Category 1 streams.

#### 5.5.1.4 Alteration of the Hydrologic Flow Systems

Whether the water is derived from a surface water body with or without the use of a reservoir, the downstream flow would be reduced, which could cause deposition of stream sediment and change the morphology of the stream. If a reservoir is built for regulating the water supply, sediment would be trapped upstream of the dam. The flow pattern of the stream could change depending on the discharge of the reservoir. The degradation (erosion of the streambed) and deposition along the stream channel would respond to the streamflows. Losses due to evaporation and seepage in the reservoir would affect the amount of water available (Keefer and McQuivey 1979).

The dewatering operations of a mine or dewatering through wells that may penetrate multiple aquifers can reduce groundwater discharge to seeps, springs, or surface water bodies if the surface water and the groundwater are connected. The consequence could be diminished flows of seeps, springs, or water courses even at areas remote from the mine. Depending on pumping rates and site-specific hydrogeological factors, significant groundwater withdrawals for dewatering the overburden and/or the tar sands, or for meeting operational needs, may reduce surface water base flow, spring discharges, and water levels in nearby wells.

Streamflow could be affected by both water withdrawal and wastewater discharge (after water treatment). The streamflow would be reduced in areas downstream of water intakes and increased in areas downstream from discharge outfalls. The change of the streamflow could trigger the deposition or erosion of sediments along a stream channel.

By extracting the bitumen, in situ processes could affect the permeability of the treated formation. The change in permeability for in situ treated formations would be increased further by dissolving soluble minerals and hydrofracturing the rock formation. Changes to the site groundwater flow field could occur. This could continue after reclamation of the project site.

At sites with a dewatered surface mine or in situ operations, groundwater levels would begin to recover after dewatering activities ceased. As groundwater regained its original water level, surface water previously depleted by the dewatering would be replenished by seeps and springs, and the streamflow would eventually return to predevelopment patterns.

### 5.5.2 Water Budget for Individual Tar Sands Projects

#### 5.5.2.1 Overall Water Budget

Table 5.5.2-1 summarizes the water consumption for tar sands development sites using different technologies, each with a 20,000-bbl/day capacity. The estimated water consumption does not include water use on access roads and other supportive facilities. In general, traditional surface mining operations consume large amounts of water for dust suppression at the mine site, access roads, source rock crushing locations, and source rock stockpiles. However, new hydrotransport technologies mix water with tar sands and transport the slurry through a pipeline

**TABLE 5.5.2-1 Estimated Water Consumption for Tar Sands Development**

| Production (bbl/day) | Technology | Water for Mining (bbl/day) | Process Water (bbl/day) | Produced Wastewater from Formation (bbl/day)[b] | Potable Water (operation phase) (bbl/day) | Net Water Requirement (bbl/day) | Net Water Requirement (ac-ft/yr) |
|---|---|---|---|---|---|---|---|
| 20,000 | In situ steam injection | 0 | 10,000[a]–80,000 | 0[b] | 950[d] | 11,000–81,000 | 680–5,000 |
| 20,000 | In situ combustion | 0 | 0 | –40,000[c] | | [i] | 58 |
| 20,000 | Surface mine with surface retort | 0–25,000[e] | 46,000[f]–90,000 | 0 | 0[h] | 46,000–115,000[j] | 2,800–7,100 |
| 20,000 | Surface mine with solvent extraction | 0–25,000[e] | 21,800[g] | 0 | 950 | 22,800–47,800[k] | 1,400–2,900 |

[a] The lower number is for SAGD (steam-assisted gravity drainage) technology, and the higher number is for CSS (cyclic steam stimulation) steam injection technology. Start-up water used for steam injection in the first phase in SAGD is 100,000 bbl/day; thereafter, 90% of steam/water is assumed to be recovered from steam and formation water (E&P 2007; Alberta Chamber of Resources 2004). Assumes 55 gal/bbl of water.

[b] Water from source rock formation mixed with steam and bitumen is collected (E&P 2007) as produced water.

[c] Water from source rock formation and from combustion, assumed to be 2 bbl for each bbl of oil produced. The water could be used beneficially, subject to water quality and possible treatment. About 100,000 bbl of start-up water is required to make steam for the first phase of bitumen extraction in the toe to heel air injection (THAI) technology. No process water is needed thereafter (The Oil Drum 2007). Upgrading may need additional water.

[d] A demand of 135 gal/person/day, a consumptive rate of 35%, and a population of 1,100 are assumed. The consumptive rate is based on the Colorado M&I consumptive rate (CWCB 2004).

[e] The lower number is for hydrotransport; mined tar sands are mixed with water/solvent to make slurry, which is then transported through a pipeline from the mine to the process plant. The water/solvent is counted as processed water use. The larger water use number is for mined tar sands transported by truck. Water is used for haul-road spraying (brackish water), irrigation, and dust containment (fresh water) (Daniels et al. 1981).

[f] The low number is from Syncrude Canada Ltd., which uses 2.3 bbl of water per barrel of crude oil produced, half of the industry average (Syncrude Canada Ltd. 2006a,b; Alberta-Canada 2007). Note that Canadian tar sands are water-wet tar sands, while the deposit in Utah is oil-wet sands. The number includes upgrading water use. Water demand is 14.2 bbl per barrel of crude oil produced. Most of it is recycled.

[g] For the solvent extraction process, about 109,000 bbl/day of water is required. If 80% of the water is recycled, consumption would be 21,800 bbl/day. Water use for upgrading is not included (Daniels et al. 1981).

[h] Potable water is included in the reporting process water.

[i] For potable water.

[j] Water use for upgrading is included; final product is syncrude.

[k] Water use for upgrading is not included.

to the processing facility. This process is able to reduce water consumption by reducing water use for dust suppression on access roads. Water used in hydrotransport becomes part of the process water and can later be recycled, resulting in great savings in water use. A tar sands company using surface mining and surface upgrading in Canada (Syncrude Canada Ltd.) claims that its water consumption is 2.3 $m^3$ for each cubic meter of synthetic crude oil produced (Table 5.5.2-1). However, it is expected that the water use for tar sands development in Utah using the same technologies and water conservation could be higher because the deposits are oil-wet tar sands.

Less water consumption for extracting bitumen from tar sands is expected from the use of solvent extraction technology (mixing 10 to 15% of solvent with water and source rock) than from the use of hot water extraction technology. However, the efficiency of recovering the relatively expensive solvent and the potential contaminant from spent tar sands pose a challenge in the solvent extraction technology.

In situ combustion technology uses a portion of the tar sands as fuel to raise the temperature of source rock and mobilize bitumen. The partially upgraded bitumen, gas, and water are collected by vertical or horizontal wells. Because of the combustion, water is formed. In addition, the water in the source rock is recovered. It is possible that the process water collected from the subsurface may exceed the water need in the tar sands plant. However, the captured water would need treatment before it could be reused.

In the toe to heel air injection (THAI) technology (one of the in situ combustion technologies; see Appendix B), steam injection is used in start-up to extract bitumen (leaving residual bitumen behind) before in situ combustion is conducted. Water is required to make up the steam. The majority of the steam is recaptured in production wells.

The in situ combustion variation known as wet combustion would require water. In this approach, water and air are both injected into the heated formation. Another technology option among in situ combustion techniques that require water is a combination of water flooding with combustion. The water needs associated with these technologies would need to be addressed at individual project sites.

Estimated domestic water needs are estimated for the workforce and family population required for a single 20,000-bbl/day tar sands facility. The construction workforce and families could number about 2,600 people, and the operations workforce and families would number about 1,100 people. Assuming an overall requirement of 135 gal/day/person, the fresh water need is 6,400 and 2,700 bbl/day, respectively (1 bbl of water = 55 gal). Using a consumptive rate of 0.35, the water consumption during the construction phase and operation phase would be about 2,200 and 950 bbl/day (140 and 58 acre-ft/yr), respectively.

#### 5.5.2.2 Water Availability for Individual Tar Sands Projects in STSAs

To develop tar sands, there must be enough water available, both physically and legally. This section describes the availability of water for potential tar sands development. Legal

availability is discussed in terms of the allocation of the Upper Colorado River water in Utah, based on the Upper Colorado River Basin Compact of 1948. The discussion of physical availability focuses on the water resources near the STSAs.

In Chapter 3, Table 3.4.1-3 provides the projected consumptive use of water in the years 2020 and 2050. Without counting the potential water use for tar sands development, the projected consumptive uses as percentages of the Utah allocated water are 79.4% and 85.9% for the two years. That implies about 281,000 and 193,000 acre-ft/yr are available for 2020 and 2050, respectively.

Water physically available may be limited in a dry environment such as that of the STSAs. Keefer and McQuivey (1979) analyzed surface water and groundwater resources associated with specific STSAs and related the water availability to the water requirements estimated for in situ steam injection, which uses the highest amount of water among various in situ technologies (Table 5.5.2-1). In the following subsections, the physical availability of water in various STSAs is provided. The availability can be compared with the estimated water consumption used in different tar sands technologies as shown in Table 5.5.2-1.

Although water may be legally and physically available, that does not imply that it is readily available for tar sands development. Hydrologic basins enriched with surplus water resources are not necessarily coincident with the STSAs. Storage infrastructures and delivery systems have to be built to capture water for various uses. Also, water rights and water storage rights (for reservoirs) have to be transferred or purchased before the water can be used for development, as most water rights and storage rights have been claimed in the Upper Colorado River Basin. Finally, the water uses for the development have to meet different state and federal regulations. All in all, whether enough water is available for tar sands development depends on the results of intensive negotiations among various parties, including water right owners, state and federal agencies, municipal water providers, and the tar sands developers.

**5.5.2.2.1 Asphalt Ridge.** Keefer and McQuivey (1979) describe shallow groundwater in the Ashley Creek alluvial aquifer as the best source of water for pilot facilities in the vicinity of Asphalt Ridge and Whiterocks. This water is fresh to slightly saline. They also note that Ashley Creek, with a flow of 82,000 ac-ft/yr near Vernal, could supply a production facility with treatment of its high-salinity water.

Bedrock aquifers northeast of Asphalt Ridge are also a possible source of water to support production. These aquifers are at depths of 4,000 to 6,000 ft and have fresh water. Other surface water sources in the vicinity include perennial streams with flow rates that, like that of Ashley Creek, vary in response to weather and location along the watercourse, as diversions may result in lower flow rates at downstream locations. These streams and flow rates are Dry Fork (15,000 to 26,000 ac-ft/yr), Mosby/Deep Creek (no data available), and Whiterocks River (71,000 to 88,000 ac-ft/yr) (UDWR 1999). Any water obtained from surface water or groundwater sources would not only have to be transported (by pipeline or truck) some distance to a particular project site but might also have to ascend a significant vertical elevation. Overall, it appears that water might be available to support the 20,000-bbl/day plant using in situ

technologies, although water rights might need to be purchased, suitable water quality would have to be confirmed, and the economics of transporting the water to the project area would need to be assessed. A 20,000-bbl/day plant using surface mining and surface processing technologies would use more than 6% of the annual average of Ashley Creek, a significant amount when other water users may rely on the same water source.

**5.5.2.2.2 P.R. Spring and Hill Creek.** Willow Creek has an average flow of 13,000 ac-ft/yr, although its flow is intermittent. Other streams in the vicinity of the STSA include perennial stream Sweetwater Canyon, Bitter Creek, and Center Ford, and intermittent Evacuation Creek. No flow data are available for these creeks from the Utah Division of Water Resources (UDWR 1999). No reliable groundwater sources were noted for P.R. Spring by Keefer and McQuivey (1979). However, springs are quite common in the S.R. Spring STSA, especially east of Willow Creek.

Water resource support for any of the proposed project sites at P.R. Spring may require the purchase of water rights to the distant White River, a regional resource. Willow Creek, even if only 10% of its water was dedicated to the tar sands operations, would not support a 20,000-bbl/day operation using surface mining and processing technologies. If in situ combustion technology is selected, it will consume about 3.5% of the annual average streamflow of Willow Creek. Whether water from the other, ungauged streams in the vicinity could be combined to support one or more tar sands operations is uncertain, because of unknown flow rates and availability of water rights. Reservoir construction may be necessary on one or more of the rivers and creeks selected for tar sands operations. Willow Creek is classified as Category 5A impaired waters (UDEQ 2006). Discharge of any low-quality water from a project site, such as untreated wastewater or surface runoff, may further adversely affect the water quality in the lower reaches.

For P.R. Spring, Keefer and McQuivey (1979) recommend a White River reservoir as the best water source, despite its distance from the STSA. This river has a flow on the order of 480,000 ac-ft/yr (Keefer and McQuivey 1979). Withdrawing water from the Green River is another possible option.

**5.5.2.2.3 Sunnyside.** For this STSA, Keefer and McQuivey (1979) recommend constructing a reservoir on intermittent Minnie Maude Creek (estimated at 12,000 ac-ft/yr) or obtaining water from Price River (75,000 ac-ft/yr more than Price). However, Minnie Maude Creek falls far short of being able to support production at the proposed level, even with a reservoir.

Minnie Maude Creek and Price River are two streams in the vicinity of the Sunnyside STSA, with average annual flows of 12,000 ac-ft/yr and 75,000 ac-ft/yr, respectively. Minnie Maude Creek flows into the perennial Nine Mile Creek, which has a flow of 38,000 ac-ft/yr near its junction with the Green River (UDWR 1999) and 12,000 ac-ft/yr at an unspecified upstream point (Keefer and McQuivey 1979). Minnie Maude Creek was a designated TMDL impaired stream in 2006, and the water of the Price River may be of low quality (Keefer and

McQuivey 1979). Both locations would require the transport of water over long distances and elevation increases to the STSA. Other creeks in the vicinity of the STSA include perennial creeks Dry Creek and Cottonwood Canyon. The UDWR (1999) does not provide flow data for these creeks. The intermittent headwaters of Range Creek are nearby, but flow is only 5,000 ac-ft/yr (UDWR 1999), and it is a state-classified Category 1 stream. The upper reaches of Nine Mile Creek, Dry Creek, and Cottonwood Creek drain the tar sands area and are classified as Category 5A impaired waters (UDEQ 2006). Groundwater in the area has high TDS.

Overall water resources in the Sunnyside vicinity are limited, as compared with the operational water consumption using surface mining and process technologies. The in situ combustion process uses much less water (about 4% of the average annual flow of Minnie Maude Creek) for potable use. Development of the tar sands in this area would likely degrade the surface water further and diminish the flow of the streams and their tributaries.

**5.5.2.2.4 Tar Sand Triangle.** The Dirty Devil River flows in the vicinity of the STSA. Mean flow for the Dirty Devil is about 74,000 ac-ft/yr, although it runs dry each summer for 1 to 2 months. Other creeks in the vicinity of the Tar Sand Triangle are the intermittent Horse Canyon and the perennial Big Water Canyon/Happy Canyon. No flow data are available on those (UDWR 2000). The STSA is situated in the eastern part of Lower Dirty Devil River groundwater basin. The Navajo Sandstone of Mesozoic age is a major aquifer in the basin (UDWR 2000). The extent and yield of the aquifer near the STSA are unclear. However, spring sites are found in the STSA area (UDWR 2000).

In situ combustion and steam injection technologies with conservation practices are likely capable of supporting a 20,000-bbl/day tar sands development site in the Tar Sand Triangle by using the Dirty Devil River water. Other technologies could consume more than 5% of the Dirty Devil River mean flow. Other water sources may include the Colorado or Green Rivers.

**5.5.2.2.5 Other STSAs.** Other STSAs are expected to have water availability problems similar to those described above. The UDWR (1999, 2000) provides average annual flows for creeks and rivers in the STSA study areas. The available water rights to these flow systems have not been determined, and the given average flows are likely representative of downstream values rather than values in upland areas adjacent to (both areally and vertically) the STSAs.

For any reservoir project, Keefer and McQuivey (1979) note that losses due to evaporation and seepage would affect the amount of water available. Also, the use of reservoirs would change the flow of natural water bodies downstream of the reservoir and modify the erosional and depositional features of the river channels. Sedimentation would be enhanced along the stream channels upstream of the reservoirs. Discharge of treated or nontreated wastewater to a stream from the project site could potentially change the streamflow as well as the stream’s water quality, especially during the low-flow season. Water rights would be a key issue for any intended use of groundwater or surface water.

### 5.5.3 Mitigation Measures

The potential impacts on water resources are closely related to the technologies used to mine, extract, process, and upgrade the bitumen from the tar sands. At the programmatic level, the impacts can be tremendously reduced starting from the planning stage. Local hydrologic conditions, including surface water and groundwater and the interactive relationship between them, must be characterized and considered in selecting areas for developmental sites, access roads, pipelines, transmission lines, and/or reservoirs. Sensitive areas should be avoided or receive special attention in tar sands development. Important factors include but are not limited to:

- Highly erodible geologic material;
- Steep terrain prone to soil erosion;
- Groundwater discharge and recharge areas; and
- River/stream segments that are sensitive to human impacts (such as streamflow, water quality, and channel modification) that can affect ecosystems.

In selecting the technologies to develop tar sands, the technologies that would minimize potential contaminant sources should be considered. Several important factors to reduce impacts on water resources include:

- Technologies that result in minimum footprint of disturbed areas;
- Technologies that have minimum total water consumption;
- Technologies that can use wastewater or brackish water in processing source rocks;
- Technologies that result in minimum disturbance between groundwater flow regimes to avoid cross flows between aquifers; and
- Technologies that have the highest recovery of tar sands, leaving spent material with the least amount of contaminants to be leached.

Other mitigation measures that BLM might consider requiring, if warranted by the results of the lease-stage or plan of development-stage NEPA analyses, are related to engineering practices. They are as follows:

- Water should be treated and recycled as much as possible.
- The size of cleared and disturbed lands should be minimized as much as possible, and disturbed areas should be reclaimed as quickly as possible.

- Erosion controls that comply with county, state, and federal standards and BLM guidelines (Fogg and Hadley 2007; USFS Region 2 2000) should be applied.

- Existing roads and borrow pits should be used as much as possible.

- Earth material would not be excavated from, and excavated material would not be stored in, any stream, swale, lake, or wetland.

- Vegetated buffers would be maintained near streams and wetlands. Silt fences could be used along edges of streams and wetlands to prevent erosion and transport of disturbed soil, including spoil piles.

- Earth dikes, swales, and lined ditches could be used to divert work-site runoff that would otherwise enter streams.

- Topsoil removed during construction should be stockpiled and reapplied during reclamation. Practices such as jute netting, silt fences, and check dams should be applied near disturbed areas.

- Operators should identify unstable slopes and local factors that could induce slope instability (such as groundwater conditions, precipitation, earthquake potential, slope angles, and dip angles of geologic strata). Operators also should avoid creating excessive slopes during excavation and blasting operations. Special construction techniques should be used where applicable in areas of steep slopes, erodible soil, and stream channel or wash crossings.

- Existing drainage systems should not be altered, especially in sensitive areas such as erodible soils or steep slopes. Culverts of adequate size to accommodate the runoff of a 25- and 100-year storm for temporary and permanent roads, respectively, should be used when constructing stream or wash crossings. Potential soil erosion should be controlled at culvert outlets with appropriate structures. Catch basins, roadway ditches, and culverts should be cleaned and maintained regularly.

- Runoff controls would be applied to disconnect new pollutant sources from surface water and groundwater.

- Foundations and trenches should be backfilled with originally excavated material as much as possible. Excess excavated material should be disposed of only in approved areas.

- When pesticides and herbicides are used, the goal would be to minimize unintended impacts on soil and surface water bodies. Common practices include but are not limited to (1) minimizing the use of pesticides and herbicides in areas with sandy soils near sensitive areas; (2) minimizing their

use in areas with high soil mobility; (3) maintaining the buffer between herbicide and pesticide treatment areas and water bodies; (4) considering the climate, soil type, slope, and vegetation type in determining the risk of herbicide and pesticide contamination; and (5) evaluating soil characteristics prior to pesticide and herbicide application, to assess the likelihood of their transport in soil.

- Pesticides used should be limited to nonpersistent, immobile ones, and should only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.

- Vehicle service and fuel areas, chemical storage and use areas, and waste dumps and areas are to be located on gentle upland sites. Mixing, loading, and cleaning should be done on upland sites with gentle slopes. Chemicals and containers would be disposed of in state-certified disposal areas.

- Contour berms and trenches could be installed around vehicle service and refueling areas, chemical storage and use areas, and waste dumps to fully contain spills. Liners could be used as needed to prevent seepage into groundwater.

- An erosion and sedimentation control plan, as well as a surface water protection plan, should be prepared in accordance with federal and State regulations.

## 5.6 AIR QUALITY AND CLIMATE

### 5.6.1 Common Impacts

The potential for air quality impacts from commercial tar sands development, including ancillary facilities such as access roads, upgrading facilities, and pipelines, is directly related to the amount of land disturbance, drilling/mining operations, processing methods, and the quantity of oil and gas equivalent produced. Indirect effects, such as impacts resulting from secondary population growth, are also considered.

Impacts on air quality would occur in several ways, as described below.

- Temporary, localized impacts (primarily PM and $SO_2$, with some CO and $NO_x$ emissions) would result from the clearing of the project area; grading, excavation, and construction of facilities and associated infrastructure; and mining (extraction) or drilling of the tar sands resource.

- Long-term, regional impacts (primarily CO and $NO_x$, with lesser amounts of PM, $SO_2$, and VOC emissions) would result from tar sands processing,

upgrading, and transport (pipelines). Depending on location, meteorology, and topography, $NO_x$ and $SO_2$ emissions could cause regional visibility impacts (through the formation of secondary aerosols) and contribute to regional nitrogen and sulfur deposition. In turn, atmospheric deposition could cause changes in sensitive (especially alpine) lake chemistry. In addition, depending on the amounts and locations of $NO_x$ and VOC emissions, photochemical production of ozone (a very reactive oxidant) is possible, with potential impacts on human health and vegetation. Localized impacts due to emissions of HAPs (particularly benzene, toluene, ethylbenzene, xylene, and formaldehyde) and diesel PM could also present health risks to workers and nearby residents.

It is not possible to predict site-specific air quality impacts until actual tar sands projects are proposed and designed. Once such a proposal is presented, impacts on these resources would be further considered in project-specific NEPA evaluations and through consultations with the BLM prior to actual development.

The tar sands deposits that are in the study area for this PEIS are found only in the state of Utah. There are two tar sands–rich areas: One is in the Uinta Basin near Vernal, Utah, and the other is near Canyonlands and Capitol Reef National Parks in east central Utah. Table 5.6-1 identifies those counties where direct and indirect air pollutant emissions could result from tar sands development.

**TABLE 5.6.1-1 Counties within the Tar Sands Study Area That Could Be Affected by Air Pollutant Emissions**

| | | | Estimated Population | |
|---|---|---|---|---|
| State | County | Land Area ($mi^2$) | July 1, 2001 | July 1, 2005 |
| Utah | Carbon | 1,478 | 19,768 | 19,437 |
| | Duchesne | 3,238 | 14,563 | 15,354 |
| | Emery | 4,452 | 10,751 | 10,711 |
| | Garfield | 5,174 | 4,691 | 4,470 |
| | Grand | 3,682 | 8,490 | 8,743 |
| | San Juan | 7,820 | 13,607 | 14,104 |
| | Uintah | 4,477 | 25,773 | 26,995 |
| | Utah | 1,998 | 389,866 | 443,738 |
| | Wasatch | 1,177 | 16,172 | 18,974 |
| | Wayne | 2,460 | 2,529 | 2,450 |
| Regional | Total | 35,956 | 506,210 | 564,976 |

Source: U.S. Bureau of the Census (2007a,b).

Impacts on air quality would be limited by applicable local, state, Tribal, and federal regulations, standards, and implementation plans established under the CAA and administered by the applicable air quality regulatory agency (e.g., the Utah Department of Environmental Quality-Division of Air Quality (UTDEQ-DAQ), with EPA oversight. Air quality regulations require that proposed new or modified existing air pollutant emission sources undergo a permitting review before their construction can begin. Therefore, the state agencies have the primary authority and responsibility to review permit applications and to require emission permits, fees, and control devices prior to construction and/or operation. The U.S. Congress (through CAA Section 116) authorized local, state, and Tribal air quality regulatory agencies to establish air pollution control requirements that are more (but not less) stringent than federal requirements.

In addition, under the CAA and FLPMA, federal agencies cannot authorize any activity that does not conform to all applicable local, state, Tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans.

Before tar sands development could occur, additional project-specific NEPA analyses would be performed, subject to public and agency review and comment. The applicable air quality regulatory agencies (including the states and EPA) would also review site-specific preconstruction permit applications to examine potential projectwide air quality impacts. As part of these permits (depending on source size), the air quality regulatory agencies could require additional air quality impact analyses or mitigation measures. Those evaluations would take into consideration the specific project features being proposed (e.g., specific air pollutant emissions and control technologies) and the locations of project facilities (including terrain, meteorology, and spatial relationships to sensitive receptors). Project-specific NEPA assessments would predict site-specific impacts, and these detailed assessments (along with BLM consultations) would result in the required actions by the applicant to avoid or mitigate significant impacts. Under no circumstances can the BLM conduct or authorize activities that would not comply with all applicable local, state, Tribal, or federal air quality laws, regulations, standards, or implementation plans.

Ongoing scientific research has identified the potential effects of so-called GHG emissions (including $CO_2$, methane, $NO_x$, water vapor, and several trace gases) on global climate. Recent industrialization and burning of fossil carbon sources have caused $CO_2$ concentrations to increase dramatically and are likely to contribute to overall climatic changes. Increasing $CO_2$ concentrations also lead to preferential fertilization and growth of specific plant species. The assessment of GHG emissions and climate change is in its formative phase, and it is not yet possible to know with confidence the net impact on climate. However, the IPCC (2007) recently concluded that “warming of the climate system is unequivocal” and that “most of the observed increase in globally average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic [man-made] greenhouse gas concentrations.”

Global mean surface temperatures have increased nearly 1.0°C (1.8°F) from 1890 to 2006 (Goddard Institute for Space Studies 2007). However, the northern latitudes (above 24°N — which includes all of the United States) have exhibited temperature increases of nearly 1.2°C (2.1°F) since 1900, with nearly a 1.0°C (1.8°F) increase since 1970 alone. Without

additional meteorological monitoring systems, it is difficult to determine the spatial and temporal variability and change of climatic conditions, but increasing concentrations of GHG are likely to accelerate the rate of climate change. The direct emissions of climate change air pollutants from tar sands development facilities are likely to be a small fraction of global emissions.

#### 5.6.1.1 Impacts from Emissions Sources for Tar Sands Facilities

To estimate total potential air pollutant emissions, emission factors for a specific activity must be identified and then multiplied by activity levels and engineering control efficiencies. The emission factors from proposed project activities would be estimated in future NEPA analyses by using appropriate equipment manufacturer's specifications, testing information, EPA AP-42 emission factor references (EPA 1995), and other relevant references. Anticipated levels of operational activities (e.g., load factors, hours of operation per year, vehicle miles traveled) would be computed. Emission inventories would be made for selected years during the assumed plant life (including construction, operation, maintenance, and reclamation).

**5.6.1.1.1 Construction.** Mining and surface process technologies may include construction of a surface mine and mine bench, with primary crushing facilities, processing and upgrading facilities, spent material disposal areas, reservoirs for flood control, and a catchment dam below the disposal pile. For in situ conversion processes, considerable construction and preproduction development work includes extensive drilling and construction of upgrading/refining facilities.

Irrespective of surface or in situ technologies, additional construction activities include access roads, power distribution systems, pipelines, water storage and supply facilities, construction staging areas, hazardous materials handling facilities, housing, and auxiliary buildings.

Impacts on air quality associated with these construction activities include fugitive dust emissions and engine exhaust emissions from heavy equipment and commuting/delivery vehicles on paved and/or unpaved roads. Another emission source affecting air quality is wind erosion of soil disturbed by construction activities or from soil stockpiles.

**5.6.1.1.2 Production.** Emissions impacting air quality could result from surface operations (such as mining and crushing activities), processing (such as pyrolysis of the base material at high temperatures), upgrading of the hydrocarbon products, support utilities, and the disposal of waste products. Major processing steps for in situ processes would include heating the base material in place, extracting the liquid from the ground, and transporting the liquid to an upgrading/refining facility. Because in situ processing does not involve mining, with limited waste material disposal, such processing does not permanently modify land surface topography and therefore produces fewer air pollutant emissions.

**5.6.1.1.3 Maintenance.** Maintenance activities primarily include access road maintenance and periodic visits to facilities and structures away from the main facilities. The primary emissions that could affect air quality would be fugitive dust and engine exhaust emissions.

**5.6.1.1.4 Reclamation.** During reclamation activities, which proceed continuously throughout the life of the project, waste material disposal piles would be smoothed and contoured by bulldozers. Topsoil would be placed on the graded spoils, and the land would be prepared for revegetation by furrowing, mulching, etc. From the time an area is disturbed until the new vegetation emerges, all disturbed areas are subject to wind erosion. Fugitive dust and engine exhaust emissions from reclamation activities are similar to those from construction activities, although with a lower level of activity.

**5.6.1.1.5 Population Growth.** Population growth and related emission increases associated with potential development would include those resulting from direct employment; employees of suppliers (e.g., equipment, materials, supplies, and services); consumers (e.g., additional retail stores); additional employees in federal, state, and local governments; and families.

**5.6.1.1.6 Mobile (onroad and nonroad).** Additional air pollutant emissions that could affect air quality would be associated with on-road mobile sources (e.g., cars, trucks, and buses) and nonroad mobile sources (e.g., graders and backhoes used in construction).

### 5.6.2 Mitigation Measures

Since all activities conducted or approved through use authorizations by the BLM must comply with all applicable local, state, Tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans, it is unlikely that future tar sands leasing and development would cause significant adverse air quality impacts.

However, on a case-by-case basis, future individual leases and use authorizations could include specific measures to minimize potential air quality impacts. These mitigation measures could include, but are not limited to (1) treating access roads with water or other surfactants to reduce fugitive dust from traffic; (2) reducing vehicle speeds on dirt roads to reduce fugitive dust from traffic; (3) specifying emission control devices on production equipment to reduce potential CO, $NO_x$, $PM_{2.5}$, $PM_{10}$, and VOC emissions; (4) specifying low-sulfur-content fuels to reduce potential $SO_2$ emissions; and/or (5) regulating the timing of emissions to reduce the formation of $O_3$ in the atmosphere from $NO_x$ and VOC emissions.

In addition, to ensure that BLM-authorized activities comply with applicable ambient air quality standards as well as those applying to potential impacts on AQRVs (e.g., visibility, atmospheric deposition, noise), specific monitoring programs may be established.

Potential global warming impacts could be reduced if tar sands substituted for the use of other fossil carbon-based energy sources, or if atmospheric loadings were reduced by emission controls or sequestration methods.

## 5.7 NOISE RESOURCES

Generic noise impacts from construction, operation, and reclamation of tar sands extraction facilities were estimated; however, detailed information on equipment types, schedules, layouts, and locations was not available at the programmatic level. When available, published estimates of noise impacts from technology assessments and EAs for facilities expected to be similar to those considered here were used as the basis for this assessment. Use of these existing studies required making reasonable assumptions and extrapolations. In addition, the lack of detailed information also precluded making quantitative estimates of the impacts from noise mitigation measures that might be applied, if warranted by the results of lease-stage and/or plan-of-development-stage NEPA analyses.

The characteristics of the area around a noise source influence the impacts caused by that source. However, sources produce the same amount of noise independent of their location; also, to a first approximation, noise propagates identically everywhere. At the programmatic level, information that could help differentiate between noise impacts in different locations is unavailable, as are estimates of the noise levels associated with some of the technologies. The approach taken here assesses the impacts of technologies. Noise levels are assumed to be independent of location. Thus, differences in impacts due solely to restrictions in areas available for leasing are not considered.

When published estimates for facilities were unavailable, simple noise modeling was used to estimate noise impacts (HMMH 1995). To predict an impact, the model requires that the noise level associated with the technology be assessed. Noise levels were not available for some technologies. In these cases, noise levels associated with similar technologies were used.

Published information was generally for a facility with a single capacity. Noise impacts were extrapolated by using a conservative approach equivalent to the 3-dBA rule of thumb.[2] For example, if noise levels were available for a reference facility producing 20,000 bbl/day, the noise impact of a 40,000-bbl/day facility was assumed to be 3 dBA higher, an assumption equivalent to locating two 20,000-bbl/day facilities at the same point.

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[2] A 3-dB change in sound level is considered barely noticeable on the basis of individuals' responses to changes in sound levels (NWCC 1998; MPCA 1999).

**Noise Modeling Parameters**

| | |
|---|---|
| All calculations: | |
| Ground type: | Soft |
| For calculating $L_{dn}$: | |
| Daytime background noise level: | 40 dBA (typical of rural areas) |
| Nighttime background noise level: | 30 dBA (typical of rural areas) |
| Daytime hours: | 15 hours from 7 a.m. to 10 p.m. |
| Nighttime hours: | 9 hours from 10 p.m. to 7 a.m. |

As is generally the practice, this PEIS uses the EPA guideline of 55 dBA ($L_{dn}$), deemed adequate to protect human health and welfare, as a significance criterion for assessing noise impacts (EPA 1974). However, tar sands development would occur mostly in remote rural locations. In these areas, background (already existing) noise levels are low (40 dBA during the day and 30 dBA during the night are representative levels), and an increase in noise levels to 55 dBA would be noticeable and annoying to both people and wildlife (Harris 1991). However, this guideline may not be appropriate for all wildlife impacts or for people seeking solitude or a natural, wilderness experience. Depending on ambient conditions, the activities being pursued by the receptors, and the nature of the sound, wildlife and human activities can be affected at levels below 55 dBA, but quantitative guidelines were unavailable. In addition, the NPS has determined that $L_{dn}$ and $L_{eq}$ alone are not appropriate for determining impacts in National Parks and typically uses audibility metrics to characterize impacts on humans and wildlife. Site-specific impacts on resources administered by the NPS would be assessed by using audibility-based metrics and other appropriate data and methodologies. See Sections 5.8 and 5.9 for impacts on wildlife and human aesthetic experiences, respectively, that could result from increased levels of noise.

### 5.7.1 Common Impacts

Noise impacts from the construction and reclamation of tar sands facilities would be largely independent of the type of facility being constructed and are discussed below. Noise impacts from associated on-road vehicular traffic would also be largely independent of the facility type. Deviations from these general discussions are noted in the discussions of specific technologies. The noise from electric transmission lines and the product pipeline associated with these facilities is also discussed.

#### 5.7.1.1 Construction

Construction would include a variety of activities, including building of access roads, grading, drilling, pouring concrete, trenching, laying pipe, cleanup, revegetation, and perhaps blasting. With the exception of blasting, construction equipment constitutes the largest noise source at construction sites. Table 5.7.1-1 presents noise levels for typical construction

**TABLE 5.7.1-1 Noise Levels at Various Distances from Typical Construction Equipment**

| | Noise Level $L_{eq(1-h)}$[a] at Distances (dB[A]) | | | | | |
|---|---|---|---|---|---|---|
| Construction Equipment | 50 ft | 250 ft | 500 ft | 1,000 ft | 2,500 ft | 5,000 ft |
| Bulldozer | 85 | 66 | 58 | 50 | 40 | 32 |
| Concrete mixer | 85 | 66 | 58 | 50 | 40 | 32 |
| Concrete pump | 82 | 63 | 55 | 47 | 37 | 29 |
| Crane, derrick | 88 | 69 | 61 | 53 | 43 | 35 |
| Crane, mobile | 83 | 64 | 56 | 48 | 38 | 30 |
| Front-end loader | 85 | 66 | 58 | 50 | 40 | 32 |
| Generator | 81 | 62 | 54 | 46 | 36 | 28 |
| Grader | 85 | 66 | 58 | 50 | 40 | 32 |
| Shovel | 82 | 63 | 55 | 47 | 37 | 29 |
| Truck | 88 | 69 | 61 | 53 | 43 | 35 |

[a] $L_{eq(1-h)}$ is the equivalent steady-state sound level that contains the same varying sound level during a 1-hour period.

Source: HMMH (1995).

equipment. For a programmatic assessment of construction impacts, it can be assumed that the two noisiest pieces (derrick crane and truck) would operate simultaneously and in close proximity to each other. Together these would produce a noise level of 91 dBA. Assuming a 10-hour workday, noise levels would exceed the EPA guideline of 55 dBA ($L_{dn}$) up to about 850 ft from the location where the equipment was operating. Construction impacts could last up to 2 years and could recur during the operational phase if additional processing facilities needed to be constructed.

If used, blasting would create a compressional wave with an audible noise portion. Potential impacts on the closest sensitive receptors could be determined, but most sensitive receptors, at least human sensitive receptors, would probably be located at a considerable distance from the construction sites.

### 5.7.1.2 Vehicular Traffic

Heavy-duty trucks produce most of the noise associated with vehicular traffic during construction.[3] Vehicular traffic includes hauling of materials, transport of equipment, delivery of water for fugitive dust control, and worker personal vehicles. Light-duty trucks, such as pickups and personal vehicles, produce less noise than heavy duty trucks (10 passenger cars make about the same noise as a single heavy-duty truck on an $L_{eq}$ basis). Except for short periods when workers are arriving at and leaving the construction site, heavy-truck traffic would dominate the

[3] The average noise from a passing car is about 15 dBA less than that from a passing truck (BLM 2006a).

vehicular traffic. Table 5.7.1-2 presents the noise impacts from heavy trucks estimated at various distances from a road for different hourly levels of truck traffic. For these estimates, a peak pass-by noise level from a heavy-duty truck operating at 35 mph was based on Menge et al. (1998) and a 10-hour working day. Except for locations very close to the road or with high traffic levels, noise levels would not exceed the EPA guideline level.

#### 5.7.1.3 Surface Mining with Surface Retort

No well drilling would be required for surface mining with surface retort (see Section 5.7.1.1 for general construction impacts). This assessment relies on data on noise from a mine supporting a 20,000-bbl/day surface retort and its associated surface mine (Appendix B). Noise from the retort is expected to be 73 to 88 dBA at 50 ft, while noise from the mine is expected to be about 61 dBA at 500 ft.[4] Both the retort and the mine would operate continuously. To be conservative, the higher noise level was used for the retort, and both sources were modeled at the same point. Table 5.7.1-3 presents the results. Given the distances at which the EPA guideline level might be exceeded, these results indicate that the potential noise impacts from surface mines and retorts should be evaluated thoroughly. If high noise impacts are projected, noise-reduction equipment such as mufflers, blowdown mutes, and pipe wrap and enclosures may be required (Daniels et al. 1981).

#### 5.7.1.4 Surface Mining with Solvent Extraction

No well drilling would be required for this technology (see Section 5.7.1.1 for general construction impacts). The noise levels for operation of this technology described in Appendix B

**TABLE 5.7.1-2 Noise Levels at Various Distances from Heavy Truck Traffic**

| | Noise Level $L_{dn}$ at Distances (dB[A])[a] | | | | | |
|---|---|---|---|---|---|---|
| Hourly Number of Trucks | 50 ft | 75 ft | 100 ft | 125 ft | 250 ft | 500 ft |
| 1 | 48 | 45 | 43 | 42 | 37 | 32 |
| 10 | 58 | 55 | 53 | 52 | 47 | 42 |
| 50 | 65 | 62 | 60 | 58 | 54 | 49 |
| 100 | 68 | 65 | 63 | 62 | 57 | 52 |

[a] Estimated assuming a 10-hour daytime shift and heavy trucks operating at 35 mph.

Source: Menge et al. (1998).

[4] The reference estimate included only the effects of geometric spreading and is equivalent to a level of 81 dBA at 50 ft.

are identical to those for surface mining with surface retorting. Noise impacts would be identical to those noted in Section 5.7.1.3.

**TABLE 5.7.1-3 Noise Levels from a Surface Mine with Surface Retort Site and a Surface Mine with Solvent Extraction Site**

| Plant Capacity ($10^3$ bbl/day) | Distance to $L_{dn}$ of 55 dBA (ft)[a] |
|---|---|
| 20 | 1,640 |

[a] Assuming 24 hours per day for continuous operation, the estimated noise level at a given distance is about 48.5 dBA.

### 5.7.1.5 In Situ Steam Injection

BLM (1984) provides noise impact estimates for construction of a 30,000-bbl/day in situ steam injection tar sands processing facility. At 250 ft, typical maximum construction noise was estimated to be 67 dBA. This estimate was revised to include the ground effects and to estimate $L_{dn}$, assuming 10 hours per day of construction time. The distance to where the $L_{dn}$ noise level reached the EPA guideline level was modeled. Table 5.7.1-4 gives this distance for an in situ steam plant with a capacity of 20,000 bbl/day.

During operation, the BLM (1984) estimated a maximum noise level of 78 dBA at 250 ft. This estimate was also revised by assuming 24 hours per day of operational time, and the results are presented in Table 5.7.1-4. The reference noise levels were estimated by using a simple aggregation technique and ignoring the spatial separation of the sources. This practice will generally lead to overestimates of noise levels. In view of the potential for overestimation of these noise estimates, the potential noise impacts of in situ steam injection plants should be evaluated thoroughly.

### 5.7.1.6 In Situ Combustion

On the basis of estimates in Daniels et al. (1981), a 20,000-bbl/day in situ combustion operation might have about 80 wells covering 160 acres operating at any time. The wells would be spaced about 330 ft apart. Daniels et al. (1981) did not specify the number of drilling rigs used during construction. For estimation purposes, it was assumed that 9 to 10 drilling rigs would be operating 10 hours per day. This situation was modeled as a square array of 9 sources, each separated by 800 ft. This arrangement would allow all 81 wells to be drilled while about the same separation between rigs would be maintained as they moved to new locations. The results indicate that the $L_{dn}$ noise level would be reached at just under 500 ft, with a corresponding noise level of almost 59 dBA. (For additional construction impacts see Section 5.7.1.1.)

To estimate noise levels during operations, a square array of 81 pumps (one for each well) was modeled, and operation of 24 hours per day was assumed. The noise level for each pump was taken as 82 dBA at 50 ft (BLM 2000). The results indicated that the EPA $L_{dn}$ guideline level might be exceeded to about 3,700 ft, with a corresponding noise level of 48 dBA. Given the distances at which the EPA guideline level might be exceeded, these results indicate that the potential noise impacts of in situ combustion should be evaluated thoroughly. If high noise impacts are projected, noise-reduction equipment such as mufflers, blowdown mutes, and pipe wrap and enclosures may be required (Daniels et al. 1981).

As indicated in Appendix B, in situ combustion is the only technology for possible deployment in the Tar Sand Triangle STSA. Much of the leasable land in this STSA is located within 3,000 to 6,000 ft of special designated areas such as potential ACECs and WSAs (see Figure 3.1.1-9). In addition, some part of the leasable lands lies within the Glen Canyon NRA and abuts with other lands in the NRA that are zoned for natural use. In all these areas, the intrusion of noise into the natural environment may be a particular concern with regard to the development of in situ combustion projects.

**TABLE 5.7.1-4 Noise Levels from an In Situ Steam Injection Site**

| Plant Capacity (20,000 bbl/day) | Distance to $L_{dn}$ of 55 dBA (ft) | |
|---|---|---|
| | Construction[a] | Operation[b] |
| 20 | 300 | 1,860 |

[a] Assuming 10 hours per day for daytime construction, the estimated noise level at a given distance is about 58.7 dBA.

[b] Assuming 24 hours per day for continuous operation, the estimated noise level at a given distance is about 48.5 dBA.

#### 5.7.1.7 Reclamation

In general, noise impacts from reclamation activities would be similar to but less than those associated with construction activities because the activity type and level would be similar but shorter in duration. Most reclamation would also occur during the day when noise is better tolerated by people, and noise levels would return to background levels at night and would be intermittent in nature. Reclamation activities would last for a short period compared with the period of construction operations.

#### 5.7.1.8 Transmission Lines

General construction impacts are discussed in Section 5.7.1.1. During operation, the main sources of noise from the transmission line would be substation noise and corona discharge. Substation noise comes primarily from transformers and switchgear. A transformer produces a constant low-frequency hum. The average A-weighted sound level at about 490 ft for a transformer of abut 400 MW is about 49 dBA (Wood 1992). The number and size of transformers are currently unknown, but a single transformer could exceed the EPA guideline at 500 ft. Transformer noise and mitigating measures must be addressed if substations are required along the transmission lines. Switchgear noise is generated when a breaker opens, producing an impulsive sound that is loud but of short duration. These sounds occur infrequently, and the industry trend is toward breakers that generate significantly less noise. The potential impacts of switchgear noise would be temporary, infrequent, and minor.

Transmission lines generate corona discharge, which produces a noise having a hissing or crackling character. During dry weather, transmission line noise is generally indistinguishable from background noise at the edge of typical ROWs. During rainfall, the level would be less than 47 dBA 100 ft from the center of a 500-kV transmission line (BPA 1996). This is the noise level typical of a library (MPCA 1979). Even if several transmission lines of this capacity were required, the overall corona noise would be lost even in rural background noise within several hundred feet.

#### 5.7.1.9 Pipeline

General construction impacts are discussed in Section 5.7.1.1. Depending on the topography, a pipeline 95 mi long could require several pump stations. Pumps will generally be the noisiest equipment associated with a pump station. Contra Costa County (2003) gives a noise level of 94 dBA at 3 ft from a 400-hp pump but does not specify the throughput. Assuming that three pumps would be needed, the EPA guideline would be exceeded to a distance of about 260 ft from the pumps. Pumps are almost always located in structures for protection from the weather and for security. The enclosure would reduce noise levels. Because the pumps that would be needed to move the assumed output may be larger and noisier than those assumed here, noise impacts would need to be assessed during planning for the actual pump stations.

### 5.7.2 Mitigation Measures

Regulatory requirements regarding noise already largely address the mitigation of impacts. To reinforce those regulatory requirements, mitigation measures will be required and could include those that follow.

#### 5.7.2.1 Preconstruction Planning

- Developers should conduct a preconstruction noise survey to identify nearby sensitive receptors (e.g., residences, schools, child-care facilities, hospitals, livestock, ecological receptors of critical concern, and areas valued for solitude and quiet) and establish baseline noise levels along the site boundary and at the identified sensitive receptors.

- On the basis of site-specific considerations identified through the preconstruction noise survey, proponents should develop a noise management plan to mitigate noise impacts on the sensitive receptors. The plan would cover construction, operations, and reclamation. The plan should ensure that the standards to be implemented reflect conditions specific to the lease site. This plan could provide for periodic noise monitoring at the facility boundary and at nearby sensitive receptors on a monthly or more frequent basis at a time when the facility is operating at normal or above-normal levels. Monitoring results could be used to identify the need for corrective actions in existing mitigation measures or the need for additional noise mitigation.

#### 5.7.2.2 Construction and Reclamation

Wherever there are sensitive receptors, as identified in the preconstruction survey, construction noise should be managed to the extent necessary to mitigate adverse impacts on the sensitive receptors. Efforts to mitigate these impacts could include the following measures:

- A noise complaint manager could be designated to receive any noise complaints from the public. This employee could have the responsibility and authority to convene a committee to investigate noise complaints, determine the causes of the noise leading to the complaints, and recommend mitigation measures.

- General construction activities could be limited to daytime hours between 7 a.m. and 7 p.m. On the basis of the results of the baseline noise survey, these hours could be extended to between 7 a.m. and 10 p.m. in areas remote from sensitive receptors.

- Particularly noisy activities, such as pile driving, blasting, and hauling by heavy trucks, could be limited to daytime hours between 8 a.m. and 5 p.m. on weekdays and prohibited on weekends and state and federal holidays. The noise management plan could identify alternate methods for conducting noisy activities and available mitigation methods. The least noisy of these could be chosen for use during construction unless its use was precluded by site-specific characteristics.

- When feasible, different particularly noisy activities could be scheduled to occur at the same time, since additional sources of noise generally do not add significantly to the perceived noise level. That is, less-frequent noisy activities may be less annoying than frequent less-noisy activities.

- If blasting or other impulsive-noise activities are required, nearby sensitive human receptors could be notified in advance.

- All construction equipment should have sound control devices that are no less effective than those provided on the original equipment. Construction equipment and the equipment's sound control devices could be required to be well tuned, in good working order, and maintained in accordance with the manufacturer's specifications. Appropriate record keeping of these maintenance activities could be required.

- Where possible, construction traffic could be routed to minimize disruption to sensitive receptors.

- Temporary barriers could be erected around areas where construction noise could disturb sensitive receptors.

- To the extent possible, stationary noisy equipment (such as compressors, pumps, and generators) could be located as far as practicable from sensitive receptors.

#### 5.7.2.3 Operation

Wherever there are sensitive receptors, as identified in the preconstruction survey, noise from operations should be managed to the extent necessary to mitigate adverse impacts on the sensitive receptors. Efforts to mitigate these impacts could include the following measures:

- A noise complaint manager could be designated to handle noise complaints from the public. This employee could have the responsibility and authority to convene a committee to investigate noise complaints, determine the causes of the noise leading to the complaints, and recommend mitigation measures.

- Noisy equipment (such as compressors, pumps, and generators) could be required to incorporate noise-reduction features such as acoustic enclosures, mufflers, silencers, and intake noise suppression.

- Facilities could be required to demonstrate compliance with EPA's 55-dBA guideline at the nearest human sensitive receptor. Sensitive ecological receptors and appropriate associated lower noise levels could also be considered. In special areas where quiet and solitude have been identified as a value of concern, a demonstration that a lower noise level would be attained might be required. Such demonstrations might require use of additional or different criteria such as audibility.

- Depending on the specific site, maintenance of off-site noise at suitable levels might require the establishment of an activity-free buffer inside the fenceline.

- Facility design could include all feasible noise-reduction methods, including, but not limited to, mounting equipment on shock absorbers; mufflers or silencers on air intakes, exhausts, blowdowns, and vents; noise barriers; noise-reducing enclosures; noise-reducing doors and windows; sound-reducing pipe lagging; and low-noise ventilation systems.

- Where feasible, facility design could be required to incorporate low-noise systems such as ventilation systems, pumps, generators, compressors, and fans.

## 5.8 ECOLOGICAL RESOURCES

### 5.8.1 Common Impacts

#### 5.8.1.1 Aquatic Resources

Impacts on aquatic resources from the tar sands development projects and associated facilities could occur because of (1) direct disturbance of aquatic habitats within the footprint of construction or operation activities; (2) sedimentation of nearby aquatic habitats as a consequence of soil erosion from operational areas; (3) changes in water quantity or water quality as a result of construction (e.g., grading that affects surface runoff patterns) and operations (e.g., reductions or increases in discharges of water into nearby aquatic habitats), or releases of chemical contaminants into nearby aquatic systems; or (4) development of infrastructure such as roads and ROWs that increase public access to fishery resources. These impacts could occur to some degree during the construction period and throughout the operational life of the projects. In addition, some impacts could continue to occur beyond the operational life of the project.

Depending on the characteristics of specific development projects, new aquatic habitats could be formed after site development. For example, over time, drainage patterns associated with sediment control ponds that caught runoff from disturbed surfaces could create habitats that would support aquatic plants and invertebrates as well as fish. Although the development of such habitats could be beneficial in some instances, their ecological value would depend on the amount of habitat created and the types and numbers of species supported. In general, it is anticipated that the ecological value of these created habitats would be limited. Habitats that promoted the survival and expansion of non-native aquatic species that competed with or preyed upon native species could have negative ecological impacts on existing aquatic habitats.

Turbidity and sedimentation from erosion are part of the natural cycle of physical processes in water bodies, and most populations of aquatic organisms have adapted to short-term changes in these parameters. However, if sediment loads were unusually high or lasted longer than they would under natural conditions, adverse impacts could occur (Waters 1995). Increased sediment loads could suffocate aquatic vegetation, invertebrates, and fish; decrease the rate of photosynthesis in plants and phytoplankton; decrease fish feeding efficiency; decrease the levels of invertebrate prey; reduce fish spawning success; and adversely affect the survival of incubating fish eggs, larvae, and fry (Waters 1995). Fish adapted to living in clearer waters (e.g., cutthroat trout and mountain whitefish) are more sensitive to increased sediment loads than are species that are adapted to higher-turbidity conditions (e.g., humpback chub, Colorado pikeminnow, flannelmouth sucker). The level of effects from increased sediment loads would also depend on the natural condition of the receiving waters and the timing of sediment inputs. Although most aquatic systems might be affected if increases in the levels of suspended and deposited sediments were large, if the increases in suspended sediment loads were small to moderate, aquatic habitats that normally have turbid water might be less sensitive than those that normally have clear water. In a similar fashion, increased sedimentation might have less impact

on aquatic biota during periods of the year when sediment levels were naturally elevated (e.g., wet periods) than when the levels were lower.

The potential for soil erosion and sediment loading of nearby aquatic habitats is proportional to the amount of surface disturbance, the condition of disturbed areas at any given time, and the proximity to aquatic habitats. It is anticipated that areas being actively disturbed during construction or operations would have a higher erosion potential than areas that are undergoing reclamation activities, and that reclamation areas would become less prone to erosion over time because of completion of site grading and reestablishment of vegetated cover. Assuming that reclamation activities are successful, restored areas should eventually become similar to natural areas in terms of erosion potential. In addition to areas directly affected by project construction and operations, surface disturbance could occur as a result of the development of access roads, utility corridors, and employer-provided housing. Implementation of measures to control erosion and runoff into aquatic habitats (e.g., silt fences, retention ponds, runoff-control structures, and earthen berms) would reduce the potential for impacts from increased sedimentation.

Changes in flow patterns of streams and depletion of surface water within tar sands areas could affect the quality of associated aquatic habitats and the survival of populations of aquatic organisms within affected bodies of water. Most obviously, perhaps, complete dewatering of streams or stream segments would preclude the continued presence of aquatic communities within the affected areas. However, changes in flows and flow patterns could affect the nature of the aquatic communities that are supported even if there is not complete dewatering. Reductions in flow levels can result in depth changes and reductions in water quality (e.g., dissolved oxygen levels) that some species of fish and invertebrates may be unable to tolerate. Reduced depths can affect the susceptibility of some fish species to predation from avian and terrestrial predators. Reductions in dissolved oxygen levels, especially during warm periods of the year when the ability of oxygen to dissolve in water is already reduced, could result in mortality of fish and invertebrates. This would be especially critical in streams that support cooler water species, such as trout, that are typically more sensitive to lowered dissolved oxygen conditions.

Contaminants could enter aquatic habitats as a result of leachate runoff from exposed tar sands deposits, including spent tar sands; the accidental release of fuels, lubricants, or pesticides; or spills from pipelines used to transport petroleum products from the site. Both raw and spent tar sands remaining on the surface could become a chronic source of contaminated runoff unless adequate containment measures are implemented or unless they are transported off-site for disposal. Exposure to the leachate from tar sands and spent tar sands tailings has been shown to reduce the survival of some fish and aquatic invertebrate species if the concentrations are high enough (Siwik et al. 2000; Sik-Cheung et al. 2001; Colavecchia et al. 2004). Thus, spent tar sands returned to surface mine pits following processing could affect aquatic resources if they result in contaminants entering surface waters via surface runoff or groundwater. Spent tar sands remaining underground following in situ combustion or steam injection could similarly contaminate aquatic habitats if groundwater passes through these spent sands deposits and later enters surface waters. Because the resulting concentrations in aquatic habitats would depend largely on the dilution capability, and, therefore, the flow of the receiving waters, impacts would

be more likely if runoff from spent tar sands deposits entered small perennial streams than if it entered larger streams.

Toxic materials (e.g., fuels, lubricants, and herbicides) could also be accidentally introduced into waterways during construction and maintenance activities or as a result of leaks from pipelines used to transport petroleum products from the project site to collection areas. The level of impacts from releases of toxic materials would depend on the type and volume of chemicals entering the waterway, the location of the release, the nature of the water body (e.g., size, volume, and flow rate), and the types and life stages of organisms present in the waterway. In general, lubricants and fuel would not be expected to enter waterways in detrimental quantities as long as (1) heavy machinery is not used in or near waterways, (2) fueling locations for construction and maintenance equipment are situated away from waterways, and (3) measures are taken to control spills that occur.

In areas where access roads, pipelines, or utility corridors cross streams, obstructions to fish movement could occur if culverts, low-water crossings, or buried pipelines are not properly installed, sized, or maintained. During periods of low water, vehicular traffic can result in rutting and accumulation of cobbles in some crossings that can interfere with fish movements. In streams with low flows, flow could become discontinuous if disturbance of the streambed during construction activities results in increased porosity or if the altered channel spreads across a wider area. Restrictions on fish movement would likely be most significant if they occur in streams that support species that need to move to specific areas in order to reproduce.

In addition to the potential for the direct impacts identified above, indirect impacts on fisheries could occur as a result of increased public access to remote areas via newly constructed access roads and utility corridors. Fisheries could be impacted by increased fishing pressure, and other human activities (e.g., OHV use) could disturb riparian vegetation and soils, resulting in erosion and sediment-related impacts on water bodies, as discussed previously. Such impacts would be smaller in locations where existing access roads or utility corridors that already provide access to waterways would be utilized. Because all of the proposed projects would require similar levels of infrastructure that could result in increased public access, the level of impact would be similar regardless of the technology used. Overall, it is anticipated that impacts on fishery resources from increased access would be minor.

#### 5.8.1.2 Plant Communities and Habitats

Potential impacts on terrestrial, riparian, and wetland plant communities and habitats from activities associated with tar sands development would include direct impacts from habitat removal, as well as a wide variety of indirect impacts. Impacts would be incurred during initial site preparation and continue throughout the life of the project, extending over a period of several decades. Some impacts may also continue beyond the termination of asphalt or syncrude production.

Direct impacts would include the destruction of habitat during initial land clearing on the lease site, as well as habitat losses resulting from the construction of ancillary facilities such as

access roads, pipelines, transmission lines, and employer-provided housing. Land clearing on the site would be required for the construction of processing facilities, storage areas for soil and spent tar sands, and excavation areas. Land clearing would also occur incrementally throughout the life of the project, resulting in continued losses of habitat. Storage of woody vegetation cleared from project areas would impact additional areas of vegetation. Native vegetation communities present in project areas would be destroyed. Riparian habitats or wetlands may be affected by ROWs that cross streams or other water bodies. Impacts on jurisdictional wetlands (those under the regulatory jurisdiction of the CWA, Section 404, and the USACE) on or near the project site or locations of ancillary facilities would be avoided or mitigated. Preconstruction surveys would identify wetland locations and boundaries, and the permitting process would be initiated with the USACE for unavoidable impacts.

Reclamation of impacted areas would include reestablishment of vegetation on restored soils. Although revegetation of disturbed soils in many locations may successfully establish a productive vegetation cover, with biomass and species richness similar to those of local native communities, the resulting plant community may be quite different from native communities in species composition and the representation of particular vegetation types, such as shrubs (Newman and Redente 2001). Community composition of revegetated areas would likely be greatly influenced by the species that are initially seeded, particularly perennial grasses, and colonization by species from nearby native communities may be slow (Newman and Redente 2001; Paschke et al. 2005; Belnap and Herrick 2006). The establishment of mature native plant communities may require decades. Successful reestablishment of some vegetation types, such as shrubland communities, may be difficult and would require considerable periods of time, likely more than 20 years. Restoration of plant communities in STSAs with arid climates (generally averaging less than 9 in. of annual precipitation), such as shadscale-saltbush communities, may be very difficult (Monsen et al. 2004). Although vegetation within ROWs would become reestablished, ROW management programs may prevent the establishment of mature native communities. Areas along ROWs that would be impacted by ROW construction would be restored in the same manner as other disturbed project areas. The loss of intact native plant communities could result in increased habitat fragmentation, even with the reclamation of impacted areas.

Disturbed soils may provide an opportunity for the introduction and establishment of non-native invasive species. Seeds or other propagules of invasive species may be inadvertently brought to a project site from infested areas by heavy equipment or other vehicles used at the site. Invasive species may also colonize disturbed soils from established populations in nearby areas. The establishment of invasive species may greatly reduce the success of the establishment of native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. In addition, the planting of non-native species in reclaimed areas may result in the introduction of those species into nearby natural areas.

Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. Impacts on surface water and groundwater systems, which subsequently affect terrestrial plant communities, wetlands, and riparian areas, are

described in Section 5.5. Deposition of fugitive dust, including associated salts, generated during clearing and grading, construction, and use of access roads or resulting from wind erosion of exposed soils, could reduce photosynthesis and productivity in plants near project areas and could result in foliar damage. Plant community composition could be subsequently altered, resulting in habitat degradation. In addition, pollinator species could be affected by fugitive dust, potentially reducing pollinator populations in the vicinity of a tar sands project. Temporary, localized effects to plant populations and communities could occur if seed production in some plant species is reduced. Soil compaction could reduce the infiltration of precipitation or snowmelt and, along with reduced vegetation cover, result in increased runoff and subsequent erosion and sedimentation. Reduced infiltration and altered surface runoff and drainage characteristics could result in changes in soil moisture characteristics, reduced recharge of shallow groundwater systems, and changes in the hydrologic regimes of downgradient streams and associated wetlands and riparian areas. Soils on steep slopes, such as those that occur in many STSAs, could be particularly susceptible to increased erosion resulting from changes in stormwater flow patterns.

Erosion and reductions in soil moisture could alter affected terrestrial plant communities adjacent to project activities, resulting in reduced growth and reproduction. Altered hydrologic regimes, particularly reductions in the duration, frequency, or extent of inundation or soil saturation (potentially resulting from elimination of ephemeral or intermittent streams), could result in species or structural changes in wetland or riparian communities; changes in distribution; or reduction in community extent. Increased volumes or velocities of flows could affect wetland and riparian habitats, thereby removing fine soil components, organic materials, and shallow rooted plants. Large-scale surface disturbance that reduces infiltration may increase flow fluctuations, reduce base flows, and increase flood flows, resulting in impacts on wetland and riparian community composition and extent. Sedimentation, and associated increases in dissolved salts, could degrade wetland and riparian plant communities. Effects may include reduced growth or mortality of plants; altered species composition; reduced biodiversity; or, in areas of heavy sediment accumulation, reduction in the extent of wetland or riparian communities. Disturbance-tolerant species may become dominant in communities affected by these changes in hydrology and water quality. Increased sedimentation, turbidity, salt loading, or other changes in water quality may provide conditions conducive to the establishment of invasive species.

Alterations of groundwater flow or quality in project areas, such as during tar sands extraction or in situ processing, may affect wetlands and riparian areas that directly receive groundwater discharge, such as at springs or seeps, or that are present in streams with flows maintained by groundwater. Wetland and riparian communities far downgradient from tar sands extraction or retorting activities may be affected by reduced flows or reduced water quality. Flow reductions in alluvial aquifers from tar sands extraction, water withdrawals, or pipeline installation may also result in reductions, or changes in community composition, in wetland or riparian communities associated with streams receiving alluvial aquifer discharge. Water withdrawals from surface water features, such as rivers and streams, may reduce flows and water quality downstream, which may, in turn, reduce the extent or distribution of wetlands and riparian areas along these water bodies or degrade these plant communities. The construction of reservoirs would also affect downstream wetlands and riparian areas by reducing flows and

sediment transport and increasing salt loading. Wetlands and riparian areas within the area of the reservoir and dam would be lost.

Plant communities and habitats could be adversely affected by impacts on water quality, resulting in plant mortality or reduced growth, with subsequent changes in community composition and structure and declines in habitat quality. Leachate from stockpiles of spent tar sands or overburden may adversely affect terrestrial (such as phreatophytic), riparian, or wetland plant communities as a result of impacts on surface water or groundwater quality. Produced water from tar sands retorting or saline water pumped from lower aquifers, if discharged on the land surface, may result in impacts on terrestrial, riparian, or wetland communities because of reduced water quality. Herbicides used in ROW maintenance could be carried to wetland and riparian areas by surface runoff or may be carried to nearby terrestrial communities by air currents. Impacts on surface water quality from deposition of atmospheric dust or pollutants from equipment exhaust could degrade terrestrial, wetland, and riparian habitats. Accidental spills of chemicals, fuels, or oil would adversely affect plant communities. Direct contact with contaminants could result in mortality of plants or degradation of habitats. Spills could impact the quality of shallow groundwater and indirectly affect terrestrial plants.

#### 5.8.1.3 Wildlife

All tar sands leasing projects that would be constructed and operated have the potential to affect wildlife, including wild horses (*Equus caballus*) and burros (*E. asinus*), over a period of several decades. Reclamation that would occur after extraction activities are completed would serve to reduce or eliminate ongoing impacts by recreating habitats and ecological conditions that could be suitable to wildlife species. The effectiveness of any reclamation activities would depend on the specific actions taken; the best results, however, would occur where original site topography, hydrology, soils, and vegetation patterns could be reestablished.

The following discussion provides an overview of the potential effects on wildlife that could occur from the construction and operation of a tar sands project. The use of mitigation measures and SOPs (e.g., predisturbance surveys, erosion and dust suppression control practices, establishment of buffer areas, reclamation of disturbed areas using native species, and netting of on-site ponds) would reduce impacts on wildlife species and their habitats. The specifics of these practices would be established through consultations with federal and state agencies and other stakeholders.

Impacts on wildlife from tar sands projects could occur in a number of ways and are related to (1) habitat loss, alteration, or fragmentation; (2) disturbance and displacement; (3) mortality; and (4) increase in human access. These can result in changes in habitat use; changes in behavior; collisions with structures or vehicles; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminants.

Wildlife may also be affected by human activities that are not directly associated with the tar sands project or its workforce but that are instead associated with the potentially increased access to BLM-administered lands that had previously received little use. The construction of

new access roads or improvements to old access roads may lead to increased human access into the area. Potential impacts associated with increased access include (1) the disturbance of wildlife from human activities, including an increase in legal and illegal harvest and an increase of invasive vegetation, and (2) an increase in the incidence of fires.

Wildlife impacts from the impacting factors discussed below are summarized in Table 5.8.1-1. The potential magnitude of the impacts that could result from tar sands development is presented for representative wildlife species types. Impacts are designated as small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of the local population (less than 10%), and does not result in a measurable change in carrying capacity or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of the local population, and result in a measurable but moderate change (less than 50%) in carrying capacity or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 50% of a local population, and result in a large measurable change (50% or more) in carrying capacity or population size in the affected area.

**5.8.1.3.1 Habitat Disturbance.** The reduction, alteration, or fragmentation of habitat would result in a major impact on wildlife. Habitats within the construction footprint of the projects, utility ROWs, access roads, and other infrastructure would be destroyed or disturbed. The amount of habitat impacted would be a function of the degree of disturbance already present in the project site area. With certain exceptions, areas lacking vegetation (e.g., operational areas, access roads, and active portions of tar sands mining) provide minimal habitat. The construction activities associated with the projects would not only result in the direct reduction or alteration of wildlife habitat within the project footprint but could also affect the diversity and abundance of area wildlife through habitat fragmentation. Habitat fragmentation causes both a loss of habitat and habitat isolation. Wildlife species least impacted by habitat fragmentation include those that can inhabit a variety of habitats, have the ability to colonize and reproduce in the habitat patches created by management actions, and are relatively abundant (e.g., rodents and migratory birds) (Lehmkuhl 2005).

A decline in wildlife use near roads or other facilities would be considered an indirect habitat loss. Avoidance of habitat associated with roads has been reported to be 2.5 to 3.5 times as great as the actual habitat loss associated with the road's footprint (Reed et al. 1996). Mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) may avoid areas up to 0.40 km (0.25 mi) from a project area (BLM 2006c). Similarly, bird nesting may be disrupted within 0.40 km (0.25 mi) of construction activities during the nesting and brooding periods (e.g., February 1 to August 25) (BLM 2006a). Road avoidance by wildlife could be greater in open landscapes compared with forested landscapes (Thomson et al. 2005). Mule deer use declined within 2.7 to 3.7 km (1.7 to 2.3 mi) of gas well pads, suggesting that indirect habitat loss can be larger than direct habitat loss (Sawyer et al. 2006). Density of sagebrush obligates, particularly Brewer's sparrow (*Spizella breweri*) and sage sparrow (*Amphispiza belli*), was reduced 39 to 60% within a 100-m (328-ft) buffer around dirt roads with low traffic volumes. The declines may have been due to a combination of traffic, edge effects, habitat fragmentation, and increases in other passerine species along road corridors. Thus, declines may persist until

**TABLE 5.8.1-1 Potential Impacts on Wildlife Species Resulting from Commercial Tar Sands Development**

| | Potential Magnitude of Impacts According to Species Type[a] | | | | | | |
|---|---|---|---|---|---|---|---|
| Impact Category | Amphibians and Reptiles | Shorebirds and Waterfowl | Land Birds | Raptors | Small Game and Nongame Mammals | Big Game Mammals | Wild Horses and Burros |
| Vegetation clearing | Large | Small | Large | Large | Large | Large | Large |
| Habitat fragmentation | Moderate | Small | Moderate | Moderate | Moderate | Moderate | Moderate |
| Movement/dispersal blockage | Moderate | Small | Small | Small | Moderate | Moderate | Moderate |
| Alteration of topography | Small | Small | Small | Small | Small | Small | Small |
| Erosion and sedimentation | Small | Small | Small | Small | Small | Small | Small |
| Contaminant spills | Small | Small | Small | Small | Small | Small | Small |
| Fugitive dust | Small | Small | Small | Small | Small | Small | Small |
| Injury or mortality | Moderate | Moderate | Large | Moderate | Large | Large | Moderate |
| Collection | Moderate | Small | Small | Small | Small | Small | Small |
| Human disturbance/harassment | Small | Moderate | Large | Large | Large | Large | Large |
| Increases in predation rates | Moderate | Moderate | Moderate | Small | Moderate | Moderate | Small |
| Noise | Small | Large | Large | Large | Large | Large | Large |
| Spread of invasive plant species | Small | Small | Moderate | Small | Moderate | Small | Small |
| Air pollution | Small | Small | Small | Small | Small | Small | Small |
| Fire | Small | Small | Moderate | Small | Moderate | Small | Small |

[a] Potential impact magnitude (without mitigation) is presented as small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of the local population (less than 10%), and does not result in a measurable change in carrying capacity or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of the local population, and result in a measurable but moderate change (less than 50%) in carrying capacity or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 50% of a local population, and result in a large measurable change (50% or more) in carrying capacity or population size in the affected area.

roads are fully reclaimed (Ingelfinger and Anderson 2004). Those individual animals that make use of areas within or adjacent to project areas could be subjected to increased physiological stress. This combination of avoidance and stress reduces the capability of wildlife to use habitat effectively (WGFD 2004). As noise and human presence are reduced (e.g., as may occur following the switch from construction to operation), wildlife may increase their use of otherwise suitable habitats, although probably not at the same levels as before disturbance began (BLM 2006e).

Some species such as the common raven (*Corvus corax*) are more abundant along roads because of automobile-generated carrion, whereas ravens and other raptors are more common along transmission lines because of the presence of perch and nest sites (Knight and Kawashima 1993).

Displaced animals would likely have lower reproductive success because nearby areas are typically already occupied by other individuals of the species that would be displaced (Riffell et al. 1996). Increasing the concentration of wildlife in an area may result in a number of adverse effects, including potential mortality of the displaced animals from depletion of food sources, increased vulnerability to predators, increased potential for the propagation of diseases and parasites, increased intra- and interspecies competition, and increased potential for poaching.

Long-term displacement of elk, mule deer, pronghorn (*Antilocapra americana*), or other species from critical (crucial) habitat because of habitat disturbance would be considered significant (BLM 2004a). For example, activities around parturition areas have the potential to decrease the usability of these areas for calving and fawning. A tar sands development project located within a crucial winter area could directly reduce the amount of habitat available to the local population. This could force the individuals to use suboptimal habitat, which could lead to debilitating stress. Habitat loss and an associated decrease in the raptor prey base could increase the foraging area necessary to support an individual and/or decrease the number of foraging raptors an area could support (BLM 2006e). With decreasing availability of forbs and grasses, greater sage-grouse (*Centrocercus urophasianus*) broods could move longer distances and expend more energy to find forage. Increased movement, in addition to decreased vegetative cover, could expose chicks to greater risk of predation (see BLM 2006e). The following text box provides more detailed information about how greater sage-grouse may be impacted by tar sands development, including information about possible measures to mitigate impacts.

Potential impacts on waterfowl and shorebirds could primarily occur from impacts on habitat or changes in habitat. Construction could cause short-term changes in water quality from increases in siltation and sedimentation related to ground disturbance. Long-term impacts could result from habitat alterations (i.e., changing forested wetlands to scrub-shrub and emergent wetlands within the ROWs). This could have a slight beneficial impact on most waterfowl and shorebird species.

The presence of tar sands development projects and associated facilities could disrupt movements of wildlife, particularly during migration. Migrating birds would be expected to simply fly over the project and continue their migratory movement. However, herd animals, such

**Compatibility of Tar Sands Leasing and Greater Sage-Grouse**

Most concerns about the effects of tar sands development on greater sage-grouse (*Centrocercus urophasianus*) have focused on potential impacts associated with the reduction, fragmentation, and modification of grassland and shrubland habitats.

Populations of greater sage-grouse can vary from nonmigratory to migratory (having either one-stage or two-stage migrations) and can occupy an area that exceeds 1,040 $mi^2$ on an annual basis. The distance between leks (strutting grounds) and nesting sites can exceed 12 mi (Connelly et al. 2000; Bird and Schenk 2005). Nonmigratory populations can move 5 to 6 mi between seasonal habitats and have home ranges up to 40 $mi^2$. The distance between summer and winter ranges for one-stage migrants can be 9 to 30 mi. Two-stage migrant populations make movements among breeding habitat, summer range, and winter range. Their annual movements can exceed 60 mi. The migratory populations can have home ranges that exceed 580 $mi^2$ (Bird and Schenk 2005). However, the greater sage-grouse has a high fidelity to a seasonal range. They also return to the same nesting areas annually (Connelly et al. 2000, 2004).

The greater sage-grouse needs contiguous, undisturbed areas of high-quality habitat during its four distinct seasonal periods: (1) breeding, (2) summer-late brooding and rearing, (3) fall, and (4) winter (Connelly et al. 2000). The greater sage-grouse occurs at elevations ranging from 4,000 to 9,000 ft. It is omnivorous and consumes primarily sagebrush and insects. More than 99% of its diet in winter consists of sagebrush leaves and buds. Sagebrush is also important as roosting cover, and the greater sage-grouse cannot survive where sagebrush does not exist (USFWS 2004).

Leks are generally areas supported by low, sparse vegetation or open areas surrounded by sagebrush that provide escape, feeding, and cover. They can range in size from small areas of 0.1 to 10 acres to areas of 100 acres or more (Connelly et al. 2000). The lek/breeding period occurs March through May, with peak breeding occurring from early to mid-April. Nesting generally occurs 1 to 4 mi from lek sites, although it may range up to 11 mi (BLM 2004a). The nesting/early brood-rearing period occurs from March through July. Sagebrush at nesting/early brood-rearing habitat is 12 to 32 in. above ground, with 15 to 25% canopy cover. Tall, dense grass combined with tall shrubs at nest sites decreases the likelihood of nest depredation. Hens have a strong year-to-year fidelity to nesting areas (BLM 2004a). The late brood-rearing period occurs from July through October. Sagebrush at late brood-rearing habitat is 12 to 32 in. tall, with a canopy cover of 10 to 25% (BLM 2004a). The greater sage-grouse occupies winter habitat from November through March. Suitable winter habitat requires sagebrush 10 to 14 in. above snow level with a canopy cover ranging from 10 to 30%. Wintering grounds are potentially the most limiting seasonal habitat for greater sage-grouse (BLM 2004a).

While no single factor or combination of factors have been proven to have caused the decline in greater sage-grouse numbers over the past half-century, the decline is thought to be caused by a number of factors, including drought, oil and gas wells and their associated infrastructure, power lines, predators, and a decline in the quality and quantity of sagebrush habitat (due to livestock grazing, range management treatments, and development activities) (Connelly et al. 2000; Crawford et al. 2004). West Nile virus is also a significant stressor of greater sage-grouse (Naugle et al. 2004).

Loud, unusual sounds and noise from construction and human activities disturb greater sage-grouse, cause birds to avoid traditional use areas, and reduce their use of leks (Young 2003). Disturbance at leks appears to limit reproductive opportunities and may result in regional population declines. Most observed nest abandonment is related to human activity (NatureServe 2006). Thus, site construction, operation, and site-maintenance activities could be a source of auditory and visual disturbance to greater sage-grouse.

Tar sands lease area facilities, transmission lines, pipelines, access roads, and employer-provided housing may adversely affect important greater sage-grouse habitats by causing fragmentation, reducing habitat value, or reducing the amount of habitat available (Braun 1998). Transmission lines, aboveground portions of pipelines,

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and other structures can also provide perches and nesting areas for raptors and ravens that may prey upon the greater sage-grouse.

Measures that have been suggested for management of greater sage-grouse and their habitats (e.g., Paige and Ritter 1999; Connelly et al. 2000; WGFD 2003) that have pertinence to tar sands projects and associated facilities include the following:

- Identify and avoid both local (daily) and seasonal migration routes.
- Consider sage-grouse and sage habitat when designing, constructing, and utilizing project access roads and trails.
- Avoid, when possible, siting energy developments in breeding habitats.
- Adjust the timing of activities to minimize disturbance to sage-grouse during critical periods.
- When possible, locate energy-related facilities away from active leks or near other sage-grouse habitat.
- When possible, restrict noise levels to 10 dB above background noise levels at lek sites.
- Minimize nearby human activities when birds are near or on leks.
- As practicable, do not conduct surface-use activities within crucial sage-grouse wintering areas from December 1 through March 15.
- Maintain sagebrush communities on a landscape scale.
- Provide compensatory habitat reclamation for impacted sagebrush habitat.
- Avoid the use of pesticides at sage-grouse breeding habitat during the brood-rearing season.
- Develop and implement appropriate measures to prevent the introduction or dispersal of noxious weeds.
- Avoid creating attractions for raptors and mammalian predators in sage-grouse habitat.
- Consider measures to mitigate impacts at off-site locations to offset unavoidable sage-grouse habitat alteration and reduction at the project site.
- When possible, avoid establishing artificial water bodies (e.g., stormwater and liquid industrial wastewater ponds) that could serve as breeding habitat for mosquitoes.

The BLM manages more habitats for greater sage-grouse than any other entity; therefore, it has developed a National Sage-Grouse Habitat Conservation Strategy for BLM-administered public lands to manage public lands in a manner that will maintain, enhance, and restore greater sage-grouse habitat while providing for multiple uses of BLM-administered public lands (BLM 2004c). The strategy is consistent with the individual state sage-grouse conservation planning efforts. The purpose of this strategy is to set goals and objectives, assemble guidance and resource materials, and provide more uniform management directions for the BLM's contributions to the multistate sage-grouse conservation effort being led by state wildlife agencies (BLM 2004c). The BLM strategy includes guidance for (1) addressing sagebrush habitat conservation in BLM land use plans, and (2) managing sagebrush plant communities for sage-grouse conservation. This guidance is designed to support and promote the rangewide conservation of sagebrush habitats for sage grouse and other sagebrush-obligate wildlife species on public lands administered by the BLM and presents a number of suggested management practices (SMPs). These SMPs include management or reclamation activities, restrictions, or treatments that are designed to enhance or restore sagebrush habitats. The SMPs are divided into two categories: (1) those that will help maintain sagebrush habitats (e.g., practices or treatments to minimize unwanted disturbances while maintaining the integrity of the sagebrush communities), and (2) those that will enhance sagebrush habitat components that have been reduced or altered (BLM 2004c).

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SMPs that are or may be pertinent to energy transmission facilities include the following:

- Development of monitoring programs and adaptive management strategies.
- Control of invasive species.
- Prohibition or restriction of OHV activity.
- Consideration of sage-grouse habitat needs when developing reclamation plans.
- Avoidance of placing facilities in or next to sensitive habitats such as leks and wintering habitat.
- Location or construction of facilities so that facility noise does not disturb grouse activities or leks.
- Consolidation of facilities as much as possible.
- Initiation of reclamation practices as quickly as possible following land disturbance.
- Installation of antiperching devices on existing or new power lines in occupied sage-grouse habitat.
- Design of facilities to reduce habitat fragmentations and mortality to sage-grouse.

In addition to BLM's national sage-grouse habitat conservation strategy, the Western Association of Fish and Wildlife Agencies has produced two documents that make up a Conservation Assessment for Greater Sage-Grouse. The first is the *Conservation Assessment of Greater Sage-Grouse and Sagebrush Habitats* (Connelly et al. 2004). The second document is the *Greater Sage-Grouse Comprehensive Conservation Strategy* (Stiver et al. 2006).

as elk, deer, and pronghorn, could potentially be affected if the corridor segments transect migration paths between winter and summer ranges or in calving areas. The utility corridor segments would be maintained as areas of low vegetation that may hinder or prevent movements of some wildlife species. It is foreseeable that utility corridor segments may be used for travel routes by big game if they lead in the direction of normal migrations.

Migration corridors are vulnerable, particularly at pinch points where physiographic constrictions force herds through relatively narrow corridors (Berger 2004). Loss of habitat continuity along migration routes would severely restrict the seasonal movements necessary to maintain healthy big game populations (Sawyer and Lindsay 2001; Thomson et al. 2005). Any activity or landscape modification that prevents the use of migration corridor constrictions (migration bottlenecks or pinch points) could effectively reduce the use of habitats either above or below the constriction (BLM 2004b). As summarized by Strittholt et al. (2000), roads have been shown to impede the movements of invertebrates, reptiles, and small and large mammals. For large mammals, blockages of a route between foraging or bedding areas and watering areas could cause the animals to abandon a larger habitat area altogether (BLM 2004b). High snow embankments as a result of plowing can greatly influence the mobility of wildlife such as moose (*Alces alces*) (WGFD 2004). Barriers to movement that prevent snakes from accessing wintering dens or that isolate amphibian breeding pools from feeding areas could affect or even eliminate a population (BLM 2004b).

Larger and/or more mobile wildlife, such as medium-sized or large mammals and birds, would be most likely to leave an area that experiences habitat disturbance. Nevertheless,

development of the site would represent a loss of habitat for these species and potentially a reduction in carrying capacity in the area. A species affected by habitat disturbance may be able to shift its habitat use for a short period. For example, the density of several forest-dwelling bird species has been found to increase within a forest stand soon after the onset of fragmentation as a result of displaced individuals moving into remaining habitat (Hagan et al. 1996). However, it is generally presumed that the habitat into which displaced individuals move would be unable to sustain the same level of use over the long term (BLM 2004b). The subsequent competition for resources in adjacent habitats would likely preclude the incorporation of the displaced individual into the resident populations. If it is assumed that areas used by wildlife before development were preferred habitat, then an observed shift in distribution because of development would be toward less preferred and presumably less suitable habitats (Sawyer et al. 2006). Overcrowding of species such as mule deer in winter ranges can cause density-dependent effects such as increased fawn mortality (Sawyer et al. 2006).

Rather than being displaced, smaller animals such as small mammals, reptiles, and amphibians may be killed during clearing and construction activities. If land clearing and construction activities occurred during the spring and summer, bird nests and eggs or nestlings could be destroyed. Fossorial species could be crushed or buried by construction equipment.

The creation of edge habitat along the boundary between two habitats can (1) increase predation and parasitism of vulnerable forest or sagebrush interior animals in the vicinity of edges; (2) have negative consequences for wildlife by modifying their distribution and dispersal patterns; (3) be detrimental to species requiring large undisturbed areas, because increases in edge are generally associated with concomitant reductions in habitat size and possible isolation of habitat patches and corridors (habitat fragmentation); or (4) increase local wildlife diversity and abundance. Species that could benefit from the proposed utility or access road ROWs include those that prefer or require some open areas, edge habitat, and/or shrubs and small trees. Access roads through forested areas have been found to be positively correlated with bat activity because these areas can provide productive foraging areas and/or travel corridors (Zimmerman and Glanz 2000).

The utility and access road ROWs may hinder or prevent movements of some small mammals. In particular, species preferring heavy cover in forested areas may be adversely affected (Oxley et al. 1974; Forman and Alexander 1998). The degree to which roads serve as barriers to wildlife movement depends on traffic volume and speed, roadside vegetation, traditional movement patterns, and environmental factors motivating animal movement (e.g., predator avoidance).

Periodic removal of woody vegetation to maintain the ROW, particularly in forested areas, would maintain those sections of the ROW in an early stage of plant community succession that could benefit small mammals that use such habitats (e.g., hares) and their predators (e.g., bobcat [*Lynx rufus*]). Temporary growth of willows and other trees following brush cutting could benefit moose and other ungulates that use browse. Conversely, habitat maintenance would have localized adverse effects on species such as the red squirrel (*Tamiasciurus hudsonicus*), southern red-backed vole (*Myodes gapperi*), and American marten (*Martes americana*), which prefer late-successional or forested habitats (BLM 2002). Except

where annual vegetation maintenance may be required over the pipelines to facilitate periodic corrosion and leak surveys, routine vegetation maintenance within a ROW segment conducted once every few years would lessen impacts on migratory bird species and other wildlife species that may make permanent use of the ROW segments. As ROWs become more densely vegetated toward the end of each maintenance cycle, bird species diversity would probably increase.

Overall, impacts on most wildlife would be proportional to the amount of habitat lost directly and indirectly and to the duration of the loss (BLM 2006e). Project development within the tar sands study area could impact crucial winter and summer ranges for mule deer and elk; crucial lambing and rutting grounds and water sources for bighorn sheep (*Ovis canadensis*); substantial-value habitat for pronghorn, black bear (*Ursus americanus*), and cougar (*Puma concolor*); portions of several wild horse and burro herds; year-long, nesting, or strutting grounds for greater sage-grouse; and foraging habitat for raptors (BLM 1984). Impacts on neotropical migrants that do not breed within the project area would be minor. Nonbreeders generally use riparian areas for feeding, and these areas would be minimally impacted by project construction and operation.

**5.8.1.3.2 Wildlife Disturbance.** Activities associated with construction and operation of a tar sands project may cause wildlife disturbance, including interference with behavioral activities. The response of wildlife to disturbance is highly variable and species specific. Intraspecific responses can also be affected by the physiological or reproductive condition of individuals; the distance from disturbance; and the type, intensity, and duration of disturbance. Wildlife can respond to disturbance in various ways, including attraction, habituation, and avoidance (Knight and Cole 1991). For example, wildlife may cease foraging, mating, or nesting, or vacate active nest sites in areas where construction is occurring; some species may permanently abandon the disturbed areas and adjacent habitats. In contrast, wildlife such as bears, foxes, and squirrels readily habituate and may even be attracted to human activities, primarily when a food source is accidentally or deliberately made available. Human food wastes and other attractants in developed areas can increase the population of foxes, gulls, common ravens, and bears, which in turn prey on waterfowl and other birds.

Disturbance can reduce the relative habitat value for wildlife such as mule deer, especially during periods of heavy snow and cold temperatures. When wildlife are experiencing physiological stress, which requires higher levels of energy for survival and reproductive success, increased human presence can further increase energy expenditures that can lead to reduced survival or reproductive outcomes. Furthermore, disturbance could prevent access to sufficient amounts of forage necessary to sustain individuals (BLM 2006f). Hobbs (1989) determined that mule deer doe mortality during a severe winter period could double if they were disturbed twice a day and caused to move a minimum of 1,500 ft per disturbance.

The average mean flush distance for several raptor species in winter was 118 m (387 ft) due to walk disturbance and 75 m (246 ft) due to vehicle disturbance (Holmes et al. 1993). Bighorn sheep have been reported to respond at a distance of 500 m (1,640 ft) from roads with more than one vehicle per day, while deer and elk response occurs at a distance of 1,000 m (3,280 ft) or more (Gaines et al. 2003). Snowmobile traffic was found to affect the behavior of

moose located within 300 m (984 ft) of a trail, and displaced them to less favorable habitats (Colescott and Gillingham 1998).

Mule deer will habituate to and ignore motorized traffic provided that the deer are not pursued (Yarmoloy et al. 1988). Harassment, an extreme type of disturbance caused by intentional actions to chase or frighten wildlife, generally causes the magnitude and duration of displacement to be greater. As a result, there is an increased potential for physical injury from fleeing and higher metabolic rates because of stress (BLM 2004b). Bears can be habituated to human activities, particularly moving vehicles, and these animals are more vulnerable to legal and illegal harvest (McLellan and Shackleton 1989). Wild horses and burros could also be impacted by increased encounters with vehicles. Noise and the presence of humans and vehicles could force herds to move to other areas. They would be most susceptible during spring foaling.

Disturbed wildlife can incur a physiological cost either through excitement (i.e., preparation for exertion) or locomotion. A fleeing or displaced animal incurs additional costs through loss of food intake and potential displacement to lower-quality habitat. If the disturbance becomes chronic or continuous, these costs can result in both reduced animal fitness and reproductive potential (BLM 2004b). Disturbance associated with a project would likely result in fewer nest initiations, increased nest abandonment and/or reproductive failure, and decreased productivity of successful nests (BLM 2006e). Factors that influence displacement distance include the following:

- Inherent species-specific characteristics,
- Seasonally changing threshold of sensitivity as a result of reproductive and nutritional status,
- Type of habitat (e.g., longer disturbance distances in open habitats),
- Specific experience of the individual or group,
- Weather (e.g., adverse weather such as wind or fog may decrease the disturbance),
- Time of day (e.g., animals are generally more tolerant during dawn and dusk), and
- Social structure of the animals (e.g., groups are generally more tolerant than solitary individuals) (BLM 2004b).

Regular or periodic disturbance could cause adjacent areas to be less attractive to wildlife and result in long-term reduction of wildlife use in areas exposed to a repeated variety of disturbances such as noise. Principal sources of noise would include vehicle traffic, operation of machinery, and blasting. The response of wildlife to noise would vary by species; physiological or reproductive condition; distance; and type, intensity, and duration of disturbance (BLM 2002). Wildlife response to noise can include avoidance, habituation, or attraction. Responses of birds

to disturbance often involve activities that are energetically costly (e.g., flying) or affect their behavior in a way that might reduce food intake (e.g., shift away from a preferred feeding site) (Hockin et al. 1992). On the basis of a literature review by Hockin et al. (1992), the effects of disturbance on bird breeding and breeding success include reduced nest attendance, nest failures, reduced nest building, increased predation on eggs and nestlings, nest abandonment, inhibition of laying, increased absence from the nest, reduced feeding and brooding, exposure of eggs and nestlings to heat or cold, retarded chick development, and lengthening of the incubation period. The most adverse impacts associated with noise could occur if critical life-cycle activities were disrupted (e.g., mating and nesting). For instance, disturbance of birds during the nesting season can result in nest or brood abandonment. The eggs and young of displaced birds would be more susceptible to cold or predators. Construction noise could cause a localized disruption to wild horses and burros, particularly during the foaling season (BLM 2006c).

**5.8.1.3.3 Noise.** Much of the research on wildlife-related noise effects has focused on birds. This research has shown that noise may affect territory selection, territorial defense, dispersal, foraging success, fledging success, and song learning (e.g., Reijnen and Foppen 1994; Foppen and Reijnen 1994; Larkin 1996). Several studies have examined the effects of continuous noise on bird populations, including the effects of traffic noise, coronal discharge along electric transmission lines, and gas compressors. Some studies (e.g., Reijnen and Foppen 1994, 1995; Foppen and Reijnen 1994; Reijnen et al. 1995, 1996, 1997) have shown reduced densities of a number of species in forest (26 of 43 species) and grassland (7 of 12 species) habitats adjacent to roads, with effects detectable from 66 to 11,581 ft from the roads. On the basis of these studies, Reijnen et al. (1996) identified a threshold effect sound level of 47 dBA for all species combined and 42 dBA for the most sensitive species; the observed reductions in population density were attributed to a reduction in habitat quality caused by elevated noise levels. This threshold sound level of 42 to 47 dBA (which is somewhat below the EPA-recommended limit for residential areas) is at or below the sound levels generated by truck traffic that would likely occur at distances of 250 ft or more from the construction area or access roads, or the levels generated by typical construction equipment at distances of 2,500 ft or more from the construction site.

Blast noise has been found to elicit a variety of effects on wildlife (Manci et al. 1988; Larkin 1996). Brattstrom and Bondello (1983) reported that peak sound pressure levels reaching 95 dB resulted in a temporary shift in hearing sensitivity in kangaroo rats, and that they required at least 3 weeks for the hearing thresholds to recover. The authors postulated that such hearing shifts could affect the ability of the kangaroo rat to avoid approaching predators. A variety of adverse effects of noise on raptors have been demonstrated, but in many cases, the effects were temporary, and the raptors became habituated to the noise (Andersen et al. 1989; Brown et al. 1999; Delaney et al. 1999).

**5.8.1.3.4 Mortality or Injury.** Construction, operation, maintenance, and reclamation activities would result in mortality of wildlife that are not mobile enough to avoid these activities (e.g., reptiles and amphibians, small mammals, and the young of other wildlife), that utilize burrows (e.g., ground squirrels and burrowing owls [*Athene cunicularia*]), or that are defending nest sites (e.g., ground-nesting birds). More mobile species of wildlife, such as deer and adult

birds, may avoid direct impacts by moving into habitats in adjacent areas. However, it can be conservatively assumed that adjacent habitats are at carrying capacity for the species that live there and could not support additional biota from impacted areas. The subsequent competition for resources in adjacent habitats would likely preclude the incorporation of the displaced individuals into the resident populations.

The presence of tar sands development projects and ancillary facilities (e.g., buildings, transmission lines, elevated portions of the pipelines, and other ancillary facilities) would create a physical hazard to some wildlife. In particular, birds may collide with transmission lines and buildings, while mammals may collide with fences. However, collisions with tar sands facilities would probably be infrequent, because human activity and project-related noise would discourage wildlife presence in the immediate project area. An open pipeline trench can trap small animals and injure larger wildlife trying to cross it, particularly at night. Artificial lighting can potentially affect birds by providing more feeding time (i.e., allowing nocturnal feeding) and by causing direct mortality or disorientation (Hockin et al. 1992). Areas of standing water (e.g., stormwater and liquid industrial waste ponds) could potentially provide habitat for mosquitoes that are vectors of West Nile virus, which is a significant stressor on sage-grouse and probably other at-risk bird species (Naugle et al. 2004).

Direct mortality from vehicle collisions would be expected to occur along new access roads, while increases in road mortality would occur along existing roads because of increased traffic volumes (e.g., associated with increased numbers of construction and operational personnel). Collision with vehicles can be a source of wildlife mortality, especially in wildlife concentration areas or travel corridors. When major roads cut across migration corridors, the effects can be dangerous for animals and humans. Between Kemmerer and Cokeville, Wyoming, hundreds of mule deer are killed during spring and fall migrations when they attempt to cross U.S. Highway 30 (Feeney et al. 2004). In unusual cases, mass casualties of wildlife occur from vehicular collision incidents, particularly in winter when animals may congregate near snow-free roads. Since 2003, there have been four vehicular incidents in which 7 to 21 pronghorn were killed or injured per incident in Wyoming. There was also an incident in which 41 pronghorn were killed by a train (Maffly 2007).

Being somewhat small and inconspicuous, amphibians are vulnerable to road mortality when they migrate between wetland and upland habitats, while reptiles are vulnerable because they will make use of roads for thermal cooling and heating. Greater sage-grouse are susceptible to road mortality in spring because they often fly to and from leks near ground level. They are also susceptible to vehicular collision along dirt roads because they are sometimes attracted to them to take dust baths (Strittholt et al. 2000). Utility ROWs and access roads increase use by recreationists and other public land users, which can increase the amount of human presence and the potential for harassment and legal or illegal harvesting of wildlife. This activity may include the collection of live animals, particularly reptiles and amphibians, for pets. Direct mortality from snowmobiles may occur because of crushing or suffocation of small mammals occupying subnivean spaces and from increased access to predators over compacted vehicular trails (Gaines et al. 2003).

No electrocution of raptors would be expected when they are perching on the transmission line structures because the spacing between the conductors and between a conductor and ground wire or other grounding structure would exceed the wing span of the largest raptors in the project area (i.e., bald and golden eagles [*Haliaeetus leucocephalus* and *Aquila chrysaetos*]). However, although a rare event, electrocution can occur to flocks of small birds that cross a line or when several roosting birds take off simultaneously because of current arcing. This occurrence is most likely in humid weather conditions (Bevanger 1998; BirdLife International 2003). Arcing can also occur by the excrement jet of large birds roosting on the crossarms above the insulators (BirdLife International 2003).

Electromagnetic field exposure can potentially alter the behavior, physiology, endocrine system, and the immune function of birds, which, in theory, could result in negative repercussions on their reproduction or development. However, the reproductive success of some wild bird species, such as ospreys (*Pandion haliaetus*), does not appear to be compromised by electromagnetic field conditions (Fernie and Reynolds 2005).

Any species of bird capable of flight can collide with power lines. Birds that migrate at night, fly in flocks, and/or are large and heavy with limited maneuverability are at particular risk (BirdLife International 2003). The potential for bird collisions with a transmission line depends on variables such as habitat, relation of the line to migratory flyways and feeding flight patterns, migratory and resident bird species, and structural characteristics of the line (Beaulaurier et al. 1984). Near wetlands, waterfowl, wading birds, shorebirds, and passerines are most vulnerable to colliding with transmission lines; in habitats away from wetlands, raptors and passerines are most susceptible (Faanes 1987). The highest concern for bird collisions is where lines span flight paths, including river valleys, wetland areas, lakes, areas between waterfowl feeding and roosting areas, and narrow corridors (e.g., passes that connect two valleys). A disturbance that leads to a panic flight can increase the risk of collision with transmission lines (BirdLife International 2003).

The shield wire is often the cause of bird losses involving higher voltage lines because birds fly over the more visible conductor bundles only to collide with the relatively invisible, thin shield wire (Thompson 1978; Faanes 1987). Young inexperienced birds, as well as migrants in unfamiliar terrain, appear to be more vulnerable to wire strikes than resident breeders. Also, many species appear to be most highly susceptible to collisions when alarmed, pursued, searching for food while flying, engaged in courtship, taking off, landing, when otherwise preoccupied and not paying attention to where they are going, and during night and inclement weather (Thompson 1978). Sage-grouse and other upland game birds are vulnerable to colliding with transmission lines because they lack good acuity and because they are generally poor flyers (Bevanger 1995).

Meyer and Lee (1981) concluded that, while waterfowl (in Oregon and Washington) were especially susceptible to colliding with transmission lines, no adverse population or ecological results occurred because all species affected were common and because collisions occurred in fewer than 1% of all flight observations. Stout and Cornwell (1976) reached a similar conclusion and suggested that fewer than 0.1% of all nonhunting waterfowl mortalities nationwide were caused by collisions with transmission lines. The potential for waterfowl and

wading birds to collide with the transmission lines could be assumed to be related to the extent of preferred habitats crossed by the lines and the extent of other waterfowl and wading bird habitats within the immediate area.

Raptors have several attributes that decrease their susceptibility to collisions with transmission lines: (1) they have keen eyesight; (2) they soar or use relatively slow-flapping flight; (3) they are generally maneuverable while in flight; (4) they learn to use utility poles and structures as hunting perches or nests and become conditioned to the presence of lines; and (5) they do not fly in groups (like waterfowl), so their position and altitude are not determined by other birds. Therefore, raptors are not as likely to collide with transmission lines unless distracted (e.g., while pursuing prey) or when other environmental factors (e.g., weather) contribute to increased susceptibility (Olendorff and Lehman 1986).

Some mortality resulting from bird collisions with transmission lines is considered unavoidable. However, anticipated mortality levels are not expected to result in long-term loss of population viability in any individual species or lead to a trend toward listing as a rare or endangered species, because mortality levels are anticipated to be low and spread over the life of the transmission lines. A variety of mitigation measures, such as those outlined in *Avian Protection Plan (APP) Guidelines* (APLIC and USFWS 2005) and *Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances* (Romin and Muck 1999), would minimize impacts on birds.

**5.8.1.3.5 Exposure to Contaminants.** Wildlife may be exposed to accidental spills or releases of product, fuel, herbicides, or other hazardous materials. Exposure to these materials could affect reproduction, growth, development, or survival. Potential impacts on wildlife would vary according to the type of material spilled, the volume of the spill, the media within which the spill occurs, the species exposed to the spilled material, and the home range and density of the wildlife species. For example, as the size of a species' home range increases, the effects of a spill would generally decrease (Irons et al. 2000). Generally, small mammal species that have small home ranges and/or high densities per acre would be most affected by a land-based spill. A population-level adverse impact would only be expected if the spill was very large or contaminated a crucial habitat area where a large number of individual animals were concentrated. The potential for either event would be unlikely. Because the amounts of most fuels and other hazardous materials are expected to be small, an uncontained spill would affect only a limited area. In addition, wildlife use of the project area where contaminant spills may occur would be limited, thus greatly reducing the potential for exposure.

The potential effects on wildlife from a spill could occur from direct contamination of individual animals, contamination of habitats, and contamination of food resources. Acute (short-term) effects generally occur from direct contamination of animals; chronic (long-term) effects usually occur from such factors as accumulation of contaminants from food items and environmental media (Irons et al. 2000). Moderate to heavy contact with a contaminant is most often fatal to wildlife. In aquatic habitats, death occurs from hypothermia, shock, or drowning. In birds, chronic oil exposure can reduce reproduction, result in pathological conditions, reduce chick growth, and reduce hatching success (BLM 2002). Water quality contamination could

reduce emergent vegetation and invertebrate biomass that provide a food resource for wildlife such as waterfowl, amphibians, and bats. The reduction or contamination of food resources from a spill could also reduce survival and reproductive rates. Contaminant ingestion during preening or feeding may impair endocrine and liver functions, reduce breeding success, and reduce growth of offspring (BLM 2002).

A land-based spill would contaminate a limited area. Therefore, a spill would affect relatively few individual animals and a relatively limited portion of the habitat or food resources for large-ranging species (e.g., moose, mule deer, pronghorn, elk, and black bear). It would be unlikely that a land-based spill would cause significant impacts on movement (e.g., block migration) or foraging activities at the population (herd) level, largely because of the vast amount of surrounding habitat that would remain unaffected (BLM 2002).

Human presence and activities associated with response to spills would also disturb wildlife in the vicinity of the spill site and spill-response staging areas. In addition to displacing wildlife from areas undergoing contaminant cleanup activities, habitat damage could also occur from cleanup activities (BLM 2002). Avoidance of contaminated areas by wildlife during cleanup because of disturbance would minimize the potential for wildlife to be exposed to contaminants before site cleanup is completed.

Most herbicides used on BLM-administered lands pose little or no risk to wildlife or wild horses and burros unless they are exposed to accidental spills, direct spray, herbicide drift, or by consuming herbicide-treated vegetation. The licensed use of herbicides would not be expected to adversely affect local wildlife populations. Applications of these materials would be conducted by following label directions and in accordance with applicable permits and licenses. Thus, any adverse toxicological threat from herbicides to wildlife is unlikely. The response of wildlife to herbicide use is attributable to habitat changes resulting from treatment rather than direct toxic effects of the applied herbicide on wildlife. However, accidental spills or releases of these materials could impact exposed wildlife. Effects could include death, organ damage, growth decrease, and decrease in reproductive output and condition of offspring (BLM 2005).

Herbicide treatment reduced structural and floral complexity of vegetation on clear cuts in Maine, resulting in lower overall abundance of birds and small mammals because of a decrease in invertebrate and plant foods and cover associated with decreased habitat complexity (Santillo et al. 1989a,b). However, some researchers have found increases in small mammal numbers because of increases in species that use grassy habitats (particularly microtine rodents). Nevertheless, small mammal communities rapidly returned to pretreatment numbers (e.g., within a 2-year period) because of regrowth of vegetation damaged by herbicides (Anthony and Morrison 1985). Moose tended to avoid herbicide-treated areas of clear cuts because browse was less available for 2 years posttreatment. When they did feed in treated clear cuts, they fed heavily in areas that were inadvertently skipped by spraying (Santillo 1994; Eschholtz et al. 1996). Selective herbicide use (e.g., cut-stump treatments) encourages the development of shrub habitat without negatively impacting birds nesting in such habitats (Marshall and Vandruff 2002).

Wildlife can be exposed to herbicides by being directly sprayed, inhaling spray mist or vapors, drinking contaminated water, feeding on or otherwise coming in contact with treated

vegetation or animals that have been contaminated, and directly consuming the chemical if it is applied in granular form (DOE 2000). Raptors, small herbivorous mammals, medium-sized omnivorous mammals, and birds that feed on insects are more susceptible to herbicide exposure because they either feed directly on vegetation that might have been treated or feed on animals that feed on the vegetation. The potential for toxic effects would depend on the toxicity of the herbicide and the amount of exposure to the chemical. Generally, smaller animals are more at risk because it takes less substance for them to be affected (DOE 2000).

Indirect adverse effects on wildlife from herbicides would include a reduction in the availability of preferred forage, habitat, and breeding areas because of a decrease in plant diversity; a decrease in wildlife population densities as a result of limited vegetation regeneration; habitat and range disruption because wildlife may avoid sprayed areas following treatment; and an increase in predation of small mammals because of loss of ground cover (BLM 2005). However, population-level impacts on unlisted wildlife species are unlikely because of the limited size and distribution of treated areas relative to those of the wildlife populations and the foraging area and behavior of individual animals (BLM 2005).

Wildlife species that consume grass (e.g., deer, elk, rabbits and hares, quail, and geese) are at potentially higher risk from herbicides than species that eat other vegetation and seeds because herbicide residue concentrations tend to be higher on grass. However, harmful effects are not likely unless the animal forages exclusively within the treated area shortly after application. Similarly, bats, shrews, and numerous bird species that feed on herbicide-contaminated insects could be at risk (BLM 2005).

**5.8.1.3.6 Erosion and Runoff.** As described in Section 5.8.1.1, it is assumed that the potential for soil erosion and the resulting sediment loading of nearby aquatic or wetland habitats would be proportional to the amount of surface disturbance, the condition of disturbed lands at any given time, and the proximity to aquatic habitats. It is also assumed that areas being actively disturbed during mining or construction activities would have higher erosion potential than areas that are undergoing reclamation activities, and that areas being restored would become progressively less prone to erosion over time because of completion of site grading and the reestablishment of vegetated cover. Erosion and runoff from freshly cleared and graded sites could reduce water quality in aquatic and wetland habitats that are used by amphibians, thus potentially affecting their reproduction, growth, and survival. Any impacts on amphibian populations would be localized to the surface waters receiving site runoff. Although the potential for runoff would be temporary, pending completion of construction activities and stabilization of disturbed areas with vegetative cover, erosion could result in significant impacts on local amphibian populations if an entire recruitment class is eliminated (e.g., complete recruitment failure for a given year because of siltation of eggs or mortality of aquatic larvae). Implementation of measures to control erosion and runoff into aquatic and wetland habitats would reduce the potential for impacts from increased turbidity and sedimentation. Assuming that reclamation activities are successful, restored areas should eventually become similar to natural areas in terms of erosion potential.

**5.8.1.3.7 Fugitive Dust.** Little information is available regarding the effects of fugitive dust on wildlife; however, if exposure is of sufficient magnitude and duration, the effects may be similar to the respiratory effects identified for humans (e.g., breathing and respiratory symptoms). A more probable effect would be from the dusting of plants that could make forage less palatable. Fugitive dust that settles on forage may render it unpalatable for wildlife and wild horses and burros, which could increase competition for remaining forage. The highest dust deposition would generally occur within the area where wildlife and wild horses and burros would be disturbed by human activities (BLM 2004b). Fugitive dust generation during construction activities is expected to be short term and localized to the immediate construction area and is not expected to result in any long-term individual or population-level effects. Dusting impacts would be potentially more pervasive along unpaved access roads.

**5.8.1.3.8 Invasive Vegetation.** Utility corridors and access roads can facilitate the dispersal of invasive species by altering existing habitat conditions, stressing or removing native species, and allowing easier movement by wild or human vectors (Trombulak and Frissell 2000). Wildlife habitat could be impacted if invasive vegetation becomes established in the construction-disturbed areas and adjacent off-site habitats. The establishment of invasive vegetation could reduce habitat quality for wildlife and locally affect wildlife occurrence and abundance. The introduction or spread of non-native plants would be detrimental to wildlife such as neotropical migrants and sage-grouse by reducing or fragmenting habitat, increasing soil erosion, or reducing forage (BLM 2006b).

**5.8.1.3.9 Fires.** Increased human activity can increase the potential for fires. In general, the short-term and long-term effects of fire on wildlife are related to fire impacts on vegetation, which, in turn affect habitat quality and quantity, including the availability of forage shelter (Hedlund and Rickard 1981; Groves and Steenhof 1988; Knick and Dyer 1996; Schooley et al. 1996; Watts and Knick 1996; Sharpe and Van Horne 1998; Lyon et al. 2000b; USDA 2002a–c).

While individuals caught in a fire could incur increased mortality, depending on how quickly the fire spreads, most wildlife would be expected to escape by either outrunning the fire or seeking underground or aboveground refuge within the fire (Ford et al. 1999; Lyon et al. 2000a). However, some mortality of burrowing mammals from asphyxiation in their burrows during fire has been reported (Erwin and Stasiak 1979).

In the absence of long-term vegetation changes, rodents in grasslands usually show a decrease in density after a fire; they often recover, however, to achieve densities similar to or greater than preburn levels (Beck and Vogel 1972; Lyon et al. 2000b; USDA 2002d). Long-term changes in vegetation from a fire (such as loss of sagebrush or the invasion or increase of non-native annual grasses) may affect food availability and quality and habitat availability for wildlife; the changes could also increase the risk from predation for some species (Hedlund and Rickard 1981; Groves and Steenhof 1988; Schooley et al. 1996; Watts and Knick 1996; Knick and Dyer 1997; Lyon et al. 2000b; USDA 2002b,c).

Raptor populations generally are unaffected by, or respond favorably to, burned habitat (Lyon et al. 2000b). Fires may benefit raptors by reducing cover and exposing prey; raptors may also benefit if prey species increase in response to post-fire increases in forage (Lyon et al. 2000b; USDA 2002d). Direct mortality of raptors from fire is rare (Lehman and Allendorf 1989), although fire-related mortality of burrowing owls has been documented (USDA 2002d). Most adult birds can be expected to escape fire, while fire during nesting (prior to fledging) may kill young birds, especially of ground-nesting species (USDA 2002d).

#### 5.8.1.4 Threatened, Endangered, and Sensitive Species

The evaluation in this PEIS presents the potential for impacts on federally or state-listed threatened or endangered species, BLM-designated sensitive species, or species that are proposed or candidates for listing if tar sands development occurs. It is assumed that project-specific NEPA assessments, ESA consultations, and coordination with state natural resource agencies would be conducted prior to leasing or development and would address project-specific impacts more thoroughly, and that these assessments and consultations would result in required actions to avoid or mitigate impacts on protected species.

The potential for impacts on threatened, endangered, and sensitive species by commercial tar sands development, including construction of ancillary facilities such as access roads and transmission systems, is directly related to the amount of land disturbance, the duration and timing of construction and operation periods, and the habitats affected by development (i.e., the location of the project). Indirect effects such as those resulting from the erosion of disturbed land surfaces and disturbance and harassment of animal species are also considered, but their magnitude is considered proportional to the amount of land disturbance.

Impacts on threatened and endangered species are fundamentally similar to or the same as those described for impacts on aquatic resources, plant communities and habitats, and wildlife in Sections 5.8.1.1, 5.8.1.2, and 5.8.1.3, respectively. However, because of their low population sizes, threatened, endangered, and sensitive species are far more vulnerable to impacts than more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development.

The potential magnitude of the impacts that could result from tar sands development is presented for different species types in Table 5.8.1-2. Unlike some projects where there are discrete construction and operation phases with different associated impacts, tar sands development projects include facility construction and extraction activities that would have similar types of impacts throughout the life of the project. Project construction and extraction activities would occur over a period of several decades. Reclamation that would occur after extraction activities are complete would serve to reduce or eliminate ongoing impacts by recreating habitats and ecological conditions that could be suitable for threatened, endangered,

**TABLE 5.8.1-2 Potential Impacts on Threatened, Endangered, and Sensitive Species Resulting from Commercial Tar Sands Development**

| | Potential Magnitude of Impacts According to Species Type[a] | | | | | | |
|---|---|---|---|---|---|---|---|
| Impact Category | Upland Plants | Wetland and Riparian Plants | Aquatic and Wetland Animals[b] | Terrestrial Invertebrates | Terrestrial Amphibians and Reptiles | Terrestrial Birds | Terrestrial Mammals |
| Vegetation clearing | Large | Large | Large | Large | Large | Large | Large |
| Habitat fragmentation | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate |
| Movement/dispersal blockage | Moderate | Moderate | Large | Small | Moderate | Small | Moderate |
| Alteration of topography | Moderate | Large | Large | Small | Small | Small | Small |
| Changes in drainage patterns | Moderate | Large | Large | Small | Small | Small | Small |
| Erosion | Large | Large | Large | Small | Small | Small | Small |
| Sedimentation from runoff | Large | Large | Large | Small | Small | Small | Small |
| Oil and contaminant spills | Moderate | Large | Large | Small | Large | Small | Small |
| Fugitive dust | Moderate | Moderate | Small | Small | Small | Small | Small |
| Injury or mortality of individuals | Large | Large | Large | Large | Large | Large | Large |
| Human collection | Moderate | Moderate | Small | Small | Moderate | Small | Small |
| Human disturbance/harassment | None | None | Large | None | Small | Large | Large |
| Increased human access | Moderate | Moderate | Moderate | Moderate | Moderate | Large | Large |
| Increases in predation rates | None | None | None | None | Moderate | Moderate | Moderate |
| Noise | None | None | None | None | Small | Large | Large |
| Spread of invasive plant species | Large | Large | Moderate | Moderate | Small | Small | Small |
| Air pollution | Moderate | Moderate | Small | Small | Small | Small | Small |
| Disruption of groundwater flow patterns | Small | Moderate | Moderate | Small | Small | Small | Small |
| Temperature increases in water bodies | None | None | Moderate | None | None | None | None |

[a] Potential impact magnitude (without mitigation) is presented as none, small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of the local population (less than 10%), and does not result in a measurable change in carrying capacity or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of the local population, and result in a measurable but moderate change (less than 50%) in carrying capacity or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 50% of a local population, and result in a large measurable change (50% or more) in carrying capacity or population size in the affected area.

[b] Aquatic and wetland animals include invertebrates (mollusks and arthropods), fish, amphibians, reptiles, birds, and mammals.

and sensitive species. The effectiveness of any reclamation activities would depend on the specific actions taken, but the best results would occur if site topography, hydrology, soils, and vegetation patterns were reestablished.

Post-lease land clearing and construction activities could remove potentially suitable habitat for threatened, endangered, and sensitive plant and animal species. Any plants present within the project areas would be destroyed, and plants adjacent to project areas could be affected by runoff from the site either through erosion or sedimentation and burial of individual plants or habitats. In addition, fugitive dust from site activities could accumulate in adjacent areas occupied by listed plants. Dust that accumulates on leaf surfaces can reduce photosynthesis and subsequently affect plant vigor. Disturbed areas could be colonized by non-native invasive plant species.

Larger, more mobile animals such as birds and medium-sized or large mammals would be most likely to leave the project area during site preparation, construction, and other project activities. Development of the site would represent a loss of habitat for these species and potentially a reduction in carrying capacity in the area. Smaller animals, such as small mammals, lizards, snakes, and amphibians, are more likely to be killed during clearing and construction activities. If land clearing and construction activities occurred during the spring and summer, bird nests and nestlings in the project area could be destroyed.

Operations could affect protected plants and animals as well. Animals in and adjacent to project areas would be disturbed by human activities and would tend to avoid the area while activities were occurring. Site lighting and operational noise from equipment would affect animals on and off the site, resulting in avoidance or reduction in use of an area larger than the project footprint. Runoff from the site during site operations could result in erosion and sedimentation of adjacent habitats. Fugitive dust during operations could affect adjacent plant populations.

For all potential impacts, the use of mitigation measures, possibly including predisturbance surveys to locate protected plant and animal populations in the area, erosion control practices, dust suppression techniques, establishment of buffer areas around protected populations, and reclamation of disturbed areas using native species upon project completion, would greatly reduce or eliminate the potential for effects on protected species. The specifics of these practices should be established in project-specific consultations with the appropriate federal and state agencies. ESA Section 7 consultations between the BLM and the USFWS would be required for all projects prior to leasing and before leased areas could be developed, if ESA-listed species were present and would be affected by the lease.

Those consultations would identify conservation measures, allowable levels of incidental take, and other requirements to protect listed species. Conservation measures for oil shale and tar sands development have been recommended by the USFWS to avoid and minimize impacts of commercial oil shale and tar sands development on federally listed threatened and endangered species (Appendix F).

There is a potential for commercial tar sands development projects to adversely affect most of the threatened, endangered, and sensitive species that occur in the counties where development could occur (Tables 5.8.1-3 and 5.8.1-4). This potential for adverse effects results from a lack of specificity on the locations of lease areas and the often incomplete information on species distributions. Federally listed species in study area counties that are not expected to be affected by development include the autumn buttercup, Barneby ridge-cress, Navajo sedge, Utah prairie dog, and whooping crane (Table 5.8.1-4). These species are not likely to be adversely affected because known population distributions are clearly outside of the potential lease areas.

Federally listed plant species (including species that are being proposed for listing) that could occur in project areas and that could be affected by project activities include the Barneby reed-mustard, clay reed-mustard, Jones cycladenia, last chance townsendia, Maguire daisy, San Rafael cactus, shrubby reed-mustard, Uinta Basin hookless cactus, Ute ladies'-tresses, Winkler cactus, and Wright fishhook cactus. All but the Ute ladies'-tresses are upland species that could be affected by a variety of impacting factors including vegetation clearing, habitat fragmentation, dispersal blockage, alteration of topography, changes in drainage patterns, erosion, sedimentation from runoff, oil and contaminant spills, fugitive dust, injury or mortality of individual plants, human collection, increased human access, spread of invasive plant species, and air pollution (Table 5.8.1-2).

The Ute ladies'-tresses could occur in wetland habitats and along the Green River or White River. This species is dependent on a high water table and, in addition to the factors affecting upland plants, could be adversely affected by any water depletions from the Green River or White River basins associated with tar sands development.

Impacts on the endangered Colorado River fish species (bonytail, Colorado pikeminnow, humpback chub, and razorback sucker) could result from tar sands developments in the Green River and White River basins. On the basis of proximity of populations and critical habitat to potential lease areas, the greatest potential for impacts on these species is related to development in Utah where the Green River and White River flow through tar sands areas. Some areas immediately adjacent to these rivers are either designated as ACECs (Lower Green River) or have been proposed as ACECs (Four Mile Wash and White River). If these areas are made available for leasing, there could be a relatively high probability that these species could be directly affected by tar sands development. Potential factors associated with tar sands development that could affect these species include alteration of topography, changes in drainage patterns, erosion, sedimentation from runoff, and oil and contaminant spills.

Any water depletions from the upper Colorado River Basin are considered an adverse effect on endangered Colorado River fish species. Commercial tar sands development could affect these species if they resulted in water depletions in the basin. Water depletions for individual projects could be quite large and could represent a significant adverse impact on these riverine fish.

Federally listed bird species that could be affected by commercial tar sands development include the California condor, Mexican spotted owl, and southwestern willow flycatcher. The

**TABLE 5.8.1-3 Potential Effects on BLM-Designated Sensitive Species, Federal Candidates for Listing, and State Species of Special Concern**

| Common Name | Scientific Name | Status[a] | Counties in Project Area Where Species Occurs | Potential Effect |
|---|---|---|---|---|
| ***Plants*** | | | | |
| Aquarius paintbrush | *Castilleja aquariensis* | ESA-C | Garfield, Wayne | **No impact.** Known populations and suitable habitat not present within STSAs. |
| Caespitose cat's-eye | *Cryptantha caespitosa* | BLM-S | Carbon, Duchesne, Uintah | **Potential for negative impact.** Species could occur in Argyle Canyon, Asphalt Ridge, Hill Creek, Raven Ridge, Pariette, P.R. Spring, and Sunnyside STSAs. |
| Canyonlands lomatium | *Lomatium latilobum* | BLM-S | Grand, San Juan | **No impact.** Known populations occur outside STSAs under consideration. |
| Debris milkvetch | *Astragalus detritalis* | BLM-S | Duchesne, Uintah | **Potential for negative impact.** Species could occur in Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, and Sunnyside STSAs. |
| Dolores River skeletonplant | *Lygodesmia doloresensis* | BLM-S | Grand | **Potential for negative impact.** Species could occur in P.R. Spring STSA. |
| Eastwood monkey-flower | *Mimulus eastwoodiae* | BLM-S | Garfield, Grand, San Juan | **Potential for negative impact.** Species could occur in Tar Sand Triangle and White Canyon STSAs. |
| Ephedra buckwheat | *Eriogonum ephedroides* | BLM-S | Uintah | **Potential for negative impact.** Species could occur in Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs. |
| Ferron milkvetch | *Astragalus musiniensis* | BLM-S | Emery, Garfield, Grand, Wayne | **Potential for negative impact.** Species could occur in P.R. Springs, San Rafael, Sunnyside, Tar Sand Triangle, and White Canyon STSAs. |
| Fisher Towers milkvetch | *Astragalus piscator* | BLM-S | Garfield, Grand, San Juan, Wayne | **Potential for negative impact.** Species could occur in Tar Sand Triangle and White Canyon STSAs. |
| Grand buckwheat | *Eriogonum contortum* | BLM-S | Grand | **Potential for negative impact.** Species could occur in P.R. Spring STSA. |

**TABLE 5.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | Counties in Project Area Where Species Occurs | Potential Effect |
|---|---|---|---|---|
| ***Plants (Cont.)*** | | | | |
| Jones blue star | *Amsonia jonesii* | BLM-S | Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in all STSAs. |
| Ligulate feverfew | *Parthenium ligulatum* | BLM-S | Wayne | **Potential for negative impact.** Species could occur in Tar Sand Triangle STSA. |
| Narrow-stem gilia | *Gilia stenothyrsa* | BLM-S | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, and Sunnyside STSAs. |
| Naturita milkvetch | *Astragalus naturitensis* | BLM-S | San Juan | **Potential for negative impact.** Species could occur in White Canyon STSA. |
| Northern twayblade | *Listera borealis* | BLM-S | Duchesne, San Juan | **No impact.** Suitable habitat not present within STSAs under consideration. |
| Nutall sandwort | *Minuartia nuttallii* | BLM-S | Duchesne | **Potential for negative impact.** Species could occur in Argyle Canyon and Pariette STSAs. |
| Osterhout cat's-eye | *Cryptantha osterhoutii* | BLM-S | Emery, Garfield, Grand, San Juan, Wayne | **Potential for negative impact.** Species could occur in P.R. Spring, San Rafael, Tar Sand Triangle, and White Canyon STSAs. |
| Paradox breadroot | *Pediomelum aromaticum* | BLM-S | Grand, San Juan | **Potential for negative impact.** Species could occur in White Canyon STSA. |
| Rollins' cat's-eye | *Cryptantha rollinsii* | BLM-S | Duchesne, San Rafael, Uintah, Wayne | **Potential for negative impact.** Species could occur in Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, and Sunnyside STSAs. |
| San Rafael milkvetch | *Astragalus rafaelensis* | BLM-S | Emery, Grand | **Potential for negative impact.** Species could occur in P.R. Spring and San Rafael STSAs. |

**TABLE 5.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | Counties in Project Area Where Species Occurs | Potential Effect |
|---|---|---|---|---|
| ***Plants (Cont.)*** | | | | |
| Strigose Easter-daisy | *Townsendia strigosa* | BLM-S | Duchesne, Uintah | **Potential for negative impact.** Species could occur in Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs. |
| Uinta Basin spring-parsley | *Cymopterus duchesnensis* | BLM-S | Duchesne, Uintah | **Potential for negative impact.** Species could occur in Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs. |
| Utah gentian | *Gentianella tortuosa* | BLM-S | Emery, Garfield | **No impact.** Known populations occur outside STSAs under consideration. |
| White River beardtongue | *Penstemon scariosus var. albifluvis* | ESA-C | Uintah | **Potential for negative impact.** Species could occur in Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs. |
| Wonderland Alice-flower | *Aliciella caespitosa* | ESA-C | Wayne | **Potential for negative impact.** Species could occur in Tar Sand Triangle STSA. |
| ***Invertebrates*** | | | | |
| Black Canyon pyrg | *Pyrgulopsis plicata* | UT-SC | Garfield | **No impact.** Known populations occur outside STSAs under consideration. |
| Eureka mountainsnail | *Oreohelix eurekensis* | UT-SC | Duchesne, Grand | **No impact.** Known populations occur outside STSAs under consideration. |
| Great Basin silverspot butterfly | *Speyeria nokomis nokomis* | BLM-S | Duchesne, Uintah | **Potential for negative impact.** Species could occur in Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs. |
| Utah physa | *Physa utahensis* | UT-SC | Garfield | **No impact.** Known populations occur outside STSAs under consideration. |
| Yavapai mountainsnail | *Oreohelix yavapai* | UT-SC | San Juan | **No impact.** Known populations occur outside STSAs under consideration. |

**TABLE 5.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | Counties in Project Area Where Species Occurs | Potential Effect |
|---|---|---|---|---|
| ***Fishes*** | | | | |
| Colorado River cutthroat trout | *Oncorhynchus clarkii pleuriticus* | BLM-S | Duchesne, Garfield, Uintah, Wayne | **Potential for negative impact.** Species could occur in vicinity of Argyle Canyon STSA. |
| Flannelmouth sucker | *Catostomus latipinnis* | BLM-S | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in Asphalt Ridge, Hill Creek, Pariette, Raven Ridge, San Rafael, and Tar Sand Triangle STSAs. |
| Leatherside chub | *Gila copei* | BLM-S; UT-SC | Duchesne, Emery, Garfield, Wayne | **No impact.** Known populations occur outside STSAs under consideration. |
| Roundtail chub | *Gila robusta* | BLM-S | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, Sunnyside, Tar Sand Triangle, and White Canyon STSAs. |
| ***Amphibians*** | | | | |
| Arizona toad | *Bufo microscaphus* | UT-SC | Garfield, San Juan | **No impact.** Known populations occur outside STSAs under consideration. |
| Boreal toad | *Bufo boreas* | UT-SC | Carbon, Duchesne, Emery, Garfield, Wayne, Uintah | **No impact.** Known populations occur outside STSAs under consideration. |
| Canyon treefrog | *Hyla arenicolor* | BLM-S | Garfield, Grand, Wayne, San Juan | **Potential for negative impact.** Species could occur in Tar Sand Triangle and White Canyon STSAs. |
| Great basin spadefoot | *Spea intermontana* | BLM-S | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in all STSAs under consideration. |
| Northern leopard frog | *Rana pipiens* | BLM-S | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in all STSAs under consideration. |

**TABLE 5.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | Counties in Project Area Where Species Occurs | Potential Effect |
|---|---|---|---|---|
| ***Reptiles*** | | | | |
| Common chuckwalla | *Sauromalus ater* | UT-SC | Garfield, San Juan | **No impact.** Known populations occur outside STSAs under consideration. |
| Corn snake | *Elaphe guttata* | UT-SC | Grand, San Juan | **Potential for negative impact.** Species could occur in White Canyon STSA. |
| Desert night lizard | *Xantusia vigilis* | UT-SC | Garfield, San Juan | **Potential for negative impact.** Species could occur in Tar Sand Triangle and White Canyon STSAs. |
| Smooth greensnake | *Liochlorophis vernalis* | UT-SC | Carbon, Duchesne, Grand, San Juan, Uintah | **Potential for negative impact.** Species could occur in Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, Sunnyside, and White Canyon STSAs. |
| ***Birds*** | | | | |
| American peregrine falcon | *Falco peregrinus anatum* | BLM-S; CO-SC | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in all STSAs under consideration. |
| American white pelican | *Pelecanus erythrorhynchos* | BLM-S; UT-SC | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **No impact.** Transient migrant through STSA project areas. Known breeding populations occur outside STSAs under consideration. |
| Black swift | *Cypseloides niger* | UT-SC | Duchesne, Uintah | **Potential for negative impact.** Species could occur in Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs. |
| Bobolink | *Dolichonyx oryzivorus* | UT-SC | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in all STSAs under consideration. |
| Burrowing owl | *Athene cunicularia* | BLM-S; UT-SC | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in all STSAs under consideration. |

**TABLE 5.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | Counties in Project Area Where Species Occurs | Potential Effect |
|---|---|---|---|---|
| ***Birds (Cont.)*** | | | | |
| Ferruginous hawk | *Buteo regalis* | BLM-S; UT-SC | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in all STSAs under consideration. |
| Lewis's woodpecker | *Melanerpes lewis* | UT-SC | Carbon, Duchesne, Emery Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in all STSAs under consideration. |
| Long-billed curlew | *Numenius americanus* | BLM-S; UT-SC | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in all STSAs under consideration. |
| Northern goshawk | *Accipiter gentilis* | BLM-S | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in all STSAs under consideration. |
| Greater sage-grouse | *Centrocercus urophasianus* | BLM-S; UT-SC | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, and Sunnyside STSAs. |
| Short-eared owl | *Asio flammeus* | UT-SC | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in Asphalt Ridge, Pariette, San Rafael, Tar Sand Triangle, and White Canyon STSAs. |
| Three-toed woodpecker | *Picoides tridactylus* | UT-SC | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in Argyle Canyon, Hill Creek, P.R. Spring, Sunnyside, Tar Sand Triangle, and White Canyon STSAs. |
| Western yellow-billed cuckoo | *Coccyzus americanus occidentalis* | ESA-C; BLM-S | Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in Asphalt Ridge STSA. |

**TABLE 5.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | Counties in Project Area Where Species Occurs | Potential Effect |
|---|---|---|---|---|
| ***Mammals*** | | | | |
| Allen's big-eared bat | *Idionycteris phyllotis* | UT-SC | Garfield, Grand, San Juan, Wayne | **Potential for negative impact.** Species could occur in P.R. Spring, Tar Sand Triangle, and White Canyon STSAs. |
| Big free-tailed bat | *Nyctinomops macrotis* | BLM-S; UT-SC | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, Tar Sand Triangle, and White Canyon STSAs. |
| Fringed myotis | *Myotis thysanodes* | BLM-S; UT-SC | Duchesne, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, Tar Sand Triangle, and White Canyon STSAs. |
| Gunnison prairie dog | *Cynomys gunnisoni* | UT-SC | Grand, San Juan | **No impact.** Known populations occur outside STSAs under consideration. |
| Kit fox | *Vulpes macrotis* | UT-SC | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in all STSAs under consideration. |
| Mogollon vole | *Microtis mogollonensis* | UT-SC | San Juan | **No impact.** Known populations occur outside STSAs under consideration. |
| Pygmy rabbit | *Brachylagus idahoensis* | BLM-S; UT-SC | UT-Garfield, Wayne | **Potential for negative impact.** Species could occur in Tar Sand Triangle STSA. |
| Silky pocket mouse | *Perognathus flavus* | UT-SC | San Juan | **No impact.** Known populations occur outside STSAs under consideration. |
| Spotted bat | *Euderma maculatum* | BLM-S; UT-SC | Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, Tar Sand Triangle, and White Canyon STSAs. |

**TABLE 5.8.1-3 (Cont.)**

| Common Name | Scientific Name | Status[a] | Counties in Project Area Where Species Occurs | Potential Effect |
|---|---|---|---|---|
| ***Mammals (Cont.)*** | | | | |
| Townsend's big-eared bat | *Corynorhinus townsendii pallescens* | BLM-S; UT-SC | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for negative impact.** Species could occur in all STSAs under consideration. |
| Western red bat | *Lasiuris blossevillii* | UT-SC | Carbon, Emery, Grand, Garfield, San Juan, Wayne | **Potential for negative impact.** Species could occur in P.R. Spring, San Rafael, Tar Sand Triangle, and White Canyon STSAs. |
| White-tailed prairie dog | *Cynomys leucurus* | BLM-S; UT-SC | Carbon, Duchesne, Emery, Grand, Uintah | **Potential for negative impact.** Species could occur in Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and San Rafael STSAs. |

[a] Status categories: BLM-S=listed by the BLM as sensitive; ESA-C=candidate for listing under the ESA; UT-SC=species of special concern in Utah; CO-SC=species of special concern in Colorado.

California condor occurs in mountainous areas at low to moderate elevations, especially rocky and brushy areas near cliffs, while the Mexican spotted owl could occur year-round in steep forested canyons in Utah. The two species could be affected if these types of habitats are disturbed during tar sands development. Impacts on individual condors and owls could result from injury or mortality (e.g., collisions with transmission lines), human disturbance or harassment, increased human access to occupied areas, increases in predation rates, and noise from facilities.

The southwestern willow flycatcher is most commonly found in riparian areas, especially along large rivers (e.g., Green River, White River). These riparian habitats could be affected directly by surface disturbance or indirectly by activities in their watersheds that resulted in alteration of topography, changes in drainage patterns, erosion, sedimentation from runoff, and oil and contaminant spills. In addition, impacts on riparian habitats that support these species could result if the habitats were crossed by project transmission lines or roads. Impacts on individual birds could result from injury or mortality (e.g., collisions with transmission lines), human disturbance or harassment, increased human access to occupied areas, increases in predation rates, and noise from facilities.

Federally listed mammals that could be affected by tar sands development include the black-footed ferret and Canada lynx. The black-footed ferret occurs in grasslands and shrublands

**TABLE 5.8.1-4 Potential Effects on Federally Listed Threatened, Endangered, and Proposed Species**

| Common Name | Scientific Name | Status[a] | Counties in Project Area Where Species Occurs | Potential Effect |
|---|---|---|---|---|
| ***Plants*** | | | | |
| Autumn buttercup | *Ranunculus aestivalis* | E | Garfield | **Not likely to adversely affect.** Known populations occur outside STSAs under consideration. |
| Barneby reed-mustard | *Schoenocrambe barnebyi* | E | Emery, Wayne | **Potential for adverse effect.** Possible occurrence in San Rafael STSA. |
| Barneby ridge-cress | *Lepidium barnebyanum* | E | Duchesne | **Not likely to adversely effect.** Known populations occur outside STSAs under consideration. |
| Clay reed-mustard | *Schoenocrambe argillacea* | T | Uintah | **Potential for adverse effect.** Possible occurrence in Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs. |
| Jones cycladenia | *Cycladenia humilis* var. *jonesii* | T | Emery, Garfield, Grand, Uintah | **Potential for adverse effect.** Possible occurrence in Hill Creek, Pariette, P.R. Spring, and San Rafael STSAs. |
| Last chance townsendia | *Townsendia aprica* | T | Emery, Wayne | **Potential for adverse effect.** Possible occurrence in San Rafael STSA. |
| Maguire daisy | *Erigeron maguirei* | T | Emery, Garfield, Wayne | **Potential for adverse effect.** Possible occurrence in San Rafael STSA. |
| Navajo sedge | *Carex specuicola* | T | San Juan | **Not likely to adversely affect.** Known populations occur outside STSAs under consideration. |
| San Rafael cactus | *Pediocactus despainii* | E | Emery, Wayne | **Potential for adverse effect.** Possible occurrence in San Rafael STSA. |
| Shrubby reed-mustard | *Schoenocrambe suffrutescens* | E | Duchesne, Uintah | **Potential for adverse effect.** Possible occurrence in Hill Creek, Pariette, P.R. Spring, and Sunnyside STSAs. |

**TABLE 5.8.1-4 (Cont.)**

| Common Name | Scientific Name | Status[a] | Counties in Project Area Where Species Occurs | Potential Effect |
|---|---|---|---|---|
| ***Plants (Cont.)*** | | | | |
| Uinta Basin hookless cactus | *Sclerocactus glaucus* | T | Carbon, Duchesne, Uintah | **Potential for adverse effect.** Possible occurrence in Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, and Sunnyside STSAs. |
| Ute ladies'-tresses | *Spiranthes diluvialis* | T | Duchesne, Garfield, Uintah, Wayne | **Potential for adverse effect.** Possible occurrence in Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs. |
| Winkler cactus | *Pediocactus winkleri* | T | Emery, Wayne | **Potential for adverse effect** Possible occurrence in San Rafael STSA. |
| Wright fishhook cactus | *Sclerocactus wrightiae* | E | Emery, Wayne | **Potential for adverse effect.** Possible occurrence in San Rafael and Tar Sand Triangle STSAs. |
| ***Fish*** | | | | |
| Bonytail | *Gila elegans* | E | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for adverse effect.** Possible occurrence in vicinity of Asphalt Ridge, Hill Creek, Pariette, Raven Ridge, Sunnyside, Tar Sand Triangle, and White Canyon STSAs. Depletions from the Colorado River Basin are considered an adverse effect. |
| Colorado pikeminnow | *Ptychocheilus lucius* | E | Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for adverse effect.** Possible occurrence in vicinity of Asphalt Ridge, Hill Creek, Pariette, Raven Ridge, Sunnyside, Tar Sand Triangle, and White Canyon STSAs. Depletions from the Colorado River Basin are considered an adverse effect. |
| Humpback chub | *Gila cypha* | E | Carbon, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for adverse effect.** Possible occurrence in vicinity of Asphalt Ridge, Hill Creek, Sunnyside, Tar Sand Triangle, and White Canyon STSAs. Depletions from the Colorado River Basin are considered an adverse effect. |

**TABLE 5.8.1-4 (Cont.)**

| Common Name | Scientific Name | Status[a] | Counties in Project Area Where Species Occurs | Potential Effect |
|---|---|---|---|---|
| ***Fish (Cont.)*** | | | | |
| Razorback sucker | *Xyrauchen texanus* | E | Carbon, Emery Garfield, Grand, San Juan, Uintah, Wayne | **Potential for adverse effect.** Possible occurrence in vicinity of Asphalt Ridge, Hill Creek, Pariette, Raven Ridge, Sunnyside, Tar Sand Triangle, and White Canyon STSAs. Depletions from the Colorado River Basin are considered an adverse effect. |
| ***Birds*** | | | | |
| California condor | *Gymnogyps californianus* | E | Grand | **Potential for adverse effect.** Possible occurrence in the vicinity of Tar Sand Triangle and White Canyon STSAs. |
| Mexican spotted owl | *Strix occidentalis lucida* | T | Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for adverse effect.** Possible occurrence in the vicinity of Raven Ridge, Tar Sand Triangle, and White Canyon STSAs. |
| Southwestern willow flycatcher | *Empidonax traillii extimus* | E | Carbon, Emery, Garfield, Grand, San Juan, Uintah, Wayne | **Potential for adverse effect.** Possible occurrence in the vicinity of P.R. Spring, San Rafael, Tar Sand Triangle, and White Canyon STSAs. |
| Whooping crane | *Grus americana* | E | Emery, Grand, Uintah; WY-Lincoln, Sublette, Sweetwater, Uinta | **Not likely to adversely affect.** Possible occurrence in the vicinity of the STSAs under consideration, but considered a rare migrant through the area. |
| ***Mammals*** | | | | |
| Black-footed ferret | *Mustela nigripes* | E | Carbon, Duchesne, Emery, Grand, San Juan, Uintah | **Potential for adverse effect.** Possible occurrence in the vicinity of all the STSAs under consideration except Argyle Canyon, Tar Sand Triangle, and White Canyon. |
| Canada lynx | *Lynx canadensis* | T | Emery, Uintah; WY-Lincoln, Sublette, Uinta | **Potential for adverse effect.** Possible occurrence in the vicinity of Asphalt Ridge STSA. |

**TABLE 5.8.1-4 (Cont.)**

| Common Name | Scientific Name | Status[a] | Counties in Project Area Where Species Occurs | Potential Effect |
|---|---|---|---|---|
| ***Mammals (Cont.)*** | | | | |
| Utah prairie dog | *Cynomys parvidens* | T | Garfield, Wayne | **Not likely to adversely affect.** Known populations outside the STSAs under consideration. |

[a] Status categories: E=listed under the ESA as endangered; PT=proposed for listing under the ESA as threatened; T=listed under the ESA as threatened.

that support active prairie dog towns and may potentially occur near many of the tar sands project areas. The Canada lynx occurs in coniferous forests and potentially occurs near the Asphalt Ridge STSA. Impacts on these species could result from impacts on habitat (including vegetation clearing, habitat fragmentation, and movement/dispersal blockage) and individuals (injury or mortality [e.g., collisions with vehicles]), human disturbance or harassment, increased human access to occupied areas, increases in predation rates, and noise from facilities.

## 5.8.2 Mitigation Measures

Various mitigation measures would be required to reduce the impact of tar sands development on ecological resources during construction, operations, and reclamation. Existing guidance, recommendations, and requirements related to management practices are described in detail in the BLM Gold Book (DOI and USDA 2006), and BLM field office RMPs. The BLM has also developed a guidance document, *Hydraulic Considerations for Pipeline Crossing Stream Channels*, for construction of pipeline crossings of perennial, intermittent, and ephemeral stream channels. This guidance can be found at: http://www.blm.gov/nstc/library/techno2.htm. BLM Handbook 6840—*Special Status Species Management* describes BLM policy to protect species identified by BLM as sensitive. In addition, BLM has developed a set of conservation measures in consultation with USFWS intended to minimize impacts of tar sands development on threatened and endangered species (see Appendix F).

In addition to the actions described in these guidance documents, the mitigation actions below could be used to reduce the potential for impacts on various ecological resources. Other mitigation measures may be identified by the BLM or USFWS prior to project development.

### 5.8.2.1 Aquatic Resources

- Protect wetlands, springs, seeps, ephemeral streams, and riparian areas on or adjacent to development areas either through avoidance (if possible) or

mitigation. This objective would be accomplished by conducting predisturbance surveys in all areas proposed for development following accepted protocols established by the U.S. Army Corps of Engineers, BLM, or state regulatory agencies, as appropriate. If any wetlands, springs, seeps, or riparian areas are found, plans to avoid (if possible) or mitigate impacts would be developed in consultation with those agencies and the local BLM field office prior to the initiation of ground disturbance. Examples of potential protective measures include (1) establishing buffer zones adjacent to these habitats in which development activities would be excluded or modified, (2) using erosion control techniques to prevent sediment runoff into these habitats, (3) using runoff control devices to prevent surface water runoff into these areas, and (4) identifying and implementing spill prevention technologies that would prevent or reduce the potential for oil or other contaminants from entering these habitats.

- Avoid (if possible) or mitigate changes in the function of the 100-year floodplain or flood storage capacity. To achieve this, either no activities or limited activities within floodplains would be allowed, and floodplain contours could be restored to predisturbance conditions following short-term disturbances. The effectiveness of mitigation measures would be evaluated and modified, if necessary.

- Avoid (if possible) or mitigate water quality degradation (e.g., chemical contamination, increased salinity, increased temperature, decreased dissolved oxygen, and increased sediment loads) that could result from construction and operation. Water quality in areas adjacent to or downstream of development areas would be monitored during the life of the project to ensure that water quality in aquatic habitats is protected.

- Avoid (if possible) or mitigate the impacts on aquatic habitats (including springs, seeps, and ephemeral streams), wetlands, and riparian areas that could result from changes to surface or groundwater flows. Hydrologically connected areas would be monitored for changes in flow that are development related.

#### 5.8.2.2 Plant Communities and Habitats

- Avoid (if possible) or mitigate impacts on rare natural communities and remnant vegetation associations. Predisturbance surveys would be used to identify these communities in and adjacent to development areas. Examples of potential protective measures include (1) establishing buffer zones adjacent to these habitats and excluding or modifying development activities within those areas, (2) using erosion control techniques to prevent sediment runoff into these habitats, (3) using runoff control devices to prevent surface water runoff into these areas, and (4) identifying and implementing spill prevention

technologies that would prevent or reduce the potential for oil or other contaminants from entering these habitats. Mitigation could also include reclamation or establishment of similar habitats elsewhere as compensation.

- Reclaim excavated areas and disturbed areas following backfilling operations. Spent tar sands returned to mined areas would be covered with subsoil and then topsoil. Exposed soils would be seeded and revegetated as directed under applicable BLM requirements. Only locally native plant species would be used for the reclamation of disturbed areas to reestablish native plant communities.

- Prevent the establishment and spread of invasive species and noxious weeds, thus protecting developing plant communities on the project site from colonization by these species and increasing the potential for the successful development of diverse, mature native habitats in disturbed areas. Degradation of nearby habitats by invasive species colonization from project areas would also be avoided.

- Protect plant communities and habitats near all project areas from the effects of fugitive dust. This objective could be achieved by implementing dust abatement practices (e.g., mulching, water application, paving roads, and plantings), applied to all areas of regular traffic or areas of exposed erodible soils.

#### 5.8.2.3 Wildlife (including Wild Horses and Burros)

- Identify important, unique, or high-value wildlife habitats in the vicinity of the project, and design the project to avoid (if possible) or mitigate impacts on these habitats. For example, project facilities, access roads, and other ancillary facilities could be located in the least environmentally sensitive areas (i.e., away from riparian habitats, streams, wetlands, drainages, and critical or crucial wildlife habitats). The lessee would consult with the BLM and state agencies to discuss important wildlife use areas in order to assist in the determination of facility design and location that would avoid or minimize impacts on wildlife species and their habitats to the fullest extent practicable. Where habitat impacts cannot be avoided, these losses could be mitigated by habitat enhancement or compensatory habitat mitigation of in-kind, high-value habitat areas developed in coordination with the USFWS and the Utah Division of Wildlife Resources.

- Evaluate the project site for avian use (particularly by raptors, greater sage-grouse, neotropical migrants, and birds of conservation concern), and design the project to avoid (if possible) or mitigate the potential for adverse impacts on birds and their habitat. Conduct predisturbance surveys for raptor nesting in all areas proposed for development following accepted protocols and in

consultation with the USFWS and state natural resource agencies. If raptor nests are found, an appropriate course of action would be formulated to avoid (if possible) or mitigate impacts, as appropriate. For example, impacts could be reduced if project design avoided locating transmission lines in landscape features known to attract raptors. The lessee would also, at a minimum, follow guidance provided in the APP Guidelines prepared by the APLIC and USFWS (APLIC and USFWS 2005).

- Design facilities to discourage their use as perching or nesting sites by birds and minimize avian electrocutions.

- Avoid (to the fullest extent practicable) the creation of open surface water bodies (including wastewater pits). Any surface water body created for projects would be netted and fenced to prevent use by all wildlife.

- Avoid (if possible) or mitigate wildlife mortality from vehicle collisions. To achieve this objective, important wildlife habitats could be mapped and activities within them avoided (if possible) or mitigated. Education programs could be implemented to ensure that employees are aware of wildlife impacts associated with vehicular use. Carpooling, busing, or other means to limit traffic (and vehicle collisions with wildlife) would be emphasized.

- Develop a habitat restoration plan for disturbed project areas that includes the establishment of native vegetation communities consisting of locally native plant species. The plan would identify revegetation, soil stabilization, and erosion reduction measures that would be implemented to ensure that all disturbed areas are restored. Restoration would be implemented as soon as possible after completion of activities to reduce the amount of habitat converted at any one time and to hasten the recovery to natural habitats.

- Minimize habitat loss and fragmentation due to project development. For example, habitat fragmentation could be reduced by consolidating facilities (e.g., access roads and utilities would share common ROWs, where feasible), reducing access roads to the minimum number required, and, where possible, locating facilities in areas where habitat disturbance has already occurred. Transportation management planning can be used as an effective tool to minimize habitat fragmentation to meet this performance goal.

- Protect wildlife from the negative effects of fugitive dust. Dust abatement practices include measures such as mulching, water application, road paving, and plantings.

- Avoid (to the extent practicable) human interactions with wildlife (and wild horses and burros). To achieve this objective, the following measures could be implemented: (1) instruct all personnel to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons;

(2) make personnel aware of the potential for wildlife interactions around facility structures; (3) ensure that food refuse and other garbage are not available to scavengers (e.g., by use of covered dumpsters); and (4) restrict pets from project sites.

- Avoid (if possible) or mitigate noise impacts on wildlife during construction and operation. This objective could be accomplished by limiting the use of explosives to specific times and at specified distances from sensitive wildlife areas, as established by the BLM or other federal and state agencies. Operators would ensure that all construction equipment was adequately muffled and maintained to minimize disturbance to wildlife.

- Protect wildlife from chronic and acute pesticide exposure. This objective could be accomplished by measures such as using pesticides of low toxicity, minimizing application areas where possible, and by using timing and/or spatial restrictions (e.g., do not use pesticide treatments in critical staging areas). All pesticides would be applied consistent with their label requirements and in accordance with guidance provided in the *Final Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement* (BLM 2007b).

- Construct wildlife- and wild-horse-friendly cattleguards for all new roads or the improvement of existing ways and trails that require passing through existing fences, fenceline gates, or new gates, in addition to standard wire gates alongside of them.

- Construct fencing (as practicable) to exclude livestock, wild horses, or wildlife from all project facilities, including all water sites built for the development of facilities and roadways.

- Avoid (if possible) or mitigate existing water sources used by wildlife or wild horses in the vicinity of the project if adversely impacted during project construction or operation.

- Protect important big game winter habitat by prohibiting activities or surface use from November 15 to April 30 within certain areas encompassed by the authorization. The same criteria apply to defined big game birthing areas from May 1 to June 30. Application of this limitation to operation and maintenance of a developed project must be based on environmental analysis of the operational or production aspects. Exception, waiver, or modification of this limitation in any year may be approved in writing, including documented supporting analysis, by the authorized officer.

#### 5.8.2.4 Threatened and Endangered Species

The BLM, in consultation with the USFWS, developed a set of conservation measures to support the conservation of species listed under the ESA. These are provided in Appendix F. For purposes of the PEIS, these conservation measures are assumed to be generally consistent with existing conservation agreements, recovery plans, and completed consultations. It is the intent of the BLM and USFWS to ensure that the conservation measures are consistent with those currently applied to other land management actions where associated impacts are similar. However, it is presumed that potential impacts from development described in the PEIS are likely to vary in scale and intensity when compared to land management actions previously considered (e.g., oil and gas exploration and production, surface mining, and underground mining). Hence, final conservation measures would be developed for individual projects prior to leasing or ground-disturbing activities, and will be consistent with agency policies. Current BLM guidance on similar actions (e.g., fluid mineral resources) requires that the least restrictive stipulation that effectively accomplishes the resource objectives or resource uses for a given alternative should be used while remaining in compliance with the ESA. Mitigation measures, generally applicable to all listed species, are presented below. Species-specific measures are listed in Appendix F.

- Protect federally listed and state-listed threatened and endangered species and BLM sensitive species through siting and development decisions to avoid impacts. Conduct pre-disturbance surveys in all areas proposed for development following accepted protocols and in consultation with the USFWS and/or state agencies. If any federally listed species are found, and it is determined that the proposed development “may affect” the listed species or their critical habitat, the USFWS will be consulted as required by Section 7 of the ESA and an appropriate course of action developed to avoid (if possible) or mitigate impacts and address any potential incidental take from the activity. If any state-listed or BLM sensitive species are found, plans to avoid or mitigate impacts will be developed prior to construction consistent with guidance provided in BLM Handbook 6840.

- Avoid (if possible) or mitigate harassment or disturbance of federally listed threatened and endangered animals, BLM sensitive animal species, and state-listed threatened and endangered animals and their habitats in or adjacent to project areas. This objective can be accomplished by identifying sensitive areas and implementing necessary protection measures based upon Section 7 consultation with the USFWS. Education programs could be developed to ensure employees are aware of protected species and requirements to protect them. Prohibition of non-permitted access and gating could be used to restrict access to sensitive areas.

- Avoid (if possible) or mitigate impacts on federally listed and state-listed threatened and endangered species and BLM sensitive species and their habitats during construction and operations. If deemed appropriate by the USFWS, activities and their effects on these species will be monitored

throughout the duration of the project. To ensure that impacts are avoided, the effectiveness of mitigation measures will be evaluated and, if necessary, Section 7 consultation will be reinitiated.

- Protect federally listed and state-listed threatened and endangered species and BLM sensitive species (especially plants) and their habitats from the adverse effects of fugitive dust. This objective could be achieved by implementing dust abatement practices near threatened and endangered species habitats or other special habitats of importance (to be determined at local Field Office level). Dust abatement practices (e.g., mulching, water application, paving roads, and plantings) could be applied to all areas of regular traffic or areas of exposed erodible soils, especially in areas near occupied habitats.

- Avoid the release of oil to aquatic habitats in quantities that could result in subsequent adverse impacts on federally listed and state-listed threatened and endangered species and BLM sensitive species. This objective could be accomplished by applying spill prevention technology to all oil pipelines that cross or are in close proximity to rivers or streams with threatened or endangered aquatic species. For example, pipelines crossing rivers with listed aquatic species could have remotely actuated block or check valves on both sides of the river; pipelines could be double-walled pipe at river crossings; and pipelines could have a spill/leak contingency plan that includes timely notification of the USFWS and/or state agencies.

## 5.9 VISUAL RESOURCES

### 5.9.1 Common Impacts

While visual impacts associated with the construction, operation, and reclamation of tar sands projects considered in the PEIS differ in some important aspects on the basis of the tar sands extraction and processing technologies employed, there are many impacts that are common to the development approaches. Direct visual impacts associated with construction, operation, and reclamation of commercial tar sands development can be divided into generally temporary impacts associated with activities that occur during the construction and reclamation phases of the projects, and long-term impacts that result from construction and operation of the facilities themselves. Impacts are presented below by tar sands extraction and processing technology approach. In some cases, visual impacts would be very similar to those expected for commercial oil shale development (Section 4.9), and in the following discussion, the reader is referred to the PEIS sections discussing oil shale development impacts as appropriate.

As is the case for commercial oil shale production, regardless of the technologies employed for tar sands extraction and processing, commercial production of tar sands would entail industrial processes eventually requiring more than 5,000 acres of land disturbance and the presence and operation of major industrial facilities and equipment. These activities would

introduce major visual changes to natural-appearing landscapes and create strong visual contrasts in line, form, color, and texture. While mitigation measures might lessen some visual impacts associated with these projects (Section 5.9.2), in large part the visual impacts associated with the commercial tar sands projects analyzed in the PEIS could not be effectively mitigated.

While some of the lesser elements of a tar sands project might be compatible with VRM Class III or Class II objectives (see Section 4.9), the siting of the major facility elements would be expected to be compatible with Class IV objectives only, unless careful siting hid them from view. VRM Class II or Class III areas near major facilities where open lines of sight existed between the Class II or Class III lands and the major facilities would sometimes be subject to visual impacts from the strong visual contrasts that would result, particularly if the distance was within the foreground-middleground range, but possibly farther in some cases. These impacts might be incompatible with the VRM objectives for these areas.

#### 5.9.1.1 Surface Mining with Surface Retorting

**5.9.1.1.1 Construction and Reclamation.** Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing surface mining and retorting would be very similar to those anticipated for commercial oil shale production utilizing surface mines and surface retorts. These impacts are described in Section 4.9.1.1.

It is assumed that there would be one connecting transmission line and ROW serving each site that could be up to 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide. It is assumed that there would be one pipeline and ROW serving each project site, up to 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (see Section 5.9.1.5 for a discussion of impacts associated with electric transmission line and pipeline construction).

**5.9.1.1.2 Operation.** Potential visual impacts associated with operation of commercial tar sands projects utilizing surface mining and retorting would be similar to those expected for commercial oil shale production utilizing surface mining and retorting (see Section 4.9.1.1). There would be some differences in the types of structures, buildings, and equipment used to extract and process the different materials; however, the general nature and extent of visual impacts would likely be similar. Rather than spent shale piles, tar sands projects would involve spent tar sands piles, which might be disposed of in pits and/or mounds. If stored in mounds, the form and line would likely be similar to spent shale piles, but the texture and color would likely be different, with spent tar sands being finer textured material and darker in color than spent shale. It is expected that up to 2,950 acres of land would be disturbed at a given time.

Figures 5.9.1-1 and 5.9.1-2 depict commercial surface mining activities for tar sands in Alberta, Canada. A tar sands processing facility is visible in the background in both figures. Figures 5.9.1-3 and 5.9.1-4 show closer views of a tar sands processing facility.

**FIGURE 5.9.1-1 Large-Scale Commercial Tar Sands Surface Mining, North of Fort McMurray, Alberta, Canada (A tar sands processing plant is visible in the distant background.) (Image courtesy of Suncor Energy, Inc.)**

### 5.9.1.2 Surface Mining with Solvent Extraction

**5.9.1.2.1 Construction and Reclamation.** Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing surface mining and solvent extraction would be very similar to those anticipated for commercial oil shale production utilizing surface mines and surface retorts. These impacts are described in Section 4.9.1.1.

It is assumed that there would be one connecting transmission line and ROW serving each site that could be up to 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide. It is assumed that there would be one pipeline and ROW serving each project site, up to 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (see Section 5.9.1.5 for a discussion of impacts associated with electric transmission line and pipeline construction).

**FIGURE 5.9.1-2 Large-Scale Commercial Tar Sands Surface Mining Activity North of Fort McMurray, Alberta, Canada (The shovel bucket holds approximately 100 tons of tar sands ore. A tar sands processing plant is visible in the background.) (Image courtesy of Suncor Energy, Inc.)**

**5.9.1.2.2 Operation.** Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing surface mining and solvent extraction would be similar to those expected for commercial

**FIGURE 5.9.1-3 Portion of a Large-Scale Commercial Tar Sands Processing Plant near Fort McMurray, Alberta, Canada (Image courtesy of Suncor Energy, Inc.)**

**FIGURE 5.9.1-4 Close-up View of a Large-Scale Commercial Tar Sands Processing Plant near Fort McMurray, Alberta, Canada (Image courtesy of Suncor Energy, Inc.)**

oil shale production utilizing surface mining and retorting (see Section 4.9.1.1); however, there would be some differences in the types of structures, buildings, and equipment used to extract and process the different materials. Rather than retorts, buildings and structures for solvent extraction and related processes would be required. Spent tar sands, rather than spent oil shale, would be disposed of on the surface or in pits. It is expected that up to 2,950 acres of land would be disturbed at a given time. Figure 5.9.1-5 is a depiction of an existing pilot-scale tar sands processing facility utilizing surface mining and solvent extraction on Asphalt Ridge near Vernal, Utah. The photo conveys a general sense of the appearance of the structures and layout for a tar sands processing facility. A commercial-scale facility, however, such as that analyzed in the PEIS, would be many times larger.

#### 5.9.1.3 In Situ Steam Injection

**5.9.1.3.1 Construction and Reclamation.** Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing in situ steam injection would be very similar to those anticipated for commercial oil shale production utilizing in situ methods. These impacts are described in Section 4.9.1.3.

It is assumed that there would be one connecting transmission line and ROW serving each site that could be up to 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide. It is assumed that there would be one pipeline and ROW serving each project site, up to 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (see Section 5.9.1.5 for a discussion of impacts associated with electric transmission line and pipeline construction).

**5.9.1.3.2 Operation.** Potential visual impacts associated with operation of commercial tar sands projects utilizing in situ steam injection would be similar to those expected for commercial oil shale production utilizing in situ methods (see Section 4.9.1.3); however, there would be some differences in the types of structures, buildings, and equipment used to extract

**FIGURE 5.9.1-5 Photo Mosaic of Existing Pilot-Scale Tar Sands Processing Facility Utilizing Surface Mining and Solvent Extraction on Asphalt Ridge near Vernal, Utah**

and process the different materials. Rather than retorts, steam-assisted gravity drainage of tar sands would be used. This technology requires large pieces of equipment to create steam and to recover, treat, and recycle condensate (cooling towers, holding ponds, treatment tanks, etc.). Buildings and structures associated with power generation and the transport of heat and cooling fluids, as well as numerous wells, wellpads, and associated structures and equipment, would be present. The overall visual impacts, however, would be lower than those for projects utilizing mining and aboveground processing of tar sands. It is expected that 80 to 200 acres of land would be disturbed at a given time. Development would proceed utilizing a "rolling footprint" approach.

Figure 5.9.1-6 shows an in situ steam injection facility for tar sands extraction in Alberta, Canada.

**FIGURE 5.9.1-6 In Situ Steam-Assisted Gravity Drainage (SAGD) Facility near Fort McMurray, Alberta, Canada (SAGD technology uses underground wells to inject steam into the tar sands deposits and collect the bitumen released by the heat.) (Image courtesy of Suncor Energy, Inc.)**

#### 5.9.1.4 In Situ Combustion

**5.9.1.4.1 Construction and Reclamation.** Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing in situ combustion would be very similar to those anticipated for commercial oil shale production utilizing in situ methods (see Section 4.9.1.3). However, because there is no need for coolant and associated power generation and transport, there would be fewer aboveground structures, and, therefore, less construction and reclamation activity and associated visual impacts.

It is assumed that there would be one connecting transmission line and ROW serving each site that could be up to 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide. It is assumed that there would be one pipeline and ROW serving each project site, up to 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (see Section 5.9.1.5 for a discussion of impacts associated with electric transmission line and pipeline construction).

**5.9.1.4.2 Operation.** Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing in situ combustion would be similar to those expected for commercial oil shale production utilizing in situ methods (see Section 4.9.1.3); however, there would be some differences in the types of structures, buildings, and equipment used to extract and process the different materials. Rather than retorts, combustion of tar sands would require equipment to inject oxygen, but there would likely be fewer aboveground structures than would be required for in situ steam injection. While wells, wellpads, and associated structures and equipment would be present, the overall visual impacts would likely be much lower than those for projects utilizing mining and aboveground processing of tar sands, and would likely be slightly lower than those for tar sands projects utilizing in situ steam injection. It is expected that 80 to 200 acres of land would be disturbed at a given time. Development would proceed utilizing a rolling footprint approach.

#### 5.9.1.5 Other Associated Tar Sands Project Facilities

While many visual impacts expected from commercial tar sands development projects under consideration in the PEIS would be site- or technology-specific, the tar sands projects have some common elements that would be expected to create similar visual impacts regardless of location or the tar sands extraction or processing technologies employed. These elements include transmission lines and pipelines and employer-provided housing. The elements and related visual impacts are discussed here separately from impacts associated with specific tar sands extraction and processing technologies.

**5.9.1.5.1 Electric Transmission Lines and Pipelines.** Construction and operation of electric transmission lines and oil pipelines could be required for tar sands commercial development; the projected linear extent of the facilities, however, varies by project type and

technology employed. Visual impacts associated with construction, operation, and reclamation of the electric transmission lines and pipeline facilities are discussed in Section 4.9.1.4. For a given tar sands project, up to 140 mi of transmission line and ROW might be required, and up to 95 mi of pipeline and ROW might be required.

**5.9.1.5.2 Employer-Provided Housing.** Employer-provided housing would be constructed for use by employees during the construction phase for tar sands projects. The locations of housing are unknown, but are not likely to be on public lands. Visual impacts associated with construction, operation, and reclamation of employer-provided housing are discussed in Section 4.9.1.4; however, for tar sands projects, an estimated 49 acres of land would be required for employer-provided housing during the construction phase for each project, and an estimated 13 acres of land would be required for employer-provided housing during the operations phase for each project.

### 5.9.2 Mitigation Measures

Development activities would implement visual impact mitigation measures to the extent applicable and practicable. Potential mitigation measures that may be applied to siting, development, and operation of tar sands leases, as warranted by the result of the lease-stage or plan of development-stage NEPA analyses, include the following. However, it should be noted that while mitigation measures might lessen some visual impacts associated with tar sands development, in large part the visual impacts associated with commercial tar sands projects could not be mitigated.

- Siting projects outside of the viewsheds of KOPs, or if this cannot be avoided, as far away as possible.
- Siting projects to take advantage of both topography and vegetation as screening devices to restrict views of projects from visually sensitive areas.
- Siting facilities away from and not adjacent to prominent landscape features (e.g., knobs and waterfalls).
- Avoiding placement of facilities on ridgelines, summits, or other locations such that they will be silhouetted against the sky from important viewing locations.
- Co-locating facilities to the extent possible, to utilize existing and shared ROWs, existing and shared access and maintenance roads, and other infrastructure, in order to reduce visual impacts associated with new construction.
- Siting linear facilities so that generally they do not bisect ridge tops or run down the center of valley bottoms.

- Siting linear features (above-ground pipelines, ROWs, and roads) to follow natural land contours rather than straight lines (particularly up slopes) when possible. Fall-line cuts should be avoided.

- Siting facilities, especially linear facilities, to take advantage of natural topographic breaks (i.e., pronounced changes in slope) to avoid siting facilities on steep side slopes.

- Where possible, siting linear features such as ROWs and roads to follow the edges of clearings (where they will be less conspicuous) rather than passing through the centers of clearings.

- Siting facilities to take advantage of existing clearings to reduce vegetation clearing and ground disturbance, where possible.

- Choosing locations for ROWs and other linear feature crossings of roads, streams, and other linear features to avoid KOP viewsheds and other visually sensitive areas and minimize disturbance to vegetation and landform.

- Siting linear features (e.g., trails, roads, rivers) to cross other linear features at right angles whenever possible to minimize viewing area and duration.

- Minimizing the number of structures required.

- Constructing low-profile structures whenever possible to reduce structure visibility.

- Siting and designing structures and roads to minimize and balance cuts and fills and to preserve existing rocks, vegetation, and drainage patterns to the maximum extent possible.

- Selecting and designing materials and surface treatments in order to repeat and/or blend with existing form, line, color, and texture of the landscape.

- Using appropriately colored materials for structures, or appropriate stains/coatings, to blend with the project's backdrop.

- Using nonreflective or low-reflectivity materials, coatings, or paints whenever possible.

- Painting grouped structures the same color to reduce visual complexity and color contrast.

- Designing and installing facility lighting so that the minimum amount of lighting required for safety and security is provided but not exceeded and that upward light scattering (light pollution) is minimized.

- Siting construction staging areas and laydown areas outside of the viewsheds of KOPs and visually sensitive areas, where possible, including siting in swales, around bends, and behind ridges and vegetative screens.

- Developing a site reclamation plan and implementing it as soon as possible after construction begins.

- Discussing visual impact mitigation objectives and activities with equipment operators prior to commencement of construction activities.

- Mulching slash from vegetation removal and spreading it to cover fresh soil disturbances or, if not possible, burying slash.

- If slash piles are necessary, staging them out of sight of sensitive viewing areas.

- Avoiding installation of gravel and pavement where possible to reduce color and texture contrasts with existing landscape.

- Using excess fill to fill uphill-side swales resulting from road construction in order to reduce unnatural-appearing slope interruption and to reduce fill piles.

- Avoiding downslope wasting of excess fill material.

- Rounding road-cut slopes, varying cut and fill pitch to reduce contrasts in form and line, and varying slope to preserve specimen trees and nonhazardous rock outcroppings.

- Leaving planting pockets on slopes where feasible.

- Providing benches in rock cuts to accent natural strata.

- Using split-face rock blasting to minimize unnatural form and texture resulting from blasting.

- Segregating topsoil from cut and fill activities and spreading it on freshly disturbed areas to reduce color contrast and aid rapid revegetation.

- If topsoil piles are necessary, staging them out of sight of sensitive viewing areas.

- Where feasible, removing excess cut and fill from the site to minimize ground disturbance and impacts from fill piles.

- Burying utility cables where feasible.

- Minimizing signage and painting or coating reverse sides of signs and mounts to reduce color contrast with existing landscape.

- Prohibiting trash burning during construction, operation, and reclamation; storing trash in containers to be hauled off-site for disposal.

- Controlling litter and noxious weeds and removing them regularly during construction, operation, and reclamation.

- Implementing dust abatement measures to minimize the impacts of vehicular and pedestrian traffic, construction, and wind on exposed surface soils during construction, operation, and reclamation.

- Undertaking interim restoration during the operating life of the project as soon as possible after disturbances.

- During road maintenance activities, avoiding blading existing forbs and grasses in ditches and along roads.

- Recontouring soil borrow areas, cut and fill slopes, berms, waterbars, and other disturbed areas to approximate naturally occurring slopes during reclamation.

- Randomly scarifying cut slopes to reduce texture contrast with existing landscape and to aid in revegetation.

- Covering disturbed areas with stockpiled topsoil or mulch, and revegetating with a mix of native species selected for visual compatibility with existing vegetation.

- Removing or burying gravel and other surface treatments.

- Restoring rocks, brush, and forest debris whenever possible to approximate pre-existing visual conditions.

In order to mitigate visual impacts on high-value scenic resources in lands outside of, but adjacent to or near tar sands leasing areas, the following mitigation measures should be applied to siting, development, and operation of tar sands projects, as warranted by the result of lease-stage or plan of development-stage NEPA analyses:

- Tar sands-related development and operation activities within 5 mi of National Scenic Highways, All-American Roads, state-designated scenic highways, Wild and Scenic Rivers, and river segments designated as eligible for wild and scenic river status should conform to VRM Class II management objectives, with respect to impacts visible from the roadway/river. Beyond

5 mi but less than 15 mi from the roadway/river, development activities should conform to VRM Class III objectives.

- Development activities within 15 mi of high-potential sites and segments of National Trails, National Historic Trails, and National Scenic Trails should conform to VRM Class II management objectives, with respect to impacts visible from the adjacent trail high-potential sites and segments. Beyond 15 mi, development activities should conform to VRM Class III objectives.

- Development activities on BLM-managed public lands within 15 mi of KOPs (e.g., scenic overlooks, rest stops, and scenic highway segments) in National Parks, National Monuments, NRAs, and ACECs with outstandingly remarkable values for scenery should conform to VRM Class II management objectives, with respect to impacts visible from the KOPs. Beyond 15 mi, development activities will conform to VRM Class III objectives. KOPs for non-BLM-managed lands should be determined in consultation with the managing federal agency.

## 5.10 CULTURAL RESOURCES

### 5.10.1 Common Impacts

Significant cultural resources, listed or eligible for listing on the NRHP, could be affected by commercial tar sands leasing and development. The potential for impacts on cultural resources from commercial tar sands development, including ancillary facilities such as access roads, transmission lines, pipelines, and employer-provided housing, is directly related to the amount of land disturbance and the location of the project. Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces and from increased accessibility to possible site locations, are also considered. Leasing itself has the potential to impact cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development to cultural properties.

Several impacts on cultural resources could occur, as described below.

- *Complete site destruction* could result from the clearing of the project area, grading, excavation, and construction of facilities and associated infrastructure if sites are located within the footprint of the project.

- *Site degradation and/or destruction* could result from the alteration of topography; alteration of hydrologic patterns; removal of soils; erosion of soils; runoff into and sedimentation of adjacent areas; and oil or other contaminant spills if sites are located near the project area. Such degradation could occur both within the project footprint and in areas downslope or downstream. While the erosion of soils could negatively impact sites

downstream of the project area by potentially eroding materials and portions of sites, the accumulation of sediment could serve to protect some sites by increasing the amount of protective cover. Contaminants could affect the ability to conduct analyses of the material present at the site and thus the ability to interpret site components.

- *Increases in human access* and subsequent disturbance (e.g., looting, vandalism, and trampling) of cultural resources could result from the establishment of corridors or facilities in otherwise intact and inaccessible areas. Increased human access (including OHV use) exposes archaeological sites and historic structures and features to a greater probability of impact from a variety of stressors.

- *Visual degradation of setting* associated with significant cultural resources could result from the presence of commercial tar sands development and associated land disturbances and ancillary facilities. This degradation could affect significant cultural resources for which visual integrity is a component of the sites' significance, such as sacred sites and landscapes, historic trails, and historic landscapes.

Cultural resources are nonrenewable; once they are damaged or destroyed, they are not recoverable. Therefore, if a cultural resource is damaged or destroyed during oil shale development, it would constitute an irretrievable commitment of this particular cultural location or object. For cultural resources that are significant for their scientific value, data recovery is one way in which some information may be salvaged should a cultural resource site be adversely impacted by development activity. Certain contextual data are invariably lost, but new cultural resources information is made available to the scientific community. Loss of value for education, heritage tourism, or traditional uses is less easily mitigated.

### 5.10.2 Mitigation Measures

For all potential impacts, the application of mitigation measures developed in consultation under Section 106 of the NHPA will avoid, reduce, or mitigate the potential for adverse impacts on significant cultural resources. Section 106 consultations between the BLM and the SHPOs, appropriate Tribes, and other consulting parties would be required at the lease stage and at the plan of development stage. The use of BMPs, such as training/education programs, could reduce occurrences of human-related disturbances to nearby cultural sites. The specifics of these BMPs would be established in project-specific consultations between the applicant and the BLM, as well as with the SHPO and Tribes, as appropriate.

An ethnohistory and cultural resources overview were completed for the project area (Bengston 2007 and O'Rourke et al. 2007, respectively). The overviews synthesized existing information on cultural resources that had been previously identified. Also, Tribal consultation was initiated to further identify significant cultural resources. This phase of analysis did not identify geographical areas that would preclude moving areas forward for leasing. During the

leasing phase, the overviews and ongoing Tribal consultation will be reviewed to help determine areas of sensitivity and appropriate survey and mitigation needs.

BLM will conduct a phased approach to meet the agency's obligations under Section 106 of the NHPA. This approach is necessary for identification and evaluation efforts where alternatives under consideration consist of large land areas across a multistate region and when effects on historic properties cannot be fully determined prior to approval of leasing. Each phase of development will require an appropriate level of Section 106 analysis. The Section 106 analysis will be tiered to the PEIS. Oil shale and tar sands leasing may require additional consultation and information gathering prior to the lease sale. The final phase is that the lessee will then submit a plan of development for a site-specific project. Additional site-specific NEPA analyses will be conducted on these individual project plans of development. BLM will complete comprehensive identification (e.g., field inventory), evaluation, protection, and mitigation following the policies and procedures contained within the 1997 BLM National Programmatic Agreement and State Protocols. Also, BLM will continue to implement government-to-government consultation with Tribes and with other consulting parties on a case-by-case basis for plans of development.

The BLM does not approve any ground-disturbing activities that may affect any historic properties, sacred landscapes, and/or resources protected under the NHPA, American Indian Religious Freedom Act, NAGPRA, E.O. 13007 (U.S. President 1996), or other statutes and Executive Orders until it completes its obligations under applicable requirements of the NHPA and other authorities. The BLM may require modification to exploration or development proposals to protect such properties or disapprove any activity that is likely to result in adverse effects that cannot be successfully avoided, minimized, or mitigated. The BLM attaches this language to all lease parcels.

In some instances, additional special stipulations to the leases may be required for protection of specific cultural resources on the basis of the Ethnohistoric Overview and Cultural Resource Class I Overview (Bengston 2007 and O'Rourke et al. 2007, respectively) and information received from Tribal consultations, if it will not be possible to adequately avoid, minimize, or mitigate such resources under existing statute, regulation, or BLM policy subsequent to lease issuance.

The BLM develops specific mitigation measures to implement the lease stipulations on a project-by-project basis. Mitigation for adverse effects on the most common resource type, archaeological sites significant for their scientific value, is data recovery. To protect portions of historic trails that are potentially eligible for listing on the NRHP from visual intrusion and to maintain the integrity of the historic cultural setting, the BLM would require that surface disturbance be restricted or prohibited within the viewshed of the trail along those portions of the trail for which eligibility is based on the viewshed.

## 5.11 SOCIOECONOMICS

The analysis of the socioeconomic impacts of tar sands development in Utah consists of two interdependent parts. The analysis of *economic impacts* estimates the impacts of tar sands facilities and associated housing on employment and personal income in an ROI in which tar sands resources are located. Because of the relative economic importance of tar sands developments in small rural economies and the consequent lack of local economic and community infrastructure, large-scale tar sands developments are likely to mean a large influx of temporary population. As population increases are likely to be rapid, local communities may be unable to quickly absorb new residents, resulting in impacts on local finances and public service infrastructure. Social and psychological disruption may also occur, together with the undermining of established community social structures. Given these considerations, the analysis of *social impacts* assesses the potential impacts of tar sands developments on housing, local government, finances, and employment in the ROI in each of the three states. The analysis also assesses the potential for social disruption that may be associated with rapid population growth in small rural communities hosting large resource development projects.

The assessment of the socioeconomic impact of tar sands development was undertaken on the basis of a number of key assumptions relating to tar sands local procurement, worker in-migration, housing requirements and housing construction, and annual impacts. These assumptions are the same as those used in the analysis of the impact of oil shale development and are outlined in Section 4.11. Methods used in the analysis of the economic and social impacts of tar sands developments are briefly described in Section 4.11.1. Details of this methodology are presented in Appendix G. Underlying employment numbers are also presented in Appendix G.

### 5.11.1 Common Impacts

#### 5.11.1.1 Economic Impacts

Construction and operation of tar sands facilities and the associated temporary employer-provided housing and housing provided by local communities in Utah for tar sands workers and family members would have relatively large impacts on the economy of the ROI.

A single tar sands facility would produce 1,831 jobs in the ROI (1,187 direct jobs at tar sands facilities and 644 indirect jobs in the remainder of the local economy) during the peak construction year, and $91.3 million in income in the ROI (Table 5.11.1-1). During commercial production, 747 employees (482 direct and 265 indirect) would be required in the ROI, producing $36.8 million in income. Construction employment for a tar sands development facility would represent an increase of 4.1% over the projected ROI employment baseline.

Temporary housing built for tar sands workers and families would create 552 jobs (432 direct and 119 indirect in the remainder of the local economy) and $9.9 million in income in the ROI (Table 5.11.1-1).

**TABLE 5.11.1-1 ROI Economic Impacts of Tar Sands Development[a]**

| | Housing Construction | | Tar Sands Development: Construction | | Tar Sands Development: Operation | |
|---|---|---|---|---|---|---|
| | Employment | Income | Employment | Income | Employment | Income |
| ***Utah*** | | | | | | |
| No specified technology | | | | | | |
| Direct | 432 | 7.3 | 1,187 | 78.3 | 482 | 31.8 |
| Indirect | 119 | 2.6 | 644 | 13.0 | 265 | 5.0 |
| Total | 552 | 9.9 | 1,831 | 91.3 | 747 | 36.8 |

[a] The direct employment data presented in this table are based on data provided in BLM (1984) and are extrapolated from data presented for construction and operation of a surface mine with a capacity of 190,000 bbl/day, and an in situ facility with a capacity of 175,000 bbl/day. Direct employment numbers and multiplier data from the IMPLAN model (2001) were used to calculate total employment numbers; indirect employment numbers were then derived.

It is assumed that no new power plants or coal mines would be needed to facilitate development of tar sands resources in Utah.

### 5.11.1.2 Social Impacts

Construction and operation of tar sands facilities would have a large impact on population in the Utah ROI. The influx of tar sands workers and family members into local communities would have a relatively large impact on the housing market. The new residential population associated with the construction and operation of tar sands facilities would also require the hiring of additional local public service employees (police officers, fire personnel, local government employees, and teachers) in each ROI. Increases in ROI public service employment would also require increases in local revenues and expenditures to provide the necessary additional local public service provision.

In the peak year of construction of tar sands developments, 1,000 new residents are expected in ROI communities (Table 5.11.1-2). With commercial operation of tar sands development, 671 workers and family members would move into the local communities in the ROI. Population in-migration associated with tar sands construction would represent an increase of 1.0% over the projected ROI population baseline. During the peak year of construction, 289 housing units, or 3.2% of the projected vacant housing stock in the ROI, would be required (Table 5.11.1-2).

Construction of tar sands developments would require 25 new local government employees, with 17 required during operations (Table 5.11.1-3). The additional local public

**TABLE 5.11.1-2 ROI Demographic and Housing Impacts of Tar Sands Developments**

| | Tar Sands Development In-Migration in Local Communities | | Housing Demand in Local Communities | |
|---|---|---|---|---|
| | Construction | Operation | Number of Units | Percent Vacant |
| ***Utah*** | | | | |
| No specified technology | 1,000 | 671 | 289 | 3.2 |

**TABLE 5.11.1-3 ROI Community Impacts of Tar Sands Developments**

| | Government Employees | | Change in Local Government Expenditures (%) | |
|---|---|---|---|---|
| | Construction | Operation | Construction | Operation |
| ***Utah*** | | | | |
| No specified technology | 25 | 17 | 1.0 | 0.7 |

service provision would require an increase in 1.0% in local expenditures during the peak construction year, and 0.7% during operations.

With a relatively large in-migrant population expected in the Utah ROI during the construction and operation of tar sands facilities and the associated temporary housing, there is the potential for social disruption in communities in the ROI. The type and scope of impacts on social disruption are expected to be similar to those for oil shale development. Section 4.11.1.3 examines the experience of small rural communities in the Western states that would have rapid boomtown development associated with energy projects.

### 5.11.1.3 Recreation Impacts

Estimating the impact of tar sands development on recreation is problematic, as it is not clear how activities in the ROI would affect recreational visitation (use values) and passive use values (the value of recreational resources for potential or future visits). While it is clear that some federal land in the ROI would no longer be accessible for recreation, the majority of popular wilderness locations would be precluded from tar sands development. It is also possible that tar sands developments and associated transmission lines and transportation infrastructure elsewhere in the ROI would be visible from popular recreation locations (see Section 5.9), reducing visitation and consequently impacting the economy of the ROI.

Because the impact of tar sands development on visitation is not known, this section presents two simple scenarios to indicate the magnitude of the economic impact of tar sands development on recreation: the impact of a 10% and a 20% reduction in ROI recreation employment in the state ROI. Impacts include the direct loss of recreation employment in the recreation sectors in the ROI, and the indirect effects, which represent the impact on the remainder of the economy in the ROI as a result of a declining recreation employee wage and salary spending, and expenditures by the recreation sector on materials, equipment, and services. Impacts were estimated by using IMPLAN data for the ROI (Minnesota IMPLAN Group, Inc. 2007). IMPLAN is an input-output modeling framework designed to capture spending flows among all economic sectors and households in the ROI economy.

In the Utah ROI, total (direct plus indirect) impacts of tar sands development on recreation would be the loss of 388 jobs and $3.2 million in income in the ROI as a whole as a result of a 10% reduction in recreation employment, and 776 jobs lost and $6.3 million in income lost with the 20% reduction (Table 5.11.1-4).

#### 5.11.1.4 Impacts on Property Values

There is concern that tar sands developments and their associated transmission lines and coal mines might affect property values in ROI communities located nearby. Property values might decline in some locations as a result of the deterioration in aesthetic quality, increases in noise, real or perceived health effects, congestion, or social disruption. In other locations, property values might increase resulting from their access to employment opportunities associated with tar sands developments. Discussion of the potential impacts of energy developments on property values is presented in Section 4.11.1.6.

**TABLE 5.11.1-4 Total ROI[a] Impacts of Reductions in Recreation Sector[b] Employment Resulting from Tar Sands Development**

| | 10% Reduction | | 20% Reduction | |
|---|---|---|---|---|
| ROI | Employment | Income ($ million) | Employment | Income ($ million) |
| Utah | 388 | 3.2 | 776 | 6.3 |

[a] The Utah ROI includes Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, and Wayne Counties.

[b] The recreation sector includes amusement and recreation services, automotive rental, eating and drinking places, hotels and lodging places, museums and historic sites, RV parks and campsites, scenic tours, and sporting goods retailers.

### 5.11.2 Mitigation Measures

Mitigation measures to reduce socioeconomic impacts will be required and could include the BLM working with state and local agencies to identify potential socioeconomic impacts and develop mitigations. In doing so, a suite of potential measures could be implemented, including but not limited to the following actions:

- Operators could be required to provide housing and basic services for all direct project hires and their families in order to minimize potential (1) social disruption associated with large numbers of in-migrants locating in small rural communities, (2) short-term adverse impacts on regional housing markets and overnight accommodation facilities, (3) adverse impacts on regional consumer products' availability and price, and (4) adverse impacts on public services provided by local communities in the surrounding region.

- Operators could work with state and local agencies to develop community monitoring programs that would be sufficient to identify and evaluate socioeconomic impacts resulting from commercial development. Monitoring programs should collect data reflecting economic, fiscal, and social impacts of the development at both the state and local level. Parameters to be evaluated could include impacts on local labor and housing markets, local consumer product prices and availability, local public services (police, fire, and public health), and educational services. Programs also could monitor indicators of social disruption (e.g., crime, alcoholism, drug use, and mental health) and the effectiveness of community welfare programs in addressing these problems.

Operators could work with state and local agencies to develop community outreach programs that would help communities adjust to changes triggered by commercial development. Such programs could include any of the following activities:

- Establish vocational training programs for the local workforce to promote the development of skills required by the commercial development industries. Develop instructional materials for use in area schools to educate the local communities on the commercial development industries.

- Support community health screenings, especially those addressing potential health impacts related to commercial development activities.

- Provide financial support to local libraries for the development of information repositories on commercial development and processing, including materials on the hazards and benefits of commercial development. Electronic repositories established by the operators could also be of great value.

## 5.12 ENVIRONMENTAL JUSTICE

The construction and operation of tar sands developments and associated housing could impact environmental justice if any adverse health and environmental impacts resulting from either phase of development were significantly high and if these impacts disproportionately affected minority and low-income populations. If health and environmental impacts are not significant, there can be no disproportionate impacts on minority and low-income populations. If the impacts are significant, disproportionality is determined by comparing the proximity of high and adverse impacts with the location of low-income and minority populations. Details of the methodology for assessing environmental justice issues are presented in Appendix G. The following sections describe impacts on various resources located in the tar sands resource areas within the ROI that would be impacted by tar sands development. Local demographic and social disruption impacts, property value impacts, land use, air and water quality and use, and visual impacts are described. This discussion is followed by a determination of the extent to which impacts of tar sands development would have a disproportionate effect on low-income and minority groups on the basis of the location of low-income and minority populations.

### 5.12.1 Common Impacts

#### 5.12.1.1 Impact-Producing Factors

Rapid population growth in small rural communities hosting large tar sands development projects may produce social and psychological disruption, together with the undermining of established community social structures. Various studies have suggested that social disruption may occur in small rural communities when annual population increases are between 5 and 15% (see Section 4.11.1.3).

Property value impacts on private land in the vicinity of tar sands development projects and associated transmission lines may affect minority and low-income populations. These impacts would depend on the range of alternate uses of specific land parcels to landowners, current property values, and the perceived value of costs (e.g., visual impacts, traffic congestion, noise and dust pollution, air quality impacts, and EMF effects) and benefits (e.g., infrastructure upgrades, employment opportunities, local tax revenues) from proximity to tar sands–related facilities to potential purchasers of property owned by minority and low-income individuals in local communities.

Construction activities would produce fugitive dust emissions and engine exhaust emissions from heavy equipment and commuting and delivery vehicles on paved and/or unpaved roads, and wind erosion from soil disturbed by construction activities or from soil stockpiles. Emissions associated with these activities would consist primarily of particulate matter ($PM_{2.5}$ and $PM_{10}$), criteria pollutants, VOCs, $CO_2$, and certain HAPs released from heavy construction equipment and vehicle exhaust. Emissions during tar sands facility operations would consist of CO, $NO_2$, $PM_{2.5}$, $PM_{10}$, and $SO_2$. Construction of transmission lines and access roads required for the delivery of equipment and materials to project sites would produce fugitive dust impacts,

the magnitude of which would depend, in part, on the terrain, road length, and the length of time that they would be used for construction traffic.

Water consumption and quality impacts on land in the vicinity of tar sands development projects and associated transmission lines might affect minority and low-income populations, both in terms of water used for domestic consumption and water that may be used to support wildlife populations used for subsistence agriculture and for cultural and religious purposes. The impact on water resources during construction would consist primarily of increases in surface runoff and, consequently, in dissolved solids and in the volumetric flow of nearby streams near the project sites. The amount of water used during the operation of tar sands development projects is expected to be large at higher levels of facility production and could potentially impact minority and low-income populations if there were shortages of drinking water or water that might be used for agriculture.

Construction and operation of tar sands and supporting facilities, housing, and transmission lines would produce noise impacts, and the operation of transmission lines could lead to EMF effects.

Tar sands facilities and associated transmission towers may potentially alter the scenic quality in areas of traditional or cultural significance to minority and low-income populations, depending on the facility's size and location. Construction would introduce contrasts in form, line, color, and texture, as well as a relatively high degree of human activity into existing landscapes with generally low levels of human activity.

Land used for tar sands facilities might affect certain types of animals or vegetation that were of cultural or religious significance to certain population groups or that formed the basis for subsistence agriculture. Similarly, land that was used for facilities that also has additional economic uses might affect access to resources by low-income and minority population groups.

#### 5.12.1.2 General Population

Population in-migration would occur in each year of tar sands resource development. Workers would be required to move into the state for the construction and operation of tar sands facilities and to address the demand for goods and services resulting from the spending of tar sands and housing construction worker wages and salaries. It is projected that during the period in which a tar sands facility would be constructed in the ROI, population in the ROI would increase by 1.0%. In-migration associated with tar sands development would also require additional housing to be constructed in the ROI, with up to 3.2% of vacant housing units required during the peak year of construction.

Since tar sands development projects and the associated housing developments would lead to rapid population growth in many of the communities in each ROI, and given evidence presented in the literature (see Section 3.10.2.2), it is highly possible that some degree of social disruption would accompany these developments. In the absence of appropriate levels of local and regional planning, rapid demographic change may lead to the undermining of local

community social structures by those among the local population and in-migrants with contrasting beliefs and value systems and, consequently, to a range of changes in social and community life, including increases in crime, alcoholism, drug use, etc.

The precise nature of the impact of tar sands facility construction and operation on property values was not evaluated for this PEIS. The impact would depend on the range of alternate uses of specific land parcels by landowners, current property values, and the perceived value of costs (visual impacts, traffic congestion, noise and dust pollution, air quality impacts, and EMF effects) and benefits (infrastructure upgrades, employment opportunities, and local tax revenues) from proximity to tar sands–related facilities to potential purchasers of property owned by minority and low-income individuals in local communities.

Emissions associated with construction activities would consist primarily of particulate matter ($PM_{2.5}$ and $PM_{10}$), criteria pollutants, VOCs, $CO_2$, and certain HAPs released from heavy construction equipment and vehicle exhaust. Because all activities either conducted or approved by the BLM through use authorizations must comply with all applicable local, state, Tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans, it is unlikely that future tar sands and/or tar sands development would cause significant adverse air quality impacts.

Water from the Colorado River in Utah, plus the estimated sustainable groundwater yield, would likely be sufficient to support the amount of water needed for tar sands development, ancillary power and coal facilities, and associated population growth. It should be noted that prolonged drought conditions may occur and constrain water availability in Utah. Although discharges could have significant impacts on water quality if not properly controlled, water quality impacts of tar sands development are expected to be temporary and local, provided that mitigation measures are implemented, in part because of the dry climate where the sites are located. However, steep slopes in some areas may channel surface runoff and result in localized soil erosion.

Tar sands facilities might affect certain types of animals or vegetation that are of cultural or religious significance to certain population groups or form the basis for subsistence agriculture. Similarly, land that is used for these facilities that also has additional economic uses might affect access to resources by low-income and minority population groups.

Surface mine and surface retorting would involve the most surface disturbance and visible activity (including dust and emissions) and would be expected to generate the largest visual impacts relative to the other projects of similar size but using in situ processes. Visual impacts associated with reclamation also would likely be less than those for projects using surface mines because of the greatly reduced level of ground disturbance. Projects using in situ technologies would likely have the smallest level of visual impacts because of the absence of spent tar sands piles and other mining-related facilities and activities. These projects also would likely have the smallest reclamation impacts because of reduced surface disturbance and the absence of spent tar sands piles.

#### 5.12.1.3 Environmental Justice Populations

The construction and operation of tar sands developments could impact environmental justice if the adverse health and environmental impacts resulting from either phase of development identified in the previous sections were significantly high and if these impacts disproportionately affected minority and low-income populations. Where impacts are significant, disproportionality is determined by comparing the proximity of high and adverse impacts with the location of low-income and minority populations.

A number of census block groups in the area potentially hosting tar sands development have low-income and minority populations in which the minority population exceeds 50% of the total population in each block group, and there are a number of block groups in which the minority share of total block group population exceeds the state average by more than 20 percentage points (see Section 3.11). Within 50 mi of the tar sands area, the minority population is located in the northeastern part of the state in the immediate vicinity of the tar sands resource area itself, in the southeastern portion of the Uintah and Ouray Indian Reservation, and in the north central part of the state, to the east of Springville. The low-income population is centered in roughly the same area as the minority population, with five block groups in the southeastern portion of the Uintah and Ouray Indian Reservation, and one located in the vicinity of Price.

Given the location of environmental justice populations in each state, the construction and operation of tar sands facilities and employee housing required for the operation of tar sands development projects would produce impacts that would be experienced disproportionately by minority and low-income populations. Of particular importance would be the social disruption impacts from large increases in population in small rural communities, the undermining of local community social structures, and the resulting deterioration in quality of life. The impacts of facility operations on air and water quality and on the demand for water in the region would also be important. Depending on their locations, impacts on low-income and minority populations may also occur with the development of transmission lines associated with power development and the supply of power to tar sands facilities in each state. Land use and visual impacts might be significant, depending on the location of land parcels impacted by tar sands projects and the associated housing facilities, their importance for subsistence, their cultural and religious significance, and alternate economic uses.

### 5.12.2 Mitigation Measures

Various procedures might be used to protect low-income and minority groups from high and adverse impacts of tar sands and associated facilities. Most important of these would be to develop and implement focused public information campaigns to provide technical and environmental health information directly to low-income and minority groups or to local agencies and representative groups. Included in these campaigns would be descriptions of existing air and groundwater monitoring programs; the nature, extent, and likelihood of existing and future airborne or groundwater releases from tar sands facilities; and the likely characteristics of environmental and health impacts. Key information would include the extent of

any likely impact on air quality, drinking water supplies, and subsistence resources and the relevant preventative measures that could be taken.

Rapid population growth following the in-migration of construction and operation workers associated with OSTS and ancillary facilities into communities with low-income and minority populations could lead to the undermining of local community social structures where the in-migrants have beliefs and value systems that contrast with those of the local population. Consequently, a range of changes in social and community life, including increases in crime, alcoholism, and drug use, could result. In anticipation of these impacts, key information on the scale and timeline of OSTS developments, and on the experience of other communities that have followed the same energy development path, together with information on planning activities that may be initiated to provide local infrastructure, public services, education, and housing, could be made available to low-income and minority populations.

## 5.13 HAZARDOUS MATERIALS AND WASTE MANAGEMENT ASSOCIATED WITH TAR SANDS DEVELOPMENT

### 5.13.1 Common Impacts

Impacts related to hazardous materials and wastes are generally independent of location. Such impacts would be derivatives of the technologies employed for resource recovery and for the subsequent processing of recovered products rather than of the locations at which these activities occur.

Hazardous materials and wastes are unique to the technology combinations used for tar sands development. However, hazardous materials and waste impacts are common for some of the ancillary support activities that would be required for development of any tar sands facility regardless of the technology used. These include the impacts from development or expansions of support facilities such as employer-provided housing.

Hazardous materials impacts associated with construction or expansions of off-site support facilities would be minimal and limited only to the hazardous materials typically utilized in construction of such facilities. These would include the hazardous materials required to support construction equipment and vehicles (fuels, other vehicle and equipment fluids such as lubricating oils, hydraulic fluids, and glycol-based coolants) and miscellaneous hazardous materials typically associated with construction such as solvents, adhesives, and corrosion-control coatings. Construction-related wastes would include landscape wastes from clearing and grading of the construction sites and other wastes typically associated with construction, none of which are expected to be hazardous and all of which, except for landscape wastes, are expected to be disposed of in permitted sanitary landfills. Landscape wastes are expected to either be burned on-site or delivered to permitted off-site facilities for disposal or composting.

Once these support facilities become functional, different hazardous materials and waste impacts would result. It is expected that virtually no hazardous materials would be associated

with employer-provided housing. However, wastes would include nonhazardous solid wastes and sanitary wastewaters. Solid wastes are expected to be containerized and hauled to permitted sanitary landfills or other appropriate waste disposal facilities. As conditions permit, sanitary wastewaters are expected to be treated on-site through such technologies as septic systems or active biological treatment; all such activities would be controlled by permits issued to state or local authorities. Depending on the location of the employer-provided housing and other circumstantial factors, it is also possible that sanitary wastewaters would be delivered by truck or sewer to existing or expanded municipal treatment works for treatment.

#### 5.13.1.1 Surface Mining with Surface Retort

Hazardous materials associated with mining would primarily be used to support vehicles and equipment, most of which could not be easily transported to off-site maintenance and repair facilities. Hazardous materials would include fuels (primarily diesel fuel) and other engine and equipment fluids, such as lubricating oils, hydraulic fluids, glycol-based coolants, and battery electrolyte. Other miscellaneous hazardous materials used in the repair of mechanical equipment (cleaning solvents, welding gases, corrosion-control paints and coatings) would also likely be present in limited quantities. Explosives might also be used to support the mining activities; however, explosives are expected to be brought to the site on an as-needed basis rather than stored at the site. Limited amounts of herbicides would also be used on-site to manage vegetation in industrial areas for fire prevention and control. However, herbicides, like explosives, are not expected to be stored on-site but instead would be brought to the site on an as-needed basis.

Waste associated with surface mining operations also would be primarily associated with vehicle and equipment maintenance and would involve the spent hazardous materials described above. In addition, solid wastes (e.g., kitchen wastes, administrative wastes) and sanitary wastewater would result from the support of the workforce. Solid wastes would likely be containerized and hauled to an off-site permitted disposal facility. Sanitary wastes might be treated on-site by using septic systems or biological treatment as conditions dictate and operating permits allow, or alternatively, they might be delivered by truck or sewer to municipal treatment works. At the initial development of any given area, some landscape wastes could also result as the land surface was cleared and overburden removed. Landscape wastes would likely be burned on-site (under the authority of a state or local permit) or delivered to an off-site facility for disposal or composting. Stormwater runoff from stockpiled overburden could contain elevated amounts of suspended solids. Stormwater management is expected to be addressed by a sitewide SWPPP that is expected to be required by the site's stormwater management permit.

Other than the commercial fuel consumed as a source of heat, no hazardous materials would be required to support operation of the surface retort.[5] The inorganic phase remaining

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[5] For the purpose of this impact analysis, "retorting" means those actions conducted to separate the organic fraction, bitumen, from the inorganic materials contained in tar sands (primarily sand and silt). As it is used here, retorting implies only a separation of organic and inorganic fractions of tar sands and does not involve the chemical transformation of bitumen into other organic materials. As defined in Appendix B, a retort patterned after the Lurgi-Ruhrgas direct burn retort is considered to be representative of surface retorting.

after bitumen removal is composed primarily of sand and silt. At some Canadian tar sands developments, the sand that is recovered is a type (crystalline form) that makes it valuable for use in formation fracturing as part of enhanced recovery techniques for conventional crude oil. There is no evidence to suggest that sands recovered from retorting of U.S. tar sands would have similar value. Consequently, for the purpose of this analysis, the sand and silt that remain after bitumen removal are considered to be a solid waste. The most likely management strategies for this material involve either its use in reclamation of the mine site (to establish original contours prior to replacement of stockpiled overburden) or disposal in an on-site facility operating under a permit issued by state or local authorities. Residual sand and silt from retorting are not expected to exhibit any hazardous characteristics (although some residual bitumen may remain adsorbed to sand grains), but they nevertheless represent the potential for contaminating surface water runoff with high concentrations of suspended particulates, organic contaminants, and perhaps some dissolved minerals present in the tar sands formation. Proper design of waste sand disposal cells, appropriate vegetative covers, and other controls established under a solid waste disposal permit and/or a sitewide SWPPP should adequately address and mitigate this potential. Free water present in the formation is expected to be released during the retorting step. However, it is not expected to contain significant amounts of contamination and is likely to be of sufficient quality for beneficial use on-site for fugitive dust control.

Subsequent upgrading of recovered bitumen would be only that necessary to produce an upgraded product that could be accepted at refineries for additional processing. Hydrogen would be introduced to the site to support this upgrading (provided by commercial supplier on an as-needed basis and not generated on-site by steam reforming of natural gas). Periodic maintenance and repair of upgrading systems would result in spent catalysts (some of which might require management as hazardous waste) and sludge from the cleaning of storage tanks and reaction vessels, all of which would require characterization before waste management strategies could be determined. However, regardless of their character, the wastes resulting from upgrading operations are likely to be containerized and delivered to properly permitted off-site treatment or disposal facilities.

#### 5.13.1.2 Surface Mining with Solvent Extraction

Hazardous materials and waste impacts from surface mining discussed above would apply without change to this alternative. However, for the retorting step, a solvent in which the bitumen is soluble would be added as a means of bitumen separation rather than relying on heat, mechanical agitation, or phase separation to separate the bitumen from the inorganic fractions of tar sands. In this technique, additional hazardous materials would be introduced. A variety of solvents could be used. Those that have been used successfully for solvent extraction of tar sands in Canadian developments have included raw naphtha and raw gas oil (both condensate fractions from the distillation of conventional crude oil), hexane and cyclohexane (both chemicals produced in refineries or derived in petrochemical plants from secondary feedstocks), and ethanol. All of these materials have relatively high vapor pressures and low specific gravities,

and all are extremely flammable.[6] When practiced correctly, solvent extraction will recover the majority of solvents for reuse, although some minor evaporative losses are expected. Some aromatic solvents (naphthenic derivatives) that could be used have moderately high water solubility. If used as extraction solvents, they can be expected to partition to some extent into the free formation water that would also be present during the extraction process. While this aqueous fraction is easily separated from the organic phase (the bitumen), it will likely need treatment to remove the polar organic contaminants before it can be released back to the environment or used for beneficial purposes on-site, such as fugitive dust control.

Obviously, the accidental release of any of the extraction solvents would represent a hazardous fire situation and a potential adverse impact on the environment. Prudent management procedures would prevent such accidental releases. For cost control, facilities are likely to be established for recovery and recycling of the extraction solvents. Alternatively, this mixture of extraction solvent and bitumen could also be sent directly to a refinery, eliminating on-site upgrading activities.[7]

Subsequent upgrading of recovered bitumen would be only that necessary to produce an upgraded product that could be accepted at refineries for additional processing. Hydrogen would be introduced to the site to support this upgrading (provided by commercial supplier on an as-needed basis and not generated on-site by steam reforming of natural gas). Periodic maintenance and repair of upgrading systems would result in spent catalysts (some of which might require management as hazardous waste) and sludge from the cleaning of storage tanks and reaction vessels, all of which would require characterization before waste management strategies could be determined. However, regardless of their character, the wastes resulting from upgrading operations are likely to be containerized and delivered to properly permitted off-site treatment or disposal facilities.

#### 5.13.1.3 In Situ Steam Injection

For this technology, only bitumen is recovered from the formation, and spent sand is not generated. Steam is used to heat the bitumen, reducing its viscosity so that it can move through the formation and be recovered by a conventional production well. At the same time, steam condensates, as well as free formation water, are also recovered in the production well. Expected contaminants include suspended solids, dissolved minerals, and small amounts of polar organic constituents extracted from the bitumen. Typically, and especially in arid areas, these waters will be separated from the bitumen and recycled. Water sources for steam need to be of relatively high quality. Consequently, condensates require treatment to remove dissolved and suspended

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6 Many of the chemical constituents typically found in refinery fractionator condensates, such as raw naphtha and raw gas oil, have been identified as known or possible carcinogens. See the discussions of potential health impacts in Section 5.14.

7 It is common practice among some Canadian tar sands developers to mix bitumen with diluents (many of which are the same materials that would be used as extraction solvents) to create a less viscous mixture (known in the industry as “dil-bit”) that is delivered by conventional pipeline to refineries for processing, thereby eliminating mine site upgrading.

contaminants before being recycled. Such treatment is likely to produce sludge, which represents one of the primary wastes associated with this technology. Contaminants expected to be present in steam condensates include heavy metals and minerals dissolved from the formation, as well as small amounts of polar organic constituents extracted from the bitumen and partitioned into the aqueous phase. In addition to the primary steam cycle, secondary noncontact cooling systems may also be in operation. Water treatment chemicals are expected to be introduced into waters for primary steam loops as well as secondary cooling systems to control scale, corrosion, and bacteria, so blowdown water from both systems may also require treatment before release or beneficial use.

Bitumen recovered from steam injection is expected to undergo some upgrading on-site. To support such upgrading, hydrogen would be present on-site (delivered by a commercial vendor on an as-needed basis and not generated on-site through steam reforming of commercial natural gas). Periodic maintenance and repair of upgrading systems would result in spent catalysts (some of which might require management as hazardous waste) and sludge from the cleaning of storage tanks and reaction vessels, all of which would require characterization before waste management strategies could be determined. However, regardless of their character, the wastes resulting from upgrading operations are likely to be containerized and delivered to properly permitted off-site treatment or disposal facilities.

#### 5.13.1.4 In Situ Combustion

Hazardous materials required to support in situ combustion would be limited to the conventional fuels (natural gas or propane) that would be introduced to initiate combustion. No solid wastes would result from in situ combustion. However, free formation water, as well as waters of combustion, would be recovered from the production wells used to extract the bitumen. This aqueous fraction is expected to contain some inorganic species ($H_2S$, $NH_3$) as well as organic species (e.g., carbonyl sulfide as well as polar organic constituents that formed from partial thermal destruction of bitumen and partitioned into the aqueous phase because of their moderate water solubility). Consequently, this wastewater would require some treatment on-site before being released to the environment or beneficially used on-site (e.g., for fugitive dust control).

The organic fraction recovered from in situ combustion (largely bitumen with lesser amounts of products of incomplete thermal destruction of bitumen) is expected to undergo some upgrading on-site. To support such upgrading, hydrogen would be present on-site (delivered by commercial vendor on an as-needed basis and not generated on-site through steam reforming of commercial natural gas). Periodic maintenance and repair of upgrading systems would result in spent catalysts (some of which might require management as hazardous waste) and sludge from the cleaning of storage tanks and reaction vessels, all of which would require characterization before waste management strategies could be determined. However, regardless of their character, the wastes resulting from upgrading operations are likely to be containerized and delivered to properly permitted off-site treatment or disposal facilities. Virtually all upgrading reactions occur at elevated temperatures and pressures. Therefore, additional fuels would likely be brought to the site to support upgrading heat and pressure requirements. Where steam would be generated to

provide the needed heat, treatment of steam condensates to facilitate their recycling would result in sludge that would require characterization before disposal.

### 5.13.2 Mitigation Measures

Hazardous wastes will be present at a tar sands facility throughout construction, operation, and reclamation. During construction, hazardous wastes will be limited in both variety and volume, consisting mostly of wastes from the maintenance of construction equipment and the field applications of protective coatings. During operation, a greater variety of hazardous wastes can be expected with volumes generally proportional to the scale of the operation. Although facility owners/operators may elect to treat and even dispose of their hazardous wastes at the tar sands facility (with appropriate state-issued permits in place), it is reasonable to expect that most would adopt a strategy that minimizes the times and volumes of on-site storage of hazardous wastes, with expeditious transport to off-site, properly permitted treatment, storage, and disposal facilities (TSDFs). Elementary neutralizations of strongly corrosive wastes, as well as preliminary treatment of wastes to stabilize them for storage and transport, might occur on site but only to the extent that is minimally necessary.

Regulatory requirements to address hazardous materials and waste management already largely address the mitigation of impacts. To reinforce the regulatory requirements, additional mitigation measures and management plans could include the following:

- An individual, written management strategy for each hazardous waste anticipated;
- Written procedures for waste evaluations, containerization, on-site storage, and off-site disposal;
- Inspection procedures for hazardous material transportation vehicles and storage areas;
- Storage requirements for each hazardous material including container type, required design elements and engineering controls for storage and handling areas (e.g., secondary containment for liquids, fire protection for areas where flammables are used), and chemical incompatibilities;
- Dedicated, restricted access areas for hazardous waste storage, including adequate separations of chemically incompatible wastes;
- Formal, routine inspections of hazardous waste storage and handling areas;
- In addition to HAZCOM training required for workers who handle hazardous materials, awareness training for all facility personnel, including an identification of explicit roles and responsibilities for each individual;

- Limitations on access to hazardous material storage and use areas to authorized personnel;

- A comprehensive inventory of all hazardous materials at the facility, including notations of incompatibilities;

- Formal, written standard operating procedures addressing "cradle-to-grave" management including, receipt, containerization, storage, use, emergency response, and management and disposal of spent materials for each hazardous material at the facility;

- "Just-In-Time" purchasing strategies to limit the amounts of hazardous materials present at the facility to just those quantities immediately needed to continue operations;

- Preventative maintenance on all equipment and storage vessels containing hazardous materials;

- Aggressive pollution prevention programs to identify less-hazardous alternatives and other waste minimization opportunities;

- Establishment of comprehensive in-house emergency response capabilities to ensure expeditious response to accidental releases; and

- Documentation of all accidental releases of hazardous materials and corrective actions taken; conduct of root cause analyses; determination of the adequacy of response actions (making changes to response capabilities as necessary); assessment of long- and short-term impacts on the environment and public health; initiation of necessary remedial actions; and identification of policy or procedural changes that will prevent reoccurrence.

## 5.14 HEALTH AND SAFETY

Potential health and safety impacts from recovering oil from tar sands deposits can be associated with the following activities: (1) surface mining of the tar sands (underground mining is not considered at this time for tar sands deposits because of possible collapse of the sand deposits); (2) obtaining and upgrading of the product (primarily syncrude oil and some asphalt) through surface retorting, solvent extraction, in situ steam injection, or in situ combustion; (3) transport of construction and raw materials to the facility and transport of product from the facility; and (4) exposure to water and air contamination associated with tar sands development. Hazards from tar sands development are similar to hazards from oil shale development and are summarized in Table 5.14-1.

For mining and upgrading activities, the primary health and safety impacts are to facility workers. These worker impacts include physical hazards from accidents (including heat stress or

**TABLE 5.14-1 Potential Health Impacts Associated with Tar Sands Development[a]**

| Process or Product | Possible Hazard |
|---|---|
| Surface mining | Pneumoconiosis and/or increased cancer risk from inhalation of dust particles, tar sands particles, and/or diesel exhaust; physical hazards including highwall collapse and explosions; heat stress; noise. |
| Surface retorting, solvent extraction, and upgrading | Inhalation of or dermal contact with fumes or particles; noise; inhalation or dermal contact with contaminants in wastewater (e.g., hydrocarbons, phenols, trace elements, salts, suspended solids, oil, sulfides, ammonia, PAHs, radionuclides). |
| In situ steam injection and in situ combustion | Physical hazards associated with well drilling, use of explosives, noise, and use of steam at high temperature and pressure; inhalation of or dermal contact with fumes or particles in product, recovered process water, or process chemicals. |
| Raw and spent tar sands storage | Exposure to contaminants in drinking water; concentration of contaminants in edible aquatic organisms; inhalation of airborne particulates. |
| Products (syncrude, asphalt) | Potential cancers from dermal contact with or inhalation of volatile products. |
| Combustion products | Inhalation of HAPs from emissions of chemicals (e.g., criteria pollutants, trace elements, sulfur and nitrogen compounds, PAHs, radionuclides). |
| All | Increased physical hazards and exposure risks from transportation of raw materials and products to and from the facility. |

[a] Adapted from DOE (1988) and Brown (1979).

stroke, explosion, or injuries related to working around large, moving equipment); health risks from chemical exposures (usually inhalation or dermal) to hazardous substances present in tar sands, the products, other process chemicals, and wastes; and loss of hearing because of potentially high on-the-job noise levels. This section will mainly address worker physical hazards and worker chemical exposure risks. Noise risks are discussed in Section 5.7. Potential water and air contamination, which could lead to exposures for the general public, are discussed in Sections 5.5 and 5.6, respectively. Since, in general, water and air standards are set to be protective of public health, the discussion in those sections addresses potential impacts on the public.

A potential safety impact on the local off-site population that must be considered is risk due to an increased volume of vehicular traffic. The presence of construction and product transport trucks on narrow, two-lane roads could create unique hazards for children waiting at the roadside for their school bus. Additional transportation hazards would include exposure to particulate dusts created by the large trucks, as well as the increased potential for accidents. Transport of bitumen and other by-products is expected to occur by tractor trailer or by pipeline.

Traffic accidents involving truck movements or accidents involving the pipelines could also impact public safety.[8]

## 5.14.1 Common Impacts

### 5.14.1.1 Surface Mining

Tar sands mining is generally surface mining, because the instability of tar sands does not allow underground mining. The hazards associated with surface mining tar sands would be similar to those associated with surface mining other materials. These include the following (Bhatt and Mark 2000; Speight 1990; Daniels et al. 1981):

- Injuries from highwall-spoilbank failures;
- Hazards associated with storage, handling, and detonation of explosives;
- Inhalation of dust and particulates, possibly containing bitumen or VOCs; inhalation of exhaust fumes from mining equipment;
- Accidents and injuries from working in close proximity to large equipment (such as shovels, trucks, loaders) and equipment with moving parts;
- Injury hazards from lifting, stooping, and shoveling; exposure to climate extremes and sun while working outside; and
- Elevated noise levels (discussed in Section 5.7).

Highwall failures are very dangerous, often resulting in fatalities when the falling material hits workers. MSHA statistics show that there were 428 accidents caused by highwall instability in active coal and nonmetal surface mines from 1988 to 1997; 28 fatalities were recorded (Bhatt and Mark 2000). About one-half of the injuries occurred when the workers were hit directly with the failed highwall material; the other injuries involved the material hitting heavy or miscellaneous equipment. More than one-half of the accidents resulted in lost workdays.

Deaths and injuries from accidental ignition of explosives used to blast the formations and allow removal of the tar sands are a serious hazard in mining operations. Injuries and fatalities may also result from the high physical demands of surface mining. Large machinery

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8 Waste tar sands (tar sand tailings) would be generated in large quantities in any surface processing technology. However, it is expected that disposal of these tailings would occur on the leased site. Consequently, little if any tar sand tailings would be transported to disposal areas over public roadways. However, other chemical wastes associated with the operation may not be acceptable for on-site disposal and would, therefore, be transported by truck to permitted treatment or disposal facilities.

could be used to remove the tar sands; a truck-and-shovel approach might also be used. This approach can be more efficient, but it also requires a larger number of employees to conduct the work. In Utah, where the water supplies are limited, making hydrotransport from the excavation site unattractive, it is most likely that excavated tar sands would either be trucked to the retorting or extraction facility or moved by conveyor. The degree of mechanization in the surface mining processes used would greatly influence the number of worker injuries. In general, more mechanization would be expected to result in a lower number of worker injuries, because fewer workers would be needed to conduct the mining (although the number of machinery-related injuries would increase).

Injury and fatality incidence from tar sands surface mining is likely to be lower than that from the mining industry as a whole, since the latter also includes the more hazardous underground mining accidents. However, as an indicator, the recent statistics for the mining industry as a whole are provided here. Statistics for work-related injuries and deaths show that mining is one of the most hazardous occupations, with approximately 28.3 deaths per 100,000 mine workers in the United States in 2004 (NSC 2006). Because of improved safety practices and the use of more advanced machinery, mining deaths have decreased since the 1970s. For example, the death rate in 1970 was 200 per 100,000 workers; the rate has decreased to about 30 deaths per 100,000 in recent years (DOL 2006). The number of work-related injuries for miners was 3.8 nonfatal injuries per 100 mine workers annually in 2004 (NSC 2006).

Inhalation of dusts generated during the mining process can cause disease. If these are tar sands dusts, they will likely contain PAHs, a carcinogenic component of the sands (further discussed in Section 5.14.1.2 below). Chronic inhalation of irritants such as mineral or metal particles causes pneumoconiosis or miner's lung, a condition characterized by nodular fibrotic lung tissue changes. Prolonged inhalation of silica dusts causes a form of pneumoconiosis termed silicosis, which is a severe fibrosis of the lungs that results in shortness of breath. Both conditions can be fatal. Although concentrations of these dusts are lower for surface mining in comparison with underground mining, additive exposures may nonetheless result in these diseases.

#### 5.14.1.2 Surface Retorting and Solvent Extraction

The composition and toxicity of tar sands, produced oils, the residual char or coke, and process chemicals partially determine the potential hazards of processing the materials. Tar sands are deposits of consolidated or unconsolidated sediments that have pore spaces saturated with heavy, viscous petroleum known as bitumen. In contrast to heavy oils, the bitumen in tar sands is semisolid and cannot be pumped and collected at a well bore (Daniels et al. 1981).

Bitumen is composed of a mix of hydrocarbons with a high carbon-to-hydrogen ratio, and it may contain elevated concentrations of sulfur, nitrogen, oxygen, and heavy metals. Fumes from heated bitumens contain PAHs, many of which have been classified as probable human carcinogens in the EPA's Integrated Risk Information System (EPA 2006). According to the IARC, there is inadequate evidence to classify bitumens alone as human carcinogens (IARC 1985). Several studies have shown an increased risk of several types of cancer in workers

exposed to bitumens. However, these workers were also exposed to other carcinogenic materials such as coal tars. The refined bitumens have not been classified for human carcinogenicity.

For animals, there is sufficient evidence for the carcinogenicity of extracts of steam- and air-refined bitumens, limited evidence for the carcinogenicity of undiluted steam-refined bitumen and cracking-residue bitumen (char), and inadequate evidence for the carcinogenicity of air-refined bitumens. The possible increased cancer risk from inhalation of or dermal exposure to crude and processed bitumens is a primary chemical health concern for tar sands workers.

In addition to the array of organic chemicals that would be produced during bitumen recovery and processing, additional chemicals, including caustic agents, would be present during the treatment of steam condensates and raw water to allow for the recycling of steam, which would most likely be necessary to control costs.

The potential for hazardous exposures differs among the various retorting and separation processes (i.e., hot and cold water processes and thermal processes). The cold water process has a lower potential for exposure to volatile compounds. Potential chemical exposure pathways for workers include inhalation (especially for processes that take place at elevated temperatures) and dermal contact. At all facilities, worker exposures would be monitored and limited to stay within OSHA standard levels, by using engineered controls and also PPE if necessary.

Physical hazards to facility workers during retorting can be associated with equipment and systems. These include potential contact with hot pipes, fluids, and vapors; exposure to ruptured pipes and their contents; accidents from maintenance operations; and physical contact with chemical agents. Comprehensive facility safety plans and worker safety training can minimize these hazards.

Recovery of bitumen from mined tar sands through solvent extraction rather than through more conventional retorting presents many of the same hazards as discussed above for retorting, as well as additional hazards associated with exposure to the extraction solvent. Such solvents are typically naphthenic hydrocarbons (e.g., cyclohexane, raw naphtha) that pose both chemical and physical hazards. Many chemicals could be used successfully for solvent extraction. Since bitumen is soluble in a wide variety of organic solvents, the selection is based primarily on cost and availability rather than specific chemical or physical properties. Solvents could exhibit toxic properties through dermal, inhalation, or ingestion pathways (or through multiple pathways) as well as physical hazards such as volatility and flammability. Potential exposure pathways for workers include inhalation (especially for extractions that take place at elevated temperatures) and dermal contact.

#### 5.14.1.3 In Situ Steam Injection and Combustion

The hazards for steam injection processes are similar to those for thermal retorting, although there is much less potential for exposure to the char or coke, since they will remain underground. Steam injection can occur without prior modification to the formation, or it may be

preceded by explosive or hydraulic fracturing of the formation to enhance bitumen recovery. Hazards particularly associated with in situ steam injection processes include the following:

- Physical hazards associated with the high-pressure steam boilers and pumps and compressors used for injection;
- Hazards associated with the storage, handling, and detonation of explosives for modified in situ processes employing explosives to cause or enhance reservoir fracturing;
- Physical hazards associated with well drilling; and
- Exposures to hazardous substances in the recovered tar sands, in recovered process water, and in chemicals used to treat and recycle recovered water.

The hazards associated with explosives are as discussed above under surface mining. An additional hazard associated with in situ processes that is not applicable to mined tar sands is well drilling, in order to pump the mobilized bitumen to the surface. The phases of drilling wells include site preparation, drilling, well completion, servicing, and abandonment; each is associated with unique physical hazards (e.g., falling from heights, being struck by swinging equipment or falling tools, burns from cutting and welding equipment or steam).

Health and safety procedures implemented at an in situ steam injection research facility (TS-1) near Vernal, Utah (Daniels et al. 1981) required that the workers (a) handle produced oil and recovered process water as toxic substances; (b) handle de-emulsifiers, water-treatment chemicals, oxygen scavengers, organic sequestering agents, and corrosion-control substances so as to prevent exposure; and (c) wear protective clothing and receive safety training.

Hazards associated with in situ combustion processes are similar to those associated with in situ steam injection processes; however, the hazards associated with high-temperature and high-pressure steam are eliminated and replaced with hazards associated with the storage and use of fuels used to initiate combustion and the hazards of potential exposures to combustion by-products (primarily CO as well as a wide variety of partial decomposition products of complex organic molecules). For most in situ combustion technologies, high-pressure sweeping gases may also be used to control the direction of the combustion front and to aid in product recovery. Sweeping gases such as $CO_2$ would introduce asphyxiant and toxic gas hazards.

### 5.14.2 Mitigation Measures

Regulatory requirements to address occupational health and safety issues already largely address the mitigation of impacts (e.g., OSHA standards under 29 CFR 1910 and 1926 [1910.109 is specific for explosives] and the Mine Safety and Health Administration [MSHA] standards 30 CFR Parts 1–99). Also, electrical systems must be designed to meet applicable safety standards (e.g., National Electric Code [NEC] and International Electrochemical Commission [IEC]).

To reinforce the regulatory requirements, additional mitigation measures could include the following:

- To address traffic safety, installation of appropriate highway signage and warnings should be carried out to alert populace of increased traffic and to alert vehicle operators to road hazards and pedestrian traffic. Construction of safe bus stops for children waiting for school buses; these stops should be located well away from the roadway.

- To avoid highwall-spoilbank failure, use of benching, blasting patterns specifically designed for each mine site, adequate compacting of spoilbanks, and adequate miner training can allow for recognition and remediation of hazardous conditions (Bhatt and Mark 2000).

- The use of appropriate PPE can minimize some safety and exposure hazards.

- The risks from accidental explosions risk can be lowered by implementing applicable occupational standards and following general safety measures (e.g., good housekeeping for explosives storage areas; requiring safety training for all workers using explosives).

- Safety assessments for tar sands facilities should be conducted to describe potential safety issues and the means that could be taken to mitigate them.

- A comprehensive facility health and safety program should be developed to protect workers during all phases of a tar sands project. The program should identify all applicable federal and state occupational safety standards, establish safe work practices for each task, establish fire safety evacuation procedures, and define safety performance standards.

- A comprehensive training program and hazards communications program should be developed for workers, including documentation of training and a mechanism for reporting serious accidents or injuries to appropriate agencies.

- Secure facility access control should be established and maintained for all tar sands project facilities. Site boundaries should be defined with physical barriers, and site access should be restricted to only qualified personnel.

- Hazards from well drilling may be mitigated through use of measures recommended by the Occupational Safety and Health Administration (OSHA 2007).

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# 6 IMPACT ASSESSMENT FOR OIL SHALE AND TAR SANDS ALTERNATIVES

## 6.1 OIL SHALE ALTERNATIVES

This section presents the impacts associated with the three oil shale alternatives. Alternative A, the no action alternative, is discussed in Section 6.1.1. The impacts of Alternatives B and C are discussed in Sections 6.1.2 and 6.1.3, respectively. Section 6.1.4 presents a comparison of the oil shale alternatives. Discussions of the cumulative impacts and other NEPA considerations associated with Alternatives B and C are presented in Sections 6.1.5 and 6.1.6, respectively.

### 6.1.1 Impacts of Alternative A, No Action Alternative

As discussed in Section 2.3.2, under Alternative A, the no action alternative, it is assumed that the six RD&D projects will move forward on the 160-acre leases issued by the BLM in 2007. These include five projects in Rio Blanco County, Colorado, evaluating in situ processes, and one project in Duchesne County, Utah, evaluating underground mining with surface retort (see Figure 2.3-2). Alternative A includes only the RD&D activities and does not evaluate future commercial leasing at these or any other locations. A total of 960 acres will be involved in the six projects. Under Alternative A, land use plans will not be amended to allow for leasing for commercial development of oil shale. Decisions embedded in existing plans regarding oil shale leasing and development will not be modified.

The BLM evaluated the environmental and socioeconomic impacts of the RD&D activities on the six leases prior to issuance of the leases through the preparation of EAs. Four separate EAs were prepared and Findings of No Significant Impact (FONSIs) were issued for each project. These include separate documents for the Chevron project (BLM 2006a,b), EGL project (BLM 2006c,d), three Shell projects (BLM 2006e–h), and OSEC project (BLM 2007a,b). These EAs assess only the RD&D activities at each project site and do not examine the potential impacts of future commercial development on the associated preference right lease areas.

This section provides an overview of the impacts associated with the RD&D activities at each of the six project sites, as well as the impacts associated with the establishment of utility ROWs for electric transmission lines and pipelines and the construction of access roads. Unless otherwise noted, the information presented in this section assessing the impacts of Alternative A is summarized from the individual EAs; more detailed discussions are contained in the EAs. The EAs and FONSIs identify a number of terms, conditions, and stipulations that will be applied to the RD&D projects to mitigate the potential impacts discussed below.

#### 6.1.1.1 Land Use

The five Colorado lease areas are located within 15 mi of each other in Rio Blanco County, Colorado. They are all located between 25 and 30 mi southwest of the town of Meeker and 20 to 30 mi southeast of the town of Rangeley. The region in which these lease areas are located is rural and relatively undeveloped. Existing land uses include open rangeland; ranching; oil and gas development; utility corridors; historic nahcolite and oil shale mining, as well as more recent sodium solution mining; seasonal recreation, including big-game hunting; and wild horse herd management (primarily at Shell Sites 1 and 3, within the Piceance–East Douglas Creek HMA). Throughout the duration of the projects, RD&D activities on the 160-acre lease sites will preclude all other land uses. Land use on adjacent parcels of land should be largely unaffected by the RD&D activities, except that noise and human activity could alter the quality of hunting and other recreational experiences in the area and impact wild horses (see Section 6.1.1.7.3 for more information about the impact on wild horses under Alternative A). Land use along the new utility ROWs and access roads will be impacted during the construction phases, but these impacts will be largely short term. Although these lease areas are located in the same general area and will be undergoing RD&D activities during the same period of time, they are dispersed enough so that cumulatively, their impacts on land use will be relatively minor.

Only one of the five Colorado lease areas, Shell Site 2, is located within the Multimineral Zone. The Shell Site 2 RD&D activities are focused on evaluating the practicability of combining already developed nahcolite extraction methods with Shell's in situ hydrocarbon extraction technology. Although the Chevron RD&D lease area is outside the Multimineral Zone, this project will include an assessment of the development potential for nahcolite and dawsonite in the project area and the potential conflicts between oil shale development using Chevron's in situ technology and the development of these resources.

The OSEC RD&D project is located at the White River Mine site in Uintah County, Utah. This 160-acre lease area is located within the Ua Tract of the 1974 Federal Prototype Oil Shale Leasing Program. Current land use within the RD&D lease and on adjacent lands includes oil and gas development, gilsonite mining, wildlife habitat, recreational use, and livestock grazing. The project site does not coincide with any wild horse or burro HMAs. OSEC plans to conduct RD&D activities in three phases. On-site construction activities will not begin until Phase 2, and construction of the utility ROWs will not begin until Phase 3. Because this project is located at an existing mine site, the RD&D activities will not substantively change the existing land use within the leased area. Land use on adjacent parcels of land should be largely unaffected by the RD&D activities, except that noise and human activity could alter the quality of hunting and other recreational experiences. These impacts will not occur until the start of Phase 2 activities. Land use along the new infrastructure ROWs will be impacted during the construction phases, but these impacts will be largely short term.

#### 6.1.1.2 Soil and Geologic Resources

In combination, the six RD&D projects are expected to result in up to 960 acres of disturbed land at the lease sites, plus additional disturbed land for access roads and utilities. Soil erosion impacts, including potential related impacts on surface water salinity and overall water quality (see Section 6.1.1.4), are of concern. The erosion hazard of the soils at each of the sites is variable. The Chevron site is composed of soil with moderate to very high erosion potential. The erosion potential at the EGL site ranges from moderate to very high for water erosion and slight to moderate for wind erosion; the revegetation potential is fair to very poor for site soils. Shell Site 1 is mostly moderately to highly erodable, but some areas are severely erodable by water and wind. At Shell Site 2, a small portion of the site is slightly erodable, but the bulk of it is moderately to highly erodable, including some severely erodable areas. Shell Site 3 has a wide range of erosion hazard levels, from slight to high, and also includes a portion that is severely erodable. At the OSEC RD&D site, the soils are slightly to moderately erodable by water, but have wind erodability ranging from none to moderate. Phase 3 of the OSEC project will involve construction of a ROW to the site, which will add to the overall amount of disturbed land. Along this ROW, many soil types are present, ranging in water erodability from none to very severe and ranging in wind erodability from none to high.

Each of the Colorado RD&D projects will entail extensive drilling activities. Proper management of drill cuttings is important because they can be susceptible to water and wind erosion and have a subsequent effect on water quality. At the Chevron site, drilling cuttings will be generated at approximately 5 injection or production wells, 20 groundwater monitoring wells, and 20 to 25 boreholes for tiltmeters, for collection of fracture data. At the EGL site, drill cuttings will be produced by approximately 4 to 8 dewatering wells, 2 water injection wells, 5 boreholes for heating, 4 producer wells, and additional groundwater monitoring wells. Anticipated drilling waste from each of the Shell sites will include cuttings from approximately 150 boreholes for freeze-wall construction, 10 producer boreholes, 30 heater boreholes, and additional boreholes for groundwater monitoring wells.

Each of the RD&D projects will have impacts on other mineral development activities. Chevron's in situ combustion technique could lead to the loss of other mineral resources, such as any economically extractable nahcolite or dawsonite, in or near the treated area. Because of the flammability of natural gas, gas wells will not be allowed within some distance of an in situ combustion site, likely including any directionally drilled wells targeting gas beneath the oil shale treatment zone. Producing gas wells are within 0.1 mi of the Chevron lease boundary. This site is located in the KSLA of the Piceance Basin. The nahcolite and dawsonite content beneath the site is to be determined through a drilling program. Coal is too deep to be technologically accessible.

The EGL site also is within the KSLA, although the EA does not describe the sodium minerals present at the site. The EGL site targets a zone above nahcolite, presumably leaving this mineral resource unaffected. The heating process could potentially lead to heaving and subsidence, with possible effects on nearby gas or oil wells. A producing gas well is within 0.4 mi of the EGL lease boundary.

As part of the RD&D activities, nahcolite solution mining will occur at Shell Site 2, which is located in the Multimineral Zone. The naturally occurring nahcolite at Sites 1 and 3 has been leached away by naturally circulating groundwater. Dawsonite, which is not soluble in groundwater, is present at Site 2 at an average of 5% by weight and at Site 3 at an average of 4% by weight across certain intervals. Natural gas wells, including producing wells and permitted locations awaiting drilling, are within 5 mi of Sites 1 and 3, and several are within 0.5 mi of Site 2. Directional drilling will be necessary for accessing gas beneath the RD&D sites, although technological constraints may prevent this. Coal is present at technologically infeasible depths.

Tar sands resources are not present on the OSEC RD&D site, although they do occur 10 mi to the south. Coal bed methane is present in the region, though no production takes place nearby the RD&D site. Coal is too deep to be mineable, and no other minerals are present at the site. Two gilsonite veins are present along the intended ROW. OSEC will coordinate ROW construction with the gilsonite mining company. Natural gas leases are present at the site; OSEC will also coordinate with the oil and gas lessees.

Soil impacts, occurring during construction and reclamation, are expected to be local in extent. Overall impacts will be minimized through a series of conditions identified in the EAs and FONSIs. To mitigate impacts on nahcolite and dawsonite, the proposed actions for the Colorado sites call for either avoiding oil shale zones with substantial deposits of sodium minerals, recovering the nahcolite before recovering the oil resources, or isolating the formations to avoid destruction of the nahcolite and dawsonite. The proposed actions will not adversely affect the future recovery of oil shale outside the retorted zones or of other minerals in the project area.

#### 6.1.1.3 Paleontological Resources

There is a potential for impact on paleontological resources at all six RD&D locations, consistent with those impacts discussed in Section 4.4 for commercial oil shale operations. All five of the RD&D project sites in the Piceance Basin are underlain by the Uinta Formation. As presented in Section 3.3, Table 3.3-1, the Uinta Formation is categorized as a Condition 1 area in which significant paleontological resources are known to occur and will need to be considered. At the Chevron and EGL sites, there were no bedrock exposures from which paleontological potential could be determined. Impacts on paleontological resources were determined to be possible at both sites, and to mitigate possible damage to these potential resources, it was indicated in the EAs that each site will be monitored during the RD&D activities. The monitor will be present to identify paleontological resources during ground-disturbing activities, and those activities will need to be stopped if paleontological resources are discovered. The BLM Authorized Officer will be contacted by the operator. The find will be evaluated, and if it is considered significant, mitigation measures will be established by the BLM. The operator will not be allowed to resume activities until mitigation is completed. If the find is not considered significant, the activity will be allowed to continue. Chevron and EGL also indicated that they will inform and train their personnel to not disturb or collect paleontological materials. Shell Sites 1 and 3 have been surveyed for paleontological resources (Paleontological Investigations 2003; Young 2005). No paleontological resources were found during the survey at Site 1, but it

was indicated in the EA that a BLM paleontologist will be notified prior to any excavation into the underlying rock formation. Significant plant fossil remains were encountered in an unnamed tongue of the Uinta Formation in an area adjacent to Site 3. This unnamed tongue is also exposed in drainages incised on the site, and additional plant fossils could possibly be present there; impacts on significant paleontological resources are "probable" at Site 3. Shell Site 2 has not been surveyed; there is a potential for significant paleontological resources to be present at the site. Possible mitigation that was presented in the EA included site avoidance, quarrying to recover a sampling of fossils present at the site (Site 3), and monitoring (similar to what is described above for EGL and Chevron).

The OSEC RD&D site in the Uinta Basin and proposed utility line ROWs are underlain by the Uinta and Green River Formations, both classified as Condition 1 areas for paleontological resources. The OSEC site was previously mined for oil shale, and no fossils were previously reported in existing shale ore stockpiles at the site. It is possible that any new excavation at the site could impact paleontological resources. Construction of power lines and pipelines in support of the RD&D project has less potential to impact paleontological resources because of the limited areas of bedrock near the construction location for the proposed pipeline and the limited amounts of ground disturbance associated with power pole placement. Possible mitigation presented in the EA to reduce negative impacts included the preparation of a "project-specific unanticipated discovery and monitoring plan for paleontological resources." Monitoring, stop-work instructions for suspected fossil discoveries, informing personnel that it is illegal to collect or excavate fossil materials without a permit, and curation of any significant fossil specimens that are discovered during the project were also mentioned.

#### 6.1.1.4 Water Resources

Water resource impacts can be divided into water quality and water quantity issues. The former are particularly important to surface water, in keeping with the federal Colorado River Water Quality Improvement Program (CRWQIP) (P.L. 92-500) to maintain Lower Colorado Basin water salinity at or below certain levels. The latter are related to the water allocation under the Upper Colorado River Basin Compact, stream and river flows, and their effect on sediment erosion and deposition in channels. It should be noted that the water quality in the Upper Colorado River Basin, where the six RD&D sites are located, is closely related to stream and river flows. Because water will not be withdrawn from surface water bodies near the sites and wastewater will be shipped off-site for disposal under this alternative, the impacts on surface water quantity and quality originate primarily from surface runoff, including potential spills. For the groundwater, potential impacts come from groundwater dewatering, reinjection (if used), permeability enhancement in oil shale productive zones, and release of contaminants in the subsurface. Natural groundwater discharge from seeps and springs in stream valleys will also be affected. Mitigation measures identified in the EAs and FONSIs focus extensively on limiting impacts on water resources.

During the construction phase for the RD&Ds, most of the surface water impacts are related to soil and vegetation disturbance that will occur as a result of clearing, excavation, and grading activities. These activities occur at project sites, along utility line ROWs, newly

constructed stormwater drainage systems, spent shale disposal areas, and access roads, and will result in temporary increases in sediment load carried to nearby surface water bodies by surface runoff. Because the soils and underlying sedimentary rocks near the RD&D sites have a high salt content, increased surface runoff also is likely to produce higher dissolved salts in the surface runoff. Construction activities may cause some natural drainages to be diverted or modified, and new drainage channels may be created near access roads and other specific sites. These changes could result in increased runoff velocity and increased peak discharge. An indirect consequence of drainage changes could be increased rates of surface soil erosion, especially in sloped areas. If drill cuttings are not contained or otherwise managed properly, they could represent another source of increased sediment and salinity loads to surface water. The impacts on surface water during the construction phase can be mitigated by many of the actions identified in the EAs for the projects.

At the OSEC site, mitigation of impacts from runoff and treated process water from retorting will likely be through collection in ponds or behind a retention dam. Depending on the quality of the water and the permeability of the soil underneath the retention dam area, water infiltrated to the subsurface could migrate to nearby surface water bodies and impact the surface water. At other RD&D sites, lined ponds will be used to hold and evaporate stormwater and process water; infiltrated water from the ponds will be withheld, resulting in insignificant impacts on the water resources.

During development of the five RD&D facilities employing in-situ technologies, single or multiple zones of oil shale will be fractured using different fracturing technologies (e.g., water, steam, $CO_2$, or thermal) to enhance the extraction of hydrocarbon products during in situ retorting (such as at the Chevron and EGL sites). The fractures could permanently increase the permeability of the source rock in the productive zones. At the Chevron RD&D site, where horizontal fracturing will be conducted, the fracturing will be limited to individual production zones. The groundwater aquifers below and above the production zone will be closely monitored to detect inadvertent vertical fracturing. If cross-flows between the two aquifers are detected, fracturing intervals will be adjusted or other measures may be implemented to correct this problem. Similarly, at the EGL site, a zone of oil shale adjacent to an aquifer will be preserved, allowing the production zone to remain hydraulically isolated from the aquifer.

In the case of the Shell's ICP sites, fractures could also form vertically in rocks within the freeze wall, resulting in cross-flow between aquifers after the freeze wall is allowed to dissipate. The permeability in the retorted zone likely will be increased, allowing for greater groundwater flow, and could become a groundwater discharge zone for the shallower aquifers and a groundwater recharge zone for the deeper aquifers. Increased porosity (and permeability) will occur where kerogen, nahcolite, and other soluble minerals are removed from the rock. Such alteration of permeability will promote vertical as well as horizontal flow and transport of groundwater, as well as any residual hydrocarbons, chemicals used to enhance the hydrocarbon extraction, salts, and metals.

The withdrawal of groundwater will lower the water table and potentiometric surface of the affected aquifers. During RD&D operations, the activities that will result in groundwater withdrawal include (1) dewatering operations in mines or in retorted zones to prevent

groundwater from entering work areas or production zones, and (2) drilling operations that could create conduits between aquifers if precautions and appropriate drilling technologies are not used. The withdrawals will create a cone of depression of the potentiometric surface or water table around each pumping well. If existing water supply wells were within the cone of depression, the yield of the wells could decline or the wells could go dry. In the Piceance Basin where the five in situ sites are located, the upper and lower aquifers (totaling 1,100 ft in thickness) are present above and below the Mahogany Zone of the Parachute Creek Member. The drawdown of water levels in the upper Parachute Creek Unit could reduce the streamflows in Yellow or Piceance Creeks. According to a modeling study presented in the EA for the Shell projects, 1 ft of groundwater drawdown could extend up to 2 mi from a dewatering well. At the OSEC site, the dewatering involves the Bird's Nest Aquifer (about 115 ft thick), which is above the target oil shale (the Parachute Creek Member). At Shell's ICP sites, drawdown of water levels will be limited inside the freeze wall, and impacts of the withdrawal on local surface water will be minimized. At the OSEC site, the dewatering could reduce the flows of springs in Bitter Creek that receive groundwater discharge from the connected Bird's Nest Aquifer.

Groundwater injection has the opposite effect on hydrologically connected surface water bodies, if underground injection is used to dispose of formation water or wastewater. Injection will raise the groundwater level of the recharged aquifer near recharge wells and thus increase the flows of the seeps and springs or create new seeps and springs in valleys that are hydrologically connected to the affected aquifer. At the RD&D sites, the injected fluids will originate from different activities, including disposal of formation water from the production zone and water injection to create fractures (hydrofracturing) in oil shale layers. The hot-water injection to recover dawsonite and nahcolite (used in Shell's two-step ICP) is accompanied by extraction wells and is less likely to cause a rise of water levels outside the production zone.

Impacts from groundwater–surface water interaction are primarily attributed to groundwater-related activities, including groundwater withdrawal and injection. Surface water bodies that are connected to and replenished by surficial and confined aquifers could consequently be affected. Because of the connectivity of the aquifer and the surface water bodies, the lowering of the water table could reduce or prevent the replenishment of the water bodies by the aquifers, thereby reducing the flow of the affected seeps, springs, and streams. The magnitude and the areal extent of the impact will depend on the drop or rise of the water level, the areal extent of the zone of influence, and seasonal factors. During low-flow periods, many seeps, springs, and streams in the study areas rely on groundwater discharge.

The surface water quality near an injection well may be adversely affected if the injection zone is hydraulically connected to a surface water body. During the dewatering operations, water from the lower aquifer will be mixed with the water from the upper aquifer. Because the water quality of the deeper aquifer is typically lower than that of the upper aquifer, the mixed water will result in decreased water quality compared with the water of the upper aquifer as well as the surface water bodies. The reinjection could, therefore, decrease the quality of hydraulically connected surface water through groundwater discharge at seeps and springs.

Once RD&D activities end at the in situ project sites and engineering controls such as the freeze wall are suspended, groundwater will reenter and flow through the retorted zone. Because

the porosity of the source rock in the retorted zone (and the nahcolite and dawsonite mining zone, for the cases in which they are mined) will have been increased by the in situ retorting process, residual hydrocarbons and salts in the source rock may be readily leached and moved by the groundwater. The retorted zone is likely to become a potential subsurface contamination source for hydrocarbons, various kinds of salts, and metals. Any downgradient groundwater users would, therefore, have decreased water quality. If the contaminated groundwater is discharged to surface water bodies directly or through seeps and springs, the quality of the surface water will be adversely affected. If the underground injection method is used to dispose of "rinse" water from the retorted zones (e.g., the EGL site or Shell's ICP sites in Colorado), the injection will cause environmental impacts similar to those described above. The magnitude of the impacts on groundwater and surface water will depend on the injection rate, locations of the injection wells, and the target geologic formation. Reinjection of groundwater and treated process water will be done under permits managed by the affected States. Both the standards for treatment for reinjected water and/or designation of the aquifer into which injection will be permitted would minimize the potential for adverse effect on uses down gradient from the reinjection sites.

Retention ponds will be used in all RD&D sites to capture runoff from the sites and to minimize sediment input to surface streams. Discharge of captured runoff to surface water bodies will be managed through stormwater management plans and NPDES permits. The impacts of the discharge on the surface water quality should be minor.

The water sources for the six RD&D sites vary. At the Chevron and EGL sites, water use will be limited because of using in situ combustion technologies. Water will be trucked in or derived from on-site groundwater sources. Process wastewater will be trucked off-site or placed in evaporation ponds for disposal. The water use is not likely to cause significant impact on water resources. At Shell's ICP sites, water for drilling, dust control, soil compaction, and drinking will be trucked in. During the operation and reclamation phase, groundwater and treated process water will be used. The amount of water to be consumed is unlikely to affect the groundwater resource. At the OSEC site, water used in Phases 1 and 2 will be trucked in. In Phase 3, groundwater from the alluvial aquifer connected to the White River is likely to be used. The amount of water to be withdrawn is small relative to the streamflow of the river so that the impact on the White River will be insignificant.

#### 6.1.1.5 Air Quality

Construction and operation activities associated with each of the RD&D projects have the potential to affect local air quality as a result of PM releases generated during construction activities (e.g., clearing and grading of facility areas, shale excavation, operation of graders and dump trucks), as well as exhaust gases ($SO_2$, CO, $NO_x$) from construction equipment, while operational releases (e.g., smokestack emissions from processing activities) have the potential to affect regional air quality. The EAs prepared for the RD&D projects (BLM 2006a,c,e; 2007a) identified proposed construction and operations activities, quantified potential air pollutant emissions levels, predicted potential air quality impacts using atmospheric dispersion modeling methods, and compared potential impacts with appropriate significance threshold levels. The air

quality analyses presented in the EAs indicate that no significant adverse direct, or cumulative air quality impacts are likely to occur.

#### 6.1.1.6 Noise

Ambient noise levels may be affected as a result of RD&D activities at the six project sites during the construction and operations phases. The EAs prepared for the RD&D projects (BLM 2006a–c; 2007) provide some quantification of the expected noise levels and, along with the FONSIs, identify measures that will be taken to mitigate noise impacts. Specifically, at the five in situ projects in Colorado, noise impacts could occur as a result of construction activities (e.g., clearing, excavation, grading, paving, building construction); drilling wells; use of pumps, generators, and transformers; flaring; vehicular traffic; and, at the EGL project site, use of a steam boiler. No sensitive human receptors are located within 0.5 mi of the Chevron and Shell project sites and 1 mi of the EGL project site. At OSEC's underground mine and surface retort project in Utah, noise impacts could occur as a result of construction activities; mining activities; use of a crusher and conveyor belt system, operation of a horizontal rotary kiln; use of pumps, generators, and transformers; and vehicular traffic.

#### 6.1.1.7 Ecological Resources

**6.1.1.7.1 Aquatic Resources.** Aquatic habitats and organisms that occur in the vicinity of the six RD&D projects are described in Section 3.7.1. The potential impacts on aquatic resources discussed in Section 4.8.1.1 potentially could occur at each of the RD&D project sites, although the magnitude of the impacts will be less than those discussed for commercial operations. These impacts result from increased turbidity and sedimentation, changes to water table levels, groundwater quality degradation, release of toxic substances to surface water, and increased public access to aquatic habitats.

No perennial streams occur immediately within the 160-acre tracts where the RD&D projects are to be located. Within the Uinta Basin, the White River (perennial) and Evacuation Creek (intermittent tributary of the White River) are located more than 0.75 mi from the OSEC project area. The five RD&D projects planned within the Piceance Basin are located 0.25 mi or more from the nearest perennial water bodies (Hunter Creek, Black Sulphur Creek, Corral Gulch, Ryan Gulch, and Willow Creek). A combined ROW for a power line, communication lines, and a natural gas pipeline will be constructed across Hunter Creek as part of the Chevron RD&D Project, while no such stream crossings are included as part of the remaining RD&D projects within the Piceance Basin. While portions of Black Sulphur Creek may have habitat suitable for cutthroat trout, such areas are located upstream from the proposed RD&D sites, and no erosion or sedimentation impacts on cutthroat trout habitats is anticipated under Alternative A. The use of mitigation measures identified in the EAs and FONSIs, including erosion control practices, dust suppression techniques, limiting of the length of time for completing stream crossings, use of horizontal directional drilling to install pipelines under perennial streambeds, and restoration of disturbed areas upon project completion, will greatly reduce or eliminate the potential for

effects on aquatic habitats and species from erosion or sedimentation. The relatively small amount of land surface affected (160 acres per project) further reduces the potential for large amounts of erosion or sedimentation to occur in specific watersheds.

Any changes in the elevation of the water table or in the quality of discharged groundwater that occur as a result of RD&D operations could negatively affect nearby aquatic habitats and the species they support. Dewatering activities could result in drawdown of surrounding water tables, while reinjection of water could result in localized increases in the elevation of the water table. Preliminary groundwater modeling results for the Shell RD&D sites indicate that up to 1 ft of aquifer drawdown could extend for up to 2 mi from the dewatering well locations in the Piceance Basin. It is anticipated that such a drawdown will have a relatively minor effect on water quantity in nearby perennial streams. Very small amounts of depletion are expected (about 19 ac-ft/yr at each of the three Shell test sites), and during some phases of operations an increase in flow may be realized. No depletions are expected for the EGL or Chevron projects. It is anticipated that dewatering or recharge at well sites associated with the RD&D projects under Alternative A will have minor effects on water quantity in perennial stream habitats.

Dewatering and reinjection wells have a potential to inadvertently allow connection between aquifers with differing water quality parameters (Section 4.5). In addition, groundwater passing through the retorted zone associated with in situ oil shale operations could pick up residual hydrocarbons, various salts, and metals and discharge this contaminated water into nearby stream systems (Section 4.5). Depending upon the level of changes to water quality or the concentrations of specific contaminants, aquatic organisms in receiving streams could be adversely affected. The potential for impacts from contaminated groundwater could be mitigated, in some cases, by pumping water out of the retorted zone and treating it before reinjecting it into the portion of the aquifer located downgradient of the retorted zone. This approach is proposed for the EGL RD&D site in the Piceance Basin, and impacts on aquatic organisms are expected to be minor, assuming that well locations, treatment procedures, and withdrawal and reinjection rates are properly selected. Similar treatment operations have not been proposed for the remaining RD&D sites in the Piceance Basin, and it is anticipated that some impacts on aquatic organisms could occur at these remaining locations. In situ retorting will not occur in the Uinta Oil Shale Basin under Alternative A. Rather, surface retorting will be implemented, and spent oil shale will be disposed of either off-site or in an engineered surface impoundment that will be designed to prevent off-site discharge of contaminated runoff. Contaminated water will be temporarily stored in aboveground storage tanks prior to being sent off-site for treatment and disposal.

A potential exists for toxic materials (e.g., fuel, lubricants, and herbicides) to be accidentally introduced into waterways during construction and maintenance activities or as the result of leaks or spills from pipelines and on-site fuel and material storage areas. The mitigation measures identified in the EAs and FONSIs will effectively minimize the risk for such releases and resulting impacts.

In addition to the potential for the direct impacts identified above, indirect impacts on fisheries could occur as a result of increased public access to remote areas via newly constructed access roads and utility corridors. However, given the limited development of facilities that could increase human access under Alternative A, it is anticipated that impacts on fishery resources from increased access will be minor.

**6.1.1.7.2 Plant Communities and Habitats.** Impacts on vegetation, wetlands and riparian areas, and ephemeral streams will vary between the RD&D project sites. On the Chevron site, about 100 acres of sagebrush steppe community will be cleared. The sagebrush steppe at this site is composed of Wyoming big sagebrush and associated shrubs, herbaceous species, and scattered pinyon pine and juniper. The impacts will extend throughout the duration of the project, with the cleared area remaining unvegetated for up to 10 years. Following site reclamation, herbaceous vegetation will likely become reestablished in 1 to 2 years, while sagebrush will take about 20 years to return and pinyon at least 50 years. Indirect impacts could include increased soil erosion and the invasion of noxious weeds, invasive, or non-native species, which could reduce restoration success, introduce invasive species into nearby undisturbed areas, and reduce biodiversity, with the decline and possible eventual replacement of native species by non-natives. In addition, the replacement of native species by noxious weeds could result in an increase in the intensity and frequency of fires and a change in soil nutrient regimes. Plant community structure could also be impacted by creating, eliminating, or changing the density of vegetation layers or canopy cover. No wetlands or riparian areas occur on the Chevron RD&D project site. However, the ROW for the electric transmission line, communications lines, and natural gas pipeline will cross approximately 0.1 mi of Hunter Creek, a perennial stream, resulting in disturbance of the wetland and riparian vegetation communities along Hunter Creek, including mature pinyon-juniper woodland. Herbaceous species will likely become reestablished in 1 to 3 years; however, the loss of pinyon-juniper woodland will be a long-term impact. Indirect impacts could include lower recruitment of native species resulting from mixing of topsoil and subsoil, alteration of the hydrology of the wetland and riparian areas, inhibition of seed germination, and an increase in the potential for siltation due to soil compaction and rutting.

At the EGL RD&D project site, up to 35 acres will be cleared of vegetation, with an additional acre cleared along the utility ROW. A total of 28 acres of sagebrush shrubland and 8 acres of pinyon-juniper woodland will be removed. Some vegetation, primarily grasses and small shrub species, will be allowed to reestablish on portions of the site during operations. Pinyon-juniper woodland, however, will be lost until reclamation of the site is completed. Restoration of vegetation communities similar to those existing on the sites will likely require 1 to 2 years for herbaceous vegetation, 20 to 75 years for big sagebrush communities, and 100 to 300 years for pinyon-juniper woodland. Potential indirect impacts from vegetation removal could include increased soil erosion and the invasion of noxious weeds and non-native plant species. Effects of the invasion of noxious weeds and non-native species could include the decline and possible eventual replacement of native species by non-natives, increased soil erosion, and reduction or fragmentation of habitat. The EGL RD&D project site does not contain wetlands or riparian areas, and no wetlands will be permanently filled or drained as a result of proposed construction activities. Dewatering and reinjection of formation groundwater will be conducted during operation of the EGL project and could possibly affect groundwater

fluctuations or discharges to surface water in the vicinity. Wetland and riparian areas along Black Sulphur Creek, a perennial stream, or Ryan Gulch, an intermittent stream, located 1 and 2 mi from the site, respectively, could be indirectly affected if they are hydrologically connected with the groundwater units involved and if changes in groundwater levels or discharges to surface water occur.

The majority of the vegetation on the three Shell RD&D project sites will be cleared. Potential indirect impacts from vegetation removal may include increased soil erosion, invasion of noxious weeds and non-native plant species, habitat fragmentation, and generation of fugitive dust. Effects of invasion of noxious weeds and non-native species could include reduced biodiversity, with the decline and possible eventual replacement of native species by non-natives. Plant community structure could also be impacted by creating, eliminating, or changing the density of vegetation layers or canopy cover. Replacement of native species by noxious weeds could also result in an increase in the frequency and intensity of fires and a change in soil nutrient regimes. Impacts on vegetation will extend throughout the duration of the Shell projects, including the reclamation phase, covering a period of 20 years or longer. Restoration of vegetation communities similar to those existing on the sites will require 1 to 2 years for herbaceous vegetation, 20 to 75 years for big sagebrush communities, and 100 to 300 years for pinyon-juniper woodland.

On Shell Site 1, 80% of the vegetation will be cleared for construction and operations; vegetation not cleared will be lightly disturbed. Approximately 96 acres of pinyon-juniper woodland, 49 acres of upland sagebrush shrubland, and 2 acres of bottomland sagebrush shrubland will be cleared. Thirteen acres of the site were previously impacted by the construction of well pads and associated access roads. Construction of the site access road will also impact upland sagebrush shrubland and pinyon-juniper woodland. About 110 acres will be cleared on Shell Site 2. Fifty acres of the site were previously disturbed and will not be used for in situ testing. Vegetation clearing will primarily impact upland sagebrush shrubland composed of Wyoming big sagebrush and associated shrubs and grasses, and will include 85 acres of shrubland with mixed pinyon pine and Utah juniper, 23 acres of shrubland, and 2 acres of pinyon-juniper woodland. Vegetation on 75% of Shell Site 3 will be removed; vegetation not cleared will be lightly disturbed. Vegetation clearing will impact approximately 103 acres of upland sagebrush shrubland, 48 acres of pinyon-juniper woodland, and 9 acres of bottomland sagebrush shrubland.

No wetlands or riparian habitats occur on the three Shell project sites or proposed routes for access roads. No streams were identified on Shell Test Site 1. On Test Site 2, approximately 2,000 ft of intermittent stream channels are present and could be impacted by construction and operation activities associated with the project. These streams are tributaries of Stake Springs Draw, an intermittent stream with segments of perennial flow in association with springs and seeps. About 2,100 ft of an intermittent stream, a tributary of Big Duck Creek, is located on Site 3 and could be impacted by project activities. About 1,200 ft of the stream channel will be located in the immediate area of major facilities.

At the OSEC project site in Utah, in addition to development of the site, ROWs for an access road, transmission line, and pipeline will be constructed. Vegetation on the site and along

the ROWs includes sagebrush shrubland, pinyon-juniper shrubland, greasewood flats, saltbush shrublands, and grassland communities with scattered shrubs. Approximately 134 acres of upland habitat will be disturbed by activities associated with the project. The greatest impact (63%) will occur in big sagebrush shrubland. Approximately 82 acres of the 160-acre site have been previously disturbed by development of an underground mining operation and surface storage of mined shale. No wetlands or riparian areas occur on the OSEC site; however, ephemeral streams are present. The proposed electric transmission line and pipeline routes will cross the White River, a perennial stream, as well as a number of ephemeral streams. The transmission line will also cross Evacuation Creek, an intermittent stream. Riparian and wetland areas occur along the White River and Evacuation Creek at the crossing locations. Wetlands and riparian areas will be avoided to the extent practicable; however, impacts on riparian habitat near the water supply wells will occur. The transmission line and pipeline will cross the White River 100-year floodplain, and the water supply wells will be located near the White River, within the 100-year floodplain. Cottonwood, Russian olive, and tamarisk are common species in White River riparian areas.

**6.1.1.7.3 Wildlife.** The types of impacts on wildlife that can occur from construction, operation, and maintenance associated with oil shale leasing are presented in Section 4.8.1.3. At each of the six RD&D sites, the majority of the wildlife habitat will be initially eliminated (i.e., by vegetation clearing): 100 acres at the Chevron site; 36 acres at the EGL site; 160 acres at Shell Site 1, including 13 acres that were previously impacted by construction of well pads and associated access roads; 110 acres at Shell Site 2; 160 acres at Shell Site 3; and 100 acres at the OSEC site, of which 82 acres were previously disturbed by underground mining and surface storage of mined shale. Section 6.1.1.7.2 describes the types of habitats that will be impacted at each RD&D project. Generally, the habitats present include pinyon-juniper woodlands, sagebrush shrublands, and disturbed/grassland areas.

Construction will impact 160 acres and 36 acres of elk and mule deer year-round, summer, and winter ranges at the Chevron and EGL RD&D project sites, respectively. Construction and operation of the Shell Sites 1 and 2 will each result in the loss and fragmentation of 160 acres of mule deer winter range and elk summer and winter ranges, while Shell Site 3 is within the year-round range for both species. At the OSEC site, construction will impact 100 acres of mule deer winter and year-round ranges. Construction of Shell Sites 1 and 3 will eliminate 320 acres of land within the Piceance/East Douglas HMA for wild horses. This will result in a minimal loss of forage and cover for the herd (i.e., 0.2% of the HMA).

The relatively small amount of land surface affected at each RD&D site (up to 160 acres per project plus the area encompassed by access roads and corridors) reduces the potential for population-level impacts for any wildlife species. For example, for the Chevron RD&D project, nearly 7.9 acres will be disturbed for the combined power, communications, and gas pipeline ROW. The 1,750-ft-long, 25-ft-wide ROW for the EGL project will disturb at least 1 acre of habitat outside the 160-acre tract boundary. This assumes that only the 25-ft-wide corridor will be disturbed during construction. However, construction disturbance usually occurs within an area wider than the final ROW by about 50 to 100%; therefore, construction may end up disturbing about 2 acres of habitat. For the OSEC project, an additional 100 acres will be

disturbed to accommodate the required access road and electric power, gas, and water ROWs. Specified limits on surface disturbance will be applied for big game parturition areas, raptor nesting areas, and greater sage-grouse winter concentration areas and leks. Construction restrictions (e.g., buffer zones and seasonal restrictions) will lessen the potential for inadvertent loss of migratory bird nests during the avian breeding season.

The time required for the restoration of original wildlife habitats impacted by the RD&D projects will depend on the type of vegetation communities present at the time of disturbance. For example, 1 to 2 years will be required for herbaceous vegetation, 20 to 75 years for big sagebrush communities, and 100 to 300 years for pinyon-juniper woodlands.

**6.1.1.7.4 Threatened and Endangered Species.** The six RD&D project EAs include descriptions of anticipated impacts on federally listed and state-listed threatened and endangered species as well as BLM-designated sensitive species. Protected species that occur in these two counties and that could occur on or adjacent to project areas are presented in Tables 6.1.1-1 and 6.1.1-2. Habitats typically occupied by these species are presented in Table E-1 of Appendix E.

Activities at each of the RD&D project sites have the potential to affect listed species. Land clearing and construction activities on each project site will remove potentially suitable habitat for listed plant and animal species. Any plants present within the project areas will be destroyed. Plants adjacent to project areas could be affected by runoff from the site either through erosion of occupied areas or sedimentation and burial of individual plants or habitats. In addition, fugitive dust from site activities could accumulate in adjacent areas occupied by listed plants. Dust that accumulates on leaf surfaces can reduce photosynthesis and subsequently affect plant vigor. Disturbed areas could be colonized by non-native invasive plant species.

Larger, more mobile animals such as birds and medium-sized or large mammals will be most likely to leave the project area during site preparation, construction, and other project activities. Development of the site will represent a loss of habitat for these species and potentially a reduction in carrying capacity in the area. Smaller animals such as small mammals, lizards, snakes, and amphibians are more likely to be killed during clearing and construction activities. If land clearing and construction activities occur during the spring and summer, bird nests and nestlings in the project area could be destroyed.

Operations could affect protected plants and animals as well. Animals in and adjacent to project areas will be disturbed by human activities and will tend to avoid the area while activities are occurring. Site lighting and operational noise from equipment will affect animals on and off the site, resulting in avoidance or reduction in use of an area larger than the project footprint. Runoff from the site during site operations could result in erosion and sedimentation of adjacent habitats occupied by plants. Fugitive dust during operations could affect adjacent plant populations.

For all of these potential impacts, the use of the mitigation measures identified in the EAs and FONSIs, including predisturbance surveys to locate protected plant and animal populations in the area, erosion control practices, dust suppression techniques, establishment of buffer areas

**TABLE 6.1.1-1 Potential Effects on State-Listed Threatened and Endangered Species and Species of Special Concern, Federal Candidates for Listing, and BLM-Designated Sensitive Species under the No Action Alternative**

| Common Name | Scientific Name | Status[a] | Project Areas within Species Range[b] | Potential Effect[c] |
|---|---|---|---|---|
| ***Plants*** | | | | |
| Caespitose cat's-eye | *Cryptantha caespitosa* | BLM-S | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in all project areas. |
| Debris milkvetch | *Astragalus detritalis* | BLM-S | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in OSEC project area. No known occurrences within Piceance Basin; therefore, unlikely to occur in Shell, EGL, or Chevron project areas. |
| Ephedra buckwheat | *Eriogonum ephedroides* | BLM-S | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in OSEC project area. No known occurrences within Piceance Basin; therefore, unlikely to occur in Shell, EGL, or Chevron project areas. |
| Jones blue star | *Amsonia jonesii* | BLM-S | OSEC | **Potential for negative impact.** Possible occurrence in OSEC project area. |
| Ligulate feverfew | *Parthenium ligulatum* | BLM-S | Shell (3), EGL, Chevron | **Potential for negative impact.** Possible occurrence in Shell, EGL, and Chevron project areas. |
| Narrow-stem gilia | *Gilia stenothyrsa* | BLM-S | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in all project areas. |
| Northern twayblade | *Listera borealis* | BLM-S | OSEC | **No impact.** Suitable habitat does not exist in the project area. |
| Nuttall sandwort | *Minuartia nuttallii* | BLM-S | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in all project areas. |
| Piceance bladderpod | *Lesquerella parviflora* | BLM-S | Shell (3), EGL, Chevron | **Potential for negative impact.** Possible occurrence in Shell, EGL, and Chevron project areas. |

**TABLE 6.1.1-1 (Cont.)**

| Common Name | Scientific Name | Status[a] | Project Areas within Species Range[b] | Potential Effect[c] |
|---|---|---|---|---|
| ***Plants (Cont.)*** | | | | |
| Rollins' cat's-eye | *Cryptantha rollinsii* | BLM-S | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in OSEC project area. No known occurrences within Piceance Basin; therefore, unlikely to occur in Shell, EGL, or Chevron project areas. |
| Strigose Easter-daisy | *Townsendia strigosa* | BLM-S | OSEC | **Potential for negative impact.** Possible occurrence in OSEC project area. |
| Uinta Basin spring-parsley | *Cymopterus duchesnensis* | BLM-S | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in all project areas. |
| Utah gentian | *Gentianella tortuosa* | BLM-S | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in Shell, EGL, and Chevron project areas. Suitable habitat does not exist in OSEC project area. |
| White River beardtongue | *Penstemon scariosus* var. *albifluvis* | ESA-C | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in OSEC project area. No known occurrences within Piceance Basin; therefore, unlikely to occur in Shell, EGL, or Chevron project areas. |
| ***Invertebrates*** | | | | |
| Great Basin silverspot butterfly | *Speyeria nokomis Nokomis* | BLM-S | OSEC | **No impact.** Suitable habitat not present in project area. |
| ***Fish*** | | | | |
| Colorado River cutthroat trout | *Oncorhynchus clarkia pleuriticus* | BLM-S; CO-SC | Shell (3), EGL, Chevron, OSEC | **No impact.** Suitable habitat not present in project areas. |
| Flannelmouth sucker | *Catostomus latipinnis* | BLM-S | OSEC | **Potential for negative impact.** Occurs in White River near utility line crossing for OSEC project area. |

**TABLE 6.1.1-1 (Cont.)**

| Common Name | Scientific Name | Status[a] | Project Areas within Species Range[b] | Potential Effect[c] |
|---|---|---|---|---|
| ***Fish (Cont.)*** | | | | |
| Roundtail chub | *Gila robusta* | BLM-S; CO-SC | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Suitable habitat not present in Shell, EGL, or Chevron project areas. Occurs in White River crossed by OSEC utilities. |
| ***Amphibians*** | | | | |
| Boreal toad | *Bufo boreas* | BLM-S; CO-E | Shell (3), EGL, Chevron | **No impact.** Suitable habitat not present in project areas. |
| Great basin spadefoot | *Spea intermontana* | BLM-S | Shell (3), EGL, Chevron | **Potential for negative impact.** Suitable habitat present in Shell and Chevron project areas. Suitable habitat does not exist in EGL project area. |
| Northern leopard frog | *Rana pipiens* | BLM-S | OSEC | **No impact.** Suitable habitat does not exist in project area. |
| ***Reptiles*** | | | | |
| Longnose leopard lizard | *Gambelia wislizenii* | BLM-S; CO-SC | Shell (3), EGL, Chevron | **Potential for negative impact.** Possible occurrence in Shell, EGL, and Chevron project areas. |
| Midget faded rattlesnake | *Crotalus oreganus concolor* | BLM-S; CO-SC | Shell (3), EGL, Chevron | **Potential for negative impact.** Suitable habitat present in Shell, EGL, and Chevron project areas. |
| Smooth greensnake | *Liochlorophis vernalis* | UT-SC | OSEC | **Potential for negative impact.** Possible occurrence along White River crossed by OSEC utilities. |
| ***Birds*** | | | | |
| American peregrine falcon | *Falco peregrinus anatum* | BLM-S; CO-SC | Shell (3), EGL, Chevron | **Potential for negative impact.** May forage in Shell, EGL, and Chevron project areas. |
| American white pelican | *Pelecanus erythrorhynchos* | BLM-S; UT-SC | OSEC | **Potential for negative impact.** Possible occurrence along White River crossed by OSEC utilities. |
| Bald eagle | Haliaeetus leucocephalus | NL | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** May forage in project areas. May roost and forage along White River crossed by OSEC utilities. |

**TABLE 6.1.1-1 (Cont.)**

| Common Name | Scientific Name | Status[a] | Project Areas within Species Range[b] | Potential Effect[c] |
|---|---|---|---|---|
| ***Birds (Cont.)*** | | | | |
| Barrow's goldeneye | *Bucephala islandica* | BLM-S | Shell (3), EGL, Chevron | **No impact.** Suitable habitat not present in project areas. |
| Black swift | *Cypseloides niger* | CO-SC; UT-SC | Shell (3), EGL, Chevron, OSEC | **No impact.** May forage over project areas. |
| Bobolink | *Dolichonyx oryzivorus* | UT-SC | OSEC | **No impact.** Suitable habitat not present in project area. |
| Burrowing owl | *Athene cunicularia* | BLM-S; CO-T; UT-SC | Shell (3), EGL, Chevron, OSEC | **No impact.** Suitable habitat not present in project areas. |
| Ferruginous hawk | *Buteo regalis* | BLM-S; CO-SC; UT-SC | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Suitable habitat does not exist in Shell or EGL project areas. Possible occurrence in Chevron and OSEC project areas. |
| Greater sandhill crane | *Grus canadensis tabida* | CO-SC | Shell (3), EGL, Chevron | **No impact.** Suitable habitat does not exist in project areas. |
| Lewis's woodpecker | *Melanerpes lewis* | UT-SC | OSEC | **No impact.** Suitable habitat does not exist in project area. |
| Long-billed curlew | *Numenius americanus* | BLM-S; CO-SC; UT-SC | Shell (3), EGL, Chevron, OSEC | **No impact.** Suitable habitat does not exist in project areas. |
| Mountain plover | *Charadrius montanus* | BLM-S; CO-SC | Shell (3), EGL, Chevron | **Potential for negative impact.** Suitable habitat does not exist in Shell or EGL project areas. Possible occurrence in Chevron project area. |
| Northern goshawk | *Accipiter gentilis* | BLM-S | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Potential occurrence in Shell, EGL, and Chevron project areas. Suitable habitat does not exist in OSEC project area. |
| Sage grouse | *Centrocercus urophasianus* | BLM-S; CO-SC; UT-SC | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in Shell, EGL, and Chevron project areas. Species not present in OSEC project area. |
| Short-eared owl | *Asio flammeus* | UT-SC | OSEC | **Potential for negative impact.** Possible occurrence in OSEC project area. |

**TABLE 6.1.1-1 (Cont.)**

| Common Name | Scientific Name | Status[a] | Project Areas within Species Range[b] | Potential Effect[c] |
|---|---|---|---|---|
| ***Birds (Cont.)*** | | | | |
| Three-toed woodpecker | *Picoides tridactylus* | UT-SC | OSEC | **No impact.** Suitable habitat does not exist in project area. |
| Western yellow-billed cuckoo | *Coccyzus americanus occidentalis* | ESA-C; BLM-S | OSEC | **No impact.** Suitable habitat does not exist in project area. |
| White-faced ibis | *Plegadis chihi* | BLM-S | Shell (3), EGL, Chevron | **No impact.** Suitable habitat not present in project areas. |
| ***Mammals*** | | | | |
| Big free-tailed bat | *Nyctinomops macrotis* | BLM-S; UT-SC | OSEC | **No impact.** Suitable habitat does not exist in project area. |
| Fringed myotis | *Myotis thysanodes* | BLM-S; UT-SC | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in all project areas. |
| Kit fox | *Vulpes macrotis* | CO-E; UT-SC | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in all project areas. |
| Spotted bat | *Euderma maculatum* | BLM-S; UT-SC | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in Shell, EGL, and Chevron project areas. |
| Townsend's big-eared bat | *Corynorhinus townsendii pallescens* | BLM-S; CO-SC; UT-SC | Shell (3), EGL, Chevron, OSEC | **Potential for negative impact.** Possible occurrence in all project areas. |
| White-tailed prairie dog | *Cynomys leucurus* | BLM-S; UT-SC | OSEC | **No impact.** Does not occur in project area. |
| Wolverine | *Gulo gulo* | CO-E | Shell (3), EGL, Chevron | **No impact.** Suitable habitat does not exist in project areas. |

[a] Federal listings: BLM-S = listed by the BLM as sensitive; ESA-C = candidate for listing under the ESA. State listings: CO = Colorado, UT = Utah; E = listed as endangered; NL = not listed; T = listed as threatened; SC = listed as species of special concern.

[b] Based on counties in which species has been recorded or could occur.

[c] Based on information provided in BLM (2006a,c,e; 2007a).

**TABLE 6.1.1-2 Potential Effects on Federally Listed Threatened, Endangered, and Proposed Species under the No Action Alternative**

| Common Name | Scientific Name | Status[a] | Project Areas within Species Range[b] | Potential Effect[c] |
|---|---|---|---|---|
| ***Plants*** | | | | |
| Clay reed-mustard | *Schoenocrambe argillacea* | T | OSEC | **No effect.** Suitable habitat does not exist in project area. |
| Dudley Bluffs bladderpod | *Lesquerella congesta* | T | Shell (3), EGL, Chevron | **May adversely affect.** Possible occurrence in Shell, EGL, and Chevron project areas. |
| Dudley Bluffs twinpod | *Physaria obcordata* | T | Shell (3), EGL, Chevron | **May adversely affect.** Possible occurrence in Shell, EGL, and Chevron project areas. |
| Shrubby reed-mustard | *Schoenocrambe suffrutescens* | E | OSEC | **No effect.** Suitable habitat does not exist in the project area. |
| Uinta Basin hookless cactus | *Sclerocactus glaucus* | T | OSEC | **May adversely affect.** Possible occurrence in OSEC project area. |
| Ute ladies'-tresses | *Spiranthes diluvialis* | T | OSEC | **May adversely affect.** Although species does not occur in project area, water depletions from the White River Basin could result in adverse impact. |
| ***Fish*** | | | | |
| Bonytail | *Gila elegans* | E | OSEC | **May adversely affect.** Although species does not occur in project area, water depletions from Colorado River Basin could result in adverse impact. |
| Colorado pikeminnow | *Ptychocheilus lucius* | E | Shell (3), EGL, Chevron, OSEC | **May adversely affect.** Although species does not occur in project area, water depletions from Colorado River Basin (Shell and OSEC projects) could result in adverse impact. |
| Humpback chub | *Gila cypha* | E | OSEC | **May adversely affect.** Although species does not occur in project area, water depletions from Colorado River Basin could result in adverse impact. |
| Razorback sucker | *Xyrauchen texanus* | E | Shell (3), EGL, Chevron, OSEC | **May adversely affect.** Although species does not occur in project area, water depletions from Colorado River Basin (Shell and OSEC projects) could result in adverse impact. |

**TABLE 6.1.1-2 (Cont.)**

| Common Name | Scientific Name | Status[a] | Project Areas within Species Range[b] | Potential Effect[c] |
|---|---|---|---|---|
| ***Birds*** | | | | |
| Mexican spotted owl | *Strix occidentalis lucida* | T | OSEC | **No effect.** Suitable habitat does not exist in project area. |
| Southwestern willow flycatcher | *Empidonax traillii extimus* | E | Shell (3), EGL, Chevron, OSEC | **No effect.** Suitable habitat does not exist in project areas. |
| ***Mammals*** | | | | |
| Black-footed ferret | *Mustela nigripes* | E | Shell (3), EGL, Chevron, OSEC | **No effect.** Suitable habitat does not exist in project areas. |
| Canada lynx | *Lynx Canadensis* | T | Shell (3), EGL, Chevron, OSEC | **No effect.** Suitable habitat does not exist in project areas. |

[a] Listing status: E = listed as endangered under the ESA; T = listed as threatened under the ESA.

[b] Based on counties in which species has been recorded or could occur.

[c] Based on information provided in BLM (2006a,c,e).

around protected populations, and restoration of disturbed areas using native species upon project completion, will greatly reduce or eliminate the potential for effects on protected species. In addition, the relatively small amount of land surface affected (160 acres per project) reduces the possibility for local extinctions of any protected plant or animal species.

Impacts on federally listed threatened and endangered species are considered in greater detail here to address ESA requirements. Federally listed species (including species that are candidates or have been proposed for listing) that are not expected to be affected by the no action alternative because they or their habitats are not present within the RD&D project areas or vicinities include the clay reed-mustard, shrubby reed-mustard, Utah valvata snail, Mexican spotted owl, black-footed ferret, and Canada lynx (Table 6.1.1-2).

Listed plant species (including species that are candidates or have been proposed for listing) that could occur in the R&D project areas and that could be affected by project activities include Dudley Bluffs bladderpod, Dudley Bluffs twinpod, Ute ladies'-tresses, Uinta Basin hookless cactus, and White River beardtongue. On the basis of reviews of soils and habitats present in project areas, it is considered unlikely that any of these species will actually occur within or adjacent to project areas. However, predisturbance surveys for these species will be conducted, and if any individuals are found, protection strategies will be developed in consultation with the USFWS. BLM lease stipulations and mitigation measures adopted by the applicants will serve to greatly reduce the chance of adverse impacts on listed plant species. The Ute ladies'-tresses could occur along the White River. This species is dependent on a high water

table and could be adversely affected by any water depletions from the White River Basin associated with the OSEC project. The amount of water depletion expected for the OSEC project is not expected to have a measurable effect on Ute ladies'-tresses.

Any water depletions from the Upper Colorado River Basin are considered an adverse effect on the endangered Colorado River fishes that exist in the major rivers of the basin. These species include the bonytail, Colorado pikeminnow, humpback chub, and razorback sucker. Operations will not directly affect these fish or their habitats, but pumping of groundwater could have indirect effects. Water will be used in drilling, operational, and reclamation phases of the project. The pumping of groundwater could affect aquifers underlying project areas, which will in turn reduce groundwater discharge to nearby creeks. No depletions are expected for the EGL or Chevron projects. Very small amounts of depletion are expected (about 19 ac-ft/yr at each of the three Shell test sites), and during some phases of operations an increase in flow may be realized.

#### 6.1.1.8 Visual Resources

Under the no action alternative, direct visual impacts associated with construction, operation of the RD&D projects, and subsequent reclamation can be divided into short-term impacts associated with activities that occur during the construction and reclamation phases of the projects, and longer-term impacts that result from construction and operation of the facilities themselves. Major construction activities that will have a visual impact include vegetation clearing; recontouring of landforms; road building and/or upgrading; pad, building, and tank construction; and utility ROW construction. Other construction activities will include digging of drilling reserve pits and possibly retention ponds, construction of berms around some tanks, and the addition of fencing around some or all of the lease sites. These various construction activities will require work crews, vehicles, and equipment that will add to visual impacts during construction. Traffic movement, associated fugitive dust emissions, and temporary parking resulting from workers' vehicles and large equipment (trucks, graders, excavators, and cranes) will also result in visual impacts. Construction equipment might produce emissions and visible exhaust plumes. In addition, piles of building materials as well as brush piles and soil piles, will be visible at times.

Visual impacts from the operation of the various RD&D projects will be associated with vegetation clearing; the presence of the project facilities and associated infrastructure; and the presence and activities of workers, vehicles, and equipment. These impacts will occur to some degree throughout the operational life of the projects, and some impacts might occur beyond the operational life of the projects. Project components and activities that will likely be associated with each of the RD&D projects and that could result in visual impacts include the following:

- Vegetation clearing (ranging between 35 acres and 160 acres cleared, depending on the project) with associated debris;

- Recontouring of landforms;

- New or upgraded roads;
- Pads for structures and or equipment (e.g., well pads);
- Buildings (generally of sheet metal construction), such as offices and laboratories;
- Groundwater monitoring wells;
- Flare stacks;
- Utilities, such as electric transmission lines, pipelines, and communication data lines (with associated rows and structures) within and/or outside the 160-acre lease boundaries depending on the project, and with ROWs 25 to 65 ft in width and up to 1 mi long, depending on the project;
- Communication towers;
- Storage tanks for water, syncrude, fuel, and other liquids associated with oil shale processing;
- Retention ponds and runoff-control structures;
- Earthen berms around some storage tanks;
- Mounds of stored soil;
- Fencing around all or part of the lease site;
- Vehicular, equipment, and worker presence and activity, and associated vegetation and ground disturbances;
- Dust and emissions; and
- Light pollution, resulting from facilities operating at night or from security lighting.

The in situ technology projects also are expected to have extensive numbers of production and injection wells and drilling reserve pits, which could result in visual impacts. Similarly, the OSEC RD&D project involving underground mining with surface retort processes will have additional visual impacts associated with the surface retorts, ore-crushing facilities, spent-shale-handling facilities, processing buildings and associated structures, and piles of raw and spent shale.

Construction activities and the presence of the visible site components described above will introduce contrasts in form, line, color, texture, and a relatively high degree of human

activity into what are generally natural-appearing landscapes (although the OSEC site currently has significant existing visual intrusions from previous development activity). In general, visual impacts associated directly with construction activities will be temporary, but because of the phased nature of the RD&D projects, construction activities will occur several times during the course of the project, giving rise to brief periods of intense construction activity (and associated visual impacts) followed by periods of inactivity. Much of the contrast will be associated with vegetation removal and the presence of buildings and other structures with strong geometric lines, spatial symmetry, and flat, monochromatic surfaces. These man-made industrial facilities will draw visual attention because of their size, color, and shape. Removal of vegetation and recontouring during construction will introduce unnatural-appearing linear features into the landscape and might create contrasting soil and vegetation colors and patterns. Soil scars, exposed slope faces, eroded areas, and areas of compacted soil could result from recontouring and equipment and vehicle movement, and could introduce noticeable color contrasts, depending on soil type. Invasive species might colonize disturbed and stockpiled soils and compacted areas. These species might be introduced naturally; in seeds, plants, or soils introduced for intermediate restoration; or by vehicles. The presence of workers and construction activities could also result in litter and debris that could create negative visual impacts within and around work sites.

The five in situ technology projects are generally similar in nature and extent of the visual impacts that are expected, although the three Shell projects will involve more vegetation clearing than the other in situ projects, prior to exercising of the preferential leases. The Chevron site will be the most prominent in its proposed location on Hunter Ridge adjacent to County Road 69. Because of the presence of a mine and associated buildings and structures, one or more retorts, and raw and spent shale piles, the OSEC project will have somewhat different impacts than the in situ technology projects; it will have more and potentially larger structures and eventually a large spent shale pile, covering 38 acres.

As portions of the RD&D project sites are reclaimed, visual impacts will be similar to those encountered during construction, but likely of shorter duration. Reclamation likely will be an intermittent or phased activity persisting over extended periods of time and will include the presence of workers, vehicles, and temporary fencing at the work site. Restoring an area to preproject conditions could also entail recontouring, grading, scarifying, seeding and planting, and perhaps stabilizing disturbed surfaces, but might not be possible in all cases (i.e., the contours of restored areas might not always be identical to preproject conditions). Newly disturbed soils might create visual contrasts that could persist for several seasons before revegetation will begin to disguise past activity. Invasive species might colonize reclaimed areas, likely producing contrasts of color and texture.

#### 6.1.1.9 Cultural Resources

Adverse impacts on significant cultural resources are possible in association with the RD&D activities, particularly at Shell Site 3 and the OSEC site. Avoidance of the resources and/or additional testing and possible data recovery will be needed to mitigate these impacts.

The 160-acre Chevron lease tract and associated utility line route were surveyed for cultural resources in March and April 2006. No cultural resources were identified, and the potential for subsurface remains is considered low in this area on the basis of results of previous surveys in the area and the north-sloping terrain (Connor 2006a,b). The proposed development of oil shale resources for RD&D activities on the Chevron lease tract will, therefore, not impact any known significant cultural resources.

The 160-acre EGL lease tract and associated utility line route were surveyed for cultural resources in April and May 2006, respectively (Hoefer and Greenberg 2006a,b). Two previously reported prehistoric sites were relocated, and two prehistoric isolated finds were encountered during the survey of the 160-acre lease tract. An isolated find is either a single artifact (that could be broken in several pieces, like a ceramic cup) or a small collection, typically fewer than five items, of the same type of artifact, such as four small pieces of chipped stone flakes. Two additional isolated finds dating to the historic period were encountered during the utility ROW survey. Of the six cultural resource locations identified during the surveys, none meet the eligibility criteria for listing on the NRHP; five of the sites have a field recommendation of "not eligible," and one of the previously recorded sites has an official determination of not eligible. The proposed development of oil shale resources for RD&D activities on the EGL lease tract will, therefore not impact any known significant cultural resources.

The three 160-acre lease tracts that Shell proposes to develop under the RD&D program have all undergone cultural resource surveys. Shell Site 1, the Oil Shale Test Site, was surveyed previously as part of two different surveys in 2004 and 2005. The total acreage previously surveyed was 1,368 acres, and 7 prehistoric sites, 1 historic site, and 10 isolated finds were recorded (Connor et al. 2004, 2005). None of these sites or isolated finds were encountered in the 160-acre lease tract of Site 1. Shell Site 2, the Nahcolite Test Site, was surveyed in 2006, and no cultural resources were recorded (Darnell 2006). The proposed development of oil shale resources for RD&D activities on the Shell Sites 1 and 2 lease tracts will, therefore, not impact any known significant cultural resources.

Shell Site 3, the Advanced Heater Test Site, was surveyed previously in 2001. The total acreage previously surveyed was 3,507 acres, and 9 prehistoric sites, 7 historic sites, and 23 prehistoric isolated finds were encountered (Connor and Davenport 2001). One site, 5RB4296, a prehistoric open camp, is located within the Site 3 lease tract. There are insufficient data regarding the eligibility of the site; therefore the site must be treated as eligible until further testing of the site can be completed. Adverse impacts on this site will occur without the application of mitigation actions. In the Shell EA, it is stated that this site will be avoided, including any necessary erosion control measures, and that conditions of approval will be added to the lease to ensure that the site will be safeguarded until eligibility of the site is determined.

The 160-acre OSEC lease tract has undergone previous land disturbance because it was previously mined for oil shale. In the OSEC EA, it is indicated that 28 separate cultural resource investigations have been conducted in the vicinity of the lease tract. The initial archaeological survey of the area was conducted in 1975 for oil shale lease areas Ua and Ub. The total acreage previously surveyed was 27,200 acres (Berry and Berry 1975). No additional survey of the lease tract was conducted for the RD&D activities specifically. On the basis of the results of previous

surveys, 5 prehistoric sites and 1 historic site have been determined to be located within areas affected by the proposed development. None of these sites have been evaluated for eligibility and they must be treated as eligible until a determination of eligibility is made. Adverse impacts on these sites will occur without the application of mitigation actions. In addition, a survey was completed for the associated utility line route in June 2006 to supplement coverage of the corridor by previous surveys. During this survey, eight isolated finds were recorded, none of which are eligible for listing on the NRHP. However, of the sites recorded in the previous surveys covering the corridor, ten prehistoric and historic sites and seven isolated finds are located within the area of the proposed utility ROW. Two sites within the area of potential impact have been determined eligible for listing on the NRHP, and four sites do not have sufficient data to determine their eligibility status. The remaining four sites and the seven isolated finds have been recommended not eligible. On the basis of data presented in the EA, 3 of the sites with undetermined eligibility are possibly located outside of the ROW and will, therefore, not be impacted by the present proposed configuration of the utility line. However, the two eligible sites and at least one site with undetermined eligibility will be adversely impacted. It is stated in the EA that the applicant will avoid these sites during construction, if possible. Mitigation measures identified in the EA also include additional archaeological investigation when sites cannot be avoided.

It is recognized in each of the EAs that responsibility for protecting cultural resources does not end with the cultural resources surveys identified above. In the event that unanticipated cultural resources are discovered during development activities, the potential impact on these resources will need to be mitigated by stopping work and contacting the BLM Authorized Officer immediately for further instruction prior to proceeding. If human remains are encountered during project operations, the BLM Authorized Officer must be notified by telephone with written confirmation immediately upon the discovery. All activities must stop in the vicinity of the discovery, and the discovery must be protected for 30 days or until the operator is notified to proceed by the BLM Authorized Officer. Pursuant to 43 CFR 10.4, this process must be followed upon the discovery of Native American human remains, funerary items, sacred objects, or objects of cultural patrimony. All employees of the operator and any subcontractors must be informed by the operator before commencement of operations that any disturbance to, defacement of, or removal of archaeological, historical, or sacred material will not be permitted. Violation of the laws that protect these resources will be treated as law enforcement/administrative issues. The operator will be held accountable for the conduct of employees and subcontractors in this regard.

#### 6.1.1.10 Socioeconomics

**6.1.1.10.1 Projections.** In addition to analysis of impacts under the no action alternative, this section includes projected baseline data for a number of economic and social variables used in the analysis of impacts under each alternative, namely, employment, personal income, population, housing, and fiscal conditions. Projections are presented for 2009, 2012, 2016, 2022, and 2027, the years likely to produce the largest impacts associated with construction and commercial operation of oil shale and tar sands facilities.

***Employment.*** Wage and salary employment projections based on county population forecasts indicate that employment will grow at a relatively modest pace in each ROI from 2004 through 2027 (Table 6.1.1-3). In the Colorado ROI, employment is expected to reach 171,200 by 2027, with an average annual growth rate of 2.6%, while employment in the state is expected to grow at 0.9% over the same period. In the Utah ROI, a growth rate of 0.9% is expected over the 2004 through 2027 period, with growth in state employment higher at 1.4%. At these rates, by 2027, employment is expected to reach approximately 53,900 in the Utah ROI. Employment is expected to stand at about 53,900 in the Wyoming ROI in 2027.

***Personal Income.*** On the basis of ROI county population projections, by 2027, personal income is expected to reach $12.0 billion in the Colorado ROI, $2.9 billion in the Utah ROI, and $3.5 billion in the Wyoming ROI (Table 6.1.1-4).

***Population.*** County and state projections indicate that population will grow at a relatively modest rate in the Colorado and Utah ROIs between 2000 and 2027. In the Colorado ROI, population is expected to reach 416,120 by 2027 at an average annual growth rate of 2.6%, while population in the Utah ROI is expected to reach 124,383 by 2027, growing at an annual rate of 0.9% over the period 2000 through 2027. In Wyoming, relatively low annual growth rates are expected in the ROI (0.8%) between 2000 and 2027, with population expected to stand at 105,925 in 2027. Fairly rapid annual population growth is expected in Utah as a whole (3.0%), with lower annual rates of growth expected for Colorado (1.7%) and Wyoming (0.8%) (Table 6.1.1-5).

**TABLE 6.1.1-3 ROI Total Employment[a]**

| | Year | | | | | |
|---|---|---|---|---|---|---|
| Parameter | 2004 | 2009 | 2012 | 2016 | 2022 | 2027 |
| ***Colorado ROI*** | 97,755 | 110,382 | 118,739 | 130,887 | 151,510 | 171,189 |
| Colorado | 2,317,759 | 2,545,143 | 2,692,146 | 2,901,442 | 3,246,285 | 3,564,763 |
| ***Utah ROI*** | 42,318 | 44,585 | 46,008 | 47,984 | 51,122 | 53,909 |
| Utah | 1,165,695 | 1,272,576 | 1,341,353 | 1,438,872 | 1,598,604 | 1,745,178 |
| ***Wyoming ROI*** | 45,101 | 48,472 | 49,712 | 50,795 | 52,414 | 53,910 |
| Wyoming | 269,651 | 285,020 | 292,200 | 300,462 | 313,013 | 324,141 |

[a] Projections for Wyoming are based on forecasted growth rates in population for the ROI and state.

Sources: U.S. Bureau of the Census (2006d); Colorado State Demography Office (2007); Utah Governor's Office of Planning and Budget (2007); U.S. Department of Commerce (2007).

**TABLE 6.1.1-4 ROI and State Personal Income ($ billions 2005)[a]**

| | Year | | | | | |
|---|---|---|---|---|---|---|
| Parameter | 2004 | 2009 | 2012 | 2016 | 2022 | 2027 |
| ***Colorado ROI*** | 6.5 | 7.4 | 8.0 | 9.1 | 10.7 | 12.0 |
| Colorado | 177.9 | 195.3 | 207.0 | 223.0 | 247.2 | 267.4 |
| ***Utah ROI*** | 2.3 | 2.4 | 2.5 | 2.6 | 2.7 | 2.9 |
| Utah | 68.9 | 77.3 | 85.9 | 100.4 | 120.6 | 138.8 |
| ***Wyoming ROI*** | 2.9 | 3.2 | 3.2 | 3.3 | 3.4 | 3.5 |
| Wyoming | 18.6 | 19.6 | 20.1 | 20.7 | 21.5 | 22.3 |

[a] Projections are based on forecasted growth rates in population for each ROI and state.

Sources: U.S. Department of Commerce (2006); U.S. Bureau of the Census (2006d); Colorado State Demography Office (2007); Utah Governor's Office of Planning and Budget (2007).

**TABLE 6.1.1-5 ROI Population[a]**

| | Year | | | | | |
|---|---|---|---|---|---|---|
| Parameter | 2000 | 2009 | 2012 | 2016 | 2022 | 2027 |
| ***Colorado ROI*** | 207,050 | 255,815 | 279,194 | 314,582 | 370,492 | 416,120 |
| Colorado | 4,301,261 | 5,109,928 | 5,414,641 | 5,835,139 | 6,467,978 | 6,995,491 |
| ***Utah ROI*** | 101,019 | 103,123 | 105,796 | 110,409 | 117,785 | 124,383 |
| Utah | 2,233,169 | 2,769,656 | 3,078,370 | 3,598,737 | 4,322,043 | 4,972,573 |
| ***Wyoming ROI*** | 87,567 | 94,900 | 97,350 | 99,550 | 102,858 | 105,925 |
| Wyoming | 493,782 | 534,720 | 548,190 | 563,690 | 587,238 | 608,115 |

[a] Projections are based on forecasted growth rates in population for each of the states and for each ROI county.

Sources: U.S. Bureau of the Census (2006c,d); Colorado State Demography Office (2007); Utah Governor's Office of Planning and Budget (2007); Wyoming Department of Administration and Information (2006).

***Housing.*** On the basis of ROI county population forecasts, the number of housing units in the Colorado ROI is expected to reach 177,190 in 2027. Of the total number of units, 16,088 housing units are expected to be vacant in the ROI in 2027, of which 4,632 are expected to be rental units. In the Utah ROI, the number of housing units is expected to reach 52,913 in 2027 (Table 6.1.1-6). The number of vacant housing units expected in the county in 2027 is 11,556, of which 2,337 are expected to be rental units. In the Wyoming ROI, the number of housing units is expected to reach 47,176 in 2027. Of these, 8,147 are expected to be vacant housing units in the county in 2027, of which 1,969 are expected to be rental units.

***Fiscal Conditions.*** On the Colorado ROI, public service expenditures are expected to reach $751.4 million by 2027 at an average annual growth rate of 2.6%, while public service expenditures in the Utah ROI are expected to reach $264.3 million by 2027, growing at an annual rate of 0.9% over the period 2000 through 2027. In Wyoming, relatively low annual growth rates are expected in the ROI (0.8%) between 2000 and 2027, with expenditures expected to stand at $319.0 million in 2027. Fairly rapid public service expenditure growth is expected in Utah as a whole (3.0%), with lower annual rates of growth expected for Colorado (1.7%) and Wyoming (0.8%) (Table 6.1.1-7).

**TABLE 6.1.1-6 State and ROI Housing Characteristics[a]**

| | Year | | | | | |
|---|---|---|---|---|---|---|
| Parameter | 2000 | 2009 | 2012 | 2016 | 2022 | 2027 |
| ***Colorado ROI*** | | | | | | |
| Owner-occupied | 57,685 | 71,026 | 77,345 | 86,931 | 102,097 | 114,535 |
| Rental | 22,714 | 28,209 | 30,874 | 34,895 | 41,237 | 46,386 |
| Vacant units | 6,228 | 10,210 | 11,060 | 12,358 | 14,405 | 16,088 |
| Total units | 86,627 | 109,585 | 119,424 | 134,337 | 157,906 | 177,190 |
| ***Utah ROI*** | | | | | | |
| Owner-occupied | 26,187 | 26,698 | 27,395 | 28,598 | 30,522 | 32,245 |
| Rental | 6,929 | 7,038 | 7,206 | 7,495 | 7,954 | 8,362 |
| Vacant units | 8,853 | 9,139 | 9,446 | 9,961 | 10,797 | 11,556 |
| Total units | 42,469 | 43,422 | 44,620 | 46,670 | 49,959 | 52,913 |
| ***Wyoming ROI*** | | | | | | |
| Owner-occupied | 24,356 | 26,437 | 27,133 | 27,765 | 28,716 | 29,598 |
| Rental | 7,967 | 8,567 | 8,770 | 8,941 | 9,164 | 9,431 |
| Vacant units | 6,747 | 7,292 | 7,476 | 7,646 | 7,904 | 8,147 |
| Total units | 39,070 | 42,296 | 43,378 | 44,351 | 45,814 | 47,176 |

[a] Projections are based on forecasted growth rates in population for each ROI and state.

Sources: U.S. Bureau of the Census (2006c,d); Colorado State Demography Office (2007); Utah Governor's Office of Planning and Budget (2006); Wyoming Department of Administration and Information (2006).

**TABLE 6.1.1-7 State and ROI Public Service Expenditures ($ millions 2005)[a]**

| | Year | | | | | |
|---|---|---|---|---|---|---|
| Parameter | 2005 | 2009 | 2012 | 2016 | 2022 | 2027 |
| ***Colorado ROI*** | 416.8 | 461.9 | 504.2 | 568.1 | 699.0 | 751.4 |
| Colorado | 39,481 | 42,720 | 45,267 | 48.783 | 54.073 | 58,483 |
| ***Utah ROI*** | 215.4 | 219.1 | 224.8 | 234.6 | 250.3 | 264.3 |
| Utah | 19,455 | 21,307 | 23,682 | 27,685 | 33,250 | 38,255 |
| ***Wyoming ROI*** | 268.8 | 285.8 | 293.2 | 299.8 | 309.8 | 319.0 |
| Wyoming | 5,638 | 5,919 | 6,068 | 6,240 | 6,501 | 6,732 |

[a] Projections are based on forecasted growth rates in population for each ROI and state.

Sources:

*Colorado*—City of Craig (2003); City of Delta (2004); City of Fruita (2005); City of Glenwood Springs (2004); City of Grand Junction (2004); City of Rifle (2004); Colorado State Demography Office (2007); Delta County (2005); Garfield County (2004); Mesa County (2003); Moffat County (2005); Rio Blanco County (2005); Town of Meeker (2005); Town of Parachute (2005); Town of Rangely (2004); Town of Silt (2005).

*Utah*—Carbon County (2004); City of Moab (2005); Duchesne County (2004); Emery County (2004); Garfield County (2004); Grand County (2004); Price Municipal Corporation (2005); Roosevelt City Corporation (2005); San Juan County (2004); Uintah County (2004); Utah Governor's Office of Planning and Budget (2006); Vernal City Corporation (2005); Wayne County (2004).

*Wyoming*—Carbon County (2006); City of Evanston (2005); City of Green River (2004); City of Kemmerer (2005); City of Rawlins (2005); City of Rock Springs (2005); Lincoln County (2006); Sweetwater County (2005); Uinta County (2005); Wyoming Department of Administration and Information (2006).

*Overall*—Standard and Poor's (2006); U.S. Bureau of the Census (2006b,d).

**6.1.1.10.2 Impacts of No Action.** Construction and operation of RD&D oil shale facilities and the associated temporary housing will impact the economies of each ROI. On the basis of employment numbers presented in the EAs and the IMPLAN model results (Minnesota IMPLAN Group, Inc. 2007; see discussion of the socioeconomic assessment methodology in Section 4.11), construction of the five in situ projects will create 1,544 jobs (810 direct jobs at oil shale facilities and 734 indirect jobs in the remainder of the local economy) in the Colorado ROI and $91.3 million in income during the peak year of construction. Operation of the in situ RD&D projects will result in 1,016 additional jobs (535 direct and 481 indirect jobs, thus producing $59.7 million in income (Table 6.1.1-8). In situ construction employment represents an increase

**TABLE 6.1.1-8 ROI Economic Impacts of Oil Shale Development under Alternative A[a]**

| | Housing Construction | | Oil Shale Development: Construction | | Oil Shale Development: Operation | |
|---|---|---|---|---|---|---|
| | Employment | Income ($ million) | Employment | Income ($ million) | Employment | Income ($ million) |
| ***Colorado*** | | | | | | |
| In situ processing (5 RD&D projects) | | | | | | |
| Direct | 251 | 6.0 | 810 | 72.0 | 535 | 47.6 |
| Indirect | 83 | 2.3 | 734 | 19.3 | 481 | 12.1 |
| Total | 334 | 8.3 | 1,544 | 91.3 | 1,016 | 59.7 |
| ***Utah*** | | | | | | |
| Underground mining with surface retorting (1 RD&D project) | | | | | | |
| Direct | 16 | 0.3 | 120 | 7.9 | 120 | 7.9 |
| Indirect | 4 | 0.1 | 60 | 1.2 | 61 | 1.2 |
| Total | 19 | 0.3 | 180 | 9.1 | 181 | 9.1 |

[a] Totals may be off due to rounding. The direct employment data presented in this table for the construction and operation of the RD&D projects are based on information contained in the final EAs prepared for the six RD&D projects. Direct employment numbers and multiplier data from the IMPLAN model (Minnesota IMPLAN Group, Inc. 2007) were used to calculate indirect employment numbers for each ROI. The direct employment numbers for the construction of the in situ projects are based on the assumption that only three projects will be under construction simultaneously (EGL, Chevron, and one Shell project). For operation of the in situ projects, it is assumed that all five projects will be under operation simultaneously.

of 1.4% over the projected ROI employment baseline for 2008 (see Section 3.10.2). Construction of the one underground mining and surface retort project in Utah will create 180 jobs (120 direct and 60 indirect jobs) and $9.1 million in income during the peak construction year, and 180 jobs (120 direct and 60 indirect) and $9.1 million in income during the first year of operation.

Temporary housing built for workers at the five in situ projects will create 334 jobs (250 direct and 83 indirect) and $8.3 million in income in the Colorado ROI (Table 6.1.1-8). Construction of housing for the one underground mine project will produce employment of 19 (16 direct and 4 indirect jobs) and $0.3 million in income in the Utah ROI.

Population increases associated with the construction of the in situ RD&D projects under Alternative A will represent a 0.4% increase over the ROI baseline population for the peak construction year of 2008 (see Section 3.10.2). In Utah, increases in population during the peak construction year of an underground mine in 2010 will lead to an increase of 0.2% in population in the ROI (see Section 3.10.2). Given the relatively small direct labor force requirements for each project, population in-migration in Colorado and Utah is likely to be small, with minor impacts on local social disruption in each ROI expected.

Given the relatively small scale of the RD&D projects under Alternative A, any property value impacts in the vicinity of federal land are likely to be local and temporary. In the ROI in Colorado and Utah, in general, few workers are expected to in-migrate. Individual projects are not expected to produce large increases in local employment and economic activity, meaning that property value impacts will be small.

#### 6.1.1.11 Environmental Justice

Environmental and human health impacts on the general population for the no action alternative are expected to be low. No significant, adverse air quality impacts are likely to occur during construction and operation of the RD&D projects. Land use impacts associated with the RD&D projects are likely to be relatively small given the small amount of land disturbed and the relative remoteness of locations in each state. Noise effects during energy project operation will also likely be minimal. In general, visual impacts associated with construction activities under Alternative A will be small, and temporary in nature, although some construction activities will occur several times during the course of the project, which will give rise to brief periods of intense construction activity and the associated visual impacts. Providing that mitigation measures are implemented as described in the EAs and FONSIs, water quality impacts of the RD&D projects are expected to be temporary and local, while water use during oil shale facility operations under Alternative A is expected to be low and within the capacity of regional water suppliers.

Construction and operation of the six RD&D projects will have minor disproportionate impacts on minority and low-income populations, primarily associated with changes in quality of life and social disruption caused by rapid in-migration of population into some rural communities, changes in air and water quality and on the impact of water diversions on agriculture. There may be property value and visual impacts depending on the locations of land parcels impacted by oil shale projects, their importance for subsistence, their cultural and religious significance, and possible alternate economic uses.

#### 6.1.1.12 Hazardous Materials and Waste Management

With few exceptions, the hazardous materials associated with the six RD&D projects will be very similar. Commercially available fuels to support equipment and/or provide for comfort heating (natural gas, propane, diesel fuel, and gasoline) are expected to represent the largest category of hazardous materials present on-site. As stated in Section 4.1, it is assumed that on-site upgrading of recovered products will not take place at the RD&D project sites; therefore, hazardous materials and wastes specifically associated with upgrading activities will not be present at the RD&D facilities.

The products of oil shale development efforts will exhibit hazardous properties. Whether it is the raw shale oil recovered from the one RD&D project utilizing an aboveground retort or the recovered upgraded products that are anticipated at any of the five in situ RD&D projects, the research nature of each of these projects suggests that the resulting products will exhibit

characteristics unique to the particular recovery and retorting schemes that created them. Consequently, each of the RD&D products will need careful characterization (i.e., creation of a Material Safety Data Sheet [MSDS]) before appropriate management protocols can be established. However, despite the research nature of these ventures, developers still have responsibilities under the General Duty Clause of OSHA or the regulations promulgated at 29 CFR 1910.1200 (Hazard Communication Standard) to protect their workers against the hazards of the products being created. It is assumed that those responsibilities will be met expeditiously and effectively in all cases.

Execution of some of the resource recovery techniques to be employed at the RD&D facilities will require the use of hazardous materials, sometimes in substantial amounts. Examples include the anhydrous ammonia that will be used as a refrigerant in each of the three Shell in situ RD&D projects and explosives that may be used in underground mining associated with the OSEC project. Small amounts of herbicides will also be used at each facility for vegetation management within industrial areas for fire safety. Neither explosives nor herbicides are expected to be stored on-site but, instead, will be brought to the site on an as-needed basis.

During RD&D operations, limited volumes of waste streams are expected to be generated. Those associated with similar activities will be virtually the same for each project. At the quantities likely to be generated, it is reasonable to expect that all of the solid and hazardous wastes will be containerized and delivered to off-site facilities for treatment and disposal. The largest volume solid waste stream that can be anticipated is the spent shale that will be generated in the later RD&D phases of the OSEC project. OSEC anticipates producing 8,000 tons of spent shale during Phase 2 and 1.2 million tons during Phase 3; these spent shales will be disposed of either in the underground mine or in an on-site facility. At these amounts, disposal at on-site facilities will likely be conducted under the auspices of permits issued by state or local authorities. Well drilling activities at the Shell projects and at the EGL project will generate cuttings; however, such cuttings are expected to be nonhazardous and will be disposed of on-site.

Both sanitary and industrial wastewater streams will be generated at each of the RD&D projects. In most instances, volumes will be small. However, for each of the three Shell projects and, as well, for the EGL project, substantial quantities of well drilling fluids will be generated. It is expected that drilling fluids will be captured in temporary sediment ponds and recycled to a great extent. Management schemes for other wastewater streams vary among the six projects and involve combinations of surface discharge, recycling, disposal by subsurface injection, on-site storage and treatment, and off-site disposal at permitted facilities. In all instances, however, the management and disposal of these wastewaters will be subject to regulatory agency approval and, in some cases, permit requirements.

In addition, one of the by-products of aboveground retorting is water (sometimes referred to as pyrolysis water). This water will often contain hydrocarbon pyrolysis products that have enough polar character to be water soluble; however, the quality of pyrolysis water will vary. Shell anticipates that pyrolysis water from its projects will be initially collected in lined ponds and treated before being released. Others plan to containerize pyrolysis water in aboveground tanks prior to shipment off-site for treatment. Pyrolysis water that is free of hydrocarbon and heavy metal contamination may be suitable for use in dust control of spent shale disposal piles or

as a wetting agent for the spent shale to promote adequate compaction in the disposal cell. Pyrolysis water is also created in all in situ retorting technologies and recovered from production wells, together with hydrocarbon pyrolysis products. Here, too, the quality of pyrolysis water can vary. Water with little to no contamination can be put to beneficial uses on the site such as for fugitive dust control on on-site roads or reinjected downgradient of the retort zone to help the groundwater contours reequilibrate. Contaminated pyrolysis water will require treatment before discharge, either to surface water or to groundwater downgradient of the retort zone.

Potentially adverse health and environmental impacts could result from improper management of hazardous materials and waste streams. In general, impacts will result from the release of hazardous materials to the environment as a result of accident or improper storage and use practices. Likewise, impacts can result from accidental release from temporary storage facilities or improper management and control of on-site waste disposal or water treatment facilities. Direct impacts of such releases could include contamination of vegetation, soil, and surface and groundwater; indirect impacts on the public and on flora and fauna populations could subsequently result. If all applicable regulations governing the use, storage, and disposal of hazardous materials and regulations and permits governing the management of wastes are complied with and appropriate management practices are implemented, the adverse impacts associated with hazardous materials and most of the anticipated wastes are expected to be minimal to nonexistent. Concerns exist, however, for the potential of spent shale disposed of at the OSEC RD&D project to cause environmental damage. As documented in the project EA, however, OSEC intends to design and construct a spent shale disposal site equipped with adequate engineering features to ensure the capacity both to identify such impacts as they develop and to mitigate them to minor consequence.

#### 6.1.1.13 Health and Safety

For the in situ RD&D projects, chemical and physical hazards associated with mining will not be applicable. The types of health hazards discussed in Section 4.14 (Table 4.14-1) that may be of concern for workers at the in situ RD&D facilities are mainly injuries and hearing loss. Workers at the OSEC underground mine facility and construction workers could be exposed to respirable dusts and thus be at risk of developing lung disease. The inhalation hazard will be lower for workers at the in situ projects, because emissions will be lower. For all the RD&D projects, the number of cases of lung disease will likely be small (if any) given the small scale of RD&D operations, the low number of employees, and required adherence to occupational health and safety standards.

A rough estimate of the numbers of injuries and fatalities that will be expected under Alternative A can be made using the numbers of direct jobs estimated (see Section 6.1.1.10.2) and published fatality and injury rates for construction and mining (NSC 2006). The 2004 fatality and injury rates for construction are 11.6 per 100,000 full-time equivalents (FTEs) and 6.4 per 100 FTEs, respectively; the rates for mining are 28.3 per 100,000 FTEs and 3.8 per 100 FTEs, respectively. For this assessment, construction rates are used to estimate impacts for all phases of in situ projects.

For all 6 RD&D projects, the estimated total number of direct construction jobs is 930 (810 in Colorado and 120 in Utah), and the number of direct operations jobs is 655 (535 in Colorado and 120 in Utah). Using these employment numbers and appropriate fatality and injury rates, the estimated numbers of annual fatalities for Alternative A are as follows: during construction, 0.14; during operations, 0.09. The estimated numbers of annual injuries for Alternative A are as follows: during construction, 75; during operations, 39. For all RD&D projects, a comprehensive facility health and safety plan and worker safety training will be required as part of the Plan of Development.

### 6.1.2 Impacts of Alternative B

Under Alternative B, the BLM would amend nine BLM land use plans to make 1,991,222 acres of public land available for application for leasing for commercial development of oil shale within Colorado, Utah, and Wyoming (see Figures 2.3.3-1, 2.3.3-2, and 2.3.3-3). These lands would include about 359,798 acres in Colorado, 630,971 acres in Utah, and 1,000,453 acres in Wyoming (Table 2.3.3-1) and are composed of 1,865,542 acres of BLM-administered lands and 125,681 acres of split estate lands. The nine land use plans that would be amended are as follows:

- Colorado
  - Glenwood Springs RMP (BLM 1988, as amended by the 2006 Roan Plateau Plan Amendment [BLM 2006i, 2007c])
  - Grand Junction RMP (BLM 1987)
  - White River RMP (BLM 1997a, as amended by the 2006 Roan Plateau Plan Amendment [BLM 2006i, 2007c])

- Utah
  - Book Cliffs RMP (BLM 1985a)
  - Diamond Mountain RMP (BLM 1994a)
  - Price River Resource Area MFP, as amended (BLM 1989)

- Wyoming
  - Great Divide RMP (BLM 1990)
  - Green River RMP (BLM 1997b, as amended by the Jack Morrow Hills Coordinated Activity Plan [BLM 2006j])
  - Kemmerer RMP (BLM 1986a).

As discussed in Section 2.3.3.1, these land use plans would be amended under Alternative B specifically to (1) identify the most geologically prospective oil shale resources within each planning unit, (2) designate lands within these most geologically prospective areas available for application for leasing, (3) identify any technology restrictions, (4) stipulate requirements for future NEPA analyses and consultation activities, and (5) specify that the BLM will consider and give priority to the use of land exchanges to facilitate commercial oil shale development pursuant to Section 369(n) of the Energy Policy Act of 2005. Specific land use plan amendments are provided in Appendix C.

The amendment of land use plans, as described above, would have no direct impacts on the environment or socioeconomic setting in the three-state study area. However, the development of commercial oil shale projects made possible by these land use plan amendments would affect these resources. In addition, Alternative B would include the same level of development of the RD&D projects as described in Section 6.1.1 for Alternative A. The following sections describe the impacts of Alternative B on the environment and on the socioeconomic setting (including the effects of land use plan amendments on the level and pace of commercial oil shale development).

In general, impacts on specific resources located within the 1,991,222 acres cannot be quantified at this time because key information about the location of commercial projects, the technologies that will be employed, the project size or production level, and development time lines are unknown. While it is not possible to quantify the impacts of project development, it is possible to draw observations and conclusions on the basis of certain lands being made available for application for leasing and their overlap with specific resources. The following sections identify the potential impact issues, many of which might be successfully avoided or mitigated, depending upon site- and project-specific factors and future regulations that will guide leasing actions.

At the time of preparation of this PEIS, industry has given no firm indication when commercial oil shale production may begin. Likewise, the location where commercial production may first occur also is not known, but for purposes of analysis it is reasonable to assume that production may begin in Colorado's Piceance Basin, where the thickest and richest known oil shale resources are found and where research and development is currently ongoing on both private and federal lands.

#### 6.1.2.1 Land Use

The identification of approximately 2 million acres of public land in Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale (approximately 87% of the study area) is expected to have no direct impacts on other land uses. The identification of these lands does not authorize or approve any ground-disturbing activities that could affect these land uses; however, existing land uses could be adversely affected by future commercial oil shale development on these lands.

As discussed in Section 3.1, lands within the three-state study area where commercial oil shale development might occur are currently used for a wide variety of activities, including recreation, mining, hunting, oil and gas production, livestock grazing, wild horse and burro management, communication sites, and ROW corridors (e.g., roads, pipelines, and transmission lines). Commercial oil shale development would have a direct effect on these uses, displacing them from areas that are being developed.

Indirect impacts of oil shale development would be associated with changing existing off-lease land uses, including conversion of land in and around local communities from existing agricultural, open space, or other uses to provide services and housing for employees and

families that move to the region in support of commercial oil shale development. Increases in traffic, increased access to previously remote areas, and development of oil shale facilities in currently undeveloped areas would continue the change in the overall character of the landscape that has already begun as a result of oil and gas development. The value of private ranches and residences in the vicinity of oil shale developments or ROWs may be reduced because of perceived noise, traffic, human health, or aesthetic concerns.

Oil shale development will require off-lease construction and operation of certain infrastructure, such as electric power plants. Such structures and activities would most directly impact uses of nonfederal lands, but could have indirect impacts on some uses of federal lands. The BLM does not decide the location of electric power plants on nonfederal land. It would be too speculative to attempt to analyze where any such electric power plant would be located, but it is possible that some or all of the additional generator capacity would be constructed within the socioeconomic region of influence.

Transmission and pipeline ROWs associated with commercial oil shale development would not preclude other land uses but would result in both direct and indirect impacts. Direct impacts, such as the loss of available lands to physical structures, maintenance of ROWs free of major vegetation, maintenance of service roads, and noise and visual impacts on recreational users along the ROW, would last as long as the transmission lines and pipelines were in place. Indirect impacts of ROW development would include the introduction of new or increased recreational use to an area due to improved access, avoidance of the area for residential or recreational use for aesthetic reasons, and increased traffic.

The specific impacts on land use and the magnitude of those impacts would depend on project location; project size, technology employed, and scale of operations; and proximity to roads, transmission lines, and pipelines. Impacts on various land uses that could be caused by commercial development of oil shale are discussed in some detail in Section 4.2 and are summarized below.

- Commercial oil shale development, using any technology under consideration in this PEIS, is largely incompatible with other mineral development activities because they dominate the lease area in which they are located. Oil and gas development is ongoing in many parts of the study area, and conflict between oil shale projects and oil and gas projects would be expected. While it is possible that undeveloped portions of an oil shale lease area could be available for other mineral development, such development would be unlikely to occur on a widespread basis, except possibly in areas where a single company is developing multiple resources. A possible exception is being investigated as part of one of the RD&D projects where nacholite mining is being conducted in advance of oil shale production.

- Where existing agricultural water rights are acquired to support oil shale development, existing irrigation-based agricultural uses of the land from which the water is acquired will be modified to support lower value dry land use of the lands and/or may result in a complete loss of agricultural uses in

some areas. Some areas could be converted to nonfarm uses depending upon local zoning decisions.

- Grazing activities would be precluded by commercial oil shale development in those portions of the lease area that were (1) undergoing active development; (2) being prepared for a future development phase; (3) undergoing restoration after development; or (4) occupied by long-term surface facilities, such as production facilities, office buildings, laboratories, retorts, and parking lots. Depending on conditions unique to the individual grazing allotment, temporary reductions in authorized grazing use may be necessary because of loss of a portion of the forage base. It is possible, depending upon how commercial leases would be developed, that some grazing uses might be accommodated on parts of the leases at various times during the lease period.

  The level of impact of the removal of acreage from individual grazing leases would be dependent upon site-specific factors regarding the grazing allotment(s) affected. There is a large variation in size and productivity of BLM grazing allotments across the PEIS area, and the loss of up to 5,760 acres for individual oil shale facilities from larger allotments would not be as significant as from smaller allotments. Some allotments could become completely unavailable for use. Others would lose varying percentages of grazing area that might affect their overall economic viability.

- Commercial oil shale development activities are largely incompatible with recreational land use (e.g., hiking, biking, fishing, hunting, bird-watching, OHV use, and camping). Recreational uses, including OHV use, would be precluded from those portions of commercial lease areas involved in ongoing development and restoration activities. Impacts on vegetation, development of roads, and displacement of big game could degrade the recreational experiences and hunting opportunities near commercial oil shale projects. The impact of displacement of recreation uses from oil shale development lease areas would be highly dependent upon site-specific factors, especially the nature of existing uses on the site.

- Specially designated areas, including all designated Wilderness Areas, WSAs, other areas that are part of the NLCS (e.g., National Monuments, NCAs, WSRs, and National Historic and Scenic Trails), and existing ACECs that are currently closed to mineral development, would not be available for application for commercial development and would not be directly affected. They might, however, incur indirect impacts (e.g., dust and degraded viewshed) resulting from commercial oil shale development on adjacent lands or on areas within the general vicinity. Section 4.9 discusses impacts on visual resources in greater detail.

- ACECs that are not closed to mineral leasing include approximately 23,000 acres and are shown in Table 6.1.2-1. The land uses within these

designated ACECs would be impacted by oil shale development through loss of the resource.

- Lands available for application for lease contain all or portions of areas that have been recognized by the BLM in Utah and Wyoming as having one or more characteristics of wilderness. Table 6.1.2-2 lists these areas. Should commercial development occur on these lands, the identified wilderness characteristics in both the areas that are developed and those that border the developed areas would be lost. Alternative B includes approximately 170,000 acres of these lands that would be subject to potential development.

- In Utah, there are areas that have been identified as being eligible for designation as ACECs. These areas are being reviewed as part of ongoing land use planning activities that may or may not be complete before this Draft PEIS is published. Table 6.1.2-3 lists the areas and the number of acres of overlap by field office that would be available for application for commercial oil shale leasing. If oil shale development occurs on these lands, depending on the nature of resources present on the lands, it is likely these resources would be lost. The decisions regarding designation of these lands will be made at the BLM Field Office level and not in this PEIS. Should designation as ACEC be

**TABLE 6.1.2-1 ACECs in the Study Area Not Closed to Mineral Leasing and Available for Leasing under Alternative B**

| ACEC Name/Field Office | Acres in Alternative B |
|---|---|
| ***White River Field Office, Colorado*** | |
| Duck Creek | 3,414 |
| Dudley Bluffs | 1,605 |
| Ryan Gulch | 1,428 |
| ***Glenwood Springs Field Office, Colorado*** | |
| Northwater Creek | 698 |
| E. Fork Parachute Creek | 988 |
| Trapper Creek | 110 |
| ***Vernal Field Office, Utah*** | |
| Lower Green River | 7,683 |
| Nine Mile Canyon | 531 |
| Pariette Wetlands | 6,523 |
| ***RockSprings/Kemmerer Field Office, Wyoming*** | |
| Special Status Plant Species | 140 |
| Total | 23,070 |

**TABLE 6.1.2-2 Areas with Wilderness Characteristics That Overlap with Lands Made Available for Application for Commercial Oil Shale Leasing under Alternatives B and C and the Amount of Overlap[a,b]**

| Name of Area with Wilderness Characteristics | Amount of Overlap (acres) | |
|---|---|---|
| | Alternative B | Alternative C |
| ***Price Field Office, Utah*** | | |
| Desolation Canyon | 85 | 85 |
| ***Vernal Field Office, Utah*** | | |
| Bitter Creek | 1,218 | 669 |
| Desolation Canyon | 29,261 | 25,313 |
| Lower Bitter Creek | 11,417 | 10,125 |
| White River | 17,642 | 17,642 |
| ***Rawlins Field Office, Wyoming*** | | |
| Adobe Town fringe | NA[c] | NA |
| ***Rock Springs Field Office, Wyoming*** | | |
| Buffalo Hump | 6118 | 0 |
| Kinney Rim North | 33,511 | 11,456 |
| Kinney Rim South | 70,007 | 44,952 |
| Sands Dunes | 37 | 0 |
| Total | 169,298 | 110,244 |

[a] The key characteristics of wilderness that may be considered in land use planning include an area's appearance of naturalness and the existence of outstanding opportunities for solitude or primitive and unconfined types of recreation.

[b] Totals may be off due to rounding. Acreage estimates were derived from GIS data.

[c] NA = data not available.

completed before this PEIS is complete, these lands may not be available for lease. If this PEIS is completed before the land use planning process is completed, the field offices still would make the decisions regarding the future management of these lands and would determine whether they would be available for application for leasing for commercial oil shale development. Alternative B includes approximately 185,000 acres of these lands that would be subject to potential development.

- A portion of the land within the preference right lease area established for the OSEC RD&D project would not be available for application for leasing under Alternative B by an applicant other than the OSEC RD&D leaseholder

**TABLE 6.1.2-3 Potential ACECs That Overlap with Lands Made Available for Application for Commercial Oil Shale Leasing under Alternatives B and C and the Amount of Overlap[a]**

| | Amount of Overlap (acres) | |
|---|---|---|
| Potential ACEC | Alternative B | Alternative C |
| ***Price Field Office, Utah*** | | |
| Nine Mile Canyon | 85 | 85 |
| ***Vernal Field Office, Utah*** | | |
| Bitter Creek | 7,917 | 3,814 |
| Bitter Creek/P.R. Spring | 2,856 | 1,471 |
| Coyote Basin–Coyote Basin | 19,270 | 19,201 |
| Coyote Basin–Kennedy Wash | 8,692 | 8,626 |
| Coyote Basin–Myton Bench | 25,403 | 19,135 |
| Four Mile Wash | 32,569 | 30,128 |
| Lower Green River | 9,588 | 1,042 |
| Main Canyon | 17,134 | 14,217 |
| Pariette Wetlands | 6,523 | 0 |
| White River | 55,423 | 38,906 |
| Total | 185,461 | 136,624 |

[a] Totals may be off due to rounding. Acreage estimates were derived from GIS data.

because a segment of a potentially eligible WSR, Evacuation Creek, runs through the area (see Figure 2.3.3-2) that is excluded from leasing. As discussed in Section 2.4.3, the BLM has determined that a corridor extending at least 0.25 mi from the high water mark on either side of this river segment would be excluded from commercial leasing under all alternatives. Although a power line will cross Evacuation Creek at two locations as part of the RD&D project development, OSEC would not be able to locate other surface facilities within 0.25 mi of the creek during commercial operations if the creek has been determined to be suitable for designation as a WSR at the time the commercial lease is issued.

Under the terms of the RD&D program, the federal government has a commitment to grant the RD&D companies leases for commercial development within the preference right lease areas, provided all conditions of the program are met (see Section 1.4.1; includes the provision that BLM finds that the environmental impacts identified in site-specific analyses for the proposed lease are acceptable). As a result, all lands within the preference right lease area will be available for issuance of a commercial lease to OSEC

under Alternative B if OSEC meets all conditions of the program. If OSEC does not meet the conditions of the RD&D lease, the lands would not otherwise be available for application for commercial development.

#### 6.1.2.2 Soil and Geologic Resources

The identification of approximately 2 million acres of public land in Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale and the amendment of land use plans to incorporate these lease areas would not have direct impacts on soil and geologic resources in these areas. The identification of these lands does not authorize or approve any ground-breaking activities that could affect these resources. Soil and geologic resources could, however, be affected by future commercial oil shale development on these lands.

Soil and geologic resources could be affected during project construction as a result of removal or compaction (e.g., during site clearing and grading, foundation excavation and preparation, and pipeline trenching) and by erosion during project construction and operation (e.g., erosion of exposed soils in construction areas or of topsoil stockpiles [see Section 4.3.1]). Erosion of exposed soils could also lead to increased sedimentation of nearby water bodies and to the generation of fugitive dust, which could affect local air quality. Project areas would remain susceptible to erosion until completion of construction, mining, oil shale processing, and site stabilization and reclamation activities (e.g., revegetation of pipeline ROWs, surface mine reclamation). Impacts on soil and geologic resources would be limited to the specific project location as well as to areas where associated off-lease infrastructure (such as access roads, utility ROWs, and power plants) would be located. For any project, the erosion potential of the soils would be a direct function of the lease and project location and also the soil characteristics, vegetative cover, and topography (i.e., slope) at that location. Development in areas that have erosive soils and steep slopes (e.g., in excess of 25%) could lead to serious erosion problems at those locations.

Under Alternative B, impacts on soil and geologic resources could occur wherever individual projects are located within the 2 million acres identified as available for leasing application. Under this alternative, Wyoming would have the most land (about 1.1 million acres) and Colorado the least (359,798 acres) where commercial oil shale development could affect soil and geologic resources.

#### 6.1.2.3 Paleontological Resources

The identification of approximately 2 million acres of public land for application for leasing for commercial development of oil shale and the amendment of land use plans to incorporate these lease areas would not have direct effects on paleontological resources. Of the nearly 2 million acres identified under Alternative B as being available within the four oil shale basins, a total of 1,793,480 acres (approximately 90%) have been identified as having potential to contain important paleontological resources (Murphey and Daitch 2007). Approximately

343,820 of these acres are in the Piceance Basin; 592,620 acres are in the Uinta Basin; and 857,040 acres are in the Green River and Washakie Basins. Paleontological resources within these areas could be adversely impacted if leasing and subsequent commercial development occurs. Impacts could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development area, and increased potential for loss of resource from looting or vandalism as a result of increased human presence/activity in the sensitive areas (see Section 4.4).

#### 6.1.2.4 Water Resources

The identification of approximately 2 million acres of public land in Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale (approximately 87% of the study area) and amendment of land use plans to incorporate these lease areas would not impact water resources in these areas. Both surface and groundwater resources could, however, be affected by subsequent commercial oil shale development on these lands. The amount of water that may be required for future commercial development and the potential mix between surface water, groundwater, and treated process water is unknown.

The inability to predict specific locations for potential future commercial development and the lack of information regarding the type of technology that might be employed make it impossible to predict the specific impacts on water resources that could occur with commercial development. Quantification of such impacts would depend on the specific location of the lease area being developed, as well as the design of the project and associated infrastructure.

Section 4.5 of this PEIS provides a generic description of the potential impacts on water resources. These impacts could occur anywhere within the 2 million acres available for application to lease in this alternative. The following is a summary of these generic impacts:

- Degradation of surface water quality caused by increased sediment load or contaminated runoff from project sites;
- Surface disturbance that may alter natural drainages by both diverting and concentrating natural runoff;
- Surface disturbance that becomes a non-point source of sediment and dissolved salt to surface water bodies;
- Withdrawal of water from a surface water body that reduces its flow and degrades the water quality of the stream downgradient from the point of the withdrawal;
- Withdrawals of groundwater from a shallow aquifer that produce a cone of depression and reduce groundwater discharge to surface water bodies or to the springs or seeps that are hydrologically connected to the groundwater;

- Construction of reservoirs that might alter natural stream flow patterns, alter local fisheries, temporarily increase salt loading, cause changes in stream profiles downstream, reduce natural sediment transport mechanisms, and increase evapotranspiration losses;

- Discharged water from a project site that could have a lower water quality than the intake water that is brought to a site;

- Spent shale piles and mine tailings that might be sources of salt, metal, and hydrocarbon contamination for both surface and groundwater;

- Dewatering operations of a mine, or dewatering through wells that penetrate multiple aquifers, that could reduce groundwater discharge to seeps, springs, or surface water bodies if the surface water and the groundwater are connected;

- Degradation of groundwater quality resulting from the injection of lower quality water, from contributions of residual hydrocarbons or chemicals from retorted zones after recovery operations have ceased, and from spent shales replaced in either surface or underground mines; and

- Reduction or loss of flow in domestic water wells from dewatering operations or from production of water for industrial uses.

As noted in Section 6.1.2.2, the lands made available for application for leasing under Alternative B include lands that have been identified in BLM land use plans as having high potential for erosion due to steep slopes and/or highly erosive soils. Surface water quality could be adversely impacted by erosion that would contribute to increases in sediment and salinity loads from these and similar lands throughout the area that would be open for application for leasing under this alternative.

In addition, lands made available for application for leasing under Alternative B overlap with sensitive hydrologic areas identified by BLM, including about 7,900 acres of identified riparian areas and wetlands in Colorado; about 6,100 acres of watershed, floodplains, and other sensitive water resources in Utah; and about 31,000 acres of identified floodplains, wetlands, and riparian areas in Wyoming. Disturbance of these areas could occur either by direct manipulation or through indirect effects, including increased sedimentation and runoff of contaminated water from project sites.

The total stream miles within the four oil shale basins is approximately 543 mi. Alternative B contains approximately 249 mi of these perennial streams that could be affected either directly or indirectly by commercial oil shale development (see Table 6.1.2-4).

**TABLE 6.1.2-4 Perennial Streams Occurring within the Lease Areas Identified under Alternative B**

| State | Number of Perennial Streams | Length of Streams (mi) |
|---|---|---|
| Colorado | 13 | 67.6 |
| Utah | 14 | 126.3 |
| Wyoming | 10 | 54.4 |
| Total | 37 | 248.3 |

#### 6.1.2.5 Air Quality

Air resources in the three states would not be affected by the identification of approximately 2 million acres of public land for leasing application, or by amendment of land use plans to incorporate these lease areas. However, air resources in and around these 2 million acres could be affected by potential future commercial development of oil shale. Under Alternative B, local, short-term air quality impacts could be incurred as a result of (1) PM releases (fugitive dust, diesel exhaust) during construction activities, such as site clearing and grading in preparation for facility construction, and (2) exhaust emissions ($SO_2$, CO, and $NO_x$) from construction equipment (see Section 4.6). These potential impacts would be largely limited to specific project locations and the immediate surrounding area. Similar short-term impacts could also occur in other areas where electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located and developed.

Similar but longer-term impacts on local air quality could occur during normal project operations, such as mining and processing of the oil shale. Processing activities could also result in regional impacts on air quality that could extend beyond the boundaries of the lease areas in each state. These regional impacts would be associated with operational releases of CO, $NO_x$, PM, and other pollutants (VOCs and $SO_2$) during oil shale excavation and processing (see Section 4.6). Operational releases of certain hazardous air pollutants (such as benzene, toluene, formaldehyde, and diesel PM) could also affect on-site workers and nearby residences (if any are present), but these impacts would be localized to the immediate project location and subject to further analyses prior to implementation.

If development of oil shale requires expansion of capacity of existing electric power plants, or the construction and operation of new electric power plants off-lease, those would also have longer-term impacts on regional air quality. See Table 6.1.5-3 for a summary of the emissions from coal-fired electric power plants.

#### 6.1.2.6 Noise

Under Alternative B, approximately 2 million acres of public land would be made available within Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale. Ambient noise levels in these areas would not be affected by the identification of these lands for leasing application, or by amendment of land use plans to incorporate these lease areas. However, ambient noise levels could be affected by the future commercial development of oil shale. Under Alternative B, local, short-term changes in ambient noise levels could occur during the construction, operation, and reclamation of oil shale projects (see Section 4.7.1). Project-related increases in noise levels could disturb or displace wildlife and recreational users in nearby areas. Impacts on wildlife and recreational users are discussed in

Sections 4.8.1 and 4.2.1.4, respectively. Noise levels could be affected as a result of the operation of construction equipment (graders, excavators, haul trucks) and as a result of any blasting activities. Increases in ambient noise levels during operations would be associated with mining and oil-shale-processing activities and would be more long term than construction-related noise. These types of impacts would be largely limited to specific project locations and the immediate surrounding area. Similar short-term and long-term impacts could also occur in other areas where electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located, developed, and operated. For example, ambient noise levels could also be increased in the immediate vicinity of any pipeline pump stations, and by project-related vehicular traffic at the project site and related locations such as access roads to the site.

Construction-related noise levels could exceed EPA and Colorado guidelines (there are currently no state guidelines for Utah or Wyoming). Similarly, operational noise associated with mining and retort activities may, in the absence of mitigation, exceed EPA guidelines at some project locations. Noise generated as a result of project-related (but nonconstruction) vehicular traffic is not expected to exceed either EPA or Colorado guideline levels except for short durations and very close to road or high traffic areas.

In the absence of lease- and project-specific information, it is not possible at the level of this programmatic EIS to identify the duration and magnitude of any project-related changes in noise levels. Changes to ambient noise levels from project development could occur wherever a project is located within the 2 million acres identified for lease application under Alternative B.

#### 6.1.2.7 Ecological Resources

Under Alternative B, approximately 2 million acres of public land would be made available within Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale. These lands support a wide variety of biota and their habitats (Section 3.7). Ecological resources in these areas would not be affected by the identification of lands available for leasing application, or by the amendment of land use plans to incorporate these lease areas. However, ecological resources in and around these 2 million acres could be affected by the future commercial development of oil shale. The following sections describe the potential impacts on ecological resources that may result from commercial oil shale development within the lease areas identified under Alternative B.

The impacts on specific ecological resources that could occur from commercial oil shale development of the Alternative B lease areas, as well as their magnitude and location, would depend on the specific location of the commercial oil shale projects as well as on the specific project design.

**6.1.2.7.1 Aquatic Resources.** There are 37 perennial named streams totaling about 248 mi within the lands that would be made available for leasing application under Alternative B (Table 6.1.2-4). These streams, as well as numerous unnamed streams and other surface waters (such as ponds), provide habitat for a variety of aquatic resources. The Alternative B lease areas

also include about 54 acres of lands that contain habitat considered important for protecting the Colorado River cutthroat trout habitat.

The development of commercial oil shale projects in lease areas identified under Alternative B could affect local aquatic biota and their habitats during project construction and operations (Section 4.8.1-1). Impacts on aquatic resources could occur from the operation of oil shale projects because of (1) direct disturbance of aquatic habitats within the footprint of construction or operation activities; (2) sedimentation of nearby aquatic habitats as a consequence of soil erosion from operational areas; and (3) decreased habitat quality because of changes in water quantity or water quality as a result of construction (e.g., grading that affects surface runoff patterns), operations (e.g., depletions or discharges of water into nearby aquatic habitats), or releases of chemical contaminants into nearby aquatic systems. Impacts could result in short- and/or long-term changes (disturbance or loss) in the abundance and distribution of affected biota and their habitats. The nature and magnitude of these impacts, as well as the specific resources affected, would depend on the location of the areas where project construction and facilities occur, the aquatic resources present in those areas, and the mitigation measures implemented.

**6.1.2.7.2 Plant Communities and Habitats.** The development of commercial oil shale projects in lease areas identified under Alternative B could affect plant communities and habitats during project construction and operations. Alternative B identifies approximately 2 million acres of land as available for lease application, and these areas support a wide variety of plant communities and habitats (see Section 3.7.2). These areas include approximately 11,405 acres that are currently identified in BLM land use plans for the protection of sensitive plants and populations. Direct and indirect impacts could be incurred during project construction and operation, extending over a period of several decades (especially within facility and infrastructure footprints) (see Section 4.8.1.2). Some impacts (e.g., habitat loss) could continue beyond the termination of shale oil production.

Direct impacts would include the destruction of vegetation and habitat during land clearing on the lease site and where ancillary facilities such as access roads, pipelines, transmission lines, employer-provided housing, and new power plants would be located. Soils disturbed during construction would be susceptible to the introduction and establishment of non-native invasive species, which in turn could greatly reduce the success of establishment of native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. Plant communities and habitats could also be adversely affected by changes in water quality or availability, resulting in plant mortality or reduced growth, with subsequent changes in community composition and structure, and declines in habitat quality. Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. These impacts could lead to changes in the abundance and distribution of plant species and changes in community structure, as well the introduction or spread of invasive species.

Affected plant communities and habitats could incur short- and/or long-term changes in species composition, abundance, and distribution. While many impacts would be local (occurring within construction and operation footprints and in the immediate surrounding area), the introduction of invasive species could affect much larger areas. The nature and magnitude of these impacts, as well as the communities or habitats affected, would depend on the location of the areas where project construction and facilities occur, the plant communities and habitats present in those areas, and the mitigation measures implemented to address impacts.

**6.1.2.7.3 Wildlife.** Under Alternative B, about 2 million acres of land in Colorado, Utah, and Wyoming would be identified as available for lease application for commercial oil shale development. These areas and surrounding locations support a diverse array of wildlife and habitats (see Section 3.7.3). Important areas identified for protection (in BLM land use plans) within the lease areas include sage grouse nesting and lek areas, raptor nest and roost sites and concentration areas, and big game species winter and summer ranges and calving areas. Table 6.1.2-5 identifies the amount of each of these habitats that would be included in the Alternative B lease areas and that could be impacted by subsequent commercial oil shale development in these areas.

The Alternative B lease areas also overlap areas identified by state natural resource agencies as important for sage grouse and big game species. These areas include sage grouse habitat and lek sites (Figure 6.1.2-1) and mule deer and elk winter and summer ranges (Figures 6.1.2-2 and 6.1.2-3). Table 6.1.2-6 presents the amounts of these habitats, identified by the states, that would occur in the Alternative B lease areas and could be impacted by potential future commercial oil shale development in these areas. In addition, 38 current and historic sage grouse leks in Wyoming have been identified in areas overlapped by the Alternative B lease areas in that state (Figure 6.1.2-1).

**TABLE 6.1.2-5 Acres of Important Wildlife Habitat Identified for Protection in BLM Land Use Plans That Would Be Present in the Alternative B Lease Areas**

| Wildlife Resource | Colorado | Utah | Wyoming | Total |
|---|---|---|---|---|
| Sage grouse habitat | 43,591 | 599 | 286,220 | 330,412 |
| Raptor habitat | 32,524 | 12,682 | 102,291 | 147,497 |
| Big game winter range[a] | 89,336 | 27,499 | 434,985 | 551,820 |
| Big game summer habitat[a] | 163,654 | NI[b] | NI | 163,654 |
| Big game calving habitat[c] | NI | NI | 12,941 | 12,941 |
| Wild horse HMA | 65,615 | NI | NI | 65,615 |

[a] Elk, mule deer, and pronghorn antelope: acreage may be overestimated because of unknown degree of habitat overlap among the species.

[b] NI = habitat not identified in land use plans.

[c] Applies only to elk.

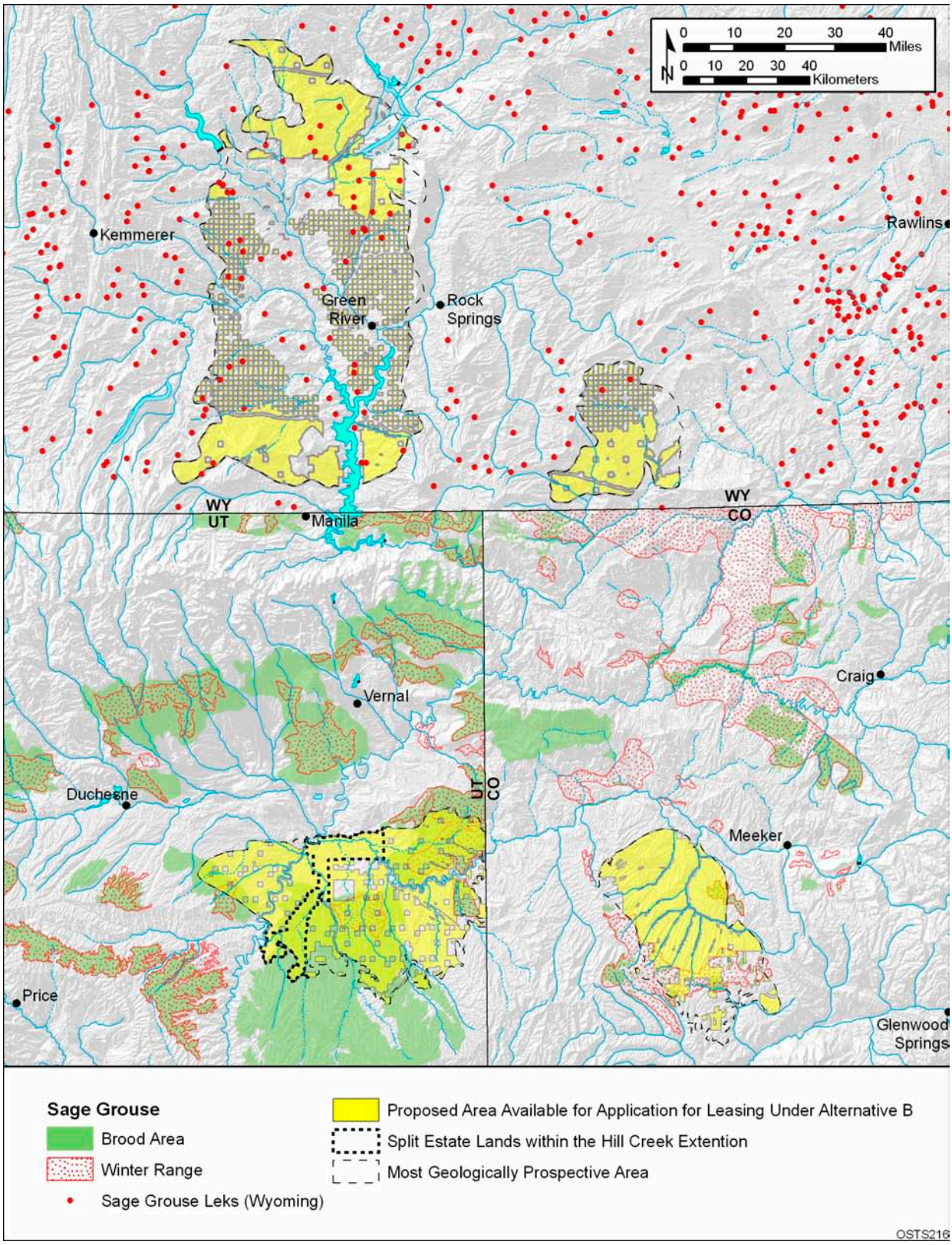


**FIGURE 6.1.2-1 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Known Distribution of the Greater Sage-Grouse**

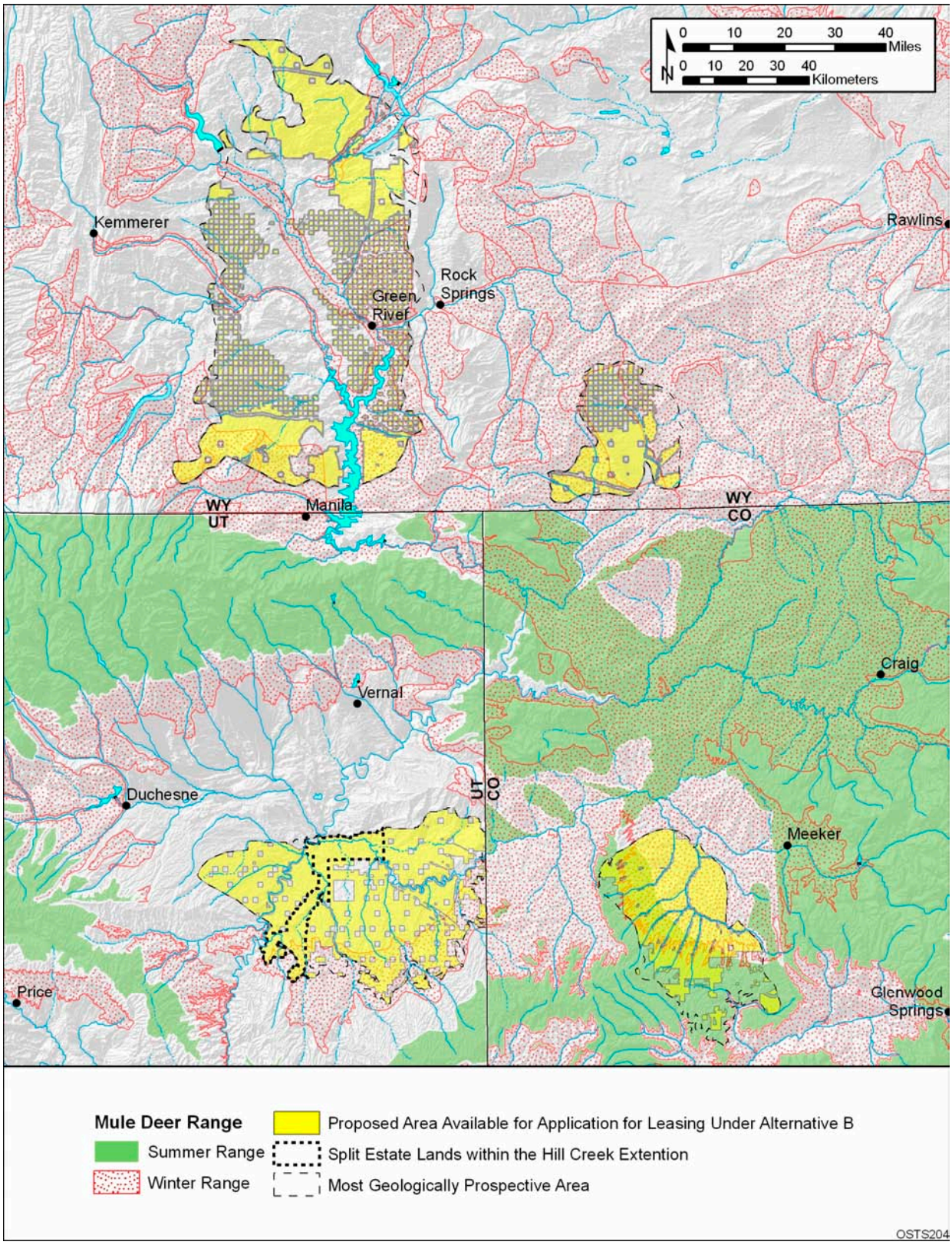


**FIGURE 6.1.2-2 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Mule Deer**

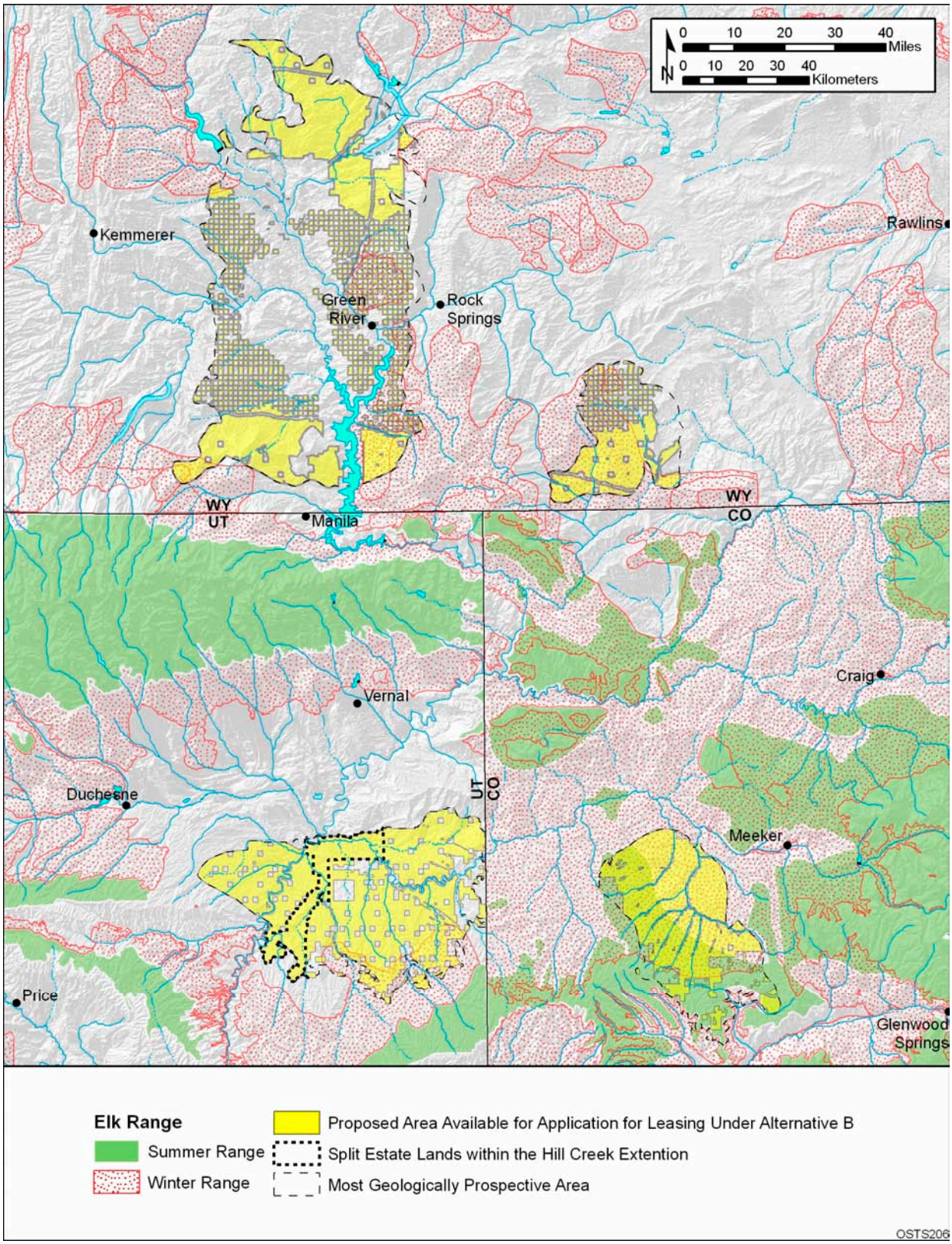


**FIGURE 6.1.2-3 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Elk**

**TABLE 6.1.2-6 Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in the Alternative B Lease Areas**

| Wildlife Resource | Colorado | Utah | Wyoming | Total |
|---|---|---|---|---|
| Sage grouse habitat | 69,216 | 432,287 | NA[a] | 501,503 |
| Mule deer winter habitat | 245,640 | 127,068 | 362,792 | 735,500 |
| Mule deer summer habitat | 181,476 | 0 | NA | 181,476 |
| Elk winter habitat | 320,288 | 67,139 | 262,273 | 649,700 |
| Elk summer habitat | 181,216 | 0 | NA | 181,216 |

[a] NA = data not available

Several wild horse HMAs overlap with the lands that would be available for application for leasing, including the Piceance–East Douglas Creek HMA in Colorado (nearly 59,700 acres); the Hill Creek HMA in Utah (more than 29,800 acres); and the Adobe Town (more than 65,100 acres), Little Colorado (about 208,700 acres), Salt Wells Creek (more than 119,750 acres), and White Mountain (nearly 170,800 acres) HMAs in Wyoming (Figure 6.1.2-4).

Impacts on wildlife from commercial oil shale projects (see Section 4.8.1.3) could occur in a number of ways and would be related to (1) habitat loss, alteration, or fragmentation; (2) disturbance and displacement of biota; (3) mortality; (4) exposure to hazardous materials; and (5) increase in human access. These impacts can result in changes in species distribution and abundance; habitat use; changes in behavior; collisions with structures or vehicles; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminant exposures.

Wildlife could also be affected by human activities not directly associated with the oil shale project or its workforce but instead associated with the potentially increased human access to BLM-administered lands that had previously received little use. The construction of new access roads or improvements to old access roads may lead to increased human access into the area. Potential impacts associated with increased access include (1) the disturbance of wildlife from human activities, including an increase in legal and illegal take and an increase of invasive vegetation, (2) an increase in the incidence of fires, and (3) increased runoff that could adversely affect riparian or other wetland areas that are important to wildlife.

**6.1.2.7.4 Threatened and Endangered Species.** There is a potential for commercial oil shale development projects to adversely affect most of the threatened, endangered, and sensitive species that occur in the counties where development could occur (Tables 4.8.1-3 and 4.8.1-4). This potential for adverse impacts results from a lack of specificity on the locations of lease areas, lack of project specifications, and the often incomplete information on species distributions.

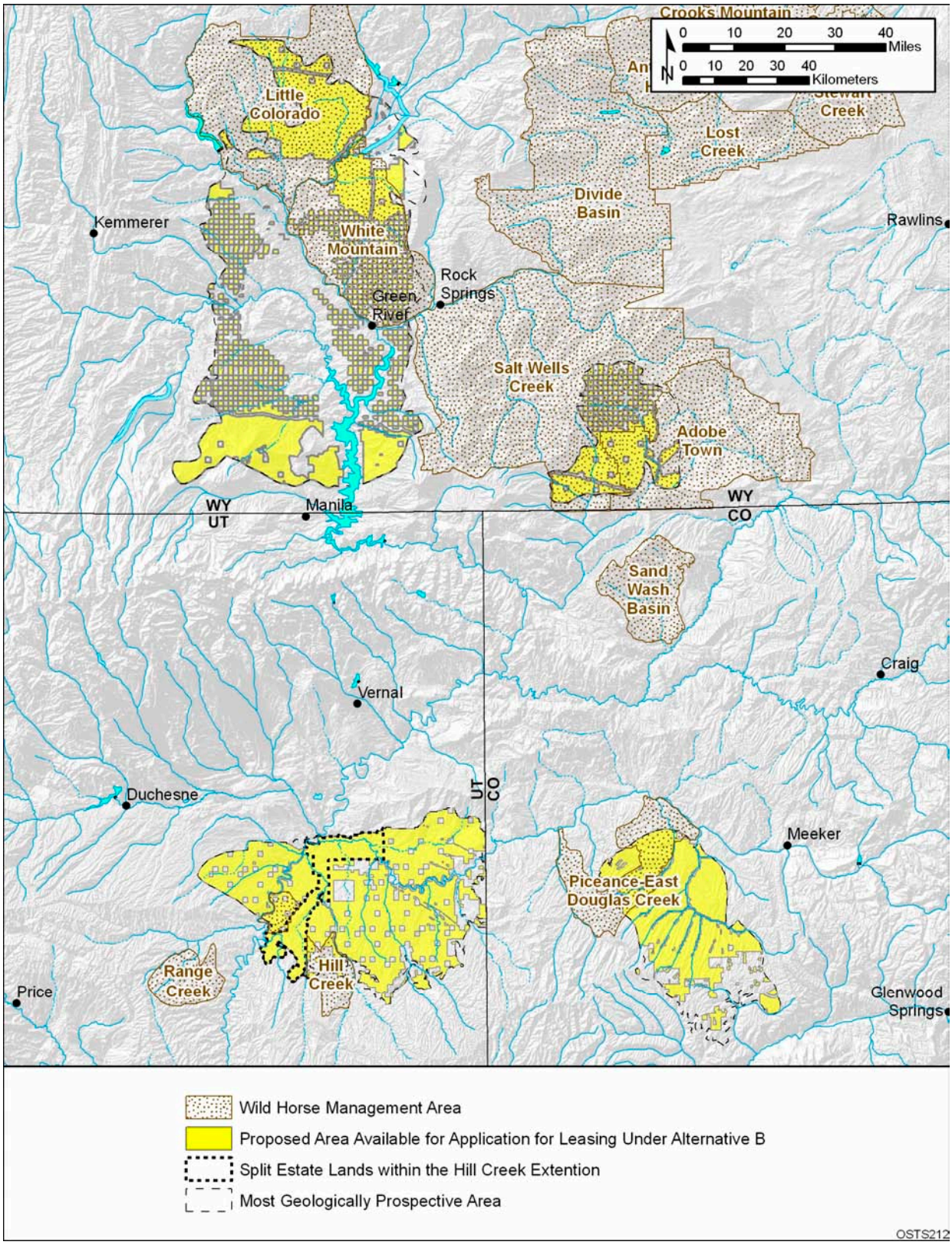


**FIGURE 6.1.2-4 Overlap of Lands Made Available for Application for Leasing under Alternative B with Wild Horse Herd Management Areas**

Fourteen federally listed threatened or endangered species could occur in areas that would be made available for leasing under Alternative B (see Table 4.8.1-4). The lease areas include about 99 mi of critical habitat for Colorado River endangered fishes in Colorado and Utah (Figure 6.1.2-5). The lease areas identified in Alternative B also include about 3,800 acres identified in BLM land use plans as potential black-footed ferret habitat, more than 46,000 acres in Colorado identified as potential habitat for federally listed and candidate species and BLM sensitive species, and about 1,900 acres in Utah identified as being occupied by special status plants.

The potential for impacts on threatened, endangered, and sensitive species (and their habitats) by commercial oil shale development is directly related to the amount of land disturbance that would occur with a commercial project (including its ancillary facilities, such as power plants and utility and pipeline ROWs), the duration and timing of construction and operation periods, and the habitats affected by development (i.e., the location of the project). Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces and disturbance and harassment of animal species, are also considered, but their magnitude also is considered proportional to the amount of land disturbance.

Impacts on threatened and endangered species (see Section 4.8.1.4) are fundamentally similar to or the same as impacts on aquatic resources, plant communities and habitats, and wildlife described in Sections 4.8.1.1, 4.8.1.2, and 4.8.1.3, respectively. The most important difference is the potential consequence of the impacts. Because of the low population sizes of threatened and endangered species, they are far more vulnerable than more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development.

#### 6.1.2.8 Visual Resources

Under Alternative B, land use plans would be amended to identify approximately 2 million acres of public land in Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale. These lands support a wide variety of visual resources (Section 3.8). These resources would not be affected by the amendment of land use plans to incorporate these lease areas, or by the identification of lands for leasing application. However, visual resources in and around these 2 million acres could be affected by future commercial development of oil shale.

Certain scenic resource areas are located within the lease areas identified under Alternative B (Figures 6.1.2-6, 6.1.2-7, and 6.1.2-8). These include the following:

- In Colorado: Duck Creek, Dudley Bluffs, Ryan Gulch, East Fork-Parachute Creek, Northwater Creek, and Trapper Creek ACECs;

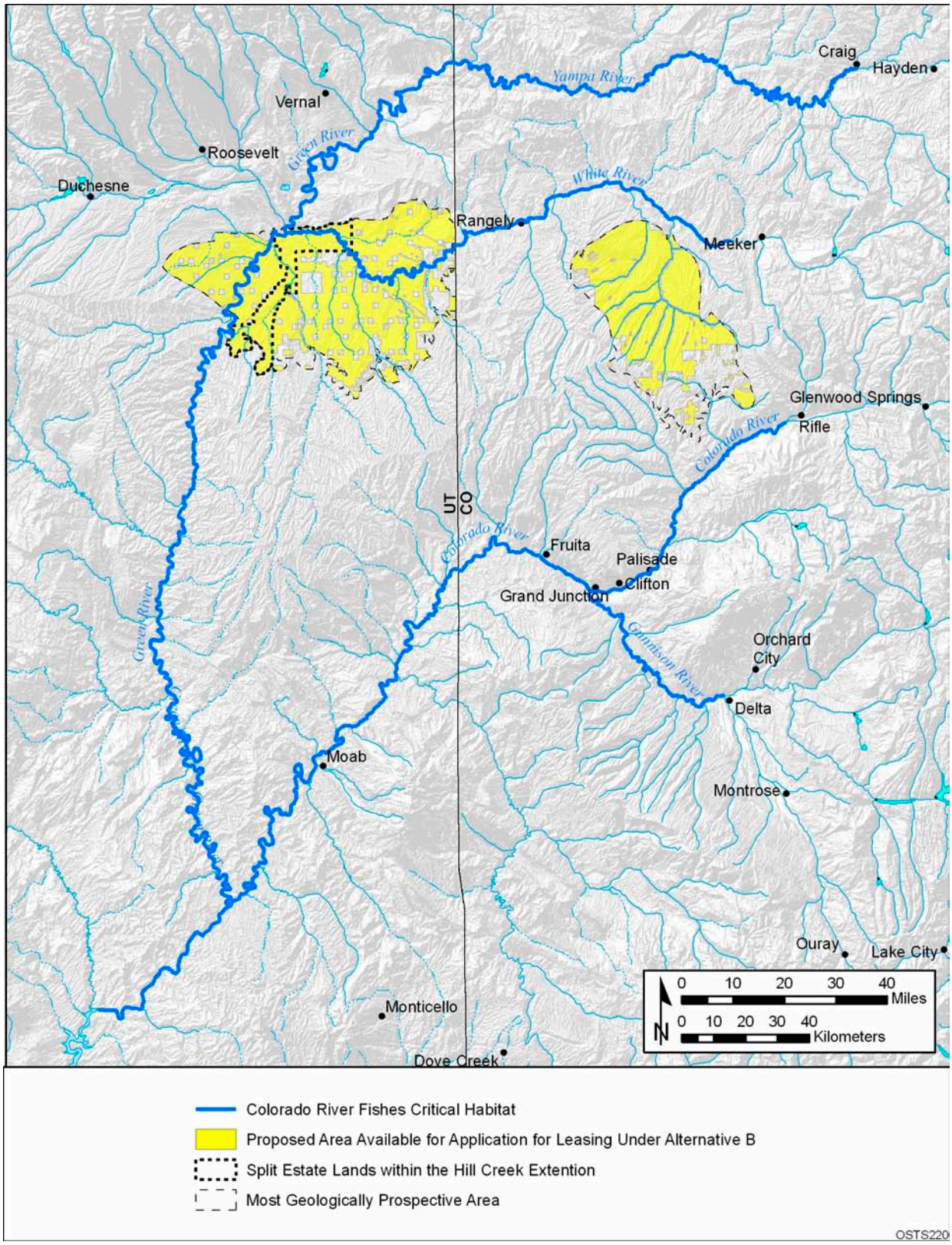


**FIGURE 6.1.2-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative B**

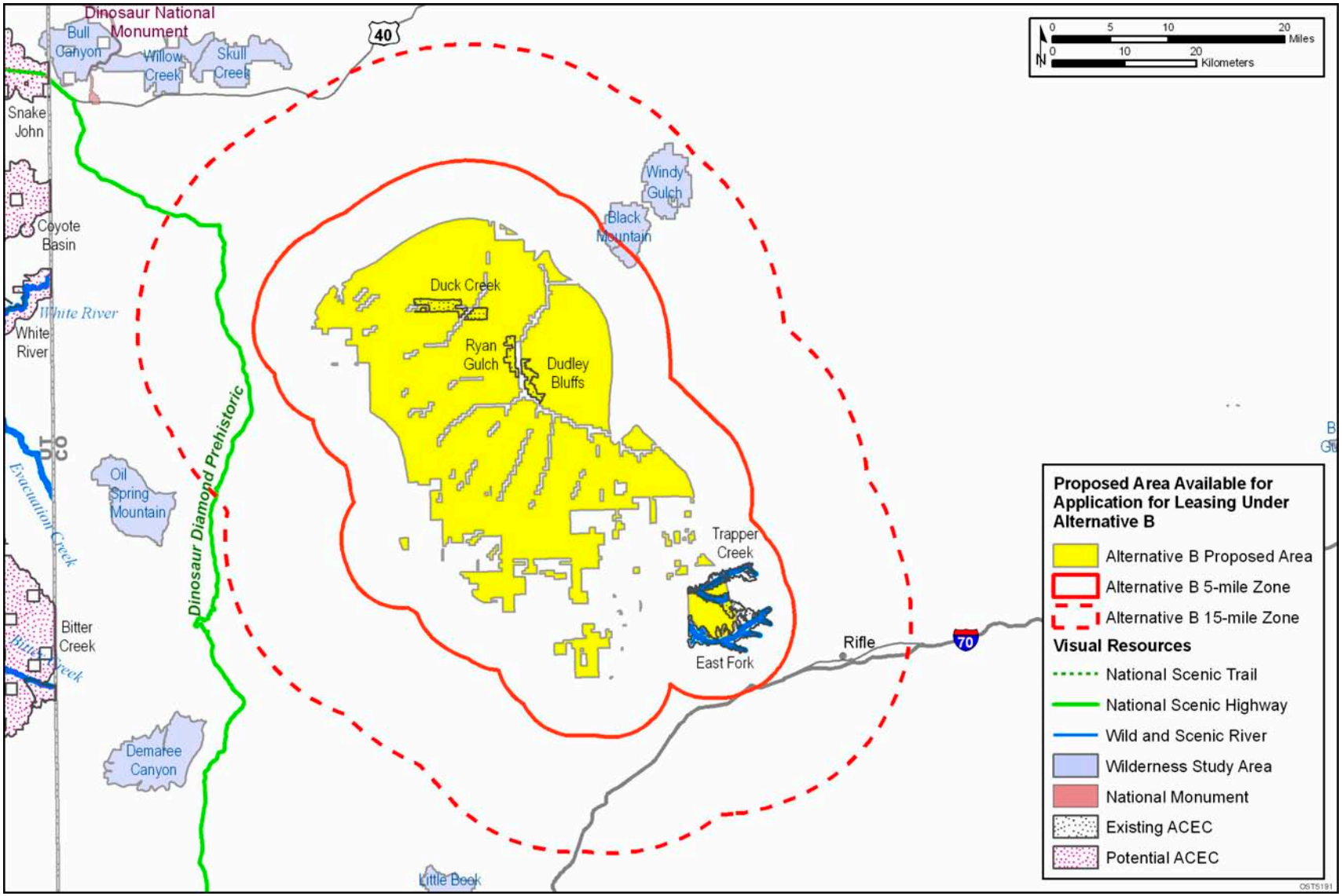


**FIGURE 6.1.2-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B in Colorado**

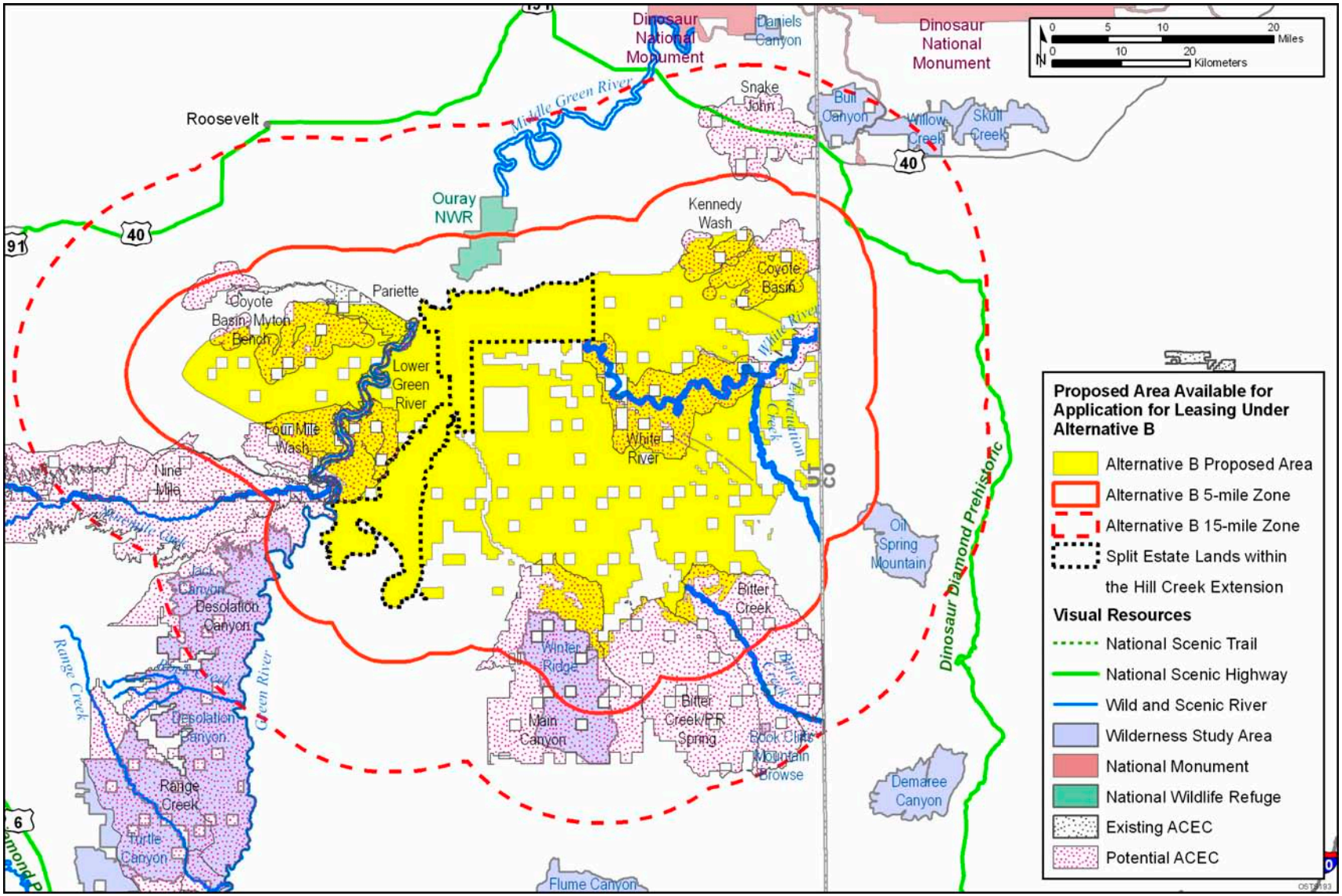


**FIGURE 6.1.2-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B in Utah**

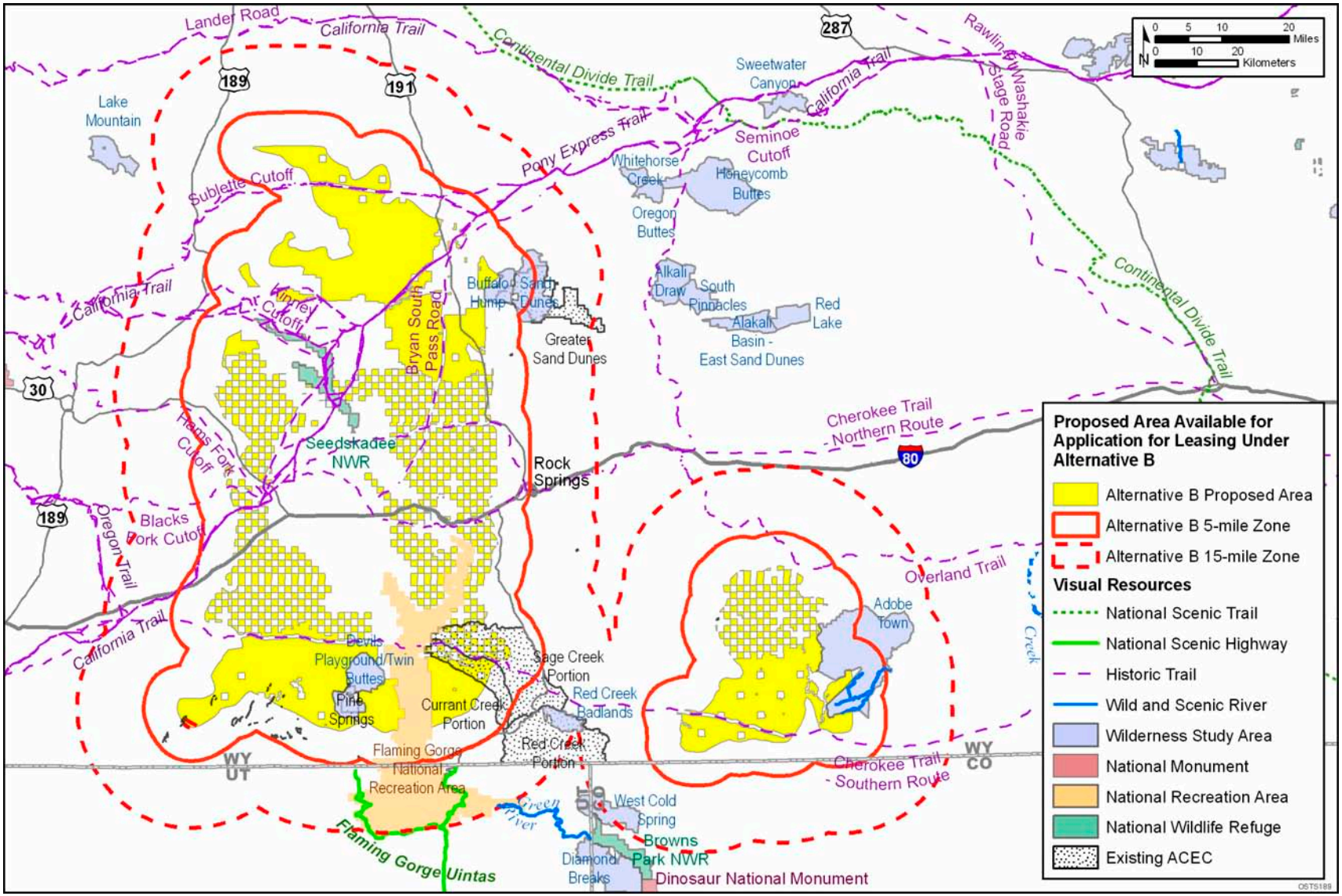


**FIGURE 6.1.2-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B in Wyoming**

- In Wyoming: Sage Creek and Currant Creek portions of Greater Red Creek ACEC; and

- In Utah: Lower Green River, Nine Mile Canyon, and Pariette ACECs; Bitter Creek–P.R. Spring, Bitter Creek, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Four Mile Wash, Lower Green River, Main Canyon, Nine Mile, and White River potential ACECs; and segments of the Green River and Lower Green River determined to be eligible for WSR designation.

Additional scenic resource areas are located within 5 miles or 15 miles of the Alternative B proposed lease areas (Figures 6.1.2-6, 6.1.2-7, and 6.1.2-8). The 5-mi zone corresponds to the BLM's VRM foreground-middleground distance limit, and the 15-mi zone corresponds to the BLM's background distance limit. Assuming an unobstructed view of the project, viewers in these areas would be likely to perceive some level of visual impact from a commercial oil shale project, with impacts expected to be greater for resources within the foreground-middleground distance, and lesser for resources within the background distance. Beyond the background distance, the project might be visible but would likely occupy a very small visual angle and create low levels of visual contrast such that impacts would be minor to negligible. Table 6.1.2-7 presents the scenic resource areas that fall within these zones.

Visual resources could be affected at and near the lease areas where commercial oil shale projects would be developed and operated, and at areas where supporting infrastructure (such as power and utility and pipeline ROWs) would be located. Visual resources could be affected by ROW clearing, project construction, and operation (see Section 4.9.1). Potential impacts would be associated with construction equipment and activity, cleared project areas, and the type and visibility of individual project components, such as shale-processing facilities, utility ROWs, and surface mines. The nature, magnitude, and extent of project-related impacts would depend on the type, location, and design of the individual project components.

#### 6.1.2.9 Cultural Resources

Under Alternative B, the amendment of land use plans to identify about 2 million acres of public land as available for commercial oil shale development would not result in impacts on cultural resources. The lands made available under Alternative B overlap with lands that have been specifically identified as having cultural resources. Approximately 18% of public lands that would be made available under Alternative B for application for leasing in the Piceance Basin have been surveyed for cultural resources; approximately 21% in the Uinta Basin; and approximately 7% in the Green River and Washakie Basins. Nearly 3,000 sites have been identified in these surveyed areas. Additional cultural resources are likely to exist in the unsurveyed portions of the proposed lease areas. On the basis of a sensitivity analysis conducted for the Class I Cultural Resources Overview (O'Rourke et al. 2007), about 270,207 acres (75%) in the Piceance Basin, 513,233 acres (81%) in the Uinta Basin, and 881,669 acres (88%) in the Green River and Washakie Basins within the Alternative B footprints have been identified as having a medium or high sensitivity for containing cultural resources.

**TABLE 6.1.2-7 Visually Sensitive Areas That Could Be Affected by Commercial Oil Shale Projects within the Lease Areas Identified under Alternative B**

| Location | Scenic Resources within 5 mi of Alternative B Lease Areas | Scenic Resources between 5 and 15 mi of Alternative B Lease Areas |
|---|---|---|
| ***Colorado*** | Black Mountain WSA; East Fork–Parachute Creek, Northwater Creek, and Trapper Creek ACECs; and segments of East Fork–Parachute Creek and Trapper Creek determined to be eligible for WSR designation. | Black Mountain and Windy Gulch WSAs; and Dinosaur Diamond Prehistoric National Scenic Highway. |
| ***Utah*** | Oil Spring Mountain, Winter Ridge, and Desolation Canyon WSAs; Lower Green River, Nine Mile, and Pariette ACECs; Bitter Creek–P.R. Spring, Bitter Creek, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Four Mile Wash, Lower Green River, Main Canyon, Nine Mile, Nine Mile–Canyon Expansion, and White River potential ACECs; and segments of the Green River, Lower Green River, Ninemile Creek, Bitter Creek, Evacuation Creek, and White River determined to be eligible for WSR designation; and Dinosaur Diamond Prehistoric National Scenic Highway. | Bull Canyon, Willow Creek, Oil Spring Mountain, Jack Canyon, Winter Ridge, Desolation Canyon, and Book Cliffs Mountain Browse WSAs; Nine Mile ACEC; Bitter Creek–P.R. Spring, Bitter Creek, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Main Canyon, Nine Mile, and Nine Mile–Canyon Expansion potential ACECs; segments of the Green River, Middle Green River, Ninemile Creek, Rock Creek, and Bitter Creek determined to be eligible for WSR designation; Dinosaur National Monument, managed by the NPS; and Dinosaur Diamond Prehistoric National Scenic Highway. |
| ***Wyoming*** | Sand Dunes, Devils Playground/Twin Buttes, Adobe Town, and Buffalo Hump WSAs; Special Status Protected Species, Sage Creek and Currant Creek portions of Greater Red Creek ACEC, Greater Sand Dunes, Pine Springs, and White Mountain Petroglyphs ACECs; Overland Trail, Bryan South Pass Road, Cherokee Trail–Northern Route, Cherokee Trail–Southern Route, Blacks Fork Cutoff, Hams Fork Cutoff, Kinney Cutoff, Slate Creek Cutoff, and Sublette Cutoff National Historic Trails; and segments of Skull Creek determined to be eligible for WSR designation. | Red Creek Badlands, Sand Dunes, Adobe Town, and West Cold Spring (Colorado) WSAs; Special Status Protected Species, Sage Creek and Currant Creek portions of Greater Red Creek ACEC, and Greater Sand Dunes ACECs; Overland Trail, Bryan South Pass Road, Cherokee Trail–Northern Route, Cherokee Trail–Southern Route, Blacks Fork Cutoff, Hams Fork Cutoff, Kinney Cutoff, Slate Creek Cutoff, and Sublette Cutoff National Historic Trails; segments of Skull Creek and Upper Green River (Utah) determined to be eligible for WSR designation; and Flaming Gorge Uintas National Scenic Highway. |

Cultural resources within these areas could be adversely impacted if leasing and future commercial development occur. Leasing itself has the potential to have an impact on cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development to cultural properties. Impacts from development could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development area, increased potential of loss of resource from looting or vandalism to resources as a result of increased human presence/activity in the sensitive areas, and visual degradation of cultural setting (see Section 4.10). Special lease stipulations may be developed for specific lease parcels based on this information and consultation with interested tribes.

#### 6.1.2.10 Socioeconomics

The socioeconomic impacts described in Section 4.11 and summarized in this section are for hypothetical individual commercial oil shale projects. These represent the types of impacts that would be incurred as a result of development made possible by the proposed land use plan amendments under Alternative B. The designation of lands as available for leasing and the amendment of land use plans would not have socioeconomic impacts. The specific socioeconomic impacts of future commercial oil shale projects would be dependent upon the technologies employed, the project size or production level, and development time lines and mitigation measures.

- Under Alternative B, surface mining with surface retorting would produce about 2,200 total (direct plus indirect) jobs in the three ROIs in the peak year of construction, with between 2,900 and 3,000 jobs during operations. Underground mining would create between 2,200 and 2,600 jobs, with between 2,900 and 3,300 jobs created during the operating period. Construction of an in situ processing facility would create between 2,300 and 2,900 jobs, producing between 780 and 950 jobs during operations. Income produced by each technology would be between $40 million and $169 million during construction and operations in the three ROIs, and peak construction employment would represent an increase of between 1.5% and 4.6% over the projected peak year employment in the three ROIs.

- Construction of power plants in association with in situ facilities (if needed) would produce between 2,800 and 3,100 total jobs in the three ROIs during the peak construction year, and between 300 and 330 jobs during operations. The construction and operation of these ancillary power plants would produce between $160 and $220 million in income in the three ROIs, and peak construction employment would represent an increase of between 2.4% and 5.6% over the projected ROI employment baseline in the peak year. Ancillary coal mine development in each ROI, also possibly associated with in situ facilities, would produce between 200 and 1,300 jobs during construction, while operations would require between 210 and 960 employees. Coal mine construction and operation would produce between $12 and $56 million in

income in the three ROIs, and peak construction employment for the coal mines would represent an increase of between 0.4% and 2.3% over the projected peak year employment in the three ROIs.

- Construction of housing provided for oil shale workers and their families would create between 560 and 620 jobs and between $10 million and $15 million in income in the ROIs. Construction of housing for power plant workers and families (associated with in situ facilities only) would create between 760 and 820 jobs, while construction of housing for coal mine workers (if needed) would produce between 52 and 320 jobs. Income of $14 million to $19 million would be produced during construction of housing for power plant workers and between $1 million and $7 million during construction of coal mine worker housing.

- Population increases associated with the construction of an underground mine project would represent an increase of between 0.6% and 1.4% over the ROI baseline population during construction and between 1% and 3.2% during operations, with similar increases expected for a surface mine. If additional power and coal are needed in association with in situ facilities, population increases associated with the construction of power plants would represent increases of between 0.8% and 1.7% during construction and between 0.1% and 0.3% during operations; and coal mine construction would increase ROI population by between 0.1% and 0.4%, with operations adding between 0.2% and 0.3% to the baseline population in each ROI.

- In-migrating population associated with oil shale facilities would absorb between 2.9% and 6.2% of vacant housing units. For a power plant (if needed), population increases associated with project construction would require between 3.8% and 6.4% of the vacant housing stock in the ROIs, while coal mine development (if needed) would require between 0.5% and 2.9% of vacant units in the ROIs.

- Construction of a surface mine facility would require an increase of between 1.1% and 1.7% in local expenditures, with increases of between 2.5% and 3.8% during operations (Table 4.11.1-5). Construction of an underground mine would require an increase in local public service provision of between 1.0% and 1.7% in expenditures during construction and between 1.8% and 3.9% during operations. Construction of an in situ facility would require an increase in local public service provision of between 1.2% and 1.9% in expenditures during construction and between 0.5% and 1.1% during operations. Construction of a power plant (if needed) would require an increase in local public service provision, requiring an increase of between 1.1% and 1.9% in expenditures during construction and between 0.2% and 0.4% during operations (Table 4.11.1-6). Coal mine development (if needed) would require an increase in local government expenditures of between 0.2%

and 0.6% during construction and of between 0.3% and 0.5% during operations.

- The number of new residents from outside the producing regions and the pace of population growth associated with the commercial development of oil shale resources, including large-scale production facilities and ancillary power plants, coal mines, and housing developments, would likely lead to substantial demographic and social change in small rural communities. These communities would likely be required to adapt to a different quality of life, with a transition away from a more traditional lifestyle in small, isolated, close-knit, homogenous communities with a strong orientation toward personal and family relationships, toward a more urban lifestyle, with increasing cultural and ethnic diversity and increasing dependence on formal social relationships within the community.

- Substantial changes in access to water by agriculture could have large impacts on the economy of each ROI, which would depend on the amount of agricultural production lost, the extent of local employment in agriculture, the reliance of other industries in each ROI on agricultural production, the extent of local procurement of equipment and supplies by agriculture, and the local spending of wage and salaries by farmers, ranchers, and farm workers. Loss of property tax revenues on agricultural land could also have an impact on local government expenditures and, consequently, on the provision of public services in local communities in each ROI. Changes in agricultural activity would likely change the character of community life in each ROI, with a movement away from activities that historically represent small rural communities.

- The impact of each oil shale technology on recreational visitation in the Colorado ROI would be the loss of 1,415 jobs if there were a 10% reduction in recreation employment, and 2,830 jobs if recreation employment were to decline by 20%. In the Utah ROI, 388 jobs would be lost as a whole as a result of a 10% reduction in recreation employment, and 776 jobs would be lost with a 20% reduction. In the Wyoming ROI, 1,360 jobs would be lost under the 10% scenario, and 2,719 jobs lost under the 20% scenario.

- Oil shale developments and their associated ancillary facilities might affect property values in ROI communities located nearby. Property values might decline in some locations as a result of the deterioration in aesthetic quality, increases in noise, real or perceived health effects, congestion, or social disruption. In other locations, property values might increase as a result of new access to employment opportunities associated with oil shale developments.

#### 6.1.2.11 Environmental Justice

The hypothetical environmental justice impacts described in Section 4.12 and summarized in this section are for hypothetical individual commercial oil shale projects. These represent the types of impacts that would be incurred as a result of development made possible by the proposed land use plan amendments under Alternative B. The designation of lands as available for leasing and the amendment of land use plans would not have environmental justice impacts. As with the environmental impacts discussed elsewhere in Section 6.1.2, the specific environmental justice impacts of future commercial oil shale projects would depend on specific project locations, the technologies employed, the project size or production level, and development time lines and mitigation measures.

Since oil shale development projects and ancillary power plant and housing developments would lead to rapid population growth in many of the communities in each ROI, it is possible that social disruption would occur, leading to the undermining of local community social structures with contrasting beliefs and value systems among the local population and in-migrants and, consequently, to a range of changes in social and community life, including increases in crime, alcoholism, drug use, etc. Impacts on property values of property owned by minority and low-income individuals would depend on the range of alternate uses of specific land parcels, current property values, and the perceived value of costs (traffic congestion, noise and dust pollution, and visual, air quality, and EMF effects) and benefits (infrastructure upgrades, employment opportunities, and local tax revenues) associated with proximity to oil shale–related facilities.

Each technology would produce surface disturbance, fugitive dust, vehicle emissions, and visible activity that could generate visual impacts. Emissions associated with construction activities would consist primarily of particulate matter ($PM_{2.5}$ and $PM_{10}$), criteria pollutants, VOCs, $CO_2$, and certain HAPs released from heavy construction equipment and vehicle exhaust. Because of the limited surface water and groundwater, the amount of water needed in Colorado for the project sites, power plants and coal mines (if needed), and associated population growth would mean that additional water resources would be needed. Oil shale facilities might impact certain animals or vegetation types that may be of cultural or religious significance to certain population groups or that form the basis for subsistence agriculture. Similarly, land used for these facilities that has additional economic uses might affect access to resources by low-income and minority population groups.

Given the location of environmental justice populations in each state, construction and operation of oil shale facilities, power plants and coal mines (if needed), and employer-provided housing could produce impacts that would be experienced disproportionately by minority and low-income populations. Of particular importance would be social disruption impacts of large increases in population in small rural communities, the undermining of local community social structures, and the resulting deterioration in quality of life. The impacts of facility operations on air and water quality and on the demand for water in the region could also be important. Land use and visual impacts might be significant depending on the location of land parcels for oil shale projects and the associated power plant and housing facilities, their importance for subsistence, their cultural and religious significance, and alternate economic uses. Depending on

the locations of low-income and minority populations, impacts could also occur with the development of transmission lines associated with power development and the supply of power to oil shale facilities in each state.

#### 6.1.2.12 Hazardous Materials and Waste Management

The identification of approximately 2 million acres of public land as being available for application for leasing and the amendment of land use plans to incorporate these areas would not result in any hazardous material or waste management concerns. Impacts related to hazardous materials and wastes could occur during future development of commercial oil shale projects within the Alternative B lease areas. Such impacts are generally independent of location and would be unique to the technology combinations used for oil shale development. However, hazardous materials and wastes are similar for some of the ancillary support activities that would be required for development of any oil shale facility regardless of the technology used. These include the impacts from development or expansions of support facilities such as employer-provided housing and power plants.

Hazardous materials and wastes would be used and generated during both the construction and operation of commercial oil shale facilities and supporting infrastructure (e.g., power plants). Hazardous materials impacts associated with project construction would be minimal and limited to the hazardous materials typically utilized in construction, such as fuels, lubricating oils, hydraulic fluids, glycol-based coolants and solvents, adhesives, and corrosion control coatings. Construction-related wastes would include landscape wastes from clearing and grading of the construction sites, and other wastes typically associated with construction, none of which is expected to be hazardous (Section 4.13.1).

During project operations, hazardous materials would be utilized, and a variety of wastes (some hazardous) would be generated. Hazardous materials used include fuels, solvents, corrosion control coatings, flammable fuel gases, and herbicides (for vegetation clearing and management at facilities or along ROWs). The types and amounts of hazardous waste generated during operations will depend on the specific design of the commercial oil shale project (surface or subsurface mining, surface retorting, in situ processes). Waste materials produced during operations may include spent shale, waste engine fuels and lubricants, pyrolysis water, flammable gases, volatile and flammable organic liquids, and heavier-molecular-weight organic compounds (Section 4.13.1).

Because the use of hazardous materials and the generation of wastes are directly related to the specific design of a commercial oil shale project, it is not possible to quantify project-related impacts of these materials. Under Alternative B, individual facilities could be located anywhere within the area identified as available for leasing, pending project review and authorization. Accidental releases of the hazardous materials or wastes could affect natural resources (such as water quality or wildlife) and human health and safety (see Section 4.14) at locations wherever the individual projects are sited within the Alternative B lease areas.

#### 6.1.2.13 Health and Safety

The identification of approximately 2 million acres of public land as being available for application for leasing and the amendment of land use plans to incorporate these areas would not result in any direct health and safety concerns. However, a number of health and safety concerns would be associated with the commercial development of oil shale projects within the Alternative B lease areas. The level of health and safety impacts would be mainly dependent on the extent of oil shale development, the extent of health and safety precautions imposed by the operators, and the design of each project (as related to the level of air and water emissions associated with a facility).

Potential health and safety impacts from the construction and operation of commercial oil shale projects would be associated with the following activities: (1) constructing project facilities and associated infrastructure, (2) mining (if processing is not in situ) the oil shale; (3) obtaining and upgrading of the crude oil, either through surface retorting or in situ processing; (4) transporting construction and raw materials to the upgrading facility and transporting product from the facility; and (5) exposing of the general public to water and air contamination associated with oil shale development. Hazards from oil shale development (summarized in Table 4.14-1) could include physical injury from construction, oil shale processing, and vehicle transportation accidents and exposure to fugitive dust and hazardous materials, such as retort emissions and industrial chemicals (Section 4.14). Health and safety impacts would be largely restricted to the immediate workforce of each facility. Accidents could also affect members of the general public who could be present in the immediate vicinity of an accident (e.g., project-related truck accident on a public road, recreational users in areas adjacent to the project lease area).

Workers could be exposed to different hazards depending on the type of jobs they do. Workers at all types of oil shale development facilities could be exposed to high noise levels, resulting in hearing loss. The health and safety of miners could be impacted by injuries or deaths due to accidents (e.g., highwall bank failures or cave-ins, uncontrolled explosions, accidents involving heavy machinery), or heat exposures. Workers operating surface retorts also could be injured or die due to accidental explosions, heat stress, or accidents involving heavy machinery. Physical hazards from well-drilling, use of explosives, and operation of heavy equipment would be present for in situ workers.

Serious and often fatal lung disease in miners has been associated with inhalation of particulates and volatile compounds containing carcinogenic PAHs; such exposures could be limited by adherence to applicable occupational health and safety standards. Lung disease caused by inhalation of emissions from the retorting process would also be of concern for retort operators, although these exposures are generally lower than those associated with mining. For workers at facilities using in situ recovery techniques, hazards associated with inhalation of emissions would also be expected to be lower than those associated with mining.

Estimates of expected injuries and fatalities can be made on the basis of numbers of employees and the type of work. Based on the numbers of employees projected to be needed for construction and operation of oil shale facilities, there would statistically be less than 1 death and

about 125 injuries per year expected per facility during construction activities, and less than one death and less than 100 injuries per year expected per facility during operations (NSC 2006). A comprehensive facility health and safety plan and worker safety training will be required as part of the Plan of Development for every proposed commercial oil shale project.

Health and safety concerns are largely independent of the location of oil shale development facilities. However, the health and safety impacts on the general public from emissions from these facilities would depend both on the specific characteristics and level of emissions, and on the distance of the emissions source from population centers. The level of air and water emissions would be regulated under required permits. Potential impacts on the general public from emissions would be assessed in future site-specific NEPA and permitting documentation.

### 6.1.3 Impacts of Alternative C

Under Alternative C, the BLM would amend the same nine BLM land use plans that would be amended under Alternative B (Section 6.1.2), but would designate only 830,296 acres of public land as available for application for leasing for commercial development of oil shale within the most geologically prospective oil shale areas in Colorado, Utah, and Wyoming (see Figures 2.3.3-4, 2.3.3-5, and 2.3.3-6). These include about 40,325 acres in Colorado, 490,460 acres in Utah, and 299,511 acres in Wyoming (Table 2.3.3-2). These public lands comprise 795,986 acres of BLM-administered lands and 34,311 acres of split estate lands. Specific land use plan amendments are provided in Appendix C.

The amendment of land use plans, as described above, would have no direct impacts on the environment or socioeconomic setting in the three-state study area. However, the development of commercial oil shale projects made possible by these land use plan amendments would have impacts on these resources. In addition, Alternative C would include the same level of development of the RD&D projects as described in Section 6.1.1 for Alternative A. The following sections describe the impacts of Alternative C on the environment and the socioeconomic setting (including the effects of land use plan amendments on the level and pace of development) of the areas identified as available for leasing application under this alternative. In general, impacts on specific resources located within the 830,296 acres cannot be quantified at this time because key information about the location of commercial projects, the technologies employed, the project size or production level, and development time lines are unknown. While it is not possible to quantify the impacts of future project development, it is possible to make observations and draw conclusions on the basis of certain lands being made available for application for leasing and their overlap with specific resources. The following sections identify the potential impact issues, many of which might be successfully avoided or mitigated depending on site- and project-specific factors and future regulations that would guide leasing actions.

At the time of preparation of this PEIS, industry has given no firm indication when commercial oil shale production may begin. Likewise, the location where commercial production may first occur also is not known, but for purposes of analysis it is reasonable to assume that

production may begin in Colorado's Piceance Basin where the thickest and richest known oil shale resources are found and where R&D is currently ongoing on both private and federal lands.

#### 6.1.3.1 Land Use

Alternative C would amend the same nine land use plans as Alternative B but would identify approximately 830,000 acres of public land in Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale (approximately 36% of the study area). The amendment of the land use plans is expected to have no direct impacts on other land uses. The identification of these lands does not authorize or approve any ground-disturbing activities that could affect existing land uses. Existing land uses could, however, be adversely affected by future commercial oil shale development on these lands.

The nature of the impacts of Alternative C on land uses would be the same as those listed under Alternative B above, with exceptions that are included below. Although Alternative C makes approximately 1.2 million fewer acres available for application for commercial leasing, it does not provide for less potential development of commercial oil shale than does Alternative B. Alternative C does remove from consideration for leasing lands with sensitive resources that have been identified in current BLM land use plans including all existing ACECs.

The following are areas where the impacts of Alternative C could differ from those described for Alternative B in Section 6.1.2.1:

- In the Piceance Basin, Alternative C would likely have less of an impact on oil and gas operations because considerably fewer acres of potentially valuable oil and gas deposits in a rapidly developing area would be available for application for commercial oil shale development.

- Alternative C removes from application for leasing approximately 23,000 acres of land identified as ACECs.

- Lands available for application for lease contain all or portions of areas that have been recognized by the BLM in Utah and Wyoming as having one or more characteristics of wilderness. Table 6.1.2-1 lists these areas. Should commercial development occur on these lands, the identified wilderness characteristics in both the areas that are developed and those which border the developed areas would be lost. Alternative C includes approximately 110,000 acres of these lands that would be subject to potential development.

- In Utah there are areas that have been identified as being eligible for designation as ACECs. These areas are being reviewed as part of ongoing land use planning activities that may or may not be complete before this Draft PEIS is published. Table 6.1.2-2 (in Section 6.1.2) lists by field office the areas and the number of acres of overlap that would be available for application for commercial oil shale leasing. If oil shale development occurs

on these lands, depending on the nature of resources present on the lands, it is likely these resources would be lost. The decisions regarding designation of these lands will be made at the field office level and not in this PEIS. Should designation as an ACEC be completed before this PEIS is complete, these lands may not be available for lease. If this PEIS is completed before the land use planning process is completed, the field offices still would make the decisions regarding the future management of these lands and would determine whether they would be available for application for leasing for commercial oil shale development. Alternative C includes approximately 137,000 acres of these lands that would be subject to potential development.

- A portion of the land within the preference right lease area established for the five Colorado RD&D projects and the OSEC RD&D project in Utah would not be available for application for leasing under Alternative C by applicants other than the existing RD&D leaseholders. These lands would be excluded in order to provide maximum protection to sensitive resources identified in these areas (see Figure 2.3.3-4). Specifically, portions of the areas associated with the Chevron, EGL, and Shell Site 2 RD&D projects would be excluded. In addition, the entire preference right lease areas for the Shell Sites 1 and 3 would be excluded. As with Alternative B, a portion of the land within the preference right lease area established for the OSEC RD&D project also may not be available for application for leasing under Alternative C, depending on whether a portion of Evacuation Creek is designated as a WSR.

  Under the terms of the RD&D program, the federal government has a commitment to grant the RD&D companies leases for commercial development within the preference right lease areas, provided all conditions of the program are met (see Section 1.4.1, which includes the provision that BLM finds the environmental impacts identified in site-specific analyses for the proposed lease are acceptable). As a result, all lands within the preference right lease areas would be available for issuance of commercial leases to the RD&D companies under Alternative C if they meet all conditions of the program. The federal government is not under an obligation to grant leases for commercial development within these areas to any other applicants.

#### 6.1.3.2 Soil and Geologic Resources

Under Alternative C, 830,296 acres of public land in Colorado, Utah, and Wyoming would be identified as available for leasing application for commercial oil shale development. The identification of these lands for leasing availability, as well as the amendment of land use plans to incorporate these areas, would not affect soil and geologic resources in these lands. Development of commercial oil shale projects could, however, affect soil and geologic resources in these lands. Construction-related activities could directly disturb surface and subsurface soils during clearing and grading activities and construction of project facilities and infrastructure. This disturbance could include soil disturbance, removal, and compaction, and disturbed areas

would be more susceptible to the effects of precipitation and wind-driven erosion (see Section 4.3.1). Surface and subsurface mining activities during project operations would directly disturb geologic resources. Erosion of exposed soils could lead to increased sedimentation of nearby water bodies and to the generation of fugitive dust. Soils in project areas would remain susceptible to erosion until completion of construction, mining, and oil shale-processing activities, and site stabilization and reclamation (e.g., revegetation of pipeline ROWs, surface mine reclamation). Impacts on soil and geologic resources would be limited to the specific project location as well as areas where associated off-lease infrastructure (such as access roads, utility ROWs, and power plants) would be located. For any project, the erosion potential of the soils will be a direct function of the lease and project location, and the soil characteristics, vegetative cover, and topography (i.e., slope) at that location. Development in areas that have erosive soils and steep slopes (e.g., in excess of 25%) could lead to serious erosion problems at those locations.

Under Alternative C, project-related impacts could occur wherever individual projects are located within the 830,296 acres identified for leasing application under this alternative. Utah would have the most land (490,460 acres) and Colorado the least land (40,325 acres) where commercial oil shale development could affect soil and geologic resources.

#### 6.1.3.3 Paleontological Resources

Under Alternative C, 830,296 acres in the four oil shale basins would be identified as being available for application for leasing and potential future commercial development. The identification of these lands as available for leasing, as well as the amendment of land use plans to incorporate these areas, would not affect paleontological resources because these actions do not authorize or approve any ground-disturbing activities. All existing ACECs, some of which have been identified for their paleontological values, would not be made available for application for leasing under this alternative, and, therefore, the paleontological resources present in these areas would not be impacted under this alternative. However, the lands that are made available for application for leasing also overlap with some lands known to be potentially rich in paleontological resources. Of the acreage identified as available for application for leasing under Alternative C, a total of 749,920 acres (approximately 90%) have been identified as having the potential to contain important paleontological resources (Murphey and Daitch 2007). Approximately 38,030 of these high potential acres are present in the Piceance Basin; 444,160 acres are present in the Uinta Basin; and 267,730 acres are present in the Green River and Washakie Basins. Resources within these areas could potentially be adversely impacted if leasing and subsequent commercial development occur. Impacts could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development areas, and increased potential for loss of resources from looting or vandalism as a result of increased human presence/activity in the sensitive areas (see Section 4.4).

#### 6.1.3.4 Water Resources

Under Alternative C, approximately 830,000 acres of public land (about 36% of the study area) would be made available for application for leasing for commercial development of oil shale within Colorado, Utah, and Wyoming. The acreage available for application for leasing in this alternative specifically excludes lands identified in BLM land use plans as sensitive for numerous different resources (see Table 2.2.3-3). Excluding these lands from application for leasing would provide complete protection from direct impacts for the resources found on these lands. In those areas that are available for application for leasing in both Alternatives B and C, the potential impacts would be the same as described in Section 6.1.2.4 of this PEIS.

The total stream miles within the four oil shale basins is approximately 543 miles. Alternative C contains approximately 66 miles of these perennial streams.

The assessment of impacts on water resources under Alternative C has the same limitations as referenced under Alternative B. Without site-specific information regarding location and type of technology to be employed, it is not possible to assess the overall impacts of this alternative.

#### 6.1.3.5 Air Quality

Air resources in the three states would not be affected by the identification of approximately 830,000 acres of public lands for leasing or by the amendment of the land use plans to incorporate these lease areas. Air resources in and around these areas could, however, be affected by potential future commercial oil shale development within the basin areas. Under Alternative C, local, short-term air quality impacts could be incurred as a result of (1) PM releases (fugitive dust, diesel exhaust) during construction activities such as site clearing and grading in preparation of facility construction, and (2) exhaust emissions ($SO_2$, CO, and $NO_x$) from construction equipment (see Section 4.6). These potential impacts would be largely limited to specific project locations and the immediately adjacent areas. Similar short-term impacts could also occur in other areas where project-related electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located and developed.

Similar but longer term impacts on local air quality could occur during normal project operations such as mining and processing of the oil shale. Processing activities could also result in regional impacts on air quality that could extend beyond the lease areas identified under Alternative C. These regional impacts would be associated with operational releases of CO, $NO_x$, PM, and other pollutants (VOCs and $SO_2$) during oil shale processing (Section 4.6). Operational releases of certain hazardous air pollutants (such as benzene, toluene, and formaldehyde) as well as diesel PM could also affect on-site workers and nearby residences, but these impacts would be localized to the immediate project location and subject to further analysis prior to implementation.

If development of oil shale requires expansion of capacity of existing electric power plants, or the construction and operation of new electric power plants off-lease, those would also

have longer-term impacts on regional air quality. See Table 6.1.5.1-3 for a summary of the emissions from coal-fired electric power plants.

#### 6.1.3.6 Noise

Ambient noise levels in the potential lease areas under Alternative C would not be affected by the identification of these lands for leasing application, or by the amendment of land use plans to incorporate these lease areas. However, ambient noise levels could be affected by future commercial development of oil shale. Under Alternative C, local, short-term changes in ambient noise levels could be incurred during the construction, operation, and reclamation of oil shale projects (see Section 4.7.1). Project-related increases in noise levels could disturb or displace wildlife and recreational users in nearby areas. Noise impacts on wildlife and recreational users are discussed in Sections 4.8.1 and 4.2.1.4, respectively.

Increased noise levels could result from the operation of construction equipment (graders, excavators, haul trucks) and from any blasting activities that might occur. Increases in noise levels during operations would be associated with mining and oil shale-processing activities and could be more long term than construction-related noise. These types of impacts would be largely limited to specific project locations and the immediate surrounding area. Similar short-term impacts could also occur in other areas where electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located, developed, and operated. For example, ambient noise levels could increase in the immediate vicinity of any pipeline pump stations and be affected by project-related vehicular traffic at the project site and related locations (such as access roads to the site).

Construction-related noise levels could exceed EPA and Colorado guidelines at some distances from the construction sites (there are currently no state guidelines for Utah or Wyoming). Similarly, operational noise associated with mining and retort activities could, in the absence of mitigation, exceed EPA guidelines at some project locations. Noise generated as a result of project-related (but nonconstruction) vehicular traffic is not expected to exceed either EPA or Colorado guideline levels except for short durations and in areas close to roads or traffic.

In the absence of lease- and project-specific information, it is not possible at the level of this programmatic EIS to identify the duration and magnitude of any project-related changes in noise levels. Changes in ambient noise levels due to project development could occur wherever a project is located within the 830,296 acres identified for lease application under Alternative C.

#### 6.1.3.7 Ecological Resources

Under Alternative C, approximately 830,296 acres of public land would be made available within Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale. These lands support a wide variety of biota and their habitats (Section 3.7). Ecological resources in these areas would not be affected by the identification of future lands available for leasing application, or by amendment of land use plans to incorporate

these lease areas. However, ecological resources in and around these areas could be affected by future commercial development of oil shale in these areas. The following sections describe the potential impacts on ecological resources that may result from commercial oil shale development within the lease areas identified under Alternative C.

The specific ecological resources that could be impacted by commercial oil shale development of the Alternative C lease areas, as well as the magnitude and location of potential impacts, would depend on the specific location of the commercial oil shale projects as well as on specific project design.

**6.1.3.7.1 Aquatic Resources.** The lands that would be made available under Alternative C for leasing application contain 18 perennial streams totaling about 65 mi (Table 6.1.3-1). These streams, as well as numerous unnamed streams and other surface waters (such as ponds), provide habitat for a variety of aquatic resources. The development of commercial oil shale projects in lease areas identified under Alternative C could affect local aquatic resources (such as local fish populations) during project construction and operations. Impacts on aquatic resources could occur from the operation of oil shale projects because of (1) direct disturbance of aquatic habitats within the footprint of construction or operation activities; (2) sedimentation of nearby aquatic habitats as a consequence of soil erosion from operational areas; and (3) decreased habitat quality because of changes in water quantity or water quality as a result of construction (e.g., grading that affects surface runoff patterns), operations (e.g., depletions or discharges of water into nearby aquatic habitats), or releases of chemical contaminants into nearby aquatic systems (see Section 4.8.1.1). Impacts could result in short- and/or long-term changes (disturbance or loss) in the abundance and distribution of affected biota and their habitats. The nature and magnitude of these impacts, as well as the specific resources affected, would depend on the location of the areas where project construction and facilities would occur, the aquatic resources present in those areas, and the mitigation measures implemented to address impacts.

**TABLE 6.1.3-1 Perennial Streams Occurring within the Lease Areas Identified under Alternative C**

| State | Number of Perennial Streams | Length of Perennial Stream (mi) |
|---|---|---|
| Colorado | 8 | 2.8 |
| Utah | 8 | 57.7 |
| Wyoming | 2 | 4.4 |
| Total | 18 | 64.9 |

**6.1.3.7.2 Plant Communities and Habitats.** Plant communities and habitats could be affected during the development of commercial oil shale projects in the lease areas identified under Alternative C. Alternative C identifies approximately 830,296 thousand acres of land as available for lease application, and these areas support a wide variety of plant communities and habitats (see Section 3.7.2). Direct and indirect impacts could be incurred during project construction and operation, extending over a period of several decades (especially within facility and infrastructure footprints) (see Section 4.8.1.2). Some impacts, such as habitat loss, may continue beyond the termination of shale oil production.

Direct impacts would include the destruction of vegetation and habitat during land clearing on the lease site and where ancillary facilities such as access roads, pipelines, transmission lines, employer-provided housing, and new power plants would be located. Soils disturbed during construction would be susceptible to the introduction and establishment of non-native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. Plant communities and habitats could also be adversely affected by changes in water quality or availability, resulting in plant mortality or reduced growth, with subsequent changes in community composition and structure and declines in habitat quality. Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. These impacts could lead to changes in the abundance and distribution of plant species and changes in community structure, as well the introduction or spread of invasive species.

Affected plant communities and habitats could incur short- and/or long-term changes in species composition, abundance, and distribution. While many impacts would be local in nature (occurring within construction and operation footprints and in the immediate surrounding area), the introduction of invasive species could affect much larger areas. The nature and magnitude of these impacts, as well as the communities or habitats affected, would depend on the location of the areas where project construction and facilities would occur, the plant communities and habitats present in those areas, and the mitigation measures implemented to address impacts.

**6.1.3.7.3 Wildlife.** Under Alternative C, about 830,296 acres of land in Colorado, Utah, and Wyoming would be identified as available for lease application for commercial oil shale development. These areas and surrounding locations support a diverse array of wildlife and habitats (see Section 3.7.3). While important areas (such as big game wintering areas and sage grouse habitat) are identified for protection in current BLM land use plans, none of these identified areas occur on the Alternative C lease areas.

The Alternative C lease areas do overlap areas identified by state natural resource agencies as important for sage grouse and big game species. These areas include sage grouse habitat and lek sites (Figure 6.1.3-1), and mule deer and elk winter and summer ranges (Figures 6.1.3-2 and 6.1.3-3). Table 6.1.3-2 presents the amounts of these habitats (as identified by state resource agencies) that would occur in the Alternative C lease areas and could be impacted by future commercial oil shale development in these areas. In addition, four current and historic sage grouse leks have been identified in Wyoming in areas overlapped by the Alternative C lease areas in that state (Figure 6.1.3-1).

Several wild horse HMAs overlap with the lands that would be available for application for leasing, including the Piceance–East Douglas Creek HMA in Colorado (nearly 9,300 acres); the Hill Creek HMA in Utah (more than 23,600 acres); and the Adobe Town (nearly 40,900 acres), Little Colorado (over 87,350 acres), Salt Wells Creek (nearly 48,300 acres), and White Mountain (nearly 38,100 acres) HMAs in Wyoming (Figure 6.1.3-4).

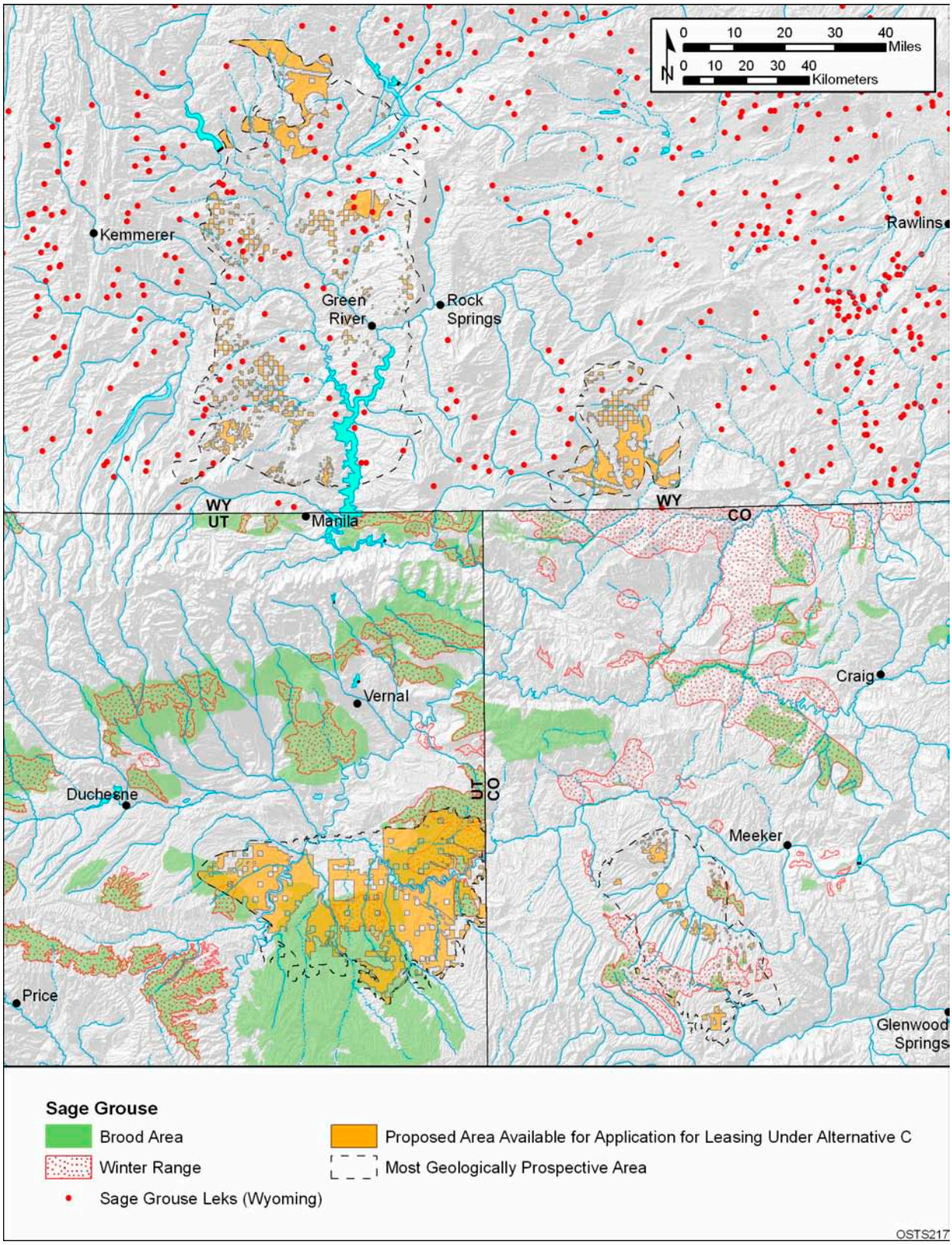


**FIGURE 6.1.3-1 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Known Distribution of the Greater Sage-Grouse**

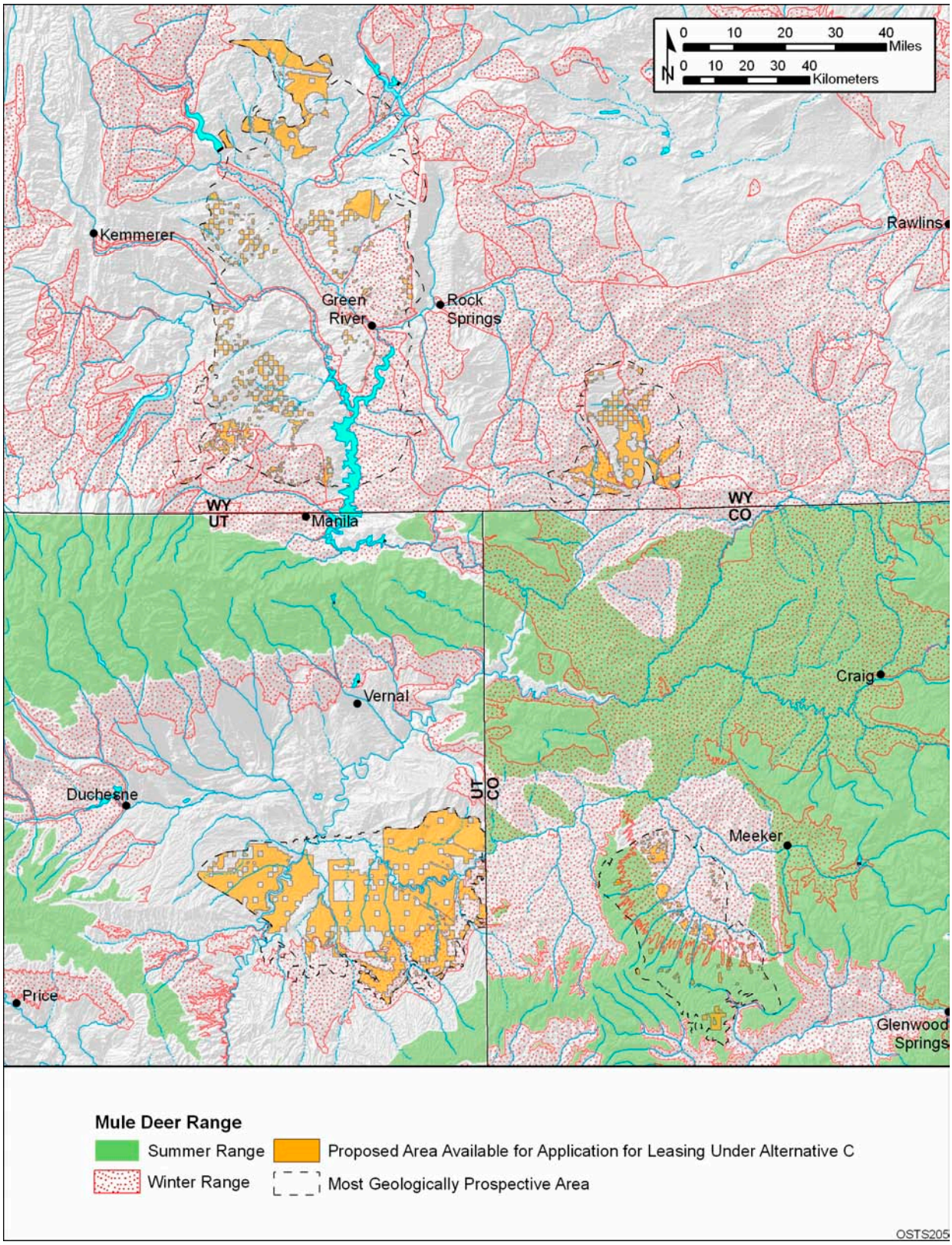


**FIGURE 6.1.3-2 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Mule Deer**

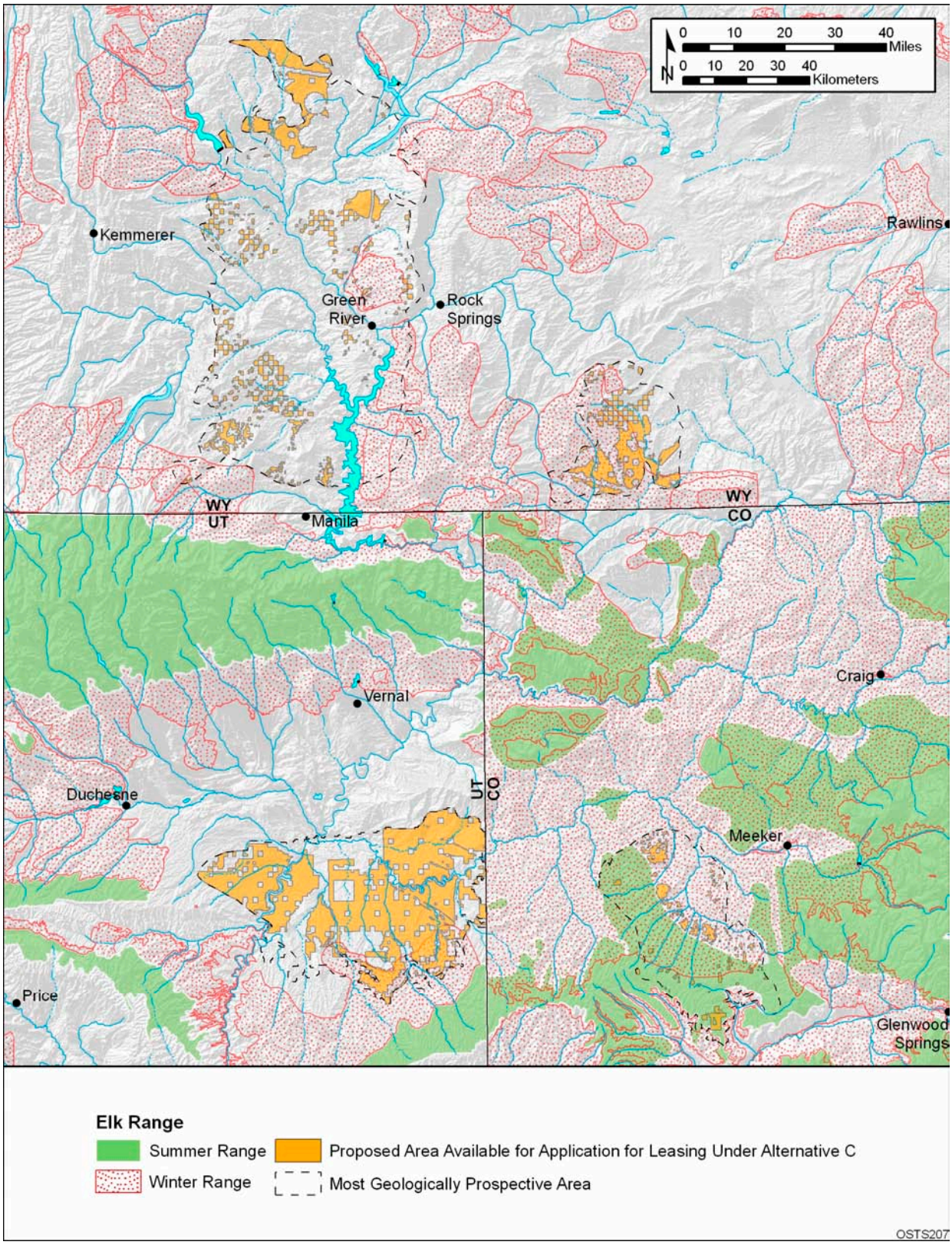


**FIGURE 6.1.3-3 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Elk**

**TABLE 6.1.3-2 Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in the Lease Areas Identified under Alternative C**

| Wildlife Resource | Colorado | Utah | Wyoming | Total |
|---|---|---|---|---|
| Sage grouse habitat | 10,078 | 345,714 | NA[a] | 355,792 |
| Mule deer winter habitat | 25,862 | 87,037 | 67,301 | 180,200 |
| Mule deer summer habitat | 12,339 | 0 | NA | 12,339 |
| Elk winter habitat | 29,406 | 51,999 | 63,795 | 145,200 |
| Elk summer habitat | 12,335 | 0 | NA | 12,335 |

[a] NA = data not available

Impacts on wildlife from commercial oil shale projects (see Section 4.8.1.3) in Alternative C lease areas could occur in a number of ways and would be related to (1) habitat loss, alteration, or fragmentation; (2) disturbance and displacement of biota; (3) mortality; (4) exposure to hazardous materials; and (5) increase in human access. These could result in changes in species distribution and abundance; habitat use; changes in behavior; collisions with structures or vehicles; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminant exposures.

Wildlife could also be affected by human activities that are not directly associated with the oil shale project or its workforce but that are instead associated with the potentially increased access to BLM-administered lands that had previously received little use. The construction of new access roads or improvements to old access roads could lead to increased human access into the area. Potential impacts associated with increased access include (1) the disturbance of wildlife from human activities, including an increase in legal and illegal take and an increase of invasive vegetation, (2) an increase in the incidence of fires, and (3) increased runoff that could adversely affect riparian or other wetland areas that are important to wildlife.

**6.1.3.7.4 Threatened and Endangered Species.** There is a potential for commercial oil shale development projects to adversely affect most of the threatened, endangered, and sensitive species that occur in the counties where development could occur (Tables 4.8.1-3 and 4.8.1-4). This potential for adverse impacts results from a lack of specificity on the locations of lease areas, lack of project specifications, and the often incomplete information on species distributions.

Fourteen federally listed threatened or endangered species could occur in areas that would be made available for leasing under Alternative C (see Table 4.8.1-4). There are about 71 mi of critical habitat for Colorado River endangered fishes in Colorado and Utah (Figure 6.1.3-5) that are located within the lands that would be made available for application for leasing and where future commercial oil shale development could occur under Alternative C.

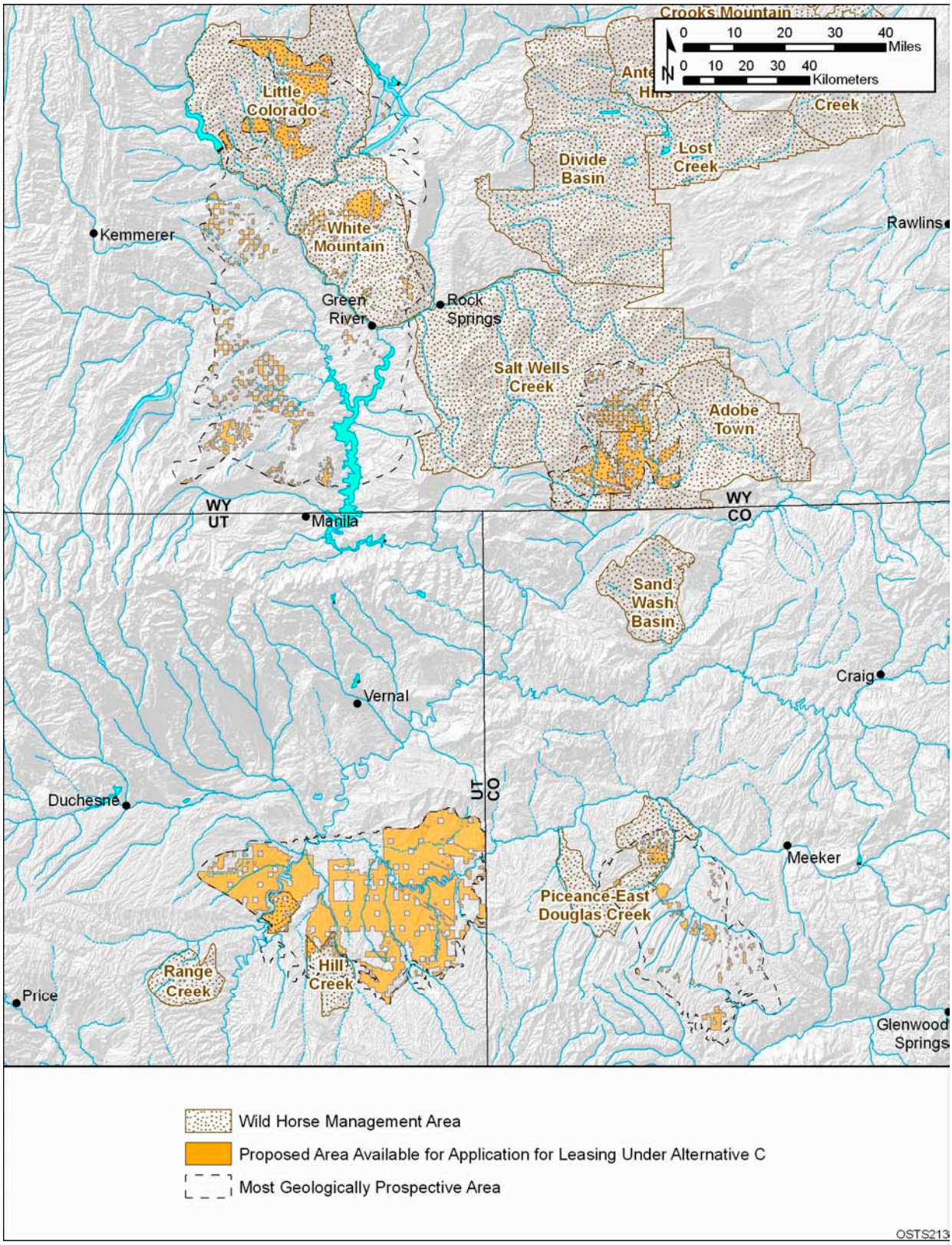


**FIGURE 6.1.3-4 Overlap of Lands Made Available for Application for Leasing under Alternative C with Wild Horse Herd Management Areas**

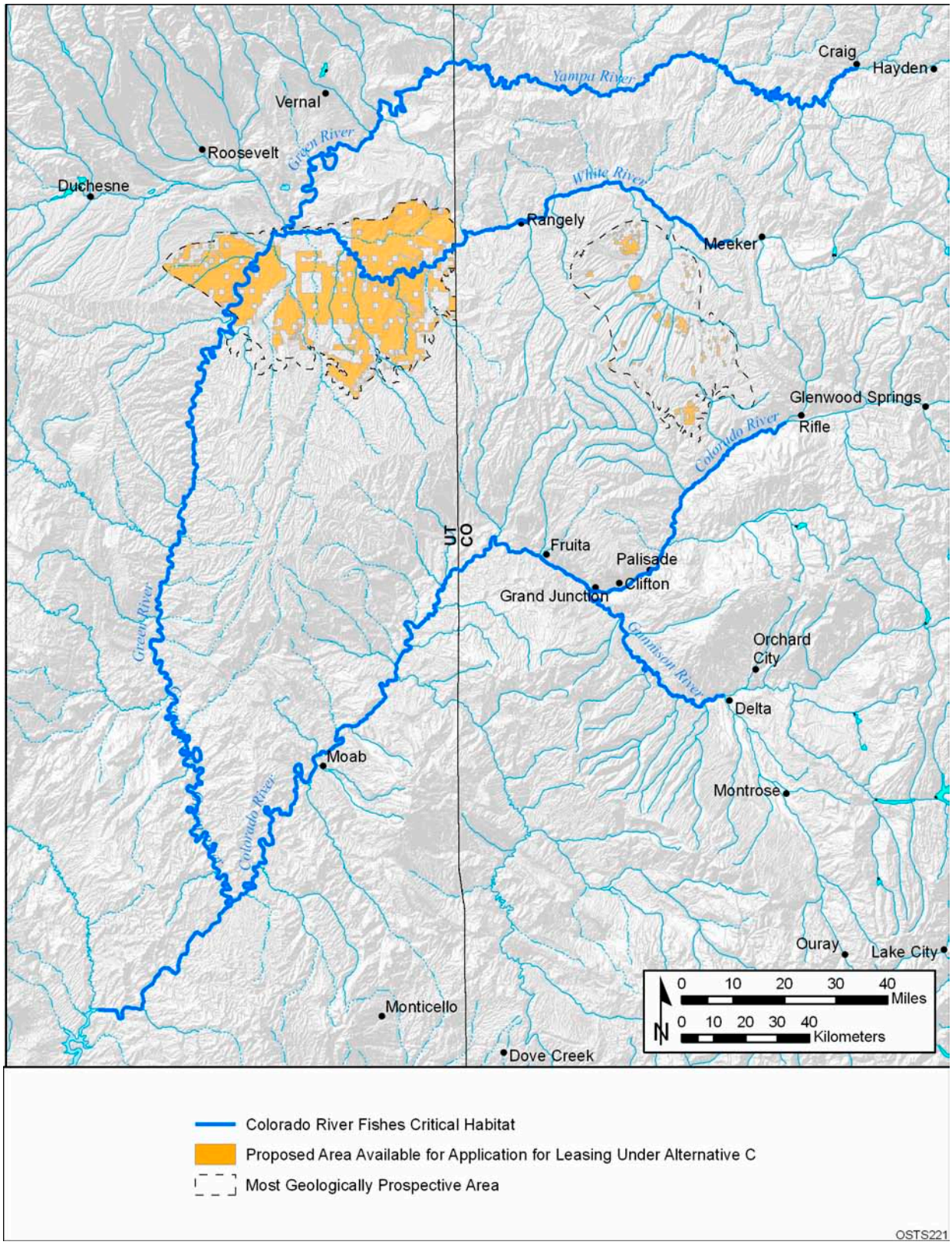


**FIGURE 6.1.3-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative C**

The potential impacts on threatened, endangered, and sensitive species (and their habitats) by commercial oil shale development are directly related to the amount of land disturbance that could occur with a commercial project (including ancillary facilities such as power plants and utility and pipeline ROWs), the duration and timing of construction and operation periods, and the habitats affected by development (i.e., the location of the project). Indirect impacts resulting from the erosion of disturbed land surfaces and disturbance and harassment of animal species would be proportional to the amount of land disturbance.

Impacts on threatened and endangered species are fundamentally similar to or the same as impacts on aquatic resources (see Section 4.8.1.4); plant communities and habitats; and wildlife described in Sections 4.8.1.1, 4.8.1.2, and 4.8.1.3, respectively. The most important difference is the potential consequence of the impacts. Because of the low population sizes of threatened and endangered species, they are far more vulnerable than more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development.

#### 6.1.3.8 Visual Resources

The lands made available for application for leasing under Alternative C support a wide variety of visual resources (Section 3.8). These resources would not be affected by the amendment of land use plans, or by the identification of these lands for leasing application to incorporate these lease areas. However, visual resources in and around these potential lease areas could be affected by subsequent commercial development of oil shale.

Several scenic resource areas are located in Utah within the area that would be available for application for commercial leasing under Alternative C. Specifically, these areas (shown in Figures 6.1.3-6, 6.1.3-7, and 6.1.3-8) include the following potential ACECs: Bitter Creek–P.R. Spring, Bitter Creek, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Four Mile Wash, Lower Green River, Main Canyon, Nine Mile, and White River.

Scenic resource areas are also located within 5 mi or 15 mi of the areas that would be made available for application for commercial leasing under Alternative C (Figures 6.1.3-6, 6.1.3-7, and 6.1.3-8). These 5-mi and 15-mi zones correspond to the BLM's VRM foreground-middleground and background distance limits, respectively. Assuming an unobstructed view of a commercial oil shale project, viewers in these areas would be likely to perceive some level of visual impact from a commercial oil shale project, with impacts expected to be greater for resources within the foreground-middleground distance, and lesser for those areas within the background distance. Beyond the background distance, the project might be visible but would likely occupy a very small visual angle and create low levels of visual contrast such that impacts would be minor to negligible. Table 6.1.3-3 presents the scenic resource areas that would fall within these zones under Alternative C.

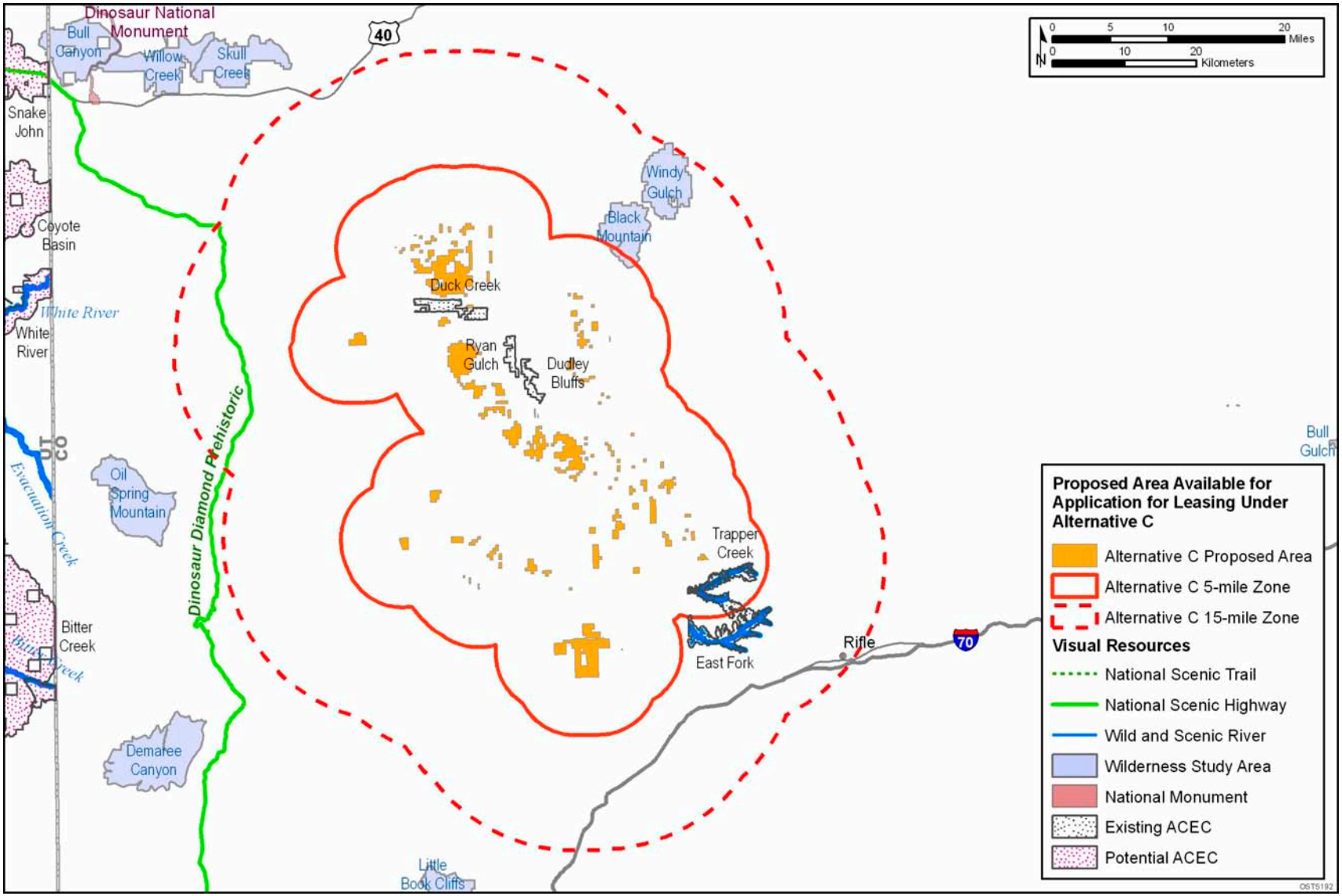


**FIGURE 6.1.3-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C in Colorado**

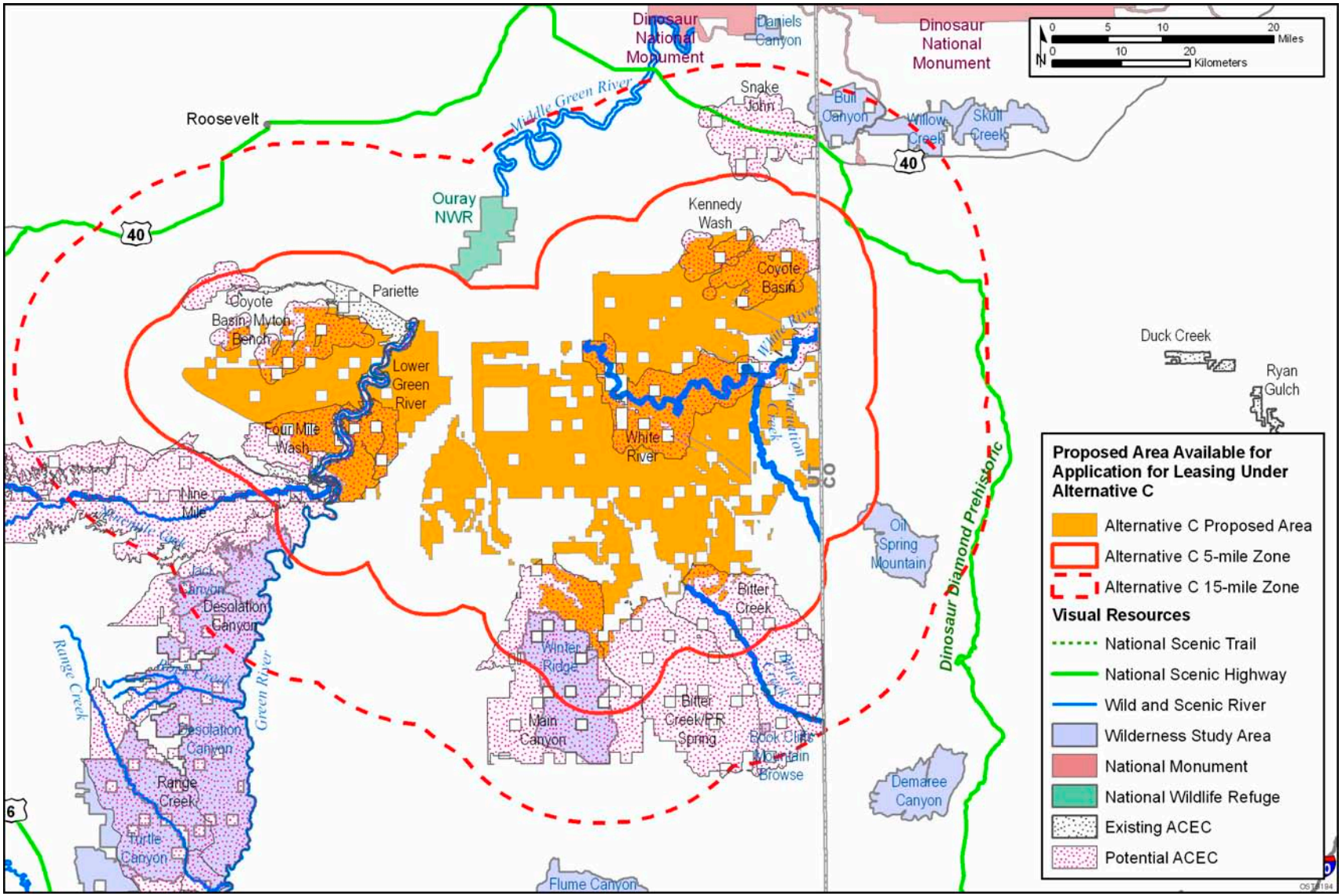


**FIGURE 6.1.3-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C in Utah**

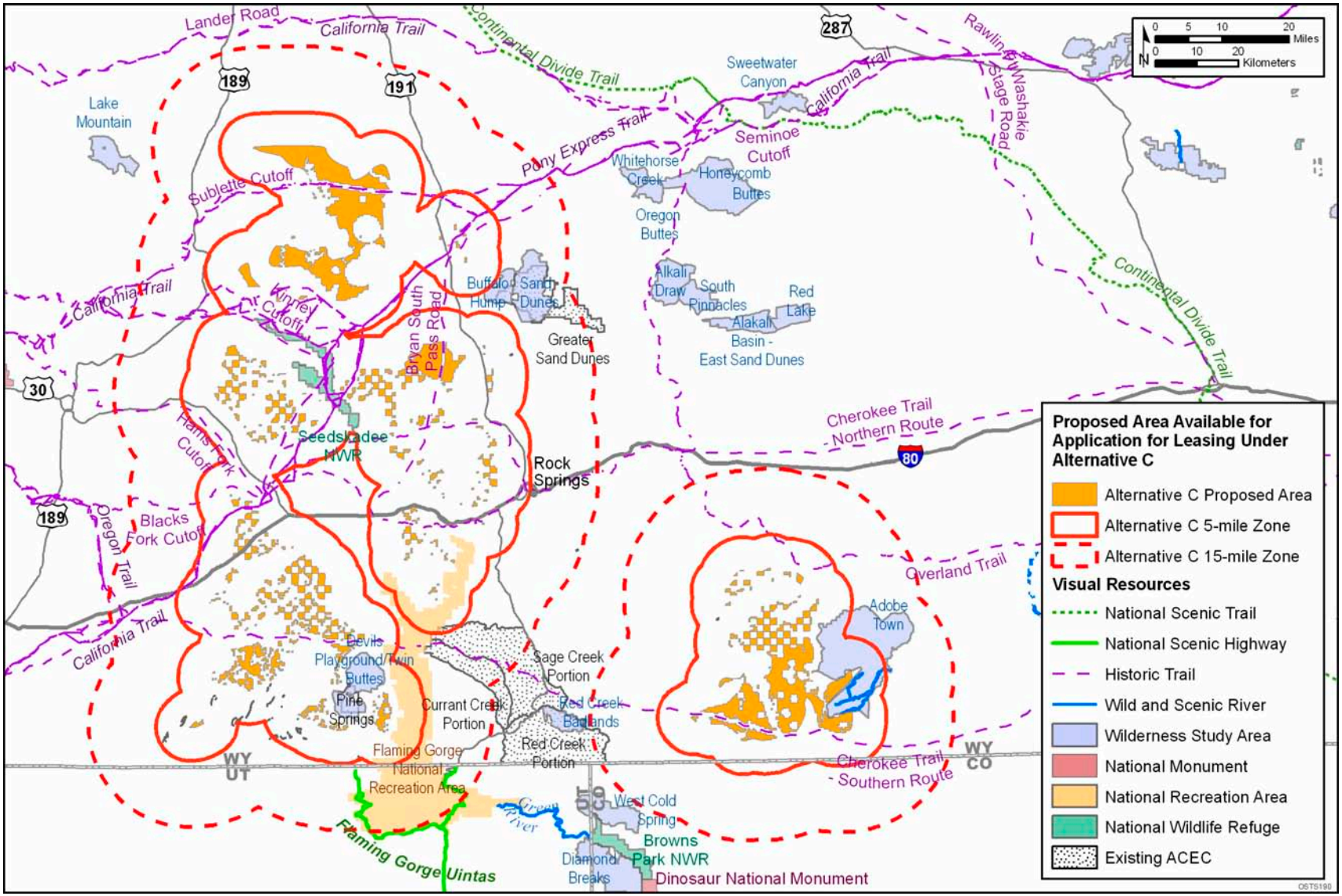


**FIGURE 6.1.3-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C in Wyoming**

**TABLE 6.1.3-3 Visually Sensitive Areas That Could Be Affected by Commercial Oil Shale Projects Developed in the Alternative C Lease Areas**

| Location | Scenic Resources within 5 mi of Alternative C Lease Areas | Scenic Resources between 5 and 15 mi of Alternative C Lease Areas |
|---|---|---|
| ***Colorado*** | Black Mountain WSA; East Fork–Parachute Creek, Northwater Creek, Ryan Gulch, Trapper Creek, Dudley Bluffs, and Duck Creek ACECs; and segments of Trapper Creek and Northwater Creek determined to be eligible for WSR designation. | Black Mountain and Windy Gulch WSAs; East Fork-Parachute Creek and Northwater Creek ACECs; segments of East Fork–Parachute Creek and First Anvil Creek determined to be eligible for WSR designation; and Dinosaur Diamond Prehistoric National Scenic Highway. |
| ***Utah*** | Oil Spring Mountain, Winter Ridge, and Desolation Canyon WSAs; Lower Green River, Nine Mile, and Pariette ACECs; Bitter Creek–P.R. Spring, Bitter Creek, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Four Mile Wash, Lower Green River, Main Canyon, Nine Mile, Nine Mile–Canyon Expansion, and White River potential ACECs; segments of the Green River, Lower Green River, Bitter Creek, Evacuation Creek, Nine Mile Creek, and White River determined to be eligible for WSR designation; and Dinosaur Diamond Prehistoric National Scenic Highway. | Bull Canyon, Willow Creek, Oil Spring Mountain, Jack Canyon, Winter Ridge, Desolation Canyon, and Book Cliffs Mountain Browse WSAs; Nine Mile ACEC; Bitter Creek–P.R. Spring, Bitter Creek, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Main Canyon, Nine Mile, and Nine Mile–Canyon Expansion potential ACECs; segments of the Green River, Middle Green River, Bitter Creek, and Nine Mile Creek determined to be eligible for WSR designation; Dinosaur National Monument, managed by the NPS; and Dinosaur Diamond Prehistoric National Scenic Highway. |
| ***Wyoming*** | Devils Playground/Twin Buttes, Adobe Town, and Buffalo Hump WSAs; Special Status Protected Species, Sage Creek Portion of Greater Red Creek ACEC, Pine Springs, and White Mountain Petroglyphs ACECs; Overland Trail, Bryan South Pass Road, Cherokee Trail–Northern Route, Cherokee Trail–Southern Route, Blacks Fork Cutoff, Hams Fork Cutoff, Kinney Cutoff, Slate Creek Cutoff, and Sublette Cutoff National Historic Trails; and segment of Skull Creek determined to be eligible for WSR designation. | Sand Dunes, Adobe Town, and Buffalo Hump WSAs; Special Status Protected Species and Greater Sand Dunes ACECs, and the Red Creek, Sage Creek and Currant Creek portions of Greater Red Creek ACEC; Overland Trail, Bryan South Pass Road, Cherokee Trail–Northern Route, Cherokee Trail–Southern Route, Blacks Fork Cutoff, Hams Fork Cutoff, Kinney Cutoff, Slate Creek Cutoff, and Sublette Cutoff National Historic Trails; segment of Skull Creek determined to be eligible for WSR designation; and Flaming Gorge Uintas National Scenic Highway. |

Visual resources could be affected at and near the Alternative C lease areas where commercial oil shale projects are developed and operated, and at areas where supporting infrastructure (e.g., plants and utility and pipeline ROWs) would be located. Visual resources could be affected by ROW clearing, project construction, and operation (see Section 4.9.1). Potential impacts would be associated with construction equipment and activity, cleared project areas, and the type and visibility of individual project components such as shale-processing facilities, utility ROWs, and surface mines. The nature, magnitude, and extent of project-related impacts would depend on the type, location, and design of the individual project components.

#### 6.1.3.9 Cultural Resources

Under Alternative C, the amendment of land use plans to identify 830,296 acres of public land as available for commercial oil shale development would not result in impacts on cultural resources. Existing ACECs, some of which have been identified for their cultural values, including about 7,300 acres in Wyoming (the West Sand Dunes Archaeological District), will not be made available for application for leasing under this alternative, and therefore the cultural resources present in these areas will not be impacted under this alternative. The remaining lands made available for application for leasing overlap, with some lands identified as having cultural resources present. Approximately 10% of public lands that would be made available for application for leasing in the Piceance Basin under Alternative B have been surveyed for cultural resources; approximately 21% in the Uinta Basin; and approximately 8% in the Green River and Washakie Basins. In these areas that have been surveyed nearly 1,200 sites have been identified. Additional resources are likely in unsurveyed portions of the study area. On the basis of a sensitivity analysis conducted for the Class I Cultural Resources Overview (O'Rourke et al. 2007), 35,440 acres (88%) of the Piceance Basin, 409,382 acres (84%) of the Uintah Basin, and 274,233 acres (92%) of the Green River and Washakie Basins Alternative C footprints have been identified as having a medium or high sensitivity for containing cultural resources.

Cultural resources within these areas could be adversely impacted if leasing and future commercial development occur. Leasing itself has the potential to have an impact on cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development on cultural properties. Impacts of development could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development area, increased potential of loss of resources from looting or vandalism as a result of increased human presence/activity in the sensitive areas, and visual degradation of cultural setting (see Section 4.10). Special lease stipulations could be developed for specific lease parcels based on this information and consultation with interested Tribes.

#### 6.1.3.10 Socioeconomics

Although the employment levels for specific technologies and the consequent socioeconomic impacts of Alternative C would not be dependent on the exact locations of

specific developments, the types of impacts that would occur as a result of development made possible by the proposed land use plan amendments under Alternative C would be the same as those described in Section 4.11 and summarized in Section 6.1.2.10. The specific socioeconomic impacts would be dependent upon the technologies employed, the project size or production level, and development time lines and mitigation measures.

#### 6.1.3.11 Environmental Justice

Although the environmental justice impacts of Alternative C would be dependent on the exact locations of specific developments, the types of impacts that would occur as a result of development made possible by the proposed land use plan amendments under Alternative C would be the same as those described in Section 4.12 and summarized in Section 6.1.2.11. As with the environmental impacts discussed elsewhere in Section 6.1.3, the specific environmental justice impacts would be dependent upon the technologies employed, the project size or production level, and development time lines and mitigation measures.

#### 6.1.3.12 Hazardous Materials and Waste Management

The amendment of land use plans under Alternative C to identify 830,296 acres of land as available for application for leasing for commercial oil shale development would not result in any hazardous material or waste management concerns. Impacts related to hazardous materials and wastes could occur during future development of commercial oil shale projects within the Alternative C lease areas. Such impacts are generally independent of location and would be unique to the technology combinations used for oil shale development. However, hazardous materials and wastes are similar for some of the ancillary support activities that would be required for development of any oil shale facility regardless of the technology used. These include the impacts from development or expansions of support facilities, such as employer-provided housing and power plants.

Hazardous materials and wastes would be used and generated during both the construction and operation of commercial oil shale facilities and supporting infrastructure (e.g., power plants). Hazardous materials impacts associated with project construction would be minimal and limited to the hazardous materials typically utilized in construction, such as fuels, lubricating oils, hydraulic fluids, glycol-based coolants and solvents, adhesives, and corrosion control coatings. Construction-related wastes would include landscape wastes from clearing and grading of the construction sites, and other wastes typically associated with construction, none of which is expected to be hazardous (Section 4.13.1).

During project operations, hazardous materials would be utilized, and a variety of wastes (some hazardous) would be generated. Hazardous materials would include fuels, solvents, corrosion control coatings, flammable fuel gases, and herbicides (for vegetation clearing and management at facilities or along ROWs). The types and amounts of hazardous waste generated during operations will depend on the specific design of the commercial oil shale project (surface or subsurface mining, surface retorting, in situ processes). Waste materials produced during

operations may include spent shale, waste engine fuels and lubricants, pyrolisis water, flammable gases, volatile and flammable organic liquids, and heavier-molecular-weight organic compounds (Section 4.13.1).

Because the use of hazardous materials and the generation of wastes are directly related to the specific design of a commercial oil shale project, it is not possible to quantify project-related impacts of these materials. Under Alternative C, individual facilities could be located anywhere within the area identified as available for leasing pending project review and authorization. Accidental releases of the hazardous materials or wastes could affect natural resources (such as water quality or wildlife) and human health and safety (see Sections 4.14 and 6.1.3.13) at locations wherever the individual projects are sited within the Alternative C lease areas.

#### 6.1.3.13 Health and Safety

The amendment of land use plans to identify 830,296 acres of land as available for application for leasing for commercial oil shale development would not result in any direct health and safety concerns. However, a number of health and safety concerns would be associated with the commercial development of oil shale projects within the Alternative C lease areas. For commercial oil shale development in Alternative C lease areas, potential health and safety impacts from the construction and operation of commercial oil shale projects would be associated with the following activities: (1) constructing of project facilities and associated infrastructure, (2) mining (if processing is not in situ) the oil shale; (3) obtaining and upgrading the crude oil, either through surface retorting or in situ processing; (4) transporting construction and raw materials to the upgrading facility and transporting product from the facility; and 5) exposing the general public to water and air contamination associated with oil shale development. Hazards from oil shale development (summarized in Table 4.14-1) could include physical injury from construction, oil shale processing, and vehicle transportation accidents and exposure to fugitive dust and hazardous materials, such as retort emissions and industrial chemicals (Section 4.14). Health and safety impacts would be largely restricted to the immediate workforce of each facility. Accidents could also affect members of the general public who could be present in the immediate vicinity of an accident (e.g., project-related truck accident on a public road, recreational users in areas adjacent to the project lease area).

Hazards for workers at oil shale development facilities include risks of accidental injuries or fatalities, lung disease caused by inhalation of particulates and other hazardous substances, and hearing loss. Estimates of expected injuries and fatalities can be made on the basis of numbers of employees and the type of work. Based on the numbers of employees projected to be needed for construction and operation of oil shale facilities, there would statistically be less than one death and about 125 injuries per year expected per facility during construction activities, and less than one death and less than 100 injuries per year expected per facility during operations (NSC 2006). A comprehensive facility health and safety plan and worker safety training would be required as part of the Plan of Development for every proposed commercial oil shale project.

Health and safety concerns are largely independent of the location of oil shale development facilities. However, the health and safety impacts on the general public from emissions from these facilities would depend both on the specific characteristics and level of emissions and on the distance of the emissions source from population centers. The level of air and water emissions would be regulated under required permits. Potential impacts on the general public from emissions would be assessed in future site-specific NEPA and permitting documentation.

### 6.1.4 Comparison of Oil Shale Alternatives

The three alternatives assessed in this PEIS are a no action alternative (Alternative A) and two alternatives for amending BLM land use plans in Colorado, Utah, and Wyoming to (1) identify the most geologically prospective oil shale areas within each planning unit; (2) designate lands within the most geologically prospective areas available for applications for leasing; (3) identify any technology restrictions; (4) stipulate requirements for future NEPA analyses and consultation activities; and (5) specify that the BLM would consider and give priority to land use exchanges, where appropriate and feasible, to consolidate land ownership and mineral interests within the oil shale basins. These alternatives are described in Sections 2.3.2 and 2.3.3; specific land use plan amendments are provided in Appendix C. The analyses of potential impacts associated with each alternative are presented in Sections 6.1.1, 6.1.2, and 6.1.3 of this chapter.

As noted in the preceding impact analysis sections for Alternatives B and C, the proposed land use plan amendments would not result in any impacts on the environment or socioeconomic setting. However, the development of commercial oil shale projects made possible by these land use plan amendments would have impacts on these resources. As discussed, the potential impacts associated with commercial oil shale development that would be made possible under the land use plan amendments, while described in Chapter 4, cannot be quantified because key information about the location of commercial projects, the technologies employed, the project size or production level, and development time lines are unknown.

#### 6.1.4.1 Land Use

The impacts of Alternative A on land use would be to exclude all other land uses in the 960 acres included in the six RD&D leases, most of which are located in the Piceance Basin in Colorado. Existing land uses on the Colorado parcels (primarily grazing, wildlife and wild horse use) would be displaced for at least a 10-year period. Land use on adjacent parcels would be largely unaffected by the RD&D activities on the five Colorado sites, except that vehicular traffic, noise, and human construction activity could alter the quality of hunting and other recreational experiences in the area and have an impact on wild horses (see Section 6.1.1.7.3 for more information about the impact on wild horses under Alternative A). Land use along the new utility ROWs and access roads supporting the RD&Ds will be impacted during the construction phases, but these impacts will be largely short term. Although five of the RD&D lease areas are located in the same general area and will be undergoing RD&D activities during the same period

of time, they are dispersed enough so that cumulatively, their impacts on land use will be relatively minor.

The Utah RD&D project is located on an old mining site. Current land use within the RD&D lease and on adjacent lands includes oil and gas development, gilsonite mining, wildlife habitat, recreational use, and livestock grazing. Because this project is located at an existing mine site, the RD&D activities would not substantively change the existing land use within the leased area. Land use on adjacent parcels of land should be largely unaffected by the RD&D activities, except that noise and human activity could alter the quality of hunting and other recreational experiences. The environmental analyses for all the RD&D projects found there would be no significant impact from the proposed activities.

Alternatives B and C do not grant any rights to third parties, or approve any ground-disturbing activity; however, it is clear that their intent is to facilitate future leasing and development of oil shale resources, which has the potential to impact existing land uses over a much larger area than does Alternative A. It is in the potential for approval of future development that Alternatives B and C could cause adverse effects on existing land uses.

The nature of the impacts of Alternatives B and C on land uses are those discussed in Sections 6.1.2.1 and 6.1.3.1, and would be essentially the same, with exceptions that are discussed below. Further, it is only at the site-specific level that the impacts of any of the alternatives can be determined. In areas where the two alternatives overlap with lands that are available for application to lease, their potential impacts would be the same.

The level of development could be the same under Alternative C as it would be under Alternative B, but Alternative C might or might not result in different locations of some of the development projects. Alternative C also results in opening many discontinuous tracts that might not be attractive for development and make the more continuous areas more attractive for leasing.

Alternative C does remove from consideration lands with sensitive resources that have been identified in current BLM land use plans, including all existing ACECs, and thus removes known sensitive land uses from consideration for future leasing. The bulk of the acreage removed from consideration in Alternative C is not excluded because of land use issues so the overall protection for existing land uses is not as great as for other resources. The following is a summary of the principal differences in impact on land uses between Alternatives B and C:

- Alternative B includes 170,000 acres of land identified as having wilderness characteristics, which could be available for application for commercial developments, while Alternative C includes 110,000 acres of these lands.

- In the Piceance Basin, Alternative C would likely have less of an impact on oil and gas operations because considerably fewer acres of potentially valuable oil and gas deposits in a rapidly developing area are available for application for commercial oil shale development.

- Alternative B includes 185,000 acres of land that are identified as potential ACECs that could be available for application for commercial development, while Alternative C includes 136,000 acres.

In comparing the overall potential for impact on land uses, Alternative C could result in fewer impacts than Alternative B.

#### 6.1.4.2 Soil and Geologic Resources

Impacts on soil and geologic resources from the six RD&D projects would be the same under all three alternatives; these impacts would be associated with soil removal and compaction, subsurface disturbance of geologic resources during drilling and mining activities, and increased potential for erosion of exposed soils and geologic materials.

The identification of public lands under Alternatives B and C as available for application for leasing for commercial oil shale development and the associated amendment of appropriate land use plans would not affect soils or geologic resources in any of the lease areas. Soil and geologic resources could, however, be affected by future development of commercial oil shale projects in these areas under either alternative. Potential impacts, related primarily to construction and operation of project facilities and related infrastructure, could include soil disturbance, removal or compaction, and erosion.

Impacts on soil and geologic resources would be identical between Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). However, soil and geologic resources could be affected by commercial oil shale development in more locations under Alternative B than under Alternative C, with Alternative B having 1,160,926 more acres of land available for leasing and future development. In Colorado, soil and geologic resources could be affected by commercial development on only 40,325 acres under Alternative C, an 89% reduction in the area that could be affected by potential future development under Alternative B. Areas in Utah and Wyoming where future development could affect soil and geologic resources would also be less under Alternative C than under Alternative B (a 22% reduction for Utah and a 70% reduction in Wyoming). The approximately 1.2 million acres of land that would be excluded under Alternative C for lease availability represent environmentally sensitive areas as identified in BLM land use plans, which could be developed in the future under Alternative B. The nature, location, and magnitude of project-related impacts on soil and geologic resources depend on the specific location of leases undergoing commercial development as well as the design of the projects.

#### 6.1.4.3 Paleontological Resources

Table 6.1.4-1 identifies the amount of available acreage that has the potential to contain important paleontological resources under each of the alternatives. Under all alternatives, 800 acres in Colorado and 160 acres in Utah that would be impacted by the RD&D projects have the potential to contain paleontological resources; however, mitigation that is required to be

**TABLE 6.1.4-1 Amount of Available Acreage That Has the Potential to Contain Important Paleontological Resources**

| Parameter | Alternative A | Alternative B | Alternative C | % Difference in Alternatives B and C |
|---|---|---|---|---|
| Acres available for application for leasing and development | 960 | 1,991,222 | 830,296 | 42% |
| Acres with potential to contain important paleontological resources | 960 | 1,793,480 | 749,920 | 42% |

applied in the development of these projects includes on-site monitoring by qualified paleontologists to determine whether important paleontological resources are present and to collect data from any such resources uncovered during the RD&D activities. Therefore, most of the possible adverse effects on paleontological resources from RD&D activities are expected to be mitigated. The impacts from the RD&D activities and expected mitigation would also occur under Alternatives B and C.

Under Alternative B, about 1.8 million acres available for application for leasing have the potential to contain important paleontological resources (Table 6.1.4-1). This acreage includes existing ACECs not closed to mineral development that contain important paleontological resources. Adverse effects on paleontological resources, as described in Sections 4.4 and 6.1.2, could occur in these areas.

Under Alternative C, the amount of acreage available for application for leasing with the potential to contain important paleontological resources is reduced considerably from that of Alternative B, to approximately 0.75 million acres. Commercial development under Alternative C potentially would have an impact on approximately 42% of the acreage with important paleontological resources that could be impacted by Alternative B. In addition, under Alternative C, no direct impacts would occur on paleontological resources present within the designated ACECs, but adverse effects could occur within the lands made available for leasing and subsequent development (see Section 6.1.3).

#### 6.1.4.4 Water Resources

Alternative A includes the potential development of the six (160-acre) RD&D leases. Surface disturbance on the 960 acres could lead to increased erosion and possible contribution to sedimentation of local streams, runoff from saline soils, and soils contaminated by industrial processes and activities. Water would not be withdrawn from surface streams near the projects but would be trucked to the site. Possible impacts on groundwater include dewatering and contamination of aquifers, as documented in the environmental analyses for the projects. Overall impacts on water resources are considered minimal, and all the EAs resulted in FONSIs.

Alternative B would designate approximately 2 million acres of land available for application to lease and includes sensitive lands identified in BLM land use plans excluded from leasing in Alternative C. Some of the lands excluded under Alternative C are designated for protection by the BLM because of steep slopes and/or fragile or highly erosive soils, which could contribute to adverse effects on water quality if disturbed. The exclusion of these soil areas from potential development may reduce impacts on water quality under Alternative C.

Table 6.1.4-2 includes a tabulation of perennial stream miles included within the four oil shale basins. Cumulatively, Alternative B contains almost half of the perennial stream miles in the four basins and, depending upon the location of any future developments, could expose more stream segments to both direct and indirect disturbance. In all basins, Alternative B contains more stream miles than does Alternative C. In the Piceance Basin, Alternative B contains substantially more stream miles that could be subject to adverse effects from commercial development within the area available for application for lease than Alternative C. Even under Alternative C, however, if development occurs on available lands in proximity to streams, there could be indirect effects on the streams as described previously. It is possible that Alternative B could result in more adverse impacts on water resources than Alternative C. However, impacts on water resources would ultimately be determined by the site location and the technology employed. The gross number of acres available for application, and even the number of stream miles included within the area available for application for leasing, is less important from a water resource standpoint than the actual location of the developments and where water to support development is obtained.

Water requirements to support oil shale development are still unknown, but it is known that general water availability has become more constrained, and not merely from a legal appropriation standpoint. However, there is water available in the Colorado River system in the three basin states that could be used to support oil shale development. Additionally, there is the likelihood that present senior water rights would be purchased to either support development and/or obtain water in a specific location. Access to water supplies, vis-a-vis locations near perennial streams where water rights could be acquired, could be greater in Alternative B because of the greater number of perennial stream miles present within the potential leasing area. This could be offset by an ability to transfer water in other ways.

**TABLE 6.1.4-2 Perennial Stream Miles within the Four Oil Shale Basins**

| Basin | Total Perennial Stream Miles | Alternative B | Alternative C |
|---|---|---|---|
| Piceance | 128 | 68 (75%) | 3 (2%) |
| Uinta | 193 | 126 (65%) | 58 (30%) |
| Green | 206 | 43 (21%) | 1 (<1%) |
| Washakie | 49 | 12 (75%) | 4 (25%) |
| Total | 543 | 249 (49%) | 66 (12%) |

#### 6.1.4.5 Air Quality

Under Alternative A, the BLM would not identify public lands in Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale. Previous analyses (summarized in Appendix A, Section A.5.3 [BLM 2006a–h; 2007a,b]) indicated that no significant, adverse direct or cumulative air quality impacts are likely to occur due to the six RD&D projects. Thus, the RD&D projects are expected to have no significant air quality impacts under any of the three alternatives.

The identification of areas available for application for leasing for commercial oil shale development and the associated amendment of appropriate land use plans would not affect air quality under Alternative B or C. However, under both alternatives, local and regional air quality could be affected by the future construction and operation of commercial oil shale projects in the lease area and by construction and operation of off-lease infrastructures, such as electric power plants, if needed. Under Alternatives B and C, the potential future commercial development of a similar project in an area where the lease areas of the two alternatives overlap would be expected to affect local and regional impacts on air quality in the same manner.

Because different areas are identified under Alternatives B and C as available for application for leasing, local air quality could be affected by commercial development in more locations under Alternative B than under Alternative C. Many of the lands that would be open for application for leasing under Alternative B would be excluded from application for leasing for commercial oil shale development under Alternative C. Thus, compared to Alternative B, the areas where local air quality could be affected by future commercial oil shale development under Alternative C would be reduced by 89% in Colorado, 22% in Utah, and 70% in Wyoming.

Because of the need for project- and site-specific information, it is not possible to identify the nature and magnitude of regional air quality impacts of commercial oil shale development under either Alternative B or Alternative C. Thus, it is not possible to differentiate between these two alternatives regarding regional air quality impacts.

#### 6.1.4.6 Noise

Under Alternative A, the BLM would not identify public lands in Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale. Localized noise impacts (i.e., increased noise levels) would occur at each of the RD&D project locations as a result of construction activities; mining activities; use of a crusher and conveyor belt system; operation of a horizontal rotary kiln; use of pumps, generators, and transformers; and vehicular traffic. These same impacts would also occur under Alternatives B and C.

The identification of areas available for application for leasing for commercial oil shale development and the associated amendment of appropriate land use plans would not affect noise levels in the available lease areas under either Alternative B or Alternative C. However, under both alternatives, local noise levels could be affected if future leasing results in the construction and operation of commercial oil shale projects in the lease areas.

Impacts on noise levels would be identical under Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). Because of the difference in the areas identified under Alternatives B and C as available for application for leasing, local noise levels could be affected by commercial development at more locations under Alternative B than under Alternative C. Compared to Alternative B, the areas under Alternative C where local noise levels could be affected by future commercial oil shale development would be reduced by 89% in Colorado, 22% in Utah, and 70% in Wyoming.

#### 6.1.4.7 Ecological Resources

**6.1.4.7.1 Aquatic Resources.** Under Alternative A, the BLM would not identify public lands in Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale. The impacts of the RD&D projects are described in Section 6.1.1.7.1; impacts on aquatic resources (i.e., increased sediment inputs) would occur at each of the RD&D project locations as a result of construction and operation activities; these same impacts would also occur under Alternatives B and C.

The identification of areas available for application for leasing for commercial oil shale development and the associated amendment of appropriate land use plans would not affect aquatic resources in the available lease areas under either Alternative B or Alternative C. However, under both alternatives, aquatic resources could be affected by the construction and operation of commercial oil shale projects in the lease areas.

Impacts on aquatic resources would be identical under Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). Because of the difference in the areas identified under Alternative B and C as available for application for leasing, aquatic resources could be affected by commercial development at more locations under Alternative B than under Alternative C. Under Alternative B, there are 37 perennial streams totaling approximately 248 miles that occur in areas where commercial oil shale projects could be developed. In contrast, much of the land identified under Alternative B is excluded from application for leasing for commercial oil shale development under Alternative C. Commercial oil shale development would be restricted to only 40,325 acres in Colorado, 490,460 acres in Utah, and 299,511 acres in Wyoming (830,296 total acres), and these areas encompass fewer perennial stream habitats than the Alternative B lease areas (Table 6.1.4-3). Because of this decrease in available lease area, there are 15 fewer perennial streams and approximately 183 fewer miles of perennial stream habitat that could be affected by future commercial oil shale development under Alternative C than under Alternative B. This represents a 73% reduction in the overall miles of stream habitat where aquatic resources could be affected with development under Alternative C.

**6.1.4.7.2 Plant Communities and Habitats.** Under Alternative A, impacts on plant communities and habitats (i.e., disturbance or destruction of individual plants and communities,

**TABLE 6.1.4-3 Perennial Streams Occurring within the Lease Areas Identified under Alternatives B and C**

| | Number of Perennial Streams | | Miles of Perennial Stream | |
|---|---|---|---|---|
| State | Alternative B | Alternative C | Alternative B | Alternative C |
| Colorado | 13 | 8 | 67.6 | 2.8 |
| Utah | 14 | 8 | 126.3 | 57.7 |
| Wyoming | 10 | 2 | 54.4 | 4.4 |
| Total | 37 | 18 | 248.3 | 64.9 |

introduction of invasive species; see Section 6.1.1.7.2) would occur at each of the RD&D project locations as a result of construction and operation activities; these same impacts would also occur under Alternatives B and C.

The identification of areas available for application for leasing for commercial oil shale development and the associated amendment of appropriate land use plans would not affect plant communities and habitats in the available lease areas under either Alternative B or Alternative C. However, under both alternatives, plant communities and habitats could be affected if leasing leads to the future construction and operation of commercial oil shale projects in the lease areas.

Impacts on plant communities and habitats would be identical between Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). Because of the difference in the areas identified under Alternatives B and C as available for application for leasing, plant communities and habitats could be affected by subsequent commercial development at more locations under Alternative B than under Alternative C. Alternative B identifies approximately 2 million acres as available for lease application, and plant communities and habitats in these areas could be impacted by the construction and operation of commercial oil shale projects. Included in this acreage are over 14,000 acres of land that have been identified in land use plans for the protection of sensitive plants and populations (Table 6.1.4-4).

In contrast, about 1.2 million acres of land identified under Alternative B (including all of the 14,000 acres identified for protection of sensitive plants and populations) would be excluded from availability for leasing under Alternative C. Commercial oil shale development would be restricted to only 40,325 acres in Colorado, 490,460 acres in Utah, and 299,511 acres in Wyoming (830,296 total acres).

**6.1.4.7.3 Wildlife.** Under Alternative A, impacts on wildlife would occur at each of the RD&D project locations as a result of construction and operation activities (see Section 6.1.1.7.3); these same impacts would also occur under Alternatives B and C.

**TABLE 6.1.4-4 Acreage of Lands in Which Plant Communities and Habitats Could Be Impacted by Future Commercial Oil Shale Development**

| | Total Land Area (acres) Available for Leasing Where Future Commercial Oil Shale Development Could Impact Plant Communities and Habitats | | |
|---|---|---|---|
| Location | Alternative B | Alternative C | Change in Potential Impact Area |
| Colorado | 359,798 | 40,325 | –319,473 |
| Utah | 630,471 | 490,460 | –140,511 |
| Wyoming | 1,000,453 | 299,511 | –700,942 |
| Total | 1,991,222 | 830,296 | –1,160,926 |

| | Land Area (acres) Identified for Protection of Sensitive Plants and Populations That Would Be Included in Lands Available for Leasing and Potentially Impacted by Future Commercial Development | | |
|---|---|---|---|
| | Alternative B | Alternative C | Change in Potential Impact Area |
| Colorado | 11,732 | 0 | –11,732 |
| Utah | 1,959 | 0 | –1,959 |
| Wyoming | 984 | 0 | –984 |
| Total | 11,405 | 0 | –11,405 |

The identification of areas available for application for leasing for commercial oil shale development and the associated amendment of appropriate land use plans would not affect wildlife in the available lease areas under either Alternative B or Alternative C. However, under both alternatives, wildlife and their habitats could be affected if leasing leads to future construction and operation of commercial oil shale projects in the lease areas.

Impacts on wildlife and their habitats (see Section 4.1.8.3) would be identical under Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). Because of the difference in the areas identified under Alternative B and C as available for application for leasing, wildlife and their habitats could be affected by subsequent commercial development at more locations under Alternative B than under Alternative C. Alternative B identifies approximately 2 million acres as available for lease application, and wildlife and their habitats in these areas could be impacted by the construction and operation of commercial oil shale projects (see Tables 6.1.2-4 and 6.1.2-5 in Section 6.1.2.7.3).

In contrast, about 1.2 million acres of land identified under Alternative B would be excluded from availability for leasing under Alternative C. As a result, thousands of acres of important wildlife habitat would be removed from the Alternative C lease areas, and these areas

and their wildlife would not be directly affected by commercial oil shale development that could occur in these lease areas. Table 6.1.4-5 shows the difference between Alternatives B and C in the amounts of wildlife habitat identified for protection in current land use plans. Table 6.1.4-6 shows similar information for important state-identified wildlife habitat. Under Alternative C, about 406,300 fewer acres of wild horse WMA could be affected by commercial oil shale development than under Alternative B.

**6.1.4.7.4 Threatened and Endangered Species.** Under Alternative A, the construction and operation of the six RD&D projects could affect six threatened and endangered species (see Table 6.1.1-1). These impacts would also occur under Alternatives B and C.

**TABLE 6.1.4-5 Acreage of Wildlife Habitats Identified for Protection in BLM Land Use Plans That Could Be Impacted by Commercial Oil Shale Development**

| | Total Land Area (acres) Available for Leasing Where Future Commercial Oil Shale Development Could Impact Wildlife Habitat Identified in BLM Land Use Plans | | |
|---|---|---|---|
| Location | Alternative B | Alternative C | Change in Potential Impact Area |
| Sage grouse habitat | 330,412 | 0 | –330,412 |
| Raptor habitat | 147,497 | 0 | –147,497 |
| Big game winter range | 551,820 | 0 | –551,820 |
| Big game summer habitat | 163,654 | 0 | –163,654 |
| Big game calving habitat | 12,941 | 0 | –12,941 |
| Wild horse HMA | 65,615 | 0 | –65,615 |

**TABLE 6.1.4-6 Acreage of State-Identified Wildlife Habitat That Could Be Impacted by Commercial Oil Shale Development**

| | Total Land Area (acres) Available for Leasing Where Commercial Oil Shale Development Could Impact State-Identified Wildlife Habitat | | |
|---|---|---|---|
| Location | Alternative B | Alternative C | Change in Potential Impact Area |
| Sage grouse habitat | 501,503 | 355,792 | –145,711 (–29%) |
| Big game winter habitat | 1,385,200 | 325,400 | –1,059,800 (–76%) |
| Big game summer habitat | 362,692 | 24,674 | –338,018 (–93%) |

The amendment of land use plans to identify areas available for application for leasing for commercial oil shale development would not affect threatened and endangered species in the lease areas identified under either Alternative B or Alternative C. However, under both alternatives, threatened and endangered species and their habitats could be affected if leasing results in the construction and operation of commercial oil shale projects in the lease areas.

The number of threatened and endangered species potentially affected by commercial oil shale development would be identical for Alternatives B and C (the same 14 species under each alternative; see Table 4.8.1-4). Impacts on threatened and endangered species and their habitats (see Section 4.8.1.4) would be identical between Alternatives B and C for similar projects located in lease areas common to the two alternatives (i.e., where the lease areas would overlap). Because of the difference in the areas identified under Alternative B and C as available for application for leasing, threatened and endangered species and their habitats could be affected by commercial oil shale development at more locations under Alternative B than under Alternative C. Alternative B identifies approximately 2 million acres as available for lease application, and threatened and endangered species and their habitats in these areas could be impacted by the construction and operation of commercial oil shale projects.

About 1.2 million acres of land identified under Alternative B would be excluded from availability for leasing under Alternative C. As a result, approximately 3,800 acres of land identified in BLM land use plans as black-footed ferret habitat, 46,000 acres of land identified in Colorado as potential habitat for threatened and endangered species, and about 1,900 acres as occupied by sensitive plant species would be removed from the Alternative C lease areas, and thus would not be directly affected by commercial oil shale development that could occur in these lease areas (Table 6.1.4-7).

#### 6.1.4.8 Visual Resources

Under Alternative A, visual resources could be affected by the construction and operation of the six RD&D projects (see Section 6.1.1.8). These impacts would also occur under Alternatives B and C.

The amendment of land use plans to identify areas available for application for leasing for commercial oil shale development would not affect visual resources within, or in the vicinity, of the lease areas identified under either Alternative B or Alternative C. However, there are a number of sensitive visual resource areas within, and in the vicinity of, the lease areas identified by both alternatives. These sensitive visual resource areas could be affected if leasing leads to the future construction and operation of commercial oil shale projects in the lease areas.

The visual resources that could be affected by the construction and operation of commercial oil shale projects would be identical under Alternatives B and C for similar projects located in lease areas common to the two alternatives (i.e., where the lease areas would overlap). Because of the difference in the areas identified under Alternatives B and C as available for

**TABLE 6.1.4-7 Threatened and Endangered Species and Selected Habitats Present in Potential Lease Sale Areas That Could Be Affected by Future Commercial Oil Shale Development**

| Resource | Alternative B | Alternative C |
|---|---|---|
| Number of federally listed species | 14 | 14 |
| Miles of critical habitat of federally endangered Colorado river fishes | 99 | 71 |
| Acres of black-footed ferret habitat | 3,800 | 0 |
| Acres of land identified in land use plans as potential habitat for federally listed and candidate species and BLM sensitive species | 46,000 | 0 |
| Acres of land identified in land use plans as including special status plants | 1,900 | 0 |

application for leasing, visual resources could be affected by commercial oil shale development at more locations under Alternative B than under Alternative C. Alternative B identifies approximately 2 million acres as available for lease application, and visual resources in and in the vicinity of these lease areas could be impacted by the construction, presence, and operation of commercial oil shale projects.

About 1.2 million acres of land identified under Alternative B would be excluded from availability for leasing under Alternative C, and visual resources in these excluded areas would not be directly affected by commercial oil shale development in the Alternative C lease areas (Table 6.1.4-8). There is relatively little difference in potentially affected visual resources that are present beyond the lease area boundaries of Alternatives B and C at the foreground-middleground and background BLM VRM distance limits.

#### 6.1.4.9 Cultural Resources

Table 6.1.4-9 identifies the amount of available acreage that has the potential to contain important cultural resources under each of the alternatives. Under Alternative A, 800 acres in Colorado and 160 acres in Utah that would be impacted by the RD&D projects have been surveyed for cultural resources, and two of the six 160-acre tracts contain sites (Section 6.1.1.9). Mitigation is required to be applied in the development of these projects. Therefore, most of the possible adverse effects on cultural resources are expected to be mitigated. These impacts from the RD&D activities would also occur under Alternatives B and C, as well as the mitigation measures.

**TABLE 6.1.4-8 Potentially Affected Sensitive Visual Resource Areas Associated with Lease Areas Identified in Alternatives B and C[a]**

| State | Alternative B | Alternative C |
|---|---|---|
| | Visual Resource Areas within Proposed Lease Areas | |
| ***Colorado*** | 6 ACECs | - |
| ***Utah*** | 3 ACECs<br>10 Potential ACECs<br>2 River segments eligible for WSR designation | 10 Potential ACECs |
| ***Wyoming*** | 1 ACEC | - |
| | Visual Resource Areas within 5 mi of the Lease Area Boundary (BLM VRM Foreground-Middleground Distance Limit) | |
| ***Colorado*** | 1 WSA<br>3 ACECs<br>2 River segments eligible for WSR designation | 1 WSA<br>5 ACECs<br>2 River segments eligible for WSR designation |
| ***Utah*** | 3 WSAs<br>3 ACECs<br>13 Potential ACECs<br>6 River segments eligible for WSR designation<br>1 National scenic highway | 3 WSAs<br>3 ACECs<br>13 Potential ACECs<br>6 River segments eligible for WSR designation<br>1 National scenic highway |
| ***Wyoming*** | 4 WSAs<br>5 ACECs<br>9 National historic trails<br>1 River segment eligible for WSR designation | 3 WSAs<br>4 ACECs<br>9 National historic trails<br>1 River segment eligible for WSR designation |
| | Visual Resource Areas within 15 mi of the Lease Area Boundary (BLM VRM Background Distance Limit) | |
| ***Colorado*** | 2 WSAs<br>1 National scenic highway | 2 WSAs<br>2 ACECs<br>1 National scenic highway<br>2 River segments eligible for WSR designation |
| ***Utah*** | 7 WSAs<br>1 ACEC<br>8 Potential ACECs<br>5 River segments eligible for WSR designation<br>1 National monument<br>1 National scenic highway | 8 WSAs<br>1 ACEC<br>8 Potential ACECs<br>4 River segments eligible for WSR designation<br>1 National monument<br>1 National scenic highway |

**TABLE 6.1.4-8 (Cont.)**

| State | Alternative B | Alternative C |
|---|---|---|
| ***Wyoming*** | 4 WSAs<br>4 ACECs<br>9 National historic trails<br>2 River segments eligible for WSR designation<br>1 National scenic highway | 3 WSAs<br>3 ACECs<br>9 National historic trails<br>1 River segment eligible for WSR designation<br>1 National scenic highway |

[a] ACEC = area of critical environmental concern; potential ACECs = areas eligible for ACEC designation; WSR = Wild and Scenic River; WSA = wilderness study area

**TABLE 6.1.4-9 Available Acreage under Each Alternative with the Potential to Contain Cultural Resources**

| Parameter | Alternative A | Alternative B | Alternative C | % Difference in Alternatives B and C |
|---|---|---|---|---|
| Acres available for application for leasing and development | 960 | 1,991,222 | 830,296 | 42 |
| Acres surveyed | 960 | 261,602 | 131,921 | 50 |
| Percentages of area surveyed | 100% | 13% | 16% | 39 |
| Number of sites recorded | 7 | 2,991 | 1,157 | 39 |
| Acres of high or medium sensitivity to contain cultural resources | NA[a] | 1,665,109 | 719,060 | 43 |
| Percentages of area with high or medium sensitivity | NA | 84% | 87% | NA |

[a] NA = not applicable.

Under Alternative B, 1,665,109 acres of the 1,991,222 acres available for application for leasing have the potential to contain important cultural resources. This acreage includes existing ACECs not closed to mineral development that contain important cultural resources. Adverse effects on cultural resources, as described in Sections 4.10 and 6.1.2, could occur in these areas as a result of future commercial development.

Under Alternative C, the amount of acreage available for application for leasing with the potential to contain important cultural resources is reduced considerably from that of Alternative B to 719,060 acres, out of 830,296 acres. Commercial development in Alternative C lease areas potentially could impact approximately 43% of the acreage with important cultural resources that could be impacted by Alternative B. Additionally, under Alternative C, no direct impacts from commercial development on cultural resources present within the designated ACECs would occur, but adverse effects could occur within the lands made available for leasing and subsequent development (see Section 6.1.3).

#### 6.1.4.10 Socioeconomics

Under Alternative A, there would be some impacts on socioeconomics from the RD&D projects (see Section 6.1.1.10). Under Alternatives B and C, the identification of areas available for application for leasing for commercial oil shale development and the associated amendment of appropriate land use plans would not have socioeconomic impacts. However, the commercial development that would be made possible by the proposed land use plan amendments under Alternatives B and C would result in impacts on the socioeconomic environment.

The socioeconomic impacts of the RD&D leases are the same for each of the alternatives. Because it is not possible to quantify the socioeconomic impacts of the commercial development that would be made possible under either Alternatives B or C at this time, it is not possible to definitively conclude which of these two alternatives would result in more impacts. However, if Alternative C results in less total commercial development as discussed in Section 6.1.6.3, the resulting socioeconomic impacts, both beneficial and adverse, would be fewer under Alternative C.

As noted in Appendix A (Section A.1), the most prospective oil shale deposits in the United States are located in the Green River Formation of the Greater Green River Basin (including the Washakie Basin), the Piceance Basin, and the Uinta Basin within the three-state study area for this PEIS. A significant portion of these deposits is located underneath public lands administered by the BLM, including split estate lands where the federal government owns the subsurface mineral estate. As a result, commercial development of the nation's oil shale resources is dependent upon access to the resources underlying these lands. Renewed interest in developing these resources is driven by significant economic and national security concerns. At this time, however, there is no federal program to facilitate leasing for the commercial development of these potentially substantial resources. The degree to which each alternative facilitates commercial leasing, and therefore affects the level and pace of commercial oil shale development, is a critical factor for comparison.

Of the alternatives examined in this PEIS, Alternative A, the no action alternative, would do the least in terms of facilitating commercial leasing of oil shale. Valuable RD&D activities are being conducted under Alternative A that are expected to provide critical information regarding potential commercial development, the viability of the various technologies being tested, and the potential environmental impacts. However, Alternative A would not establish a commercial leasing program. Specifically, it would not amend land use plans to identify the most geologically prospective oil shale resources or identify lands within the most prospective areas as available for application for commercial leasing. Any future commercial leasing or development would require additional NEPA assessments to evaluate necessary land use plan amendments, and this likely would occur on a plan-by-plan basis or, at most, on a state-by-state basis. Under the no action alternative, the BLM's approach to commercial oil shale development would be fragmented and would require costly and time-consuming individual land use plan amendments. This is likely to translate into greater costs and, possibly, protracted time lines for establishing commercial oil shale development on public lands.

The two land use plan amendment alternatives examined in this PEIS (Alternatives B and C) would be more effective at facilitating commercial leasing of oil shale than Alternative A because each one proposes to amend land use plans. By amending land use plans to identify the most prospective areas and the lands that will be available for application for leasing, the BLM would be removing the first hurdle to future commercial leasing. As shown in Table 6.1.4-10, Alternative B would make the greatest amount of land available for application for leasing. Alternative B would make 87% of the public land within the most geologically prospective oil shale area available for application for leasing (i.e., 1,991,222 acres out of 2,296,927 acres) whereas Alternative C would make about 36% of the public lands available (i.e., 830,296 acres out of 2,296,927 acres). It is possible that Alternative C would limit development to some level below what would occur under Alternative B because Alternative C makes fewer total lands available for leasing and, in Colorado and Wyoming, much of it is composed of relatively small, isolated tracts of land that may not be developable. It is also possible that Alternative C might provide relatively more encouragement for development in Utah, as opposed to Colorado and Wyoming, because there are more and larger parcels of land in Utah that could be developed. Since it is not yet clear what the most efficient size of commercial development will be, the relative effects of Alternative C are still unknown.

In summary, Alternative A, the no action alternative, would do the least to facilitate future commercial oil shale development. Alternatives B and C would be equally effective in facilitating commercial oil shale development over the next 20 years, by virtue of the land use plan amendments; however, Alternative B possibly would result in more development than Alternative C and in more choices for industry to pursue, by making more total lands available.

**TABLE 6.1.4-10 Estimated Acres Potentially Available for Application for Leasing for Commercial Oil Shale Development by State under Each Alternative[a]**

| State | Alternative A | Alternative B | Alternative C |
|---|---|---|---|
| ***Colorado*** | 0 | 359,798 | 40,325 |
| ***Utah*** | 0 | 630,971 | 490,460 |
| ***Wyoming*** | 0 | 1,000,453 | 299,511 |
| Total | 0 | 1,991,222 | 830,296 |

[a] Totals may not be exact because of rounding. These estimates were derived from GIS data compiled for the PEIS. The GIS data may contain errors; therefore, these estimates should be considered to be only representative of the proposed leasing area.

#### 6.1.4.11 Environmental Justice

Under Alternative A there would be no significant impacts on environmental justice associated with the RD&D projects. Under Alternatives B and C the changes in land use plans would not have any impacts. However, the commercial development that would be made possible by the proposed land use plan amendments under Alternatives B and C could result in environmental justice impacts, depending on the impacts on resources with respect to the locations of environmental justice populations.

Because it is not possible to quantify the environmental justice impacts of the commercial development that would be made possible under either Alternatives B or C at this time, it is not possible to definitively conclude which of these two alternatives would result in more impacts. However, if Alternative C results in less total commercial development as discussed in Section 6.1.6.3, the resulting environmental justice impacts, both beneficial and adverse, would be fewer under Alternative C.

#### 6.1.4.12 Hazardous Materials and Waste Management

Under Alternative A, the BLM would not amend land use plans to identify public lands in Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale. The construction and operation of the six RD&D projects under Alternative A will utilize and generate hazardous materials and wastes (see Section 6.1.1.12); however, the appropriate management of these materials will result in only minor impacts. These impacts would also occur under Alternatives B and C.

The amendment of land use plans to identify areas available for application for leasing for commercial oil shale development would not result in hazardous material and waste issues within or in the vicinity of the lease areas identified under either Alternative B or Alternative C. However, the construction and operation of commercial oil shale projects in the lease areas would use and generate hazardous materials and wastes under both alternatives.

Because the use of hazardous materials and the generation of wastes are related to the specific design of a commercial oil shale project rather than project location, it is not possible to differentiate among the alternatives the hazardous materials and waste that could be used or generated during commercial oil shale construction and operation. For similar commercial oil shale projects (similar in design and operation), the hazardous materials and wastes associated with projects developed in the Alternative B or C lease areas would be similar. Because of the much larger amount of land that would be made available for leasing under Alternative B, the use and/or generation of hazardous materials and wastes could occur at more locations under Alternative B than under Alternative C. In both cases hazardous material and waste handling (storage, use, and disposal) would be expected to be similar under the two alternatives (Section 4.13.1) regardless of project location.

#### 6.1.4.13 Health and Safety

Under Alternative A, the construction and operation of the six RD&D projects could result in health and safety impacts on facility workers. Impacts on health and safety from the six RD&D projects would be the same under all three alternatives; these impacts would be associated with potential for accidents causing injuries and fatalities, possible hearing loss from high noise levels, and inhalation of particulates and/or volatile compounds emitted from the facilities. As stated in Section 6.1.1.13, the statistically expected number of injuries from all the RD&D projects combined is about 75 per year during construction and 40 per year during operations. During both construction and operations, less than 1 fatality per year would be expected.

The amendment of land use plans to identify areas available for application for leasing for commercial oil shale development would not result in health and safety issues within or in the vicinity of the lease areas identified under either Alternative B or Alternative C. However, the construction and operation of commercial oil shale projects made possible by land use plan amendment would have identical health and safety concerns between Alternatives B and C for projects with identical Plans of Development located in lease areas common to the two alternatives (i.e., where the lease areas would overlap). Potential impacts could occur from accidents causing injuries and fatalities, possible hearing loss from high noise levels, and inhalation of particulates and/or volatile compounds emitted from the facilities. Construction and operation of individual facilities under either alternative would statistically be expected to result in less than 1 fatality per year and approximately 125 injuries per year. Health impacts on the general public could occur from exposure to emissions from oil shale facilities, but in the absence of site-specific and process-specific data, no differences between health and safety impacts of Alternatives B and C can be identified.

Differences in health and safety concerns between the two alternatives would be largely associated with differences in individual project designs and, to a lesser degree, differences in the locations of individual projects. For example, projects requiring longer transportation routes and longer utility and pipeline ROWs would have a greater potential for transportation accidents as well as ROW construction-related accidents. It is not possible to quantify differences in health and safety impacts from project construction and operation under Alternatives B and C in this programmatic EIS. Under either of the alternatives, health and safety issues would be evaluated at the project level (i.e., as part of project-specific NEPA analyses), and a comprehensive facility health and safety plan and worker safety training would be required as part of the Plan of Development for every proposed commercial oil shale project.

### 6.1.5 Cumulative Impacts

The purpose of this cumulative impacts assessment is to discuss how the environmental and socioeconomic conditions within the study area might be incrementally affected over the next 20 years (the study period) by oil shale development that would be made possible by land use plan amendments under either Alternative B or Alternative C. The CEQ (1997), in its

regulations implementing the procedural provisions of NEPA (40 CFR Parts 1500–1508), defines cumulative effects as follows:

> "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7).

As stated in Sections 6.1.2 and 6.1.3, there would be no environmental or socioeconomic impacts under Alternatives B and C from the amendment of land use plans to identify lands as available for commercial oil shale leasing. Therefore, there would be no incremental cumulative impacts from these alternatives. However, direct, indirect, and incremental cumulative impacts could occur due to future commercial oil shale development that would be facilitated by such land use plan amendments.

This section describes the incremental impacts of potential commercial oil shale development that could occur over the next 20 years as a result of commercial development of land use plan amendments made under Alternatives B or C. These impacts are in the context of other major activities in the study areas that could also affect environmental resources and the socioeconomic setting. The study areas considered usually include the lands managed by a BLM Field Office that contain oil shale resources and the ROI counties associated with them, as defined in Table 3.10.2-1. Larger areas are considered for certain resources (e.g., land, air, and water). This section considers five major categories of activities that could have cumulative impacts: oil and gas development, coal mining and preparation, other minerals development, energy infrastructure development, and other activities (e.g., tar sands development, grazing, fire management, forestry, and recreation). The assumptions and impact-producing factors for these categories of activities are discussed in Section 6.1.5.1. The projected level of each type of activity in the study area in each of the three states over the period 2007 to 2027 is described in Section 6.1.5.2. Section 6.1.5.3 presents the cumulative impacts analysis for Alternatives B and C and addresses the same resources analyzed in Sections 4.2 through 4.14.

The current status of resources (including past and present actions) is described in Chapter 3. This section focuses on the incremental impacts of the oil shale alternatives when added to a set of reasonably foreseeable future actions that are projected to occur or that could occur over the next 20 years (as described in Section 6.1.5.2). These projections were drawn from a variety of sources, as indicated in the text. The accuracy of such projections is greatest during the first few years of the 20-year period and decreases over the time frame assessed. In particular, future levels of commercial oil shale and tar sands development are unknown. For the purposes of analysis, this cumulative impacts assessment looks at the incremental impacts of a single oil shale facility (as described in Section 4.1) and a single tar sands facility (as described in Section 5.1), recognizing that there may be more than one of each type of these facilities brought into operation during the study period. While the cumulative impacts described in this section represent an initial estimate of impacts for activities projected to occur in the 20-year time frame, the assessment requires reevaluation if the planned level of development changes drastically in the future.

Because of the magnitude of actions on public land, the lack of information about how many projects might be undertaken under either alternative, and the lack of information regarding the likely locations for future development, the cumulative effects discussed in this section are general in nature. The magnitude of the differences between the cumulative effects of Alternatives B and C cannot be identified. The cumulative effects discussion by resource area presented in Section 6.1.5.3 is intended to place the potential development of oil shale resources into the context of impacts from known ongoing and planned activities, and highlight issues that will be considered in future, site-specific NEPA actions.

### 6.1.5.1 Overview of Assumptions and Impact-Producing Factors for Major Activities with Potential Cumulative Impacts

**6.1.5.1.1 Oil and Gas Development.** Associated with oil and gas development are impact-producing factors such as water use, the production of wastes and water, contaminant emissions to air and water, the use and alteration of land, and potential oil spills. The environmental impacts of oil and gas drilling are highly variable, depending on the depth of drilling, drilling methods used, and whether multiple wells per drill pad are constructed. Table 6.1.5-1 summarizes the estimated impacts of oil and gas drilling on a per-well basis for select resource areas.

**TABLE 6.1.5-1 Assumptions Associated with Oil and Gas Drilling**

| Impact-Producing Factor | Values Used in Impact Analysis (per well drilled) | Reference |
|---|---|---|
| Suface disturbance (acres) | 2.5–15 | McClure et al. 2005; Thompson 2006a; DOE 2006; BLM 1994b, 2002a, 2006i |
| Water use (ac-ft/yr) | 0.55 | BLM 2006i |
| Drilling waste (bbl) | 4,100 | DOE 2006 |
| Regulated emissions (CO, $SO_2$, $NO_x$) (tons) | 0.37 | DOE 2006 |
| $CO_2$ emissions (tons) | 97 | DOE 2006 |
| Other nonregulated emissions ($CH_4$, non-$CH_4$ hydrocarbons) (tons) | 0.17 | DOE 2006 |
| Amount of oil spilled (gal) | 24 | DOE 2006 |
| Employment (direct FTEs) | 3 | BLM 2006i |

Rough estimates of overall resource requirements for oil and gas drilling are available from several sources. Estimates of the amount of land disturbed vary from 2.5 to 15 acres per well. The higher end of the range is certainly an overestimate in locations where multiwell pads would be used (e.g., the Roan Plateau RMP amendments call for 17 wells per pad atop the plateau) (BLM 2006i). In addition, only about 60% of the initially disturbed area would have long-term surface disturbance, with the other 40% generally being revegetated within 2 years (BLM 2006i).

**6.1.5.1.2 Coal Mining and Preparation.** Impact-producing factors for coal mining and preparation (e.g., removal of sulfur) include water use, contaminant emissions to air and water, use and alteration of land, and occupational hazards. These factors are discussed in DOE (1988) and summarized for select resource areas in Table 6.1.5-2.

**6.1.5.1.3 Other Minerals Development.** Although several metals and minerals are mined in the three states (e.g., clay, copper, gilsonite, gold, iron, lead, lime, molybdenum, potash [potassium-based compounds], sand, gravel, silver, sodium minerals [e.g., nahcolite, trona], uranium, vanadium, and zinc), most are not mined in the counties that might experience oil shale development. The predominant materials currently mined in these areas are sand and gravel.

Sand and gravel deposits are found in river and stream terraces, floodplains, and channels, both current and ancient. These deposits are also called salable minerals (a category that also includes clays). Extraction of instream sand and gravel deposits could result in adverse environmental impacts, such as changes in streamflow and increased turbidity, that would affect fisheries and recreational use. Extraction of sand and gravel from floodplains or low terraces could create new channels and alter sediment deposition, again adversely affecting the ecology of the nearby river or stream. Other general impacts from sand and gravel mining could include land disturbance, changes in groundwater quality, noise, dust, and visual changes. The management of sand and gravel mining could decrease impacts. For example, siting mining locations high up in the landscape (on floodplains and terraces rather than in stream channels) would decrease adverse impacts on stream hydrologic processes (Langer 2002). If in-stream mining was practiced, annual withdrawals would likely be limited to less than the annual bedload.

Other materials mined in the potential oil shale development area include clay, gilsonite, gold, lime, sandstone, sodium minerals, uranium, and vanadium. These metals and minerals may be obtained through underground mining, surface (open pit) mining, or solution mining. Gold is usually open-pit-mined (EPA 1997). Mining of these substances can cause a variety of adverse environmental impacts, including the production of high volumes of solid and potentially hazardous waste, the contamination of surface water and groundwater, uncontrolled releases of produced water, land subsidence, physical instability of mine units, and air quality degradation, especially from particulate emissions. Uranium has an added potential for radiologically contaminating environmental media, leading to the subsequent possibility of exposures of biota and humans.

**TABLE 6.1.5-2 Assumptions Associated with Coal Mining and Preparation[a]**

| Impact-Producing Factor | Impact (per million tons surface mined) | Impact (per million tons underground mined) |
|---|---|---|
| Surface disturbance (acres) | | |
| Area for facilities | 4.3 | 4 |
| Strip mining | 20 | NA[b] |
| Waste storage | 2.6 | 1 |
| Water use (million gal) | | |
| Coal preparation | 20 | 20 |
| Dust control | 35 | 35 |
| Air emissions (tons)[c] | | |
| CO | 15 | 6.3 |
| $SO_2$ | 4.9 | 0.59 |
| $NO_x$ | 76 | [d] |
| Particulates | 4 | 0.48 |
| Fugitive dusts[e] | 1,870 | [d] |
| Hydrocarbons | 4.8 | 0.48 |
| Aldehyde | 1.2 | [d] |
| Diesel fuel use ($10^3$ gal) | 3,021 | 38 |
| Electricity use ($10^6$ MWh) | 6 | 39 |
| Employment (direct FTEs) | 180 | 460 |
| Occupational hazards (deaths per 100,000 workers, disabling injuries per 100 workers) | 0.07, 8 | 0.37, 45 |

[a] Coal is prepared to increase its quality and heating value by removing sulfur and ash-forming constituents.

[b] NA = information not available.

[c] Surface mining values are for the western United States; underground values are for the eastern United States.

[d] Unquantified or negligible.

[e] Based on estimates for an Illinois surface mine with the following controls: paved access roads, watered and unpaved haul roads, and enclosed coal dumps with baghouse. Without these controls, estimated fugitive dust emissions would be 3,030 tons.

Source: DOE (1988).

Metal mining historically has also caused significant contamination of surface water. The sources of contamination have included waste rock disposal, tailings, leaching sites (locations where valuable metals are collected by running solutions through the ore), and mine water. Depending on the local geology, the waste rock may contain other naturally occurring minerals toxic to biota, including arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, and nickel. In addition, cyanide (a highly toxic substance composed of carbon and nitrogen) is used extensively in the mining industry to aid in metal extraction. Serious adverse impacts on surface water from metal mining have occurred when runoff from waste sources has entered nearby water bodies; these impacts have included degradation of aquatic habitat and contamination of drinking water supplies. Additional adverse impacts would occur as a result of erosion and increased sedimentation of surface water.

A very significant environmental impact from metal mining is the large volume of waste that is generated. The product-to-waste ratio can be very high; for example, in gold mining, almost all of the material removed from the earth (99.99%) is waste rock and tailings. Another area of concern is air quality degradation. Many metal-mining operations generate large volumes of fugitive dust from ore crushing and loading, blasting, and, over time, from dried-up tailings ponds.

Many of the adverse impacts from mining discussed above occurred primarily in the past, and mitigation measures have been adopted to minimize their occurrence in present practice. Because of the wide variety of possible contaminants and impacts from mining of metals and other minerals, generic impacts (e.g., on a “per-ton-mined” basis) are not discussed in this section. Cumulative impacts are discussed in Section 6.1.5.3 on the basis of the specific types of minerals being developed in each region.

#### 6.1.5.1.4 Energy Infrastructure Development

***Energy Corridors.*** There is an extensive existing infrastructure of oil and gas pipelines and electricity transmission ROWs in the western states. Most of the existing ROWs cross public lands (National Energy Policy Development Group 2001). As of 2005, Colorado had 6,177, Utah had 5,120, and Wyoming had 15,775 ROWs crossing public lands (BLM 2001, BLM 2005k). These ROWS serve as either long-distance paths or subregional and local distribution lines. It is projected that the growing demand for additional energy and electricity will result in an increased number of ROWs across public lands in the future (National Energy Policy Development Group 2001). Other federal agencies authorized to grant ROWs for electric, oil, and gas transmission include the USFS, the NPS (electric only), the USFWS, the BOR, and the Bureau of Indian Affairs (BIA).

The BLM, along with DOE, is preparing a PEIS (DOE 2007) to designate public lands for potential use for long-distance energy transmission corridors in the West. This is an effort to expedite permitting of transmission systems, such as oil and gas pipelines and power lines (DOE 2007). The proposed action of that PEIS designates federal energy corridors on public lands in areas that would be beneficial for energy development, but excludes sensitive lands

(such as National Parks and National Monuments, ACECs, and roadless areas) to the extent practicable. Consideration is given to the locations of oil shale deposits, and possible corridor locations have been designated relatively near to these areas for future use if the oil shale is developed. The designation of public lands for potential use in energy transmission ROWs as proposed under the Draft West-wide Energy Corridor PEIS would not have direct impacts, with the possible exception of affecting current land use within the corridors and property values on private lands adjacent to or between corridor segments.

The eventual construction and operation of energy transmission ROWs, whether within federally designated energy corridors, within energy corridors on federal lands that are currently identified in land use plans, or at locations identified by industry and evaluated and authorized by appropriate federal agencies (BLM, USFS), could result in adverse environmental impacts on federal and nonfederal lands. The specific types, magnitudes, and extents of project-specific impacts would be determined by the project type (transmission line, pipeline) and its length and location on federal and nonfederal lands; thus, the impacts could be evaluated only at the project level. However, general potential impacts typical of project construction and operation include the use of geologic and water resources; soil disturbance and erosion; degradation of water resources; localized generation of fugitive dust and air emissions from construction and operational equipment; noise generation; disturbance or loss of paleontological and cultural resources and traditional cultural properties; degradation or loss of fish and wildlife habitat; disturbance of resident and migratory fish and wildlife species, including protected species; degradation or loss of plant communities; increased opportunity for invasive vegetation establishment; alteration of visual resources; land use changes; accidental release of hazardous substances; and increased human health and safety hazards. Construction and operation of energy transmission ROWs could also affect minority and low-income populations in the vicinity of the projects on both federal and nonfederal land as well as local and regional economies.

***Electric Power Plants.*** Impacts from electric power generating plants include emissions of air pollutants, water use, production of large volumes of solid waste (e.g., ash and flue-gas cleanup waste), use and alteration of land, emissions and accidents associated with the transportation of raw materials and wastes, and socioeconomic impacts. Air emissions differ depending on the quality of feed coal utilized. Table 6.1.5-3 summarizes the estimated impacts on various resource areas from the construction and operation of electric power plants. In the near term, it is most likely that low-sulfur Wyoming coal would be utilized for power plants in the study area. Additional electric power might be required over the study period to support new development.

#### 6.1.5.1.5 Other Activities

***Tar Sands Development.*** This PEIS addresses the environmental and socioeconomic impacts of land use plan amendments and potential development for both oil shale and tar sands, and thus, potential tar sands development must be considered in the cumulative impact assessment. Because the level of tar sands development over the next 20 years is unknown, this

**TABLE 6.1.5-3 Assumptions Associated with Coal-Fired Power Plants[a]**

| Impact-Producing Factor | Assumed Values for a 1,500-MW Plant (BLM 2007d) | Assumed Values for a 360-MW Current Design Plant and a 425-MW NSPS Plant (Spath et al. 1999)[b] |
|---|---|---|
| Land use (acres) | 3,000 total (includes construction acreage) | NA[c] |
| Water use (ac-ft/yr) | 8,000 ac-ft/yr | NA |
| Fuel source and composition | Wyoming-grade low-sulfur coal (0.47% sulfur, 6.4% ash); heat of combustion = 8,220 Btu/lb (Representative data from Powder River Basin coal; Ellis et al. 1999) | Illinois No. 6 bituminous (4% sulfur, 0.1% chlorine, 1.1% nitrogen, 10% ash dry basis); heat of combustion = 10,800 Btu/lb |
| Fuel requirements | 3.75 million tons/yr (2,330 tons/yr/MW)[d] | Current plant: 1.6 million tons/yr (4,320 tons/yr/MW); NSPS plant: 1.7 tons/yr (3,950 tons/yr/MW) |
| Solid waste (ash) | NA | Current plant: ~36,000 kg/GWh; NSPS plant: ~33,000 kg/GWh |
| Solid waste (flue-gas cleanup) | NA | Current plant ~86,000 kg/GWh; NSPS plant: ~92,000 kg/GWh |
| Emissions | | |
| $SO_2$ | Meet NSPS standards: 258 g/GJ heat input (0.6 lb/million Btu) | Current plant: 6,400 kg/GWh; NSPS plant: 2,229 kg/GWh |
| $NO_x$ | Meet NSPS standards: 258 g/GJ heat input (0.6 lb/million Btu) | Current plant: 3,039 kg/GWh; NSPS plant: 2,041 kg/GWh |
| CO | NA | Current plant: 134 kg/GWh; NSPS plant: 123 kg/GWh |
| $CO_2$ | NA | Current plant: ~970,000 kg/GWh; NSPS plant: ~890,000 kg/GWh |
| Particulates | Meet NSPS standards: 13 g/GJ heat input (0.03 lb/MMBtu) | Current plant: 135 kg/GWh; NSPS plant: 123 kg/GWh |
| VOCs | NA | Current plant: 16 kg/GWh; NSPS plant: 14 kg/GWh |
| Employment (direct FTEs[e]) | Construction: 800 average over 4 yr (1,200 peak); operations: 135 | NA |
| Transportation | 12 trains/week; 100 cars/train; 10,000 tons/train[d] | 13–14 trains/week; 17 cars/train; 1,445 tons/train |

**Footnotes on following page.**

**TABLE 6.1.4.1-3 (Cont.)**

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[a] Power plants are assumed to operate at 60% efficiency; thus, a 1,500-MW plant generates approximately 7,900 GWh/yr; a 325-MW plant generates 1,900 GWh/yr; and a 425-MW plant generates 2,200 GWh/yr.

[b] NSPS = new source performance standard.

[c] NA = information not available.

[d] Source for fuel requirement and transportation assumptions is Thompson (2006b, 2006c).

Sources: BLM (2007d); Ellis et al. (1999); Spath et al. (1999); Thompson (2006b, 2006c).

assessment has assumed that one tar sands facility would be constructed and operated in any one of the Utah STSAs during the study period. Impact-producing factors for such a tar sands facility include surface disturbance, water use, waste generation, and local changes in employment and population density. The assumptions used for these factors are given in Section 5.1.

***Grazing.*** Public and private lands in the study area are used extensively for livestock grazing. Environmental impacts of note associated with livestock grazing include potential degradation of soil, vegetation, wildlife habitat, and surface water quality (Krueger et al. 2002; BLM 2006k). For example, overgrazing could result in increased rates of erosion and topsoil losses. Allowing grazing during the nesting seasons of some species could result in trampling of the eggs and decreased viability of those species in the study area. Livestock could also degrade surface water quality if their manure and urine were deposited directly into the water or on land nearby. Good management practices could eliminate or mitigate many of these impacts. On BLM lands, grazing permits are required that specify the species allowed to graze, amount of grazing permitted, and other requirements to minimize environmental impacts.

***Fire Management.*** Fire management is used on public and private lands to aid in wildfire suppression. Underbrush is burned at regular intervals to avoid the buildup of large amounts of fuel on these lands. Fire is considered to have a natural role in the ecosystems and is used as a tool in managing those ecosystems. However, fires have potential environmental impacts that should be considered, particularly impacts on air quality and on threatened and endangered species (BLM 2002b). In general, impacts would be lower from more frequent, less intense, controlled fires than from infrequent wildfires.

***Forestry.*** About 25% of the 258 million surface acres that the BLM administers is classified as forested land. Forested land is defined as being 10% stocked with live trees and at least 1 acre in size and 120 ft wide. A 2006 report on the status and condition of these forests states that the national priorities for them include “maintaining and restoring forest health, salvaging dead and dying timber, providing high-quality wildlife and fish habitat, and providing economic opportunities in rural communities by making timber and other forest products,

including biomass, available from vegetation management treatments" (BLM 2006l). Management techniques for forest lands used by the BLM include grazing restrictions, selective thinning of undergrowth and dead wood, prescribed burns, and selective harvesting of trees. Adverse environmental impacts on air quality, water quality, habitat, and threatened and endangered species could occur as a result of these management practices. For example, increased erosion after land clearing could cause siltation in streams and decrease water quality.

***Recreation.*** One mission of the BLM is to accommodate recreational use of public lands, such as fishing, hiking, horseback riding, mountain biking, camping, and OHV use. However, these uses can have adverse environmental impacts. For example, OHV use can result in soil compaction, increased erosion, and the proliferation of non-native plant species. Overuse of trails in primitive areas can also result in erosion and disturbance of threatened and endangered species habitat. Other ways by which recreational visitors can affect the environment include producing waste, emitting air pollutants from motorized vehicles, and using water. However, recreational use also has benefits, including allowing visitors to enjoy outdoor wilderness areas and reduce their stress, and stimulating economic growth in the area. The BLM works to minimize the adverse environmental impacts of recreational use by managing the activity. Examples of plan requirements include habitat improvement projects in recreational areas, construction of recreational use facilities that lead to decreased random use and degradation of wild areas, and waste management (BLM 2006m).

### 6.1.5.2 Projected Levels of Major Activities in the Study Area

Data on past, current, and planned future activities on BLM-administered lands and also on nonfederal lands were obtained mainly from various BLM RMPs and EISs available through the field offices. Also, because projected developments have been changing rapidly, particularly for oil and gas development, field office staff were contacted in order to obtain their best current estimates for projected activities in the areas of oil and gas development (both on public and private lands), coal development, other minerals development, energy development, and other activities (e.g., grazing, fire management, forestry, and recreation) over the 20-year time period between 2007 and 2027. The projected levels of major activities are summarized in Table 6.1.5-4 for Colorado, Table 6.1.5-5 for Utah, and Table 6.1.5-6 for Wyoming.

#### 6.1.5.2.1 Colorado

***Oil and Gas Development.*** In the Colorado study area, it is projected that a large amount of new oil and gas drilling and production would occur over the 20-year planning horizon. The largest amount is projected for the White River Field Office, for which a maximum of 1,060 wells drilled per year is predicted; the total projected new oil and gas wells for applicable field offices in the state is 1,500 per year (see Table 6.1.5-4).

**TABLE 6.1.5-4 Projected Levels of Major Activities Considered in Cumulative Impacts Assessment for Oil Shale Development in Colorado[a]**

| | Individual Colorado Field Offices | | | | | |
|---|---|---|---|---|---|---|
| Activity | Glenwood Springs | Roan Plateau within Glenwood Springs but Assessed Separately | White River | Little Snake[b] | Grand Junction (BLM 1985b)[a] | Summary for Field Offices |
| ***Oil and Gas*** | | | | | | |
| Recoverable oil and gas reserves | NA | 15.4 TCF gas (9 TCF on federal lands); oil ~15 BB (BLM 2006i). | 86.7 MMCF gas, 11.5 MB oil over 20 yr [1997–2016] (BLM 1996). | 21 TCF federal lands gas; 175.6 MB federal oil (BLM 1986b). | NA | >36 TCF gas; >5 BB oil |
| Potential oil and gas wells drilled/yr over next 20 yr (2007–2027)[c] | 60 wells/yr (BLM 1999a) (based on 1,200 total over 20 yr [2000–2019]; assume same annual rate. | 185 wells/yr (based on 3,691 total over 20 yr [2005–2024]; 1,570 on federal lands, 2,121 private) (BLM 2006i). | 1,060 wells/yr (Hollowed 2007) (based on 21,200 total over 20 yr). | 152 wells/yr (Thompson 2006a) (based on 3,031 total over 20 yr). | 50 wells/yr (based on 1,000 over 20 yr [1986–2005]; assume same annual rate). | ~1,500 wells/yr |
| Annual surface disturbance over next 20 yr (2007–2027) (acres/yr)[d] | 150–900 | 460–2,800 | 2,650–16,000 | 380–2,300 | 125–750 | 3,800–23,000 acre/yr |
| Wells to be abandoned annually over next 20 yr (2007–2027)[e] | 15 wells/yr | 46 wells/yr | 265 wells/yr | 38 wells/yr | 13 wells/yr | ~380 wells/yr |
| Geophysical (seismic) exploration projects[f] | NA | NA | NA | NA (Ernst 2006) | NA | NA (~3,200–6,400 acres/yr of temporary vegetation and habitat disturbance) |

**TABLE 6.1.5-4 (Cont.)**

| Activity | Individual Field Offices | | | | | Summary for Field Offices |
|---|---|---|---|---|---|---|
| | Glenwood Springs | Roan Plateau within Glenwood Springs but Assessed Separately | White River | Little Snake[b] | Grand Junction (BLM 1985b)[a] | |
| ***Coal*** | | | | | | |
| Recoverable reserves (million tons) | 1,600 (BLM 1983)—Grand Hogback field | Not economically recoverable (BLM 2004a) | 740 (BLM 1994b) | 5,800 (BLM 1986a) | 4,900 | 13,000 million tons |
| Predicted production over next 20 yr (2007–2027) (million tons/yr) | None (Thompson 2006a) | None | 2–2.5 (Thompson 2006a) | 29 (2005 statewide production was 39 million tons (EIA 2006a); Little Snake produces 75% of that (BLM 1986b). | 0.3 initially, increasing to 4–6 (Thompson 2006a). | ~38 million tons/yr |
| Surface area potentially leasable (acres) | 29,000 (BLM 1983) | None | 118,000 (surface and subsurface) (BLM 1997a) | 275,000 surface only; 457,000 (includes surface and subsurface acres); (BLM 1986c). | 150,000 (Thompson 2006a) | At least 570,000 acres |
| Surface mining area potentially disturbed annually (acres/yr) | None (Thompson 2006a) | None | None (Thompson 2006a) | 200 (based on current activity) (Thompson 2006a). | None (Thompson 2006a) | 200 acre/yr |
| Surface area potentially disturbed for underground mine support facilities (total, 2007–2027) (acres) | None (Thompson 2006a) | None | 500 | 500 (in addition to 1,000 currently disturbed) (Thompson 2006a). | 500 (in addition to 100 currently disturbed) (Thompson 2006a). | 1,500 acres |
| Other coal impacts | None known | None known | None known | None known | None known | None known |
| ***Other Minerals (Sodium, Locatable and Salable Minerals)*** | | | | | | |
| Sodium reserves (billion tons) | Not known to occur | Not known to occur | 32 (nahcolite); 19 (dawsonite) (BLM 1994b). | Not known to occur | Not known to occur | 51 billion tons |

**TABLE 6.1.5-4 (Cont.)**

| Activity | Individual Field Offices | | | | | Summary for Field Offices |
|---|---|---|---|---|---|---|
| | Glenwood Springs | Roan Plateau within Glenwood Springs but Assessed Separately | White River | Little Snake[b] | Grand Junction (BLM 1985b)[a] | |
| ***Other Minerals (Sodium, Locatable and Salable Minerals) (Cont.)*** | | | | | | |
| Sodium production rate over next 20 yr (2007–2027) (tons/yr) | Not known to occur | Not known to occur | Unknown; current pilot scale at 6 tons/h nahcolite (BLM 1994b); leases have stipulation not to damage commingled/overlying oil shale. | Not known to occur | Not known to occur | Unknown |
| Surface disturbance from sodium production (acres/yr) | None | None | 20 (Thompson 2006a) | None | None | 20 acres/yr |
| Locatable minerals (e.g., precious metals/gems, uranium, bentonite, gypsum, salt, limestone) | Numerous claims, no significant activity (BLM 1983); potential for limestone production for rock dust and power plant scrubbers (Thompson 2006a). | Not known to occur | Uranium/vanadium: post-WWII mining, none current (BLM 1994b). | Uranium—several areas favorable for deposits; increasing current activity; gold—significant placer gold potential; juniper limestone—disturb 3 acres/yr (Ernst 2006); others—relatively unexplored (BLM 1986b). | Uranium: high potential for renewal of mining in Uravan Mineral Belt; currently a surge of activity in staking and exploration (Thompson 2006a). | Expected increase in uranium/vanadium exploration and development; ongoing limestone production. |
| Salable minerals (gravel, sand, clay) | Limited, localized production expected. | Limited, localized production expected (BLM 2004a). | Demand is high in Rangely area (BLM 1994b). | Limited, localized production expected (BLM 1986b). | Limited, localized production expected. | Limited, localized production expected. |

**TABLE 6.1.5-4 (Cont.)**

| Activity | Individual Field Offices | | | | | Summary for Field Offices |
|---|---|---|---|---|---|---|
| | Glenwood Springs | Roan Plateau within Glenwood Springs but Assessed Separately | White River | Little Snake[b] | Grand Junction (BLM 1985b)[a] | |
| ***Energy Development*** | | | | | | |
| Energy corridors (acres) | NA | NA | NA | NA | NA | Estimated 420 mi (262,000 acres) in Colorado; substantial portion in these field offices (DOE 2007). |
| Electric generating utilities | NA | NA | NA | NA | NA | ~1,600 MW currently produced in region (80% from coal (EIA 2007); three new plants proposed for Colorado (~2,840-MW capacity [EPA 2002]). |
| Wind power | No planned projects | No planned projects; area not rated high in wind potential (BLM 2004a). | No planned projects | No planned projects; Little Snake Field Office wind rankings poor to fair (EIA 2006b). | No planned projects | Colorado currently produces 291 MW of wind power; no current plans for further development in this part of the state (AWEA 2006). |

**TABLE 6.1.5-4 (Cont.)**

| Activity | Individual Field Offices | | | | | Summary for Field Offices |
|---|---|---|---|---|---|---|
| | Glenwood Springs | Roan Plateau within Glenwood Springs but Assessed Separately | White River | Little Snake[b] | Grand Junction (BLM 1985b)[a] | |
| ***Other*** | | | | | | |
| Forestry | NA | NA | Annual allowable harvest from 45 to 890 acres/yr (BLM 1994b) | Harvest levels 300,000 board ft in 1986, managed for sustained yield (BLM 1986b); assume same level through study period. 200 acres/yr Ponderosa pine, 50 acres/yr lodgepole pine, and 500 acres/yr pinyon/juniper woodland to be restored (BLM 2007e). | NA | Assume >300,000 board ft/yr production; total acres disturbed unknown. |
| Fire management | NA | NA | 5,400 acres/yr prescribed burn (based on total for 1995–2009 [BLM 1994b]). | NA | 1,800 acres/yr prescribed burn (based on total for 1985–1999). | NA (>7,200 acres/yr prescribed burn) |
| Geothermal (leasable) | NA (but 254 $mi^2$ with high potential) (BLM 1999a) | Area not rated high in geothermal potential (BLM 2004a). | NA | Low-temperature geothermal activity present; utilization local and limited (BLM 1986b). | NA | Geothermal development not expected. |
| Land and realty | NA | Lands on top of plateau would be retained (BLM 2006i). | NA | NA | NA | NA |

**TABLE 6.1.5-4 (Cont.)**

| Activity | Individual Field Offices | | | | | Summary for Field Offices |
|---|---|---|---|---|---|---|
| | Glenwood Springs | Roan Plateau within Glenwood Springs but Assessed Separately | White River | Little Snake[b] | Grand Junction (BLM 1985b)[a] | |
| ***Other (Cont.)*** | | | | | | |
| Grazing and rangeland management | NA | Managed using combination of administrative, project, and BMP means (e.g., pasture and rest rotation, livestock exclusion, fences, and ponds) (BLM 2004a). | NA | NA | NA | NA |
| Special management areas, recreation | NA | Of 259 mi of routes, 163 mi to be designated for motorized use, 28 mi closed and reclaimed, 68 mi for administrative use. Hubbard Mesa open to OHV use (BLM 2006i). | NA | Developed recreation sites with established campgrounds, boat ramps, or other developed recreational facilities would be protected by a 40-acre NSO stipulation (BLM 2007e). | NA | NA |
| Vegetation | NA | NA | NA | NA | NA | NA |
| Noxious/invasive weeds | NA | NA | NA | NA | NA | NA |

**Footnotes on following page.**

**TABLE 6.1.5-4 (Cont.)**

Abbreviations: BB = billion barrels; MB = million barrels; MMCF = million cubic feet; NA = information not available; NSO = No Surface Occupancy; OHV = off-highway vehicle; TCF = trillion cubic feet.

[a] Activities listed are those considered in addition to potential oil shale and tar sands development on federal lands as described in Chapters 4 and 5. For the Grand Junction Field Office, the main reference citation is given in the title field. Other references are given with specific data. In general, values are rounded to two significant figures.

[b] The Little Snake Field Office does not contain potential oil shale development areas; however, it is included in this summary because of its proximity to the potential project area and extensive related potential future development.

[c] Includes projections for federal lands and, where available, nonfederal lands.

[d] Assumes a range of 2.5 to 15 acres/well for well pads, roads, and pipelines (representative range based on 2.5 acres/well from DOE (2006), 13 acres/well from White River RMP (BLM 1994b), net disturbance of 9.3 acres/well for Little Snake (Thompson 2006a), disturbance of 3.4 acres/well for Roan Plateau (BLM 2006i), 3 acres/well from Vernal Utah Planning Area (BLM 2002a), and 15 acres/yr from Moab Utah Planning Area (BLM 2005a).

[e] Assumes 25% of new wells would be abandoned annually (based on estimate for the Rawlins Wyoming Field Office) (Allison 2006). All surface disturbance is assumed to be reclaimed within 10 yr of abandonment.

[f] If information not available, assume approximately 1 to 2 geophysical exploration projects/50 wells drilled annually (based on Wyoming estimates); 100 acres disturbed/project (this is short-term disturbance such as crushed vegetation, uprooted brush, and minor soil disturbance; disturbance is generally unidentifiable within 1 yr). At 1,600 wells drilled/yr, expect 32 to 64 projects/yr for Colorado overall.

**TABLE 6.1.5-5 Projected Levels of Major Activities for Seven Planning Areas Considered in the Cumulative Impacts Assessment for Oil Shale Development in Utah[a]**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Oil and Gas*** | | | | |
| Recoverable oil and gas reserves | NA | NA | NA | NA |
| Potential oil wells drilled/yr over next 20 yr (2007–2027)[b] | 76 wells (based on 2,055 total in VPA, 1,130 in DM only over 15 yr [2003–2017] as projected by BLM [2005b]). | 62 wells (based on 2,055 total in VPA, 925 in BC only over 15 yr [2003–2017] as projected by BLM [2005b]). | 30 wells total in RPA; 3 in HM only (includes oil, gas, and CBNG; based on 454 total over 15 yr [2005–2020]; 3/yr in HM only, as projected by BLM [2005c]). | Few (based on only 8 currently producing wells), discussion that no significant oil production expected in the future (BLM 2004b; Appendix 21). |
| Potential gas wells drilled/yr over next 20 yr (2007–2027)[b] | 147 wells (based on 4,035 total in VPA, 2,195 in DM only over 15 yr [2003–2017] as projected by BLM [2005b]). | 143 wells (based on 4,035 total in VPA, 2,150 BC only over 15 yr [2003–2017] as projected by BLM [2005b]). | Included with potential oil wells drilled for HM PA. | 55–95 wells (includes CBNG; based on 1,100–1,900 over 20 yr [2005–2024] as projected by BLM [2004b; Table 4-2]). |
| Potential CBNG wells drilled/yr over next 20 yr (2007–2027)[b] | 4 wells (based on 130 total in VPA, 50 in DM over 15 yr [2003–2017] as projected by BLM [2005b]). | 6 wells (based on 130 total in VPA, 80 in BC over 15 yr [2003–2017] as projected by BLM [2005b]). | Included with potential oil wells drilled for HM PA. HM coal field not likely to be developed for CBNG in the next 15 yr (2005–2020) (BLM 2005d). | Included with potential gas wells drilled for San Rafael PA; numbers above include Price Project: 545 wells/10 yr on 1,609 acres, 20–70 jobs; Ferron Project: 335 wells/5 yr, acres unknown. Impacts on mule deer populations and winter habitat (BLM 2004b). |
| Annual surface disturbance over next 20 yr (2007–2027) (acres/yr)[c] | 570–3,400 acres/yr total (190–1,100 oil; 370–2,200 gas; 10–60 CBNG). | 540–3,200 acres/yr total (160–930 oil; 360–2,100 gas; 15–90 CBNG). | 75–450 acres/yr RPA total; 9–45 HM (includes oil, gas, and CBNG). | 140–1,400 acres/yr (includes gas and CBNG) |

**TABLE 6.1.5-5 (Cont.)**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Oil and Gas (Cont.)*** | | | | |
| Wells to be abandoned annually over next 20 yr (2007–2027)[d] | 57 wells total (19 oil; 37 gas; 1 CBNG). | 54 wells total (16 oil; 36 gas; 2 CBNG). | 8 wells in RPA total, 1 in HM (includes oil, gas, and CBNG). | 14–24 wells (includes gas and CBNG) |
| Seismic exploration projects[e] | 2–3 projects per yr (based on 45–75 total for Vernal, assume half in DM) over 15 yr (2003–2015) (BLM 2002a). 200–300 acres/yr disturbance. | 2–3 projects per yr (based on 45–75 total for Vernal, assume half in BC) over 15 yr (2003–2015) (BLM 2002a). 200–300 acres/yr disturbance. | 340 acres/yr disturbance (based on 5,100 total over 15 yr as projected by BLM [2005c]). | 150 acres/yr disturbance (based on 2,236 total over 15 yr as projected by BLM [2004b]) |
| ***Coal*** | | | | |
| Recoverable reserves (million tons) | Tabby Mountain Coal Field: ~320 million tons (BLM 2002a). | No known reserves (BLM 2002a). | Includes south part of Wasatch Formation: ~6,000 million tons; HM Coal Field: 20 million tons (Jackson 2006). | Includes northern part of Wasatch Formation: ~690; Book Cliffs Coal Field: ~280; Emery Coal Field: ~240 (all 3 in million tons) (BLM 2004b; Section 3.3.5.2). |
| Predicted production over next 20 yr (2007–2027) (million tons/yr) | None (BLM 2002a) | None (BLM 2002a) | Wasatch Formation: 25; no production planned for HM (Jackson 2006). | Lila Canyon: 0.8–1; North Horn: 2–4; Willow Creek: 2–4 (BLM 2004b; Chapter 4). |
| Surface area potentially leasable (acres) | NA | None | NA | NA |
| Surface mining area potentially disturbed annually (acres/yr) | None | None | None | None |

**TABLE 6.1.5-5 (Cont.)**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Coal (Cont.)*** | | | | |
| Surface area potentially disturbed for underground mining support facilities (total acres, 2007–2027)[f] | None projected | None projected | 500 acres | Most coal would be mined through underground mining methods (BLM 2004b; Section 3.3.5.2); 500 acres. |
| Other coal impacts | None known | None known | None known | Lila Canyon: 5-mi road, 550 round-trips/day on US 6, 150–200 jobs; North Horn: roads, power line, and infrastructure construction, EIS ongoing, start of operations unknown; Willow Creek: not currently leased, if operations begin, 250–300 jobs, surface disturbance, safety issues (BLM 2004b; Chapter 4). |
| ***Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals)*** | | | | |
| Phosphate production over next 20 yr (2007–2027) | 5,800 acres on BLM-administered land; 14,000 acres on private land (BLM 1993 and 2002a); assume 50% surface mining (i.e, 10,000 acres). | None (BLM 2002a) | None | None |
| Gilsonite production rate over next 20 yr (2007–2027) (tons/yr) | None (BLM 2002a) | 60,000 (based on BLM projections for 2003–2017) (BLM 2002a) | None | None |

**TABLE 6.1.5-5 (Cont.)**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals) (Cont.)*** | | | | |
| Locatable minerals (e.g., precious metals/gems, uranium, bentonite, gypsum, limestone, salt) | Minor to no activity (BLM 2002a) | Minor to no activity (BLM 2002a) | Uranium, vanadium, gold, copper: high potential for occurrence and development in HM area; exploration for economic quantities is continuing (BLM 2005d). One salt mine on west side of RPA to continue operations. Gypsum and salt production unlikely in next 15 yr, especially in HM area (BLM 2005d). | Gypsum: fairly large areas in southern and central parts of PA have high potential for development over the next 15 yr (2005–2020) (BLM 2004b; Section 3.3.5.1). Number of acres: NA. |

**TABLE 6.1.5-5 (Cont.)**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals) (Cont.)*** | | | | |
| Salable minerals (gravel, sand, clay) | Stone: 30 tons/yr (based on 60 tons/yr total for VPA, 2003–2017 (BLM 2002a). Limestone: 30,000 tons/yr (based on FS land production, most in DM) (BLM 2002a). Sand and gravel: some production, quantity unknown (BLM 2002a). | Stone: 30 tons/yr (based on 60 tons/yr total for VPA), 2003–2017 (BLM 2002a); Sand and gravel: some production, quantity unknown (BLM 2002a). | For planning period of 2006–2020: 57 active sand and gravel disposal sites on BLM land; likely to continue producing ~20,000 $yd^3$/yr, additional sites on public land (BLM 2005d). Assume 2 permits at 6 acres/permit: 12 acres/yr. Clay: only small-scale development. Stone: continue at current rate of about 1–1,000 tons/yr (BLM 2005d). Humate production to continue on small scale at Factory Butte in HM (BLM 2005d). | Clay: current areas of active mining will continue over next 15 yr (2005–2020), unlikely that new deposits would be developed (BLM 2004b; Section 3.3.5.1). Sand and gravel, stone, humate: high potential areas near major paved roads would be developed 2005–2020 (BLM 2004b; Section 3.3.5.3). |
| ***Energy Development*** | | | | |
| Energy corridors | NA | NA | NA | NA |
| Electric generating utilities | NA | NA | NA | NA |

**TABLE 6.1.5-5 (Cont.)**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Energy Development (Cont.)*** | | | | |
| Existing power plants | NA | NA | NA | Hiawatha Cogeneration Plant, Questar Pipeline Dewpoint Plant, Sunnyside Cogeneration Facility, coal-fired PacifiCorp Hunter, Huntington and Carbon plants: all provide employment, emit $NO_X$, use water, decrease water quality. Planned PacifiCorp Hunter expansion: add 350 long-term jobs, increase $NO_X$ and $SO_X$ emissions, use and degrade water (BLM 2004b). |
| ***Other*** | | | | |
| Forestry | NA | NA | NA | Logging on private lands (not quantified) (BLM 2004b; Section 4.2.2) |
| Fire management | 5,500–7,800 acres/yr prescribed burns annually based on 11,000 acres total in VPA as projected by BLM for 2002–2006 (BLM 2005b; Section 3.4) or 156,425 acres/ decade total in VPA (BLM 2005b; Table 2.3). | 5,500–7,800 acres/yr prescribed burns annually based on 11,000 acres total in VPA as projected by BLM for 2002–2006 (BLM 2005b; Section 3.4) or 156,425 acres/ decade total in VPA (BLM 2005b; Table 2.3). | NA | One prescribed burn of 5,000 acres every 2 yr (based on last 20 yr of data) (BLM 2004b; Section 3.2.10.4). |

**TABLE 6.1.5-5 (Cont.)**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Other (Cont.)*** | | | | |
| Land and realty | NA | NA | NA | Utah Department of Transportation—road improvements between 2006 and 2025 on US 6 between Green River and Spanish Fork (~3-mi widening, 12 mi of new asphalt). Also SR-10 corridor (5 mi) (BLM 2004b; Section 4.2.2) |
| Livestock | NA | NA | NA | NA |
| Special management areas, recreation | 4–27 mi/yr nonmotorized recreational trails, and 54 mi/yr motorized trails would be developed total in VPA (between 2006 and 2020; BLM 2005b; Table 2.3); assume half in DM. | 4–27 mi/yr nonmotorized recreational trails, and 54 mi/yr motorized trails would be developed total in VPA (between 2006 and 2020; BLM 2005b; Table 2.3); assume half in BC. | NA | NA |
| Vegetation | 2,300–3,400 acres/yr vegetation treated total in VPA (between 2006 and 2020; BLM 2005b; Table 4.18.2); assume half in DM. | 2,300–3,400 acres/yr vegetation treated total in VPA (between 2006 and 2020; BLM 2005b; Table 4.18.2); assume half in BC. | NA | NA |
| Soils/watersheds | NA | NA | NA | NA |
| Miscellaneous | NA | NA | NA | NA |

**TABLE 6.1.5-5 (Cont.)**

| Activity | San Juan (Area Similar to Monticello PA) | Grand Staircase–Escalante NM | Moab PA | Summary for Utah PAs and GSENM |
|---|---|---|---|---|
| ***Oil and Gas*** | | | | |
| Recoverable oil and gas reserves | NA | >270 million bbl (Allison 1997) | NA | NA |
| Potential oil wells drilled/yr over next 20 yr (2007–2027)[b] | 5–21 wells (includes gas, average of 13/yr, 195 total from 2005–2020 (BLM 2005e). | Few (only 47 exploratory wells currently in GSENM; ~200,000 acres of old leased land is under review) (BLM 1999b). | 12–40 wells (includes gas, average of 26/yr, 390 total from 2005–2020 (BLM 2005a). | 190–230 oil wells drilled/yr |
| Potential gas wells drilled/yr over next 20 yr (2007–2027)[b] | Included with potential oil wells drilled for San Juan PA. | None (BLM 1999b) | Included with potential oil wells drilled for MOAB PA. | 350–390 gas wells drilled/yr |
| Potential CBNG wells drilled/yr over next 20 yr (2007–2027)[b] | None (BLM 2005f) | None (BLM 1999b) | 1 well (based on three 5-spot well clusters between 2006 and 2020 [BLM 2005g]; assume same annual rate). | 11 CBNG wells drilled/yr |
| Annual surface disturbance over next 20 yr (2007–2027) (acres/yr)[c] | 13–320 acres/yr (includes oil and gas). | NA | 33–620 acres/yr total (30–600 [oil and gas]; 3–15 CBNG (similar to 225 total acres CBNG between 2006 and 2020) (BLM 2005g). | 1,400–9,400 acres/yr |
| Wells to be abandoned annually over next 20 yr (2007–2027)[d] | 2–8 wells (includes oil and gas) (BLM 2005e). | NA | 6–20 wells (BLM 2005a). | 140–170 wells abandoned/yr |
| Seismic exploration projects[e] | 150-acres/yr disturbance (based on 2,236 total over 15 yr as projected by BLM [2005e]). | NA | 240-acres/yr disturbance (based on 3,600 total over 15 yr [2005–2020] as projected by BLM [2005a]) | NA (~1,300–1,500 acres/yr of temporary vegetation and habitat disturbance) |

**TABLE 6.1.5-5 (Cont.)**

| Activity | San Juan (Area Similar to Monticello PA) | Grand Staircase–Escalante NM | Moab PA | Summary for Utah PAs and GSENM |
|---|---|---|---|---|
| ***Coal*** | | | | |
| Recoverable reserves (million tons) | San Juan Coal Field (530,000 acres; 60% privately owned) (BLM 1991a), 77 million tons available to surface mining; no current production because of poor quality/lack of rail transport (BLM 2005f). | NA | NA (Sego Formation produced ~3 million tons up through the 1950s) (BLM 2005g). | ~7.6 billion tons |
| Predicted production over next 20 yr (2007–2027) (million tons/yr) | None (BLM 2005f) | None (BLM 1999b) | None (BLM 2005g) | 30–34 million tons/yr |
| Surface area potentially leasable (acres) | NA | NA | NA (Sego Formation may be attractive for future production because of low sulfur content, close to railway). | NA |
| Surface mining area potentially disturbed annually (acres/yr) | NA | NA | NA | NA |
| Surface area potentially disturbed for underground mining support facilities (total acres, 2007–2027)[f] | None projected | None projected | None projected | 1,000 acres total 2007–2027 |
| Other coal impacts | None known | None known | None known | See San Rafael PA. |

**TABLE 6.1.5-5 (Cont.)**

| Activity | San Juan (Area Similar to Monticello PA) | Grand Staircase–Escalante NM | Moab PA | Summary for Utah PAs and GSENM |
|---|---|---|---|---|
| ***Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals)*** | | | | |
| Phosphate production over next 20 yr (2007–2027) | None (BLM 2005f) | None (BLM 1999b) | None (BLM 2005g) | 10,000 acres surface disturbance (see DM) |
| Gilsonite production rate over next 20 yr (2007–2027) (tons/yr) | None (BLM 2005f) | None (BLM 1999b) | None (BLM 2005g) | 60,000 tons/yr gilsonite (see BC) |
| Locatable minerals (e.g., precious metals/gems, uranium, bentonite, gypsum, limestone, salt) | Uranium/vanadium: 4.2 million-ton reserves in Four Corners area–estimated disturbance of 20 acres/yr for next 15 yr (2005–2020) (BLM 2005f). Gold: 5–20 acres total disturbed for next 15 yr in Recapture Creek and Johnson Creek (BLM 2005f). Limestone: 20–30 thousand tons/yr, 20–50 acres total disturbed for next 15 yr (BLM 2005f). | Uranium/vanadium: deposits present (Allison 1997), not to be developed (BLM 1999b). Alabaster: ongoing production of 300 tons/yr, from surface, not usually quarried. | Uranium/vanadium: >1-million ton ore reserves; estimated disturbance of 10 acres/yr for next 15 yr (2005–2020) (BLM 2005g). Copper: Lisbon Valley Project, produce for 10 yr (2006–2015); disturb 110 acres/yr (1,103 total, includes 266-acre pad for leaching, processing plant, ponds, 11-mi power line). Salt/potash: 3.3 acres/yr (50-acres disturbance total over next 15 yr [2005–2020] BLM 2005g). | Uranium/vanadium: high potential for development with at least 30 acres/yr surface disturbance. Gold: at least 5 acres/yr disturbed; Limestone: at least 20 acres/yr disturbed. Gypsum: high potential for development, acres NA. Alabaster: 300 tons/yr, acres NA. Salt: at least 3 acres/yr disturbed. Copper: at least 110 acres/yr disturbed. Total: at least 170 acres/yr disturbed. |

**TABLE 6.1.5-5 (Cont.)**

| Activity | San Juan (Area Similar to Monticello PA) | Grand Staircase–Escalante NM | Moab PA | Summary for Utah PAs and GSENM |
|---|---|---|---|---|
| ***Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals) (Cont.)*** | | | | |
| Salable minerals (gravel, sand, clay) | Sand and gravel: 4 permits/yr producing ~127,000 $yd^3$/yr, 6 acres/permit, thus 24 acres/yr disturbed over next 15 yr (2005–2020) (BLM 2005f). Building stone: 5–10 acres/yr over next 15 yr (2005–2020) (BLM 2005f). | Sand and gravel: limited production for local use (Allison 1997). | Sand and gravel: 4 permits/yr producing ~60,000 $yd^3$/yr, 6 acres/permit; thus 24 acres/yr disturbed over next 15 yr (2005–2020) (BLM 2005g). Building stone: ~0.5 acres/yr over next 15 yr (1 new facility, producing 5,000–10,000 tons/yr for 5 yr between 2006 and 2020) (BLM 2005g). | Sand and gravel: at least 60 acres/yr disturbed. Stone: at least 6 acres/yr disturbed. Clay: no new deposits to be developed. |
| ***Energy Development*** | | | | |
| Energy corridors | NA | NA | NA | Estimated 640 mi (356,000 acres) in Utah; a portion of the corridor is expected to be sited near the oil shale resource (DOE 2007). |
| Electric generating utilities | NA | NA | NA | 3,200 MW currently produced in region (98% from coal) (EIA 2007). Three new plants proposed in Utah (~1,570-MW capacity [EPA 2002]). |
| Existing power plants | NA | None | NA | See San Rafael PA. |
| ***Other*** | | | | |
| Forestry | NA | NA | NA | See San Rafael PA. |

**TABLE 6.1.5-5 (Cont.)**

| Activity | San Juan (Area Similar to Monticello PA) | Grand Staircase–Escalante NM | Moab PA | Summary for Utah PAs and GSENM |
|---|---|---|---|---|
| ***Other (Cont.)*** | | | | |
| Fire management | NA | NA | NA | NA (at least 13,500 acres/yr prescribed burn) |
| Land and realty | NA | NA | NA | See San Rafael PA (roadwork planned). |
| Livestock | About 2.1 million acres used for grazing (BLM 1986d). | NA | NA | NA (About 2.1 million acres used for grazing in Monticello PA.) |
| Special management areas, recreation | About 1.3 million acres used for recreation (BLM 1986d) | ~6 acres/yr disturbed (total of 85 acres over 15 yr [2000–2014] for recreation and campsites (BLM 1999b). | NA | NA (motorized and nonmotorized trails and campsites to be developed) |
| Vegetation | NA | 1,000–3,000 acres/yr for vegetation restoration through burning (20,000 acres total for 2000–2014). | NA | At least 3,300 acres/yr vegetation treatment or burning for restoration. |
| Soils/watersheds | NA | <1 acre/yr (10 sites at 1 acre/site) (BLM 1999b). | NA | NA (at least 1 acre/yr disturbance) |
| Miscellaneous | NA | ~17 acres/yr for utility and road ROWs and communications sites (260 acres total over 15 yr [2000–2014] [BLM 1999b]). | NA | NA (at least 17 acres/yr disturbance) |

**Footnotes on following page.**

**TABLE 6.1.5-5 (Cont.)**

Abbreviations: BC = Book Cliffs; BCF = billion cubic feet; CBNG = coal bed natural gas; DM = Diamond Mountain; FS = Forest Service; GSENM = Grand Staircase–Escalante National Monument; HM = Henry Mountain; NA = information not available; PA = planning area; RPA = Richfield Planning Area; STSA = Special Tar Sand Area; VPA = Vernal Planning Area.

[a] Activities are those considered in addition to potential oil shale and tar sands development on federal lands as described in Chapters 4 and 5. In general, values are rounded to two significant figures.

[b] Includes projections for federal lands and, where available, nonfederal lands.

[c] Assumes a range of 2.5 to 15 acres/well for well pads, roads, and pipelines (representative range based on 2.5 acres from DOE (2006), 3 acres from Vernal Mineral Potential Report (BLM 2002a), and 15 acres from Moab PA (BLM 2005a). The 2.5 to 15-acre range encompasses estimates for San Rafael of 7.9 acres/well + 20-acres/ancillary facility (BLM 2004b; Appendix 21); Henry Mountain (4 acres/well + 8 acres/well for roads) (BLM 2005c); and Monticello (9.6 acres/well) (BLM 2005e).

[d] Generally assumes that 25% of new wells would be abandoned (based on estimate for the Rawlins Wyoming Field Office [Allison 2006]). Assumes 50% for Moab (BLM 2005a) and 40% for Monticello (BLM 2005e). All surface disturbance is assumed to be reclaimed within 10 yr of abandonment.

[e] If information not available, assume approximately 1 to 2 geophysical exploration projects/50 wells drilled annually (based on Wyoming estimates); 100 acres disturbed/project (this is short-term disturbance such as crushed vegetation, uprooted brush, and minor soil disturbance; disturbance is generally unidentifiable within 1 yr). At 550 to 630 wells drilled/yr, expect 11 to 26 projects/yr for Utah overall.

[f] For areas where coal mining is ongoing and subsurface, a limited amount of surface disturbance over the 20-year planning period was assumed (i.e., 500 acres).

**TABLE 6.1.5-6 Projected Levels of Major Activities Considered in Cumulative Impacts Assessment for Oil Shale Development in Wyoming[a]**

| Activity | Individual Wyoming Field Offices | | | Summary for Field Offices |
|---|---|---|---|---|
| | Kemmerer | Green River/Rock Springs | Great Divide/Rawlins | |
| ***Oil and Gas*** | | | | |
| Recoverable oil and gas reserves | 20–60 BCF gas; 63–260 MB oil (Easley 2006). | NA | 31–47 TCF gas; 55 MB oil; 748 MB natural gas liquids (Allison 2006). | >31–47 TCF gas; ~120–320 MB oil; ~750 MB natural gas liquids |
| Potential oil and gas wells drilled/yr over next 20 yr (2007–2027)[b] | 100 wells/yr (Easley 2006) (includes oil and gas; based on 2,040 total over 20 yr; includes Moxa Arch, Bear River Divide and Darby Thrust). | 140 wells/yr (based on 4,207 wells over 20 yr for Hiawatha project, 66% in Wyoming [BLM 2006n]; also 61 wells total for Bitter Creek [BLM 2005h]). | 482 wells/yr (Continental Divide/Creston, 8,850 wells; Desolation Flats, 592 wells; Atlantic Rim, 200 wells; over 20 yr) (Allison 2006). | ~720 wells/yr |
| New CBNG wells drilled/yr over next 20 yr (2007–2027)[b] | 30 wells/yr (based on 640 total over 20 yr [2004–2023] projected by BLM [2004d]). | Included with oil and gas above. | 157 wells/yr (Continental Divide/Creston, 100 wells; Atlantic Rim, 1,800 wells; Seminoe Rd, 1,240 wells; over 20 yr) (Allison 2006). | ~190 wells/yr |
| Annual surface disturbance over next 20 yr (2007–2027) acres/yr[c] | 330–2,000 (based on 130 wells/yr). | 350–2,100 (based on 140 wells/yr). | 1,600–9,600 (based on 640 wells/yr). | 2,300–14,000 acres/yr |
| Wells to be abandoned annually over next 20 yr (2007–2026)[d] | 20–33 wells/yr (15% [Easley 2006] to 25%). | 35 wells/yr | 160 wells/yr | 220–230 wells/yr |
| Geophysical (seismic) exploration projects[e] | 2–4 projects/yr within the Kemmerer Field Office area (Easley 2006). | 3 projects/yr: Hay River, South Jonah (subsurface data on 400 $mi^2$), LaBarge 3D (BLM 2004c). | 4–5 projects/yr within the Rawlins Field Office area (Allison 2006). | 9–12 projects/yr; ~900–1,200 acres/yr of temporary vegetation and habitat disturbance.[d] |

**TABLE 6.1.5-6 (Cont.)**

| Activity | Individual Wyoming Field Offices | | | Summary for Field Offices |
|---|---|---|---|---|
| | Kemmerer | Green River/Rock Springs | Great Divide/Rawlins | |
| ***Oil and Gas (Cont.)*** | | | | |
| Monell enhanced oil recovery project | Not applicable | A total of 126 wells drilled between 2006 and 2012 (80 on non-BLM-administered lands); total initial disturbance 1,100 acres; net disturbance after 20–25 yr 260 acres (BLM 2006o). | Not applicable | Land disturbance: 1,100 acres gross; 260 acres net. |
| ***Coal*** | | | | |
| Recoverable reserves (million tons) | 66 (BLM 1986e) | NA (35 for Black Butte Coal Co. Pit 14, surface mining site only (BLM 2006c); 122 for Ten Mile Rim subsurface, includes private (BLM 2004g). | 2,489 (surface mineable) (BLM 2004e) | >2,700 million tons |
| Predicted production over next 20 yr (2007–2027) (million tons/yr) | 4–5 current; annual 0.8% increase (based on predictions for 2005–2015 [BLM 2004d]). | 6–9 (based on projection for Sweetwater County through 2010 [Lyman and Jones 2005]). Individual projects: 1.5–3 tons/yr (permitted for 7) for 20 yr from Black Butte (BLM 2006p); 4.5–5.5 tons/yr for 15–20 yr from Ten Mile Rim (BLM 2004g). | None (Allison 2006) | 10–14 million tons/yr |
| Surface area potentially leasable (acres) | NA | 453,000 (30,000 of this already leased) (BLM 1997b). | 56,000 (5,000 Carbon Basin only) (BLM 2004e) | NA (at least 510,000 acres) |

**TABLE 6.1.5-6 (Cont.)**

| Activity | Individual Wyoming Field Offices | | | Summary for Field Offices |
|---|---|---|---|---|
| | Kemmerer | Green River/Rock Springs | Great Divide/Rawlins | |
| ***Coal (Cont.)*** | | | | |
| Project area (acres) | 8,600 (Easley 2006) | 4,500 (2,200 at Black Butte [BLM 2006p], 2,242 total at Ten Mile Rim but only 124 disturbed [BLM 2004g]). | None (Allison 2006) | ~13,000 acres |
| Subsurface area potentially disturbed (acres) | 6,900 (BLM 1986e) | 2,200 (BLM 2004g) | None (Allison 2006) | ~9,100 acres |
| Surface mining area potentially disturbed annually (acres/yr) | 430 (project area/20-yr project duration). | 120 (project area/20-yr project duration). | 0 (Allison 2006) | 550 acres/yr |
| ***Sodium/$CO_2$*** | | | | |
| Known sodium reserves (billion tons) | 114 | NA | NA | NA (at least 114 billion tons) |
| Sodium production rate over next 20 yr (2007–2026) (million tons/yr) | 12 (underground mines—rate in 2002, BLM projects no new leasing, permits, or off-lease drilling over life of plan [BLM 2004d]). | 6 (underground mines) (Nara-Kloepper 2006) | None | 18 million tons/yr (all from existing underground mines) |
| New sodium facilities | 2006—subsurface solution mine and processing plant (BLM 2004d). | NA | None | One subsurface solution mine and processing plant. |
| Sodium production surface disturbance (acres/yr) | Minimal surface disturbance over next 20 years (Easley 2006). | Minimal surface disturbance over next 20 years (Nara-Kloepper 2006) | None | Minimal surface disturbance over next 20 years. |

**TABLE 6.1.5-6 (Cont.)**

| Activity | Individual Wyoming Field Offices | | | Summary for Field Offices |
|---|---|---|---|---|
| | Kemmerer | Green River/Rock Springs | Great Divide/Rawlins | |
| ***Sodium/$CO_2$ (Cont.)*** | | | | |
| $CO_2$ production | Shute Creek Gas Plant, 435 M $ft^3$/day in 2001 (BLM 2004d). | None known | None known | ~160 BCF $CO_2$ production/yr |
| ***Locatable Minerals (e.g., precious metals/gems, uranium, bentonite)*** | | | | |
| Uranium | None projected | Uranium production potential low (BLM 2004c). | Little, if any, production expected (Allison 2006); reserves: >58 million lb (BLM 2004e). | Limited, if any, uranium exploration and development expected. |
| Magnetite | None projected | None projected | Little, if any, production expected (Allison 2006); reserves: ~30 million tons massive ore, 148 million tons disseminated ore (BLM 2004e). | Limited, if any, magnetite production expected. |
| Gold | Limited deposits have been identified; very limited if any activity expected (BLM 2004d). | Potentially present; current activities disturb less than 5 acres/yr (BLM 2004c). | Little, if any, production expected (Allison 2006); reserves: >100 million tons of Fe-gold ore at 28–68% Fe (BLM 2004e). | Limited gold production expected, although reserves are present. |
| Diamonds | No current production, although diamond potential is rated as high (BLM 2004d). | Potentially present, but not recovered to date (BLM 2004c). | None projected | Limited, if any, diamond production expected. |
| Bentonite | Known to occur, not produced because of co-placement with coal (BLM 2004d). | None projected | None projected | Limited, if any, bentonite production expected. |

**TABLE 6.1.5-6 (Cont.)**

| Activity | Individual Wyoming Field Offices | | | Summary for Field Offices |
|---|---|---|---|---|
| | Kemmerer | Green River/Rock Springs | Great Divide/Rawlins | |
| ***Salable Minerals (gravel, sand, clay)*** | Assume 475,000 tons/yr mined (based on 475,283 tons sold in 2002; demand expected to continue [BLM 2004d]). Two clay-producing companies, one on private land. | One 4-acre borrow area for sand and gravel in use. Clay uneconomical for production (BLM 2004c). | Assume 2.5 million tons/yr mined (based on current contracts that allow 21 million tons over 10 yr (2005–2014) [BLM 2004e] and anticipated increase [Allison 2006]). | NA (>3 million tons/yr mined) |
| ***Energy Development*** | | | | |
| Energy corridors | NA | NA | NA | Estimated 440 mi (186,000 acres) in Wyoming; substantial portion in these field offices. |
| Electric generating utilities | NA | NA | NA | ~3,600 MW currently produced in the region (85% from coal) (EIA 2007); 9 new plants proposed for Wyoming (5,930 MW [EPA 2002]). |
| Wind power | One 80-turbine facility operating in Uinta County; other proposals exist (BLM 2004f). | One 1–6 turbine facility proposed (BLM 2004c). | One 1,000-turbine facility, to disturb 6,020 acres, 45% to be revegetated, 100 additional acres/yr for miscellaneous (BLM 2004e). | Wyoming currently produces 290 MW of wind power (AWEA 2006); additional development expected. |

**TABLE 6.1.5-6 (Cont.)**

| Activity | Individual Wyoming Field Offices | | | Summary for Field Offices |
|---|---|---|---|---|
| | Kemmerer | Green River/Rock Springs | Great Divide/Rawlins | |
| ***Energy Development (Cont.)*** | | | | |
| Pipelines | 300 acres/yr short-term disturbance (over <5 yr) from pipelines, all to be reclaimed (Easley 2006). | NA | Overland Pass Pipeline: 780 mi from Opal Wyoming to Kansas; through all three field offices; would disturb total of 4,619 acres, 2,903 acres farmland; 10 acres surface facilities; employ 325–650 workers, 80% nonlocal (BLM 2007f). | NA (at least 300 acres/yr disturbed for pipeline construction) |
| ***Other*** | | | | |
| Forestry | 125 acres/yr (100% reclaimed) | NA | 300 tons biomass removal/10 yr; 6,000 trees/yr thinned (BLM 2004e). | NA (>125 acres/yr) |
| Fire management | 2,000 acres/yr prescribed burn (99% reclaimed) (Easley 2006). | NA | 1,500–10,000 acres/yr prescribed burn (BLM 2004e). | NA (>3,500–12,000 acres/yr prescribed burn) |
| Land and realty | NA | Proposed Haul Road (includes 6 pipelines and 1 fiber optic cable; ROW = 400 ft construction; 200 ft operations) (BLM 2004c). | 78 acres/yr disturbed—ditch and communications construction (BLM 2004e). | NA (at least 78 acres/yr disturbed) |
| Livestock | Approximately 6,160 acres to be maintained as public stock trails; reserve forage AUMs—no physical disturbance (BLM 1986e). | 2 projects to increase game fish populations (BLM 2004c). | 46 acres/yr (BLM 2004e) | NA (Land disturbance: at least 50 acres/yr) |

**TABLE 6.1.5-6 (Cont.)**

| Activity | Individual Wyoming Field Offices | | | Summary for Field Offices |
|---|---|---|---|---|
| | Kemmerer | Green River/Rock Springs | Great Divide/Rawlins | |
| ***Other (Cont.)*** | | | | |
| Special management areas, recreation | NA | Recreation activities assumed to require 290 wells over 20 years (BLM 2004c). | 480-acre OHV area with 5 mo/yr use (BLM 2004e). | NA (disturb at least 500 acres total) |
| Vegetation | Vegetation manipulation proposed for 82,610 acres (~4,100 acres/yr) to improve wildlife habitat (BLM 1986e). | New riparian enclosures to mitigate sheep to cattle conversion impacts (BLM 2004c). | 16,400 acres/yr treated (BLM 2004e). | ~21,000 acres/yr vegetation treated |
| Noxious/invasive weeds | NA | NA | 800–8,000 acres/yr treated. | NA (at least 800–8,000 acres/yr treated) |
| Soils/watersheds | NA | Eden/Farson Irrigation Project (supply for 17,000 acres) (BLM 2004c). | 25 stream mi restored, 50 groundwater and precipitation monitoring sites. | NA (various projects) |

Abbreviations: AUM = animal unit month; BCF = billion cubic feet; Fe = iron; MB = million barrels; MW = megawatts; NA = information not available; OHV = off-highway vehicle; ROW = right-of-way; TCF = trillion cubic feet.

[a] Activities listed are those considered in addition to potential oil shale and tar sands development on federal lands as described in Chapters 4 and 5. In general, values are rounded to two significant figures.

[b] Includes projections for federal lands and, where available, nonfederal lands.

[c] Assumes a range of 2.5 to 15 acres/well for well pads, roads, and pipelines (representative range based on Rawlins 7 acres/well (BLM 2004e), Rawlins Mineral Occurrence and Development Report (5 to 22 acres/well [BLM 2003]), Kemmerer, 3.5 to 6.5 acres/well (Easley 2006), Moab Utah Planning Area, 15 acres/well (BLM 2005a), and 2.5 acres/well (DOE 2006). The 22 acres/well estimate is not included in the range because it is for deep wells; very few deep wells are planned.

[d] Assumes that 25% of new wells would be abandoned annually (based on estimate provided for the Rawlins Field Office [Allison 2006]). All surface disturbance is assumed to be reclaimed within 10 yr of abandonment.

[e] Assumes 100 acres disturbed/project. This is short-term disturbance such as crushed vegetation, uprooted brush, and minor soil disturbance; disturbance is generally unidentifiable within 1 yr.

***Coal Mining.*** The largest coal reserves are in the Little Snake and Grand Junction Field Offices, with smaller amounts in the Glenwood Springs and White River Field Offices (see Table 6.1.5-4). Predicted production for all field offices combined is about 40 million tons/yr. About half of this production would be from surface mines, and half would be from underground mines.

***Other Minerals Development.*** Metals produced in Colorado include copper (two mines), gold (seven mines, 1.2% of U.S. production), lead (two mines), molybdenum (two mines), silver (four mines), and zinc (one mine) (EPA 1997). In the ROI counties (i.e., Moffat, Rio Blanco, and Garfield), only sand and gravel and sodium bicarbonate are produced. Sand and gravel are produced in the Colorado River valley in Garfield County (Widmann 2002), just south of the oil shale area, and sodium bicarbonate is produced by Natural Soda, Inc., in Rio Blanco County (USGS 2004a). The sodium bicarbonate is solution-mined in the Piceance Basin; the plant produced 72,000 tons of sodium bicarbonate in 2004. Currently, uranium and vanadium are mined in Montrose County, to the south of the oil shale area. Although there are currently no operating mines, it is projected that uranium and vanadium mining would increase in the Grand Junction and Little Snake Field Offices over the study period, because there has been a recent increase in exploration.

***Energy Development.*** Table 6.1.5-7 gives the projected miles and total acres of energy corridors in Colorado under the proposed action of the Draft West-wide Energy Corridor PEIS (DOE 2007). This development would be in addition to the existing 6,177 ROWs crossing public lands in Colorado as of 2005.

**TABLE 6.1.5-7 Energy Corridors on Public Lands in the Three-State Area[a]**

| | Proposed Action | |
|---|---|---|
| State | mi | acres |
| ***Colorado*** | 420 | 262,000 |
| ***Utah*** | 640 | 356,000 |
| ***Wyoming*** | 440 | 186,000 |

[a] Sources: DOE and BLM (2007).

Table 6.1.5-8 summarizes the electric generating units operating in oil shale ROI counties in Colorado in 2005, including the primary fuel source for each plant and its electric power generating capacity. Of the 1,571 MW of nameplate power available from 25 generating units, 89% was from five coal-fired generators. As of 2000, there were also three new plants proposed for Colorado with a total generating capacity of 2,840 MW (EPA 2002).

***Other (Grazing, Forestry, Fire Management, and Recreation).*** Prescribed burns are used for fire management in the study area; a total of 7,200 acres per year are burned under current management practices. The BLM manages more than 5 million acres of forest lands in Colorado; the majority are in the western half of the state. Most (80%) of the forests are woodlands (forests dominated by low-stature trees such as pinyon and juniper). The net annual growth in forest lands has been estimated as 29 million $ft^3$ (BLM 2006l); the major causes of tree mortality have been insect damage and fires. Timber is harvested on BLM lands in the White River and Little Snake Field Offices.

**TABLE 6.1.5-8 Electric Power Generating Units in ROI Counties in the Three-State Area in 2005[a]**

| State | Primary Fuel | No. of Generating Units | Combined Power (MW-nameplate) |
|---|---|---|---|
| ***Colorado*** | Coal | 5 | 1,405 |
| | Gas | 9 | 131 |
| | Oil | 2 | 0.3 |
| | Water | 8 | 35 |
| | Total | 25 | 1,571 |
| ***Utah*** | Coal | 8 | 3,157 |
| | Waste coal | 1 | 58 |
| | Water | 5 | 5.4 |
| | Total | 14 | 3,220 |
| ***Wyoming*** | Coal | 9 | 3,055 |
| | Gas | 7 | 171 |
| | Wind | 16 | 287 |
| | Water | 10 | 99 |
| | Oil | 2 | 1.5 |
| | Total | 44 | 3,614 |

[a] ROI counties include Delta, Garfield, Mesa, Moffat, and Rio Blanco Counties in Colorado; Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, and Wayne Counties in Utah; and Carbon, Lincoln, Sweetwater, and Uinta Counties in Wyoming.

Source: EIA (2007).

#### 6.1.5.2.2 Utah

***Oil and Gas Development.*** In the Utah study area, far less oil and gas production is expected over the next 20 years than in Colorado. The largest amount is projected for the Vernal Planning Area, for which about 440 wells per year are predicted; the total projected maximum number of new oil and gas wells for applicable field offices in the state is 620 per year (see Table 6.1.5-5).

***Coal Mining***. The largest coal reserves are in the Henry Mountain Planning Area, with smaller amounts in the San Rafael Planning Area (see Table 6.1.5-5). Predicted production for all field offices combined is about 30 to 34 million tons/yr. About half of this production would be from surface mines, and half would be from underground mines.

***Other Minerals Development.*** Metals produced in Utah include copper (one mine), iron (two mines), phosphate (one mine), molybdenum (one mines), potash (three mines), silver (four mines), and uranium (one mine) (EPA 1997). In the ROI counties (Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, and Wayne), only sand and gravel, gilsonite, clay, gypsum, dimension sandstone, lime, helium, and gold are produced (USGS 2004b). Phosphate production occurs in the Diamond Mountain area, and gilsonite in the Henry Mountain area. Uranium/vanadium has a high potential for development in the Henry Mountain and San Juan Planning Areas; it would result in at least 30 acres/yr of surface disturbance. A limited amount of other minerals development is expected (see Table 6.1.5-5).

***Energy Development.*** Table 6.1.5-7 gives the projected miles and total acres of energy corridors in Utah under the proposed action of the Draft West-wide Energy Corridor PEIS (DOE 2007). This development would be in addition to the existing 5,120 ROWs crossing public lands in Utah as of 2005.

Table 6.1.5-8 summarizes the electric power generating units operating in oil shale ROI counties in Utah in 2005, including the primary fuel source for each plant and its electric generating capacity. Of the 3,220 MW of nameplate power available from 14 generating units, 98% was from eight coal-fired generators. As of 2000, there were also three new generating plants proposed for Utah, with a total capacity of 1,570 MW (EPA 2002).

***Other (Tar Sands Development, Grazing, Forestry, Fire Management, and Recreation).*** Potential tar sands development would predominantly affect resources in Utah in the Monticello, Price, Richfield, and Vernal field offices where the STSAs are located. The assumptions used for impact-producing factors for a single tar sands facility are given in Section 5.1.

Although information is not available for every planning area, at least 13,500 acres/yr are planned to be used for prescribed burns under current management practices. Large tracts of land are used for grazing in the Monticello Planning Area.

The BLM manages more than 8 million acres of forest lands in Utah; the majority are in the southern half of the state, including the planning areas addressed in this PEIS. Most (more than 90%) of the forests are woodlands. The net annual growth in forest lands has been estimated as 9.2 million $ft^3$ (BLM 2006l). The major cause of tree mortality has been fires, followed by insect damage.

#### 6.1.5.2.3 Wyoming

***Oil and Gas Development.*** In the Wyoming study area, it is projected that a large amount of new oil and gas drilling and production would occur over the 20-year planning horizon. The total number of new oil and gas wells for applicable field offices in the state is projected to be

910 wells per year, with the largest amount, 635 wells/yr, projected for the Great Divide/Rawlins Field Office (see Table 6.1.5-6).

***Coal Mining.*** Most of the coal reserves are in the Great Divide/Rawlins Field Office (i.e., about 2,500 million tons); however, no coal mining is currently planned in that field office over the study period (see Table 6.1.5-6). Predicted production for the Kemmerer and Green River/Rock Springs Field Offices is about 10 to 14 million tons/yr. Production from the Black Butte Coal Pit would be from surface mines, and production from the Ten Mile Rim area would be from underground mines.

***Other Minerals Development.*** Wyoming is a large producer of uranium (two mines; >12% of U.S. production) (EPA 1997). In the ROI counties (Carbon, Lincoln, Sweetwater, and Uinta), only sulfur, helium, clay, sand and gravel, crushed stone, and sodium carbonate are produced (USGS 2004c). The largest projected development is for salable minerals (sand and gravel and clay) in Kemmerer County, which has ongoing production of about 480,000 tons/yr of these minerals. A very limited amount of other minerals development is expected (see Table 6.1.5-6).

***Energy Development.*** Table 6.1.5-7 gives the projected miles and total acres of energy corridors in Wyoming under the proposed action of the Draft West-wide Energy Corridor PEIS (DOE 2007). This development would be in addition to the existing 15,775 ROWs crossing public lands in Wyoming as of 2005.

Table 6.1.5-8 summarizes the electric generating units operating in oil shale ROI counties in Wyoming in 2005, including the primary fuel source for each plant and its electric generating capacity. Of the 3,614 MW of nameplate power available from 44 generating units, 85% was from nine coal-fired generators. As of 2000, there were also nine new generating plants proposed for Wyoming, with a total generating capacity of 5,930 MW (EPA 2002). Wyoming also currently has a capacity of 290 MW of wind power, and more development is expected. Extensive short-term disturbance from pipeline construction could occur in association with planned projects (see Table 6.1.5-6).

***Other (Grazing, Forestry, Fire Management, and Recreation).*** The BLM manages only about 1.7 million acres of forest lands in Wyoming. Almost half (47%) of the forests are juniper pine woodlands. Of Wyoming's forest lands, a large amount are classified as forest area (forests with primarily tall-stature trees such as limber and ponderosa pine) in contrast to woodland area (low-stature trees); forest areas make up about 50% of the total forest lands. The net annual growth in all forest lands has been estimated as 11 million $ft^3$ (BLM 2006p). The major cause of mortality for all tree types has been fires, followed by insect damage; however, insect damage caused a higher percentage of mortality in the tall-stature trees.

There is a small amount of BLM forest land in the three field offices addressed in this PEIS. Approximately 125 acres/yr of forest land is planned to be used for reclamation in the Kemmerer Field Office area during the study period.

Up to 12,000 acres/yr of planned burning is projected for all the field offices combined. Varying amounts of land disturbance are also projected for activities such as the management of livestock, recreation, vegetation, and weeds (Table 6.1.5-6).

### 6.1.5.3 Cumulative Impacts Assessment for Alternatives B and C

**6.1.5.3.1 Land Use.** Potential land use impacts associated with a single future commercial oil shale facility include the exclusion of grazing, recreation, and other mineral development land uses from lands used for oil shale development facilities and associated off-lease facilities (e.g., employer-provided housing, ROWs, and power plants if needed). Oil shale development could also alter the quality of lands with wilderness characteristics. Oil shale development facilities would disturb from 1,650 to 5,760 acres of public lands for the facilities themselves, and up to an additional 8,200 acres of lands for ROWs, employer-provided housing, and power plants (locations where these ancillary facilities will be sited are unknown, but are not expected to be on public lands). While the total amount of ground disturbance for an oil shale facility using in situ technology could equal that of facilities using mining technologies, the surface acreage disturbed at any one time might be considerably less depending on the cycle of preparation, production, and reclamation.

Table 6.1.5-9 presents estimates of the amount of land needed for other major industrial activities in the study area over the 20-year study period. These lands may be federal or nonfederal lands. As this table shows, land use in the three-state study area is characterized by an extensive amount of industrial activity that is expected to continue into the future. Depending on the number and types of oil shale facilities constructed and operating, future commercial oil shale development could contribute a substantial increment to the cumulative land use and disturbance impacts. Over a 20-year time horizon, a single oil shale facility could contribute 3 to 33% of total surface disturbance for the activities considered in each state (i.e., up to about 14,000 acres for a single oil shale project compared with the range of other disturbances of 69,000 to 470,000 acres, depending upon the state). If several oil shale leases are eventually granted relatively close to one another, this amount of leasing within a small area would result in substantial changes in land use in that area. Tar sands development, if it occurs, would also contribute to cumulative land disturbance impacts. Note that the projections given in Table 6.1.5-9 are very sensitive to the assumptions on amount of disturbance due to oil and gas development that will occur in the three states, with a particularly large range of possible disturbance in Colorado making the oil and gas land use estimates quite uncertain for Colorado.

As discussed in Section 6.1.5.2, many public lands are currently used as ROWs for short- and long-distance energy transmission. The Draft West-wide Energy Corridor PEIS (DOE 2007) could designate additional regional corridors on public lands for long-distance energy transmission ROWs. Under the proposed action of that PEIS, the proposed corridors include

**TABLE 6.1.5-9 Summary of Cumulative Long-Term Land Use for Oil Shale Development and Other Major Industrial Activities**

| | Estimated Acres Disturbed[a] | | |
|---|---|---|---|
| Activity | Colorado | Utah | Wyoming |
| RD&D leases | 800 | 160 | 0 |
| Commercial oil shale development on federal lands or nonfederal lands[b] | Up to 14,000 per project | Up to 14,000 per project | Up to 14,000 per project |
| Commercial tar sands development on federal or nonfederal lands[c] | 0 | Up to 9,500 per project | 0 |
| Oil and gas development (acres/yr) | 3,800–23,000 | 1,400–9,400 | 2,300–14,000 |
| Coal development (acres/yr) | 280 | 50 | 550 |
| Sodium minerals (nahcolite and dawsonite) development (acres/yr) | 20 | 0 | 0 |
| Phosphate development (acres) | 0 | 10,000 | 0 |
| Proposed power plants[d] | 5,700 | 3,100 | 12,000 |
| Annual total by state, excluding oil shale and tar sands development | 10,600–29,000 | 15,000–23,000 | 15,000–27,000 |
| 20-year totals, excluding oil shale and tar sands development | 89,000–470,000 | 42,000–200,000 | 69,000–300,000 |
| Three-state total acres disturbed | | 200,000–970,000 | |
| Single oil shale facility (percent of 20-year total by state) | 3–16 | 7–33 | 5–20 |

[a] Except where otherwise indicated, acreage estimates are the maximum projected totals from Tables 6.1.5-1, 6.1.5-2, and 6.1.5-3.

[b] Acreage estimates represent the maximum possible disturbance, which includes 4,800 acres for a new electric power generating plant, if needed.

[c] Acreage estimates represent the maximum possible disturbance for tar sands facilities (see Section 5.1).

[d] The acreages represent the estimated footprint of projected new power plant development in each state as discussed in Section 6.1.5.2, assuming that all would be coal-fired plants requiring 3,000 acres per 1,500 MW of capacity.

about 260,000 acres in Colorado, about 360,000 acres in Utah, and about 190,000 acres in Wyoming. Not all lands designated as energy corridors would be developed and/or disturbed; however, the percentage of potential disturbance is currently unknown. In each of the three states, a portion of these proposed corridors would fall within the potential oil shale development area. Should these proposed corridors be fully developed for energy-related ROWs, additional land use impacts in the region could be substantial.

**6.1.5.3.2 Soil and Geologic Resources.** Oil shale development could result in impacts on soil and geologic resources by increasing soil removal, soil compaction, and erosion. Erosion of exposed soils could also lead to increased sedimentation of nearby water bodies and to the generation of fugitive dust, which could affect local air quality. Project areas would remain susceptible to these impacts until completion of construction, mining, oil shale processing, and site stabilization and reclamation activities (e.g., revegetation of pipeline ROWs, surface mine reclamation). Impacts on soil and geologic resources would be limited to the specific project location as well as areas where associated off-site infrastructure (such as access roads, utility ROWs, and power plants) would be located.

Oil and gas development, other minerals development, tar sands development, and construction of additional power plants would cause similar impacts on soil and geologic resources in the three-state study area. Table 6.1.5-9 gives estimates of the amount of land that could be disturbed for these activities over the 20-year study period. In each state, additional types of land use could also disturb soil. These would include, but not be limited to, agricultural development, grazing, recreation, forestry, and residential development. The potential impacts from these have not been quantified. Also as discussed in Section 6.1.5.3.1, large areas might be designated as energy corridors in each state, and their development would also contribute to total soil disturbance. All these activities could result in soil being displaced, stockpiled, eroded, or compacted. The disturbance could yield more sediment to surface waters; also, in areas with high salinity in the soils, the salt content in surface water could increase.

As shown in Section 6.1.5.3.1, impacts on soil and geologic resource from oil shale development could add a substantial increment to cumulative impacts on this resource. Impacts would increase with increasing numbers of oil shale facilities. A single facility could be associated with soil disturbance of up to about 14,000 acres.

**6.1.5.3.3 Paleontological Resources.** Disturbances from oil shale development, combined with other surface-disturbing development activities, could uncover and/or destroy fossils on BLM-administered land and on other lands. Given the surface disturbance projected from oil shale facilities and from other activities (Table 6.1.5-9) in the study area during the 20-year period, it is likely that many sites would require paleontological evaluations and subsequent mitigative actions. Based on the assumption that these evaluations and mitigative actions are conducted in accordance with existing regulations, there would be increased knowledge about paleontological resources in the region and increased protection of resources based on this knowledge. However, there would inevitably be some loss of information about individual sites and some impacts. Resources lost from oil shale leasing and development would

be in addition to those losses from other activities discussed in this section. Unless a concentration of unique resources was found to exist within a small area and that area was the location of oil shale development, the individual site losses from construction and operation of an oil shale facility would be unlikely to have a major incremental adverse impact on paleontological resources in the study area.

**6.1.5.3.4 Water Resources.** Ground disturbance along ROWs and near construction sites, mining sites, access roads, and river crossings could increase sediment and dissolved solid loads of streams downstream from disturbed sites. After the protective layers of soils are disturbed, the soils become vulnerable to soil erosion by surface runoff. Leaching of mine tailings and waste, overburden piles, and source rock piles would potentially bring organic and metal contaminants to nearby streams. Potential leaks (or spills) of oil or other petroleum products from pipelines are additional risks for contamination of surface water resources. Modification of surface drainage and water extraction could cause flow regime and morphological changes of stream channels. Most of the impacts would occur in the vicinity of the water bodies close to project sites and would be incremental.

If oil and gas development, mining activities, and power plant construction continue to grow as projected from 2007 to 2027, the disturbed areas are estimated to increase by a total of 200,000 to 970,000 acres in Colorado, Utah, and Wyoming (Table 6.1.5-9). If a single oil shale facility is developed, it is projected to contribute about 3% to 16%, 7% to 33%, or 5% to 20% additional ground disturbance in Colorado, Utah, or Wyoming, respectively (Table 6.1.5-9). The incremental impacts on water resources caused by oil shale development in each state could be significant relative to these other activities. While the total amount of ground disturbance from oil shale development using in situ technologies could equal that of facilities using mining technologies, the surface acreage disturbed at any one time might be considerably less depending on the cycle of preparation, production, and reclamation.

The water uses and losses in the Upper Colorado Basin are shown in Figures 6.1.5-1 to 6.1.5-4. From the 1970s to the 1990s, the water uses increased, reflecting growth in agricultural and in municipal and industrial water uses (Figures 6.1.5-1 and 6.1.5-2). The export of Colorado River water to outside the Upper Colorado River Basin also increased gradually with time (Figure 6.1.5-3). From 1990 to 2000, the combined water use and losses in Colorado, Utah, and Wyoming within the Upper Colorado Basin fluctuated between 3,580 and 4,400 thousand ac-ft (Figure 6.1.5-4). This includes water losses from major and minor reservoirs, agricultural, and municipal and industrial water uses, and water transfers out of the basin. From 2001 to 2004, the combined water uses and losses dropped from 4,280 to 3,400 thousand ac-ft (primarily through declining agricultural water uses) because of drought conditions (BOR 2004, 2005, 2006.)

To preliminarily assess cumulative water use in the study area over the next 20 years and the potential impacts of oil shale development, water use projections for oil and gas development, coal mining, and power generation are compared with water use for individual oil shale facilities and with available water in the Upper Colorado River Basin (see Table 6.1.5-10). The sustainable, annually available water in the Upper Colorado was assumed to be 6,000 thousand ac-ft per year (SWCA 1997) (a prolonged drought condition may decrease this

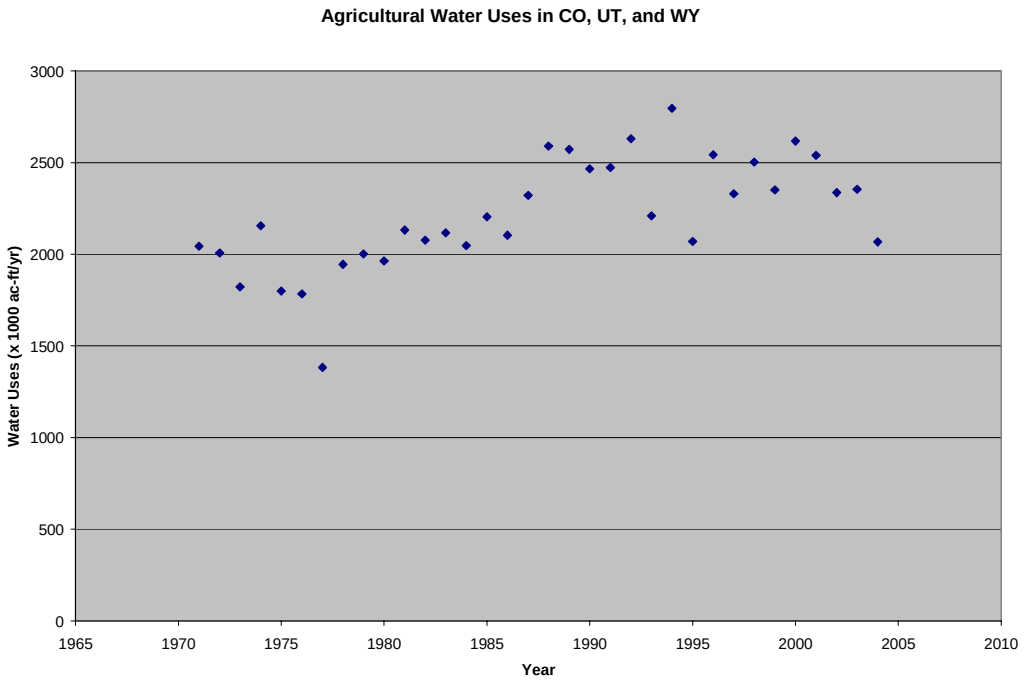


**FIGURE 6.1.5-1 Agricultural Water Uses in Colorado, Utah, and Wyoming in the Upper Colorado River Basin from 1970 through 2004 (Sources: BOR 2004, 2005, 2006)**

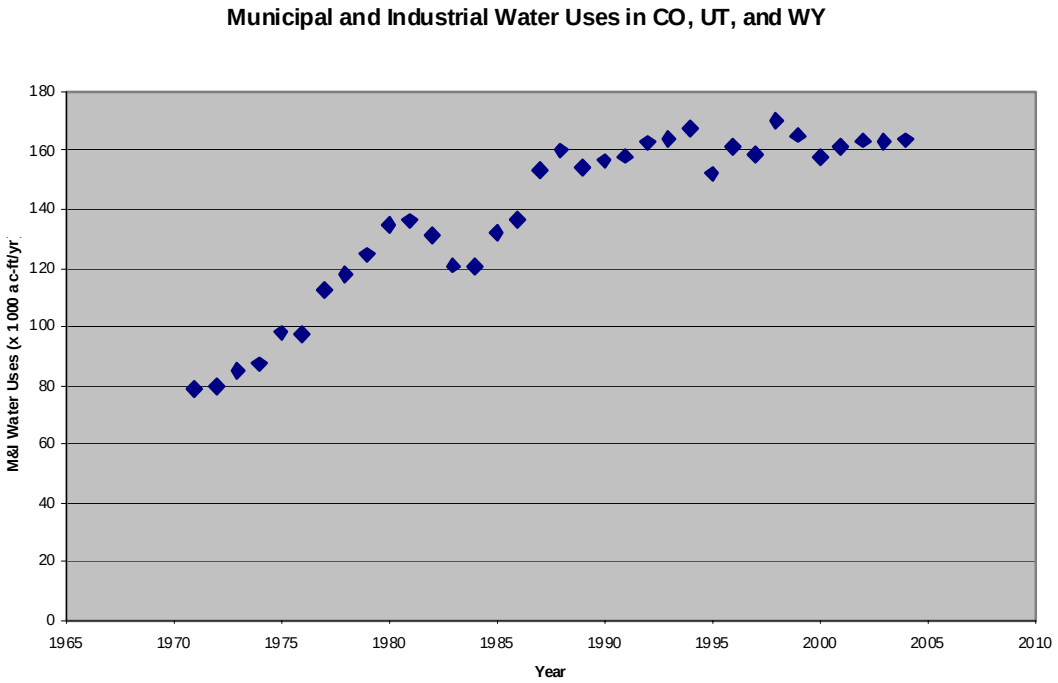


**FIGURE 6.1.5-2 Municipal and Industrial Water Uses in Colorado, Utah, and Wyoming in the Upper Colorado River Basin from 1970 through 2004 (Sources: BOR 2004, 2005, 2006)**

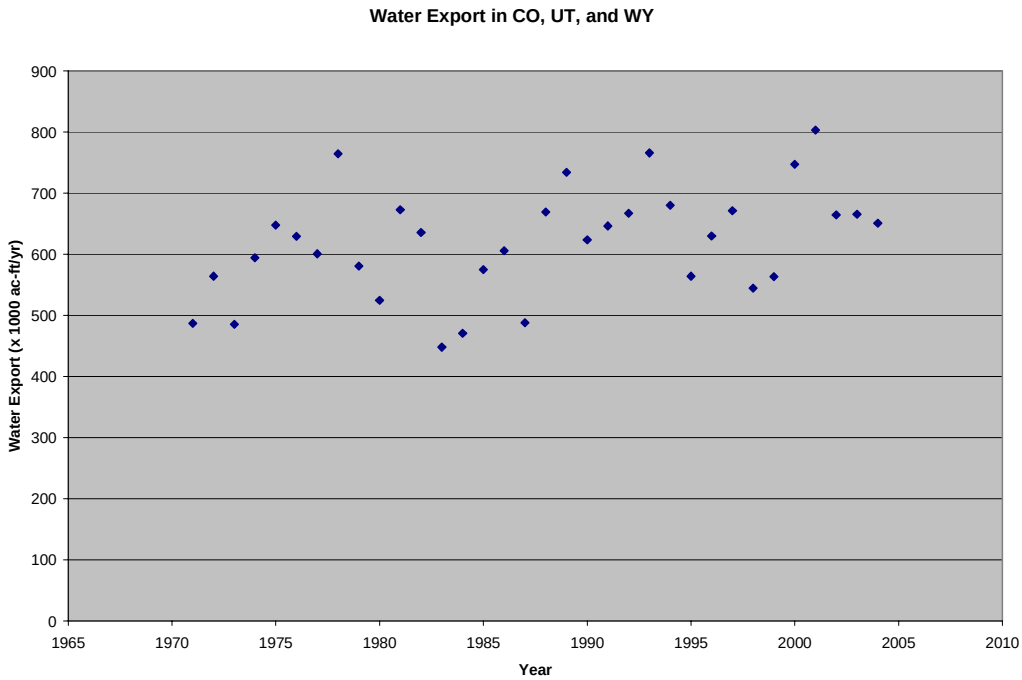


**FIGURE 6.1.5-3 Water Exports from the Upper Colorado River Basin in Colorado, Utah, and Wyoming from 1970 through 2004 (Sources: BOR 2004, 2005, 2006)**

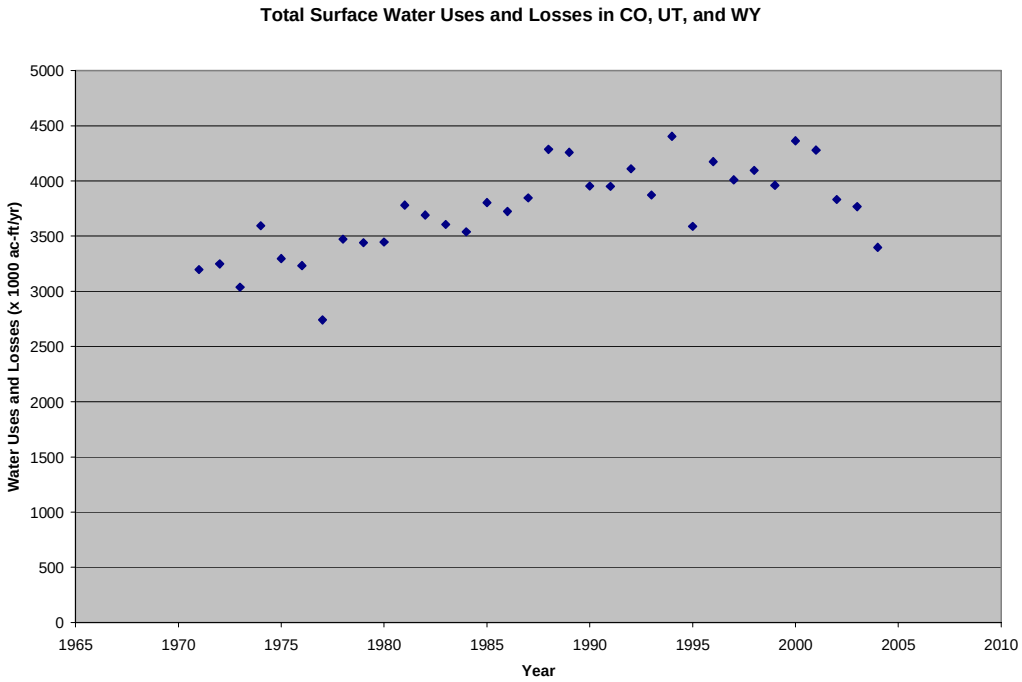


**FIGURE 6.1.5-4 Combined Water Uses and Losses in Colorado, Utah, and Wyoming in the Upper Colorado River Basin from 1970 through 2004 (Sources: BOR 2004, 2005, 2006)**

**TABLE 6.1.5-10 Major Water Uses in the Next 20 Years in the Three-State Study Area Compared with Use for Potential Oil Shale Development (× 1,000 ac-ft/yr)**

| Available Water and Water Use | Annual Volume |
|---|---|
| Amount of legally available water from the Colorado River | 5,280 |
| Consumptive uses, including export, agricultural, M&I, and evaporation | 4,140–5,200 |
| Range of net amount available | 80–1,140 |
| Water use estimates for oil shale and tar sands | |
| Commercial oil shale development on federal or nonfederal lands (individual 200,000 bbl/d in situ facility and ancillary facilities, including power plant)[a] | 21–41 |
| Commercial oil shale development on federal or nonfederal lands (individual 50,000 bbl/d surface mine/surface retort or underground mine/surface retort facility and ancillary facilities)[a] | 7–10 |
| Commercial tar sands development on federal or nonfederal lands (individual 20,000 bbl/day tar sands facility)[a,b] | <1–7.1 |
| Water use for other development | |
| Oil and gas[c] | 1.6 |
| Coal mining[d] | 0.7 |
| Power plants[e] | 53 |
| Total other development | 55.3 |

[a] Includes processing and human consumption.

[b] See Table 5.5-1.

[c] Assumes that 3,000 wells are drilled per year and that each uses 0.55 ac-ft of water.

[d] Assumes 82 million tons of production per year; 20 million gal of water per million tons of coal mined is assumed for coal preparation and 35 million gal of water per million tons of coal mined is assumed for dust control.

[e] Assumes a total of 9,940 MW new production from coal-fired power plants; water consumption of 8,000 ac-ft/yr per 1,500 MW (see Section 6.1.4.2).

Sources for water availability: SWCA 1997, BOR 2004, 2005, 2006.

water availability.) The total amount of legally apportioned water available to Colorado, Utah, and Wyoming is 5,280 thousand ac-ft per year. The water transfer out of the Upper Colorado River Basin fluctuates, but was assumed to remain in the same range (540 to 800 thousand ac-ft/yr) as for 1970 to 2004 (Figure 6.1.5-3). Also, the currently combined water uses for agricultural, municipal, and industrial activities were assumed to remain at the same level as those found in 1990 to 2000 (i.e., 3,600 to 4,400 thousand ac-ft/yr; Figure 6.1.5-4). This could occur as water is transferred from agricultural to municipal and industrial use. The available water for oil shale development consumption, therefore, would be between 80 and 1,140 thousand ac-ft/yr over the next 20 years in the three states. Each commercial oil shale

facility is assumed to require 6.5 to 41 thousand ac-ft/yr of water, depending on technologies being used. This assessment shows that although demands on Colorado River water are high and growing, between available supplies and those that could be purchased and transferred, the available water would likely be able to support some level of oil shale development over the next 20 years, depending on the type of technology used and the other competing uses of water at the time of development.

Meeting the water requirements also depends on how many facilities would be constructed, the technologies used, and the location of the sites. For example, the water demand in northwestern Colorado is more than twice its water consumption. Though the consumption is below the state's legally allocated water amount as specified by the Upper Colorado River Basin Compact, the current water demand already well exceeds the state's allocation. Alternatively, using water conservation practices and transferring agricultural water rights to industrial rights (including oil shale development) could make more water available if extensive oil shale development is desired. Currently, most of the water use in the Upper Colorado Basin is for agricultural purposes. The agricultural component ranges from 55% in the Upper Main Stem (Colorado River and its tributaries above the mouth of the Green River) to 87% in the San Juan–Colorado area (Colorado River and its tributaries below the mouth of the Green River and above Lee Ferry, Arizona) (BOR 2004, 2005, and 2006).

**6.1.5.3.5 Air Quality.** Air resources in and around the study area would be affected by commercial development of oil shale. Local, short-term air quality impacts could be incurred as a result of PM and exhaust emission releases during construction activities. Similar short-term impacts could also occur in other areas where electric transmission or oil pipeline ROWs and other infrastructure would be developed. Longer term impacts on local and regional air quality could occur during normal project operations, such as mining, and processing of the oil shale, and construction and operation of off-lease infrastructure, including electric power plants, resulting in emissions of criteria pollutants and hazardous air pollutants.

Oil and gas development, other minerals development, and other activities (e.g., agricultural development and residential development) would all involve impacts on local air quality during land clearing and construction because of increased PM emissions and exhaust emission from construction equipment. There could also be regional air quality impacts if these activities involve long-term emissions of criteria pollutants or hazardous air pollutants at substantial levels. The incremental impact of oil shale development activities on total cumulative impacts would be assessed during future site-specific NEPA analyses.

**6.1.5.3.6 Noise.** Noise is a transient problem; its impacts do not accumulate in the environment as do air and water pollutants. Dissipation mechanisms, such as geometric spreading, ground effects, and air absorption, dissipate noise energy within short distances from noise sources. However, cumulative noise impacts could occur with oil shale development on both federal and nonfederal lands, oil and gas development, surface and underground mining of coal, production of other minerals, and energy development (see Tables 6.1.5-4 through 6.1.5-6); such impacts would depend critically on site-specific considerations and the proximity of the

operations being considered to each other. The cumulative impacts of sufficiently separated noise sources are essentially the same as the noise impacts of each source considered separately. For example, the cumulative impacts of an oil shale or tar sands production facility and a gas or oil wellfield could be considerably different if the wells and pumps associated with the two facilities were only a mile apart than if they were separated by even a few miles.

Cumulative impacts also depend upon which phases in the lifetime of the sources being considered are occurring simultaneously. For example, construction associated with an oil shale facility would cause only a slight cumulative increase in the preexisting noise levels associated with a pumping station on an oil pipeline, while operation of the oil shale facility could cause a large increase over the preexisting levels around the facility and along nearby roads.

The construction noise impacts discussed in Section 4.7.1 are based on general considerations and are applicable to a wide range of construction projects. For many oil shale development projects, the leased area is large enough that noise levels would be below EPA guideline levels at the site boundaries. Because of the probable large distance between projects, it is unlikely that construction of oil shale facilities will cause a substantial incremental increase in noise impacts over those associated with existing and reasonably foreseeable future projects. However, the construction of large-scale commercial oil shale projects involving drilling of many wells could produce higher noise levels with larger cumulative impacts. Also, if oil shale development is close to other projects and construction and worker vehicles from both projects use the same roads, there could be cumulative noise increases due to increased traffic on local roads. An estimate of cumulative impacts must be made during the assessment of site-specific impacts.

As noted in Section 4.7, adverse noise impacts could be associated with the operation of commercial oil shale facilities. Drilling and pumping in oil and gas recovery fields could also contribute to high cumulative noise levels, and mining operations could cause high noise levels in the vicinity of the mine. If these other activities occur close to oil shale development operations, the possibility of substantial cumulative impacts exists; however, these impacts cannot be estimated at this time given the lack of quantitative estimates for oil shale facilities and the lack of data on specific locations of other development activities. An estimate of cumulative impacts must be made during the assessment of site-specific impacts.

**6.1.5.3.7 Ecological Resources.** Cumulative impacts of commercial oil shale development on ecological resources in the three-state study area would result from the past, present, and future impacts of a wide variety of human activities, including agricultural development and production, grazing activities, range management, timber harvest and management, residential and commercial development, recreational activities, water resource development projects, mineral resource development, and energy development. The current status of ecological resources as described in Section 3.7, reflects the cumulative impacts of past and present activities. This section focuses on the incremental impacts of the oil shale development alternatives and a set of reasonably foreseeable future actions that are expected to occur or that could occur over the next 20 years if commercial oil shale projects are developed. Reasonably foreseeable future projects include oil and gas development, coal mining, mining of

metals and minerals, energy transmission, electrical generation, and other activities, including grazing, fire management, forestry, and recreation as described in Section 6.1.5.2.

The cumulative impacts of greatest concern to ecological resources in the study area include loss or degradation of habitat and habitat fragmentation related to land disturbance; loss of individuals in populations (especially those of rare species); and changes in the amount, availability, and quality of surface water resources. All other factors described in Sections 4.8.1 and 5.8.1 have the potential to contribute to cumulative impacts, but their contributions would be relatively minor and more localized.

Section 6.1.5.2 presents available information on the projected levels of development for major activities in the study area. Major increases in land disturbance from reasonably foreseeable future projects total approximately 1 million acres for the projected 20-year study period in the three-state area of interest (see Table 6.1.5-9). Land disturbance associated with individual commercial oil shale facilities could be up to about 14,000 acres.

Water depletions associated with reasonably foreseeable future actions over the next 20 years represent significant increases in cumulative water use in the three-state study area (more than 55,000 ac-ft/yr of the 80,000 to 1.1 million ac-ft/yr potentially available). Existing water use in the three-state area totals 4.1 to 5.2 million ac-ft/yr. Water consumption associated with individual commercial oil shale development facilities would range from 7,000 to 41,000 ac-ft/yr; water consumption associated with individual commercial tar sands development facilities would range from less than 1,000 to 7,100 ac-ft/yr (see Table 6.1.5-10).

Cumulative impacts on aquatic resources; plant communities and habitats; wildlife; and threatened, endangered, and sensitive species are discussed below.

***Aquatic Resources.*** The analysis of cumulative impacts on aquatic habitats and the organisms that inhabit those habitats considered the potential impacts of oil shale development in Colorado, Utah, and Wyoming, together with impacts from other anticipated development activities as described in Section 6.1.5.2. The types of factors associated with these activities would be similar to those described in Section 4.8.1 for the direct and indirect effects of oil shale development, including (1) direct disturbance of aquatic habitats; (2) sedimentation of aquatic habitats as a consequence of soil erosion from nearby areas; (3) changes in water quantity or water quality as a result of changes in surface runoff patterns, depletions or discharges of water into nearby aquatic habitats, or releases of contaminants into nearby aquatic systems; or (4) changes in human access to aquatic habitats.

Direct disturbance of aquatic habitats could result from activities that occur within water bodies or within the active channel of streams and rivers. Such disturbance could occur as a result of mineral (e.g., gravel) extraction from streambeds; construction of stream crossings for pipelines, transmission lines, and roads; driving vehicles through or using heavy machinery within active channels; and from livestock that walk through waterways. There is a potential for all of these activities to occur within oil shale areas, although it is generally anticipated that the related impacts would be relatively small and localized. Activities such as oil and gas

development, mining, energy development, grazing, fires and fire management, and logging would affect erosion potential by disturbing soils and removing or altering vegetated cover. Such activities associated with other future projects are expected to result in a considerable increase in land disturbance over the 20-year project time frame in the three-state area and could result in a considerable increase in sediments entering aquatic habitats.

As described in Section 4.8.1.1, construction activities for oil shale development could also directly disturb aquatic habitats and alter the potential for erosion and sedimentation within affected areas, depending upon the specific locations of leased parcels, the routes selected for transmission lines, roads, and pipelines, and the configuration of structures used for crossing those habitats. Although the direct disturbance and sedimentation of aquatic habitats resulting from oil shale development would likely be somewhat localized, such development could contribute substantially to the cumulative level of such impacts within affected watersheds.

In the absence of project-specific information, it was assumed that the potential for direct habitat disturbance and soil erosion and the resulting sediment loading of nearby aquatic habitats is proportional to the amount of surface disturbance, the condition of disturbed lands at any given time, the proximity to aquatic habitats, and measures that are implemented to control erosion and sedimentation. Individual oil shale projects would contribute substantially to additional surface disturbance over the 20-year development period as compared with other activities planned within the evaluated oil shale regions, depending on location and size.

From a cumulative perspective, water quality within the oil shale regions would also be affected by many human activities that introduce excess nutrients or contaminants into water bodies, including oil and gas development, coal mining, construction of additional power plants, and grazing of livestock. Oil shale development has the potential to contribute to degradation of water quality through the introduction of contaminants, either as leachate from spent oil shale or from spills or releases of oil, lubricants, and herbicides.

Within the arid regions of Colorado, Utah, and Wyoming where oil shale development would occur, water availability is of great concern and results in conflicts over balancing water needs for current and future development with water needed to maintain ecological conditions in aquatic habitats. The anticipated water needs for individual oil shale production facilities would range from 7,000 to 42,000 ac-ft/yr. One or more oil shale facilities utilizing amounts of water at the higher end of the range could certainly contribute substantially to adverse cumulative impacts on water availability.

Cumulative impacts on fisheries could result from increased public access to remote areas via newly constructed access roads and utility corridors and from the increased population levels that are likely to occur over the 20-year project period as a combined result of reasonably foreseeable actions. As discussed in Section 6.1.5.3.10, it is projected that there would be substantial population increases within the oil shale regions over the next 20 years. Each of the states in the ROI (Colorado, Utah, and Wyoming) has designated management authority for fishery resources to the state's fish and wildlife agency. As part of their management activities, these agencies routinely monitor the condition of specific fisheries within the state and establish and enforce regulations to maintain or improve the condition of those fisheries. Examples of

regulations include limits on open fishing seasons and on the numbers, sizes, and species of fish that can be harvested from specific bodies of water. Based on the assumption that the effects of such regulations are monitored and adjusted effectively, the overall incremental and cumulative impacts on fishery resources with increased access due to potential oil shale and other development would be expected to be minor.

***Plant Communities and Habitats.*** Wetland habitats have been severely impacted throughout the lower 48 states, including Colorado, Utah, and Wyoming, since the 1700s as a result of drainage and fill activities associated with agriculture, resource extraction, urban development, and other human activities. Wetland losses in Colorado from the 1780s to 1980s have been estimated to be approximately 50%, with 30% losses in Utah and 38% losses in Wyoming; however, the rate of loss is currently much lower than historic levels (Dahl 1990). Over the past several decades, federal agencies, such as the BLM, and state and private organizations have made considerable efforts to protect and restore wetlands and riparian habitats, and ongoing and planned wetland and riparian management programs are expected to continue to contribute to the improvement in wetland and riparian habitat function (BLM 2005i).

Human activities have also had an impact on terrestrial habitats in Colorado, Utah, and Wyoming for many years. Species composition and diversity have been affected by fire suppression, heavy grazing, introduction of invasive species, and other factors (BLM 2005i). Habitat losses, fragmentation, and degradation have historically resulted from oil and gas development, mining, and other resource extraction activities that disturb surface soils. Although the BLM and other land management agencies have made considerable advances in habitat protection and restoration, ongoing resource extraction and other land uses are expected to continue to result in losses or changes to plant communities and habitats.

The factors that would affect plant communities and habitats as a result of oil shale development activities are also associated with a number of other activities that occur both within and outside of the oil shale basins. The ecoregions and associated plant communities that include the oil shale basins extend well beyond the basin boundaries, and activities that occur outside the basins can also affect these habitats. Direct losses of habitat could occur as a result of oil and gas development, coal mining, mining of metals and minerals, energy development, and other activities. Approximately 1 million acres could be directly impacted by these future development activities. Native plant communities could also be indirectly impacted or degraded by these activities. Changes in water quality, surface water or groundwater flows, or air quality, could adversely affect terrestrial or wetland plant communities, and changes in community characteristics, such as species composition or distribution, could result from vegetation disturbances related to some activities, such as grazing. Commercial oil shale development would constitute a substantial incremental increase to the impacts associated with other foreseeable activities.

***Wildlife.*** This section evaluates the potential cumulative impacts of oil shale development on wildlife, including wild horses and burros. The current status of wildlife and their habitats, as described in Section 3.8, reflects the cumulative impacts of past and present activities. This section focuses on the incremental impacts of oil shale development alternatives and a set of reasonably foreseeable federal and nonfederal activities, as described in Section 6.1.4.2, which could occur over the 20-year study period. In addition to these activities, natural events (e.g., floods, drought, and fires), disease, predation, and fluctuations in prey are among the natural phenomena that contribute to cumulative impacts on wildlife.

In general, the types of cumulative impacts on wildlife would be similar to the direct and indirect impacts associated with oil shale development (Section 4.8.1.3). Thus, cumulative impacts on wildlife resources would include (1) habitat loss, alteration, fragmentation, or enhancement; (2) disturbance or displacement; (3) mortality; (4) obstruction to movement; and (5) exposure to contaminants. The effects of these actions could include (1) immediate physical injury or death; (2) increased energy expenditures or changes in physiological condition that could reduce survival or reproduction rates; or (3) long-term changes in behavior, including the traditional use of ranges. Potential differences between cumulative impacts on wildlife and the impacts arising from the oil shale development activities alone would depend on the intensity (magnitude), scale (geographic area), duration, timing, and frequency of development activities. Although habitat protection and restoration activities are incorporated into most projects, some losses or modifications to habitats are expected from most activities.

Cumulative impacts of greatest concern to wildlife and their habitats include loss or degradation of habitat and habitat fragmentation related to land disturbance and changes in the availability and quality of surface water resources. The cumulative effects of numerous land use activities (e.g., livestock grazing, crop production, and energy development and associated infrastructure) have caused widespread habitat loss and fragmentation of sagebrush ecosystems (Knick et al. 2003). The avoidance by wildlife of areas near industrial developments that might otherwise be usable habitat (i.e., functional habitat loss) also contributes to the cumulative loss of habitat associated with facility development. Also, developments could further obstruct wildlife movements. Habitat loss and fragmentation can be particularly devastating to sagebrush-dependent species such as sage grouse and to big game species or other wildlife that have large home ranges or that make annual migrations among various habitats. Factors can act synergistically, compounding the importance of cumulative impacts. For instance, developments could result in extensive fragmentation that leaves only small, isolated areas of native vegetation. These areas are often more prone to invasive plant species and to grazing by livestock, wild horses, or feral animals (BLM 2005i; Hobbs 2001).

Wildlife disturbance and mortality associated with activities such as recreation also could have significant and widespread impacts because of the high number of recreation use days. For example, more than 1.3 million visitor days were spent hunting, and nearly 1.6 million visitor days were spent snowmobiling or other winter motorized traveling on BLM-administered lands within Colorado, Utah, and Wyoming during FY 2004 (BLM 2005j). The other factors discussed above have the potential to contribute to cumulative impacts; their contribution, however, would be relatively minor and more localized.

Other industrial developments could result in more workers within remote areas and increased public access due to new roads and ROWs. Increased access could result in increased hunting pressure and illegal poaching depending on location and extent of the developments. Repeated intrusions (e.g., from recreationists) within a specific area have been shown to cause progressive declines in avian richness and abundance (Riffell et al. 1996). Traffic associated with industrial activities and recreation could result in additional roadkills. Also, structures associated with other industrial activities could increase the number of bird collisions. Increased densities of predators and scavengers attracted to areas of human activity could result in increased predation pressure on prey populations. Increased predation would be in addition to impacts associated with habitat loss, displacement, roadkills, collisions with structures and transmission lines, and other factors.

Site-specific mitigation, standard operating procedures, wildlife-related stipulations, reclamation and rehabilitation, and monitoring would minimize cumulative impacts and/or benefit wildlife and their habitats (BLM 2005i, 2006q; DOI and USDA 2006; WGFD 2004). These would reduce the contribution of oil shale impacts to cumulative impacts throughout the project area. Also, implementation of state comprehensive wildlife conservation strategies and regional conservation plans would provide means of proactively minimizing cumulative impacts on wildlife and their habitats. For example, some of these plans identify areas where habitat is critical for the continued viability of key species and communities and areas where development can occur with lower risk to the welfare of ecosystems (Jones et al. 2004). The plans also present means of restoring and maintaining the health and function of lands within the study region. Management of game populations and enforcement of hunting laws has reduced the risk of declines in the number of game species compared with historic levels (BLM 2005i).

***Threatened, Endangered, and Sensitive Species.*** In general, the cumulative impacts on threatened, endangered, and sensitive species would be similar to those described for other ecological resources. However, for many of the species, there would be a difference in the potential consequence of the impacts. Because of their small populations, threatened, endangered, and sensitive species would be far more vulnerable to impacts than more common and widespread species.

The current status and distribution of ESA-listed species, BLM-designated sensitive species, and state-listed species are presented in Section 3.7. Current status and distribution reflect the cumulative effects of past and present human activities and natural limiting factors. Some species are considered threatened, endangered, or sensitive in the area because cumulative impacts have resulted in a reduction in numbers that has increased the chances the species would become extinct in the near future (e.g., gray wolf, bald eagle, and whooping crane). Other species (e.g., Graham beardtongue and Dudley Bluffs bladderpod) are considered vulnerable because their specific ecological requirements result in limited distributions and smaller population sizes that are less resilient. For either group of species, any incremental addition to cumulative impacts could be considered significant.

The potential direct and indirect impacts of commercial oil shale development on threatened, endangered, and sensitive species are presented in Section 4.8.1.4. The evaluation

indicates the potential for negative impact (BLM-designated sensitive, state-listed, and ESA candidate species) or adverse effects (ESA-listed or proposed species). Even without the potential impacts of commercial oil shale development, the projected major increases in land disturbance and water depletions resulting from other reasonably foreseeable future activities, taken together with the impacts of past and present actions, could result in significant cumulative impacts on these species.

Each alternative would require adherence to BLM policy on the protection of sensitive species and project-specific ESA Section 7 consultation with the USFWS. These latter consultations must include a consideration of cumulative effects. Adherence to BLM policy and consultation with the USFWS could reduce the incremental contribution of commercial oil shale development to cumulative impacts.

**6.1.5.3.8 Visual Resources.** The construction and operation of commercial oil shale projects that may occur on federal lands in Utah, Colorado, and Wyoming would likely have cumulative visual impacts in the context of other development activities under way in the three-state study area, as described in Section 6.1.5.2. These development activities could have large visual impacts on locations where concentrated development activity occurred. Where construction and operation of a commercial oil shale project occurred in the same areas as these other development activities, the visual absorption capability of some landscapes might be exceeded. Incremental visual impacts could be of particular concern where oil shale facilities, related infrastructure, and other development activities would be located near sensitive visual resources in landscapes with low visual absorption capability, and/or where the oil shale and other development would be located in the viewsheds of visually sensitive linear features, such as scenic/historic trails, highways, or scenic rivers. Careful facilities siting and application of mitigation measures along with conformance with BLM VRM classes would protect visual values in more sensitive areas from large impacts associated directly with the oil shale development projects. However, the accumulation of small impacts from the oil shale projects, together with impacts from other development activities, could potentially degrade visual qualities. For VRM Classes I through III, the classifications would likely change; Class IV areas would likely degrade further. Also, the VRM classes of surrounding areas within view of the facilities may change.

Further cumulative visual impacts could occur because the presence of the oil shale projects would likely bring workers and their families to live in local communities and recreate in the surrounding areas, and because the roads and other infrastructure associated with the oil shale development projects could cause increased visitation and usage of remote areas (e.g., OHV use). The increases in population and access could result in urbanized development that would contrast sharply with more natural-appearing existing landscapes, add to visual clutter around existing urbanized areas, increase visible human and vehicular activity in remote areas, degrade air quality (thereby negatively affecting long-distance views), and result in litter, erosion, and other visual changes that would not harmonize with the naturally occurring forms, lines, colors, and textures of existing landscapes.

**6.1.5.3.9 Cultural Resources.** Disturbances from oil shale development, combined with other surface-disturbing development activities, could uncover and/or destroy cultural resource sites on BLM-administered land and on other lands. Given the surface disturbance projected from oil shale development and from other activities (Table 6.1.5-9) in the study area during the 20-year study period, it is likely that many sites would require cultural resource evaluations and mitigations. Assuming that these evaluations and mitigations are conducted in accordance with existing regulations, there would be an increased knowledge about cultural resources in the region. However, there would inevitably be some loss of information about individual sites. Unless a concentration of unique resources was found to exist within a small area and that area was the location of oil shale development, these individual site losses from construction and operation of an oil shale facility would be unlikely to have a major incremental adverse impact on cultural resources in the area.

**6.1.5.3.10 Socioeconomics.** Economic impacts can be measured in terms of changes in employment in the three-state study area in which oil shale resources are located. Because of the relative economic importance of oil shale development in small rural economies, and the consequent lack of available local labor and economic infrastructure, oil shale development could mean a large influx of population. As population increases are likely to be rapid, with local communities unable to quickly absorb new residents, there would also be impacts on housing in the three-state study area.

The impacts of oil shale developments would include (1) wage and salary expenditures associated with the construction and operation of oil shale facilities and power plants, (2) material procurement and wage and salary expenditures associated with the construction of temporary housing in the ROI for oil shale facility and power plant workers and family members, and (3) wage and salary spending associated with indirect workers required to provide goods and services resulting from increases in economic activity in each ROI with oil shale developments. Overall, oil shale development could produce a substantial number of jobs, depending on the scale of development (e.g., for an individual facility, about 600 jobs during the construction of temporary housing, and a range of 2,100 to 2,900 jobs during construction. Operations would create between 780 and 3,300 jobs, depending on the technology used, see Table 4.11.1-1.)

Population in-migration would also occur with oil shale resource development, with workers required to move into the three-state region during construction and operation of oil shale and power plant facilities. Workers would also be required to move into the region to facilitate the demand for goods and services resulting from the spending of oil shale, power plant, and housing construction worker wages and salaries.

A substantial number of oil and gas wells are projected for the area beginning in 2008, producing about 8,900 direct jobs and an estimated 23,000 total (direct and indirect) jobs in each year through 2027 (Minnesota IMPLAN Group, Inc. 2007). Development of coal resources in the three-state study area is also expected and would produce 15,000 direct jobs and 32,500 total jobs each year between 2008 and 2027. In the three-state region, oil and gas and coal development alone could result in an increase of about 10% to 20% in total employment in the region over 20 years, and in a population increase of about 2% to 4%, if these activities would

require population in-migration. It is not known whether development of oil and gas and coal resources in the three-state region would require the in-migration of construction and operations workers or the construction of additional temporary housing.

If tar sands development occurs, it could also add a substantial number of jobs in the ROIs, depending on the scale of development (e.g., for an individual facility, 550 jobs during the construction of temporary housing, and 1,800 jobs during construction; operations would create 750 jobs.)

Rapid population growth in small rural communities hosting large resource development projects could also produce social and psychological disruption, together with the undermining of established community social structures (see Section 4.11.1.2). Various studies have suggested that social disruption may occur in small rural communities when annual population increases are between 5% and 15% (see Section 4.11.1.3).

Based on the employment estimates given above, reasonably foreseeable oil and gas and coal production in the study area is estimated to have a larger socioeconomic impact than a single oil shale facility. However, depending on the future level of oil shale development and given the estimated population increases due to construction and operation of a single oil shale facility, there may be substantial incremental socioeconomic impacts (e.g., interruption of community services, availability of housing, social disruption, decreases in property value, loss of employment and income in the recreation sector) from oil shale development when considered in conjunction with the other ongoing and reasonably foreseeable activities in the study area.

**6.1.5.3.11 Environmental Justice.** Construction and operation of oil shale facilities, employer-provided housing, and power plants (if required) could affect environmental justice if any adverse health and environmental impacts resulting from either phase of development were large and if these impacts disproportionately affected minority and low-income populations. Disproportionality is determined by comparing the proximity of high and adverse impacts on the locations of low-income and minority populations. As described in Sections 6.1.5.3.1 through 6.1.5.3.10, oil shale development in conjunction with other ongoing and reasonably foreseeable activities could potentially have high and adverse effects on several resources, including local demographics, social structures, property values, noise, landscape views, land use, water quality, and air quality.

In each of the three states potentially hosting oil shale development, there are a number of census block groups with low-income and minority populations, where the minority population exceeds 50% of the total population in each block group and where the minority share of total block group population exceeds the state average by more than 20 percentage points (see Section 3.11). Given the potential for high and adverse incremental impacts on a number of resource areas from oil shale development in conjunction with oil, gas, coal, and potential tar sands development, and given the existence of environmental justice populations in each state, impacts on these resources could disproportionately affect minority and low-income populations. Of particular importance would be the impact of large increases in population in small rural communities on social disruption, the undermining of local community social structures, and the

resulting deterioration in quality of life. The impacts of facility operations on water quality and on the demand for water in the region could also be important. Impacts on low-income and minority populations could also occur with the development of transmission lines associated with oil shale and power plant facilities in each state, depending on the locations of these infrastructures. Land use and visual environmental justice impacts might be significant, depending on the locations of land parcels affected by all these activities. Cumulative impacts on environmental justice would be evaluated in future NEPA analyses when the locations and sizes of the projects in relation to low-income and minority populations are known.

#### 6.1.5.3.12 Hazardous Materials and Waste Management

***Wastes Associated with Oil and Gas Development.*** Oil and gas development can involve three basic stages: exploration, well development, and production. Exploring, locating, and characterizing the petroleum resource can involve the installation of a relatively small number of small-bore wells to collect geologic cores for inspection and analysis. Increasingly, exploration is conducted with nonintrusive technologies, and wastes associated with exploration are limited and inconsequential.

Well development produces the greatest volume and array of wastes. Wells drilled on BLM-administered lands would be subject to the requirements and BMPs contained in the BLM's Gold Book (DOI and USDA 2006) and to any additional requirements established as lease stipulations by the BLM field office. It is expected that waste management for wells installed on private property would be in accordance with accepted industry practice. Each well installed would generate well development fluid wastes and waste cuttings, some of which could be contaminated with oil from the formation being exploited. However, unless the well progressed through previously contaminated subsurface zones or encountered contaminated groundwater, the waste typically associated with well installation would not exhibit hazardous characteristics and would most likely be managed according to standard practices. Well development fluids[1] would be collected on-site for reuse and/or disposal; free water would be separated from development fluids; drilling muds would be verified as being free of unexpected contamination and released to the ground surface; drilling muds such as bentonite clays would be accumulated on-site for recovery and reuse; and drill cuttings would be verified as being free of contamination and disposed of at the land surface, usually in the vicinity of the well.[2] Special

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1 Well development fluids are water-based (most frequently used), petroleum-based (used primarily in very deep wells where high temperatures may be encountered [usually >10,000 ft], or in directional drilling where greater lubricity is required for the drill bit), or they are composed entirely of synthetic chemicals (e.g., linear alkyl olefins, synthetic paraffins, and alkybenzenes). These fluids perform a number of functions, including cooling and lubricating the drill bit, carrying cuttings up the borehole to the surface, and temporarily filling the well bore with material that is sufficiently dense to prevent the premature inflow of groundwater, other fluids (e.g., oil), or subsurface materials that would collapse the borehole before casings are installed. Development fluids also typically contain various other chemicals, such as naturally occurring clays (referred to as drilling muds), dispersants, corrosion inhibitors, flocculants, surfactants, and biocides, to enhance their overall performance.

2 Although drill cuttings are, in most cases, nonhazardous, care must nevertheless be exercised in their disposal so as not to significantly alter surface drainage patterns or release sediments to area surface waters.

management would be required for development fluids, drilling muds, and produced water that exhibited contamination from NORM or brackish characteristics. All NORM-contaminated wastes would be collected and delivered to properly permitted treatment and disposal facilities. Brackish water would be either reinjected down the well (or an injection well) or collected for delivery to treatment facilities. Likewise, downhole equipment removed from the well and found to have NORM contamination would be managed in the same manner. It is assumed that all of the drill rigs used for well development would be portable and would not undergo routine servicing (except for maintenance of fluid levels) at the well site. No wastes associated with drill rig operation and maintenance (e.g., maintenance of the rig's diesel engine) would be expected to be generated at wellheads, but they might be generated elsewhere in the study area where the rigs are serviced.

Products recovered from oil and gas wells are typically complex mixtures of oil, hydrocarbon gases, other gases such as $H_2S$, water, suspended solids such as sand and silt, chemicals injected to enhance recovery, and water/oil emulsions. Actions to separate these phases are performed at the wellhead or at a central processing facility.

Produced water (water recovered from the oil- or gas-bearing formations or other subsurface formations) is by far the largest volume of waste produced during well production. Produced water is typically discharged back down the well or through a second injection well completed in the same formation. Produced water can also be used for nonpotable purposes such as fugitive dust control, provided it is free of contamination from polar organics (e.g., benzene, naphthalene, toluene, phenanthrene), inorganics (e.g., lead, arsenic, sulfide), or NORM, and provided it exhibits no brackish characteristics. Produced water can also need special management because of high concentrations of sodium, chloride, calcium, or magnesium. Discharge of high-salinity waters to the ground surface or surface waters would be prohibited, and capture and treatment or reinjection would be required.

The exact natures and volumes of well development-related wastes would depend on numerous site-specific factors; however, reliable approximations are possible. It is estimated that each well installed would result in the generation of an average of 4,100 bbl (172,200 gal) of well development fluids (DOE 2006). Over the study period, it is projected that many oil and gas wells would be installed in the study area, resulting in the generation of large volumes of development fluids and produced water. Some oil shale facilities might also generate large volumes of well-development wastes. If all the wastes are managed appropriately, incremental cumulative impacts from disposal of these wastes should be minimal.

***Wastes Associated with Mining of Coal and Other Minerals.*** Wastes associated with coal mining include landscape wastes from clearing active mine areas, solid industrial wastes resulting from the maintenance and repair of mining equipment, overburden soils (topsoils and

subsoils) removed to gain access to the coal resource,[3] and domestic solid wastes resulting from support of the workforce,[4] produced water, and wastes from coal preparation (e.g., shale, coal fines, and other impurities). Produced water would likely require treatment as a result of the leaching of metals from the coal resource or to adjust its pH. Treatment might result in the generation of metal-bearing sludge that would require off-site disposal in most instances. Coal preparation wastes are typically disposed of on-site or stockpiled for later use in mine reclamation.

Coal production in the study area over the period 2007 to 2027 its projected to be about 78 to 86 million tons/yr (see Tables 6.1.5-4 through 6.1.5-6). The amounts of solid wastes generated would be proportional to total coal mined, but would vary significantly with the particular mining techniques employed and the extent of coal preparation occurring at the mine site. Oil shale development using surface or underground mining would generate waste streams similar to those produced during coal mining. At the PEIS level it is not possible to equate the nature or volumes of solid wastes with the amount (tons) of coal or oil shale mined. Cumulative impacts of hazardous materials generation and waste management would be evaluated in future NEPA analyses when the locations and sizes of the projects are known.

Sodium minerals (e.g., nahcolite) are produced in Wyoming at a rate of 18 million tons/yr, and this production is expected to continue through the study period. Gilsonite, uranium, and vanadium would be mined within the study area over the period 2007 to 2027; estimated total production rates for these minerals are not available. Gold, lead, molybdenum, silver, and zinc have all been previously mined in Colorado, but no information on any projects or future activities involving these metals is available. Saleable minerals such as sand and gravel continue to be mined in small quantities, and that level of activity is expected to continue at the local level throughout the study period. In Utah, materials mined in the ROI include sand and gravel, gilsonite, clay, gypsum, dimensionless sandstone, lime, gold, uranium, vanadium, and phosphate. Materials mined in the Wyoming ROI include sand and gravel, crushed stone, and sodium carbonate.

Mineral (e.g., copper, gold, silver) mining and processing can generate wastes during recovery (i.e., mining), beneficiation (separation of mined material), and processing. Recovery can result in large volumes of overburden materials needing management, as discussed above for coal mining. Although those materials are generally not considered waste, they must be managed properly to avoid adverse impacts. Beneficiation can result in the generation of relatively large volumes of potentially hazardous material. This material, referred to as tailings, is processed through dump leaching, in which solutions containing strong acids or cyanides are sprayed onto

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3 Although overburden must be managed carefully to avoid adverse impacts (primarily increased sediment loading to area surface water bodies as a result of erosion), it is not considered a waste; it is typically stockpiled over the active life of the coal mining operation and replaced (in the order of the original soil horizon) as part of mine reclamation.

4 It is assumed that the workforce would not reside at or near the coal mine, but instead would live in nearby communities. Consequently, wastes related to workforce support would be minimal, consisting primarily of kitchen/food preparation solid wastes, small amounts of administrative (office) solid wastes, and small amounts of sanitary wastes.

the tailings to "leach" the metal of interest for capture. The tailings can be voluminous (EPA 1994) and hazardous. Processing of the mineral ore involves a variety of chemical and physical manipulations which produce a wide variety of wastes, many of them capable of producing significant adverse environmental impacts if not managed properly. In 1985, the EPA published reports to Congress on the environmental aspects of non-coal-mining activities; they provide relatively comprehensive discussions of possible environmental impacts, including the types of wastes resulting from typical recovery, beneficiation, and processing schemes for selected metals (EPA 1985).

As in the development of metallic ores, oil shale development could generate produced water and large volumes of overburden; however, tailings would not be generated. Cumulative impacts of hazardous materials generation and waste management would be evaluated in future NEPA analyses when the locations and sizes of the projects are known.

***Wastes Associated with Designation and Development of Energy Corridors.*** The designation of energy corridors within the study area would not, in and of itself, have any waste consequences. Waste would, however, be generated during actual corridor development for gas and liquid pipelines and for electric power transmission systems on public and private lands. Construction-related wastes would be similar in character to wastes generated during construction of gas and liquid pipelines.

Solid wastes associated with gas and liquid pipelines and with power transmission systems would be generated during construction, operation, and decommissioning. The majority of wastes would be generated during the construction phases. Construction wastes would include wastes generated during preparation of the ROW (these wastes would primarily consist of removed vegetation) and during installation of the pipeline or cables (primarily maintenance-related wastes for vehicles and equipment, dunnage, packaging, some chemical cleaner wastes). Support of the workforce would result in the production of domestic solid wastes and sanitary wastewaters. It is expected that the majority of construction-related wastes would be nonhazardous and would be managed in existing local landfills or existing municipal or specially built sewage treatment facilities.

Operational wastes would result from the maintenance of equipment (e.g., change-outs of lubricating oils, coolants, and hydraulic fluids from equipment that uses such materials, and sludge from the periodic cleaning of the insides of the pipelines through the use of pigs). The frequency of cleaning and the amount of waste generated would be a function of the commodity being transported, with the greatest amounts of pipeline cleaning–related wastes generated by pipelines that convey crude oil.

Solid wastes associated with the decommissioning of pipelines or power transmission systems would include wastes from cleaning equipment and some pipeline components. For pipelines it is expected that much of the underground pipeline might be abandoned in place, and for those pipeline components that were removed, the majority would be put into service in other pipeline systems or sold for scrap. As would occur during the construction phase, solid domestic and sanitary wastes would be generated in support of the workforce (albeit in lesser amounts,

since it is expected that decommissioning would take substantially less time than initial construction); all such wastes would likely be managed or disposed of in existing facilities. Finally, a certain volume of remedial wastes would be expected to result from the cleanup of spills or leaks that were not removed during operation or occurred during decommissioning.

The construction of gas and liquid pipeline ROWs and transmission ROWs to support oil shale development would generate similar types of waste to those discussed above. Large numbers of gas and liquid ROWs are already present on public lands in the study area, and many more areas may be designated as corridors for ROWs during the study period (see Section 6.1.5.2). Incremental impacts from waste generation and disposal would depend on the level of oil shale development and would be analyzed in future site-specific environmental evaluations.

***Wastes Associated with Construction and Operation of New Electric Power Generation Plants.*** Some new power plants are projected to be needed in the study area during the next 20 years. Wastes associated with power plant construction would primarily consist of wastes from maintenance of construction equipment and vehicles powered by internal combustion engines (e.g., used crankcase oil, hydraulic fluids, coolants). Other major solid waste streams would result from the support of the workforce (e.g., domestic solid wastes and sanitary wastewaters). All such wastes are expected to be easily managed in local or regional landfills or existing or specially built sewage treatment facilities. Minor amounts of industrial solid wastes would also result from the use of various chemicals (paints, coatings, adhesives, and cleaning solvents) during facility construction.

Solid wastes generated during operations by coal-fired power plants would consist of fly ash and bottom ash. It is assumed that newly constructed units would be required to conform to new source production standards. Typical coal-fired power plants generate on the order of 500,000 tons/yr of fly and bottom ash and an additional 150,000 tons/yr of sodium sulfate solid waste (generated as a part of sulfur-capture).

If new power plants are required for oil shale development (e.g., to support in situ facilities), then they would generate waste types similar to those discussed above. Incremental impacts from power plant waste generation and disposal associated with oil shale development would depend on the level of that development and would be analyzed in future site-specific environmental evaluations.

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***Wastes Associated with Tar Sands Development.*** Wastes that would be generated from tar sands development would be of the same nature as those described in Section 5.13. Incremental impacts from waste generation and disposal due to oil shale development would depend on the level of oil shale development, and would be analyzed in future site-specific environmental evaluations.

**6.1.5.3.13 Health and Safety.** Given the large amount of development for oil and gas, coal mining, and other mineral production projected in the study area over 20 years, many workers will be needed. The types of industries being developed, especially mining, have been associated with relatively high numbers of worker injuries and fatalities in the past (see Section 4.14). Oil shale production activities would add to worker injuries and fatalities in proportion to the level of development. Without more detailed information on future production levels for oil shale as well as the other industries, quantitative estimates of incremental health and safety impacts due to oil shale development are not possible. However, all these industries are required by law to protect worker health and safety by using adequate engineering controls and personal protective devices.

## 6.1.6 Other NEPA Considerations

### 6.1.6.1 Unavoidable Adverse Impacts

The identification of public lands available for application for leasing for commercial oil shale development and the amendment of land use plans to incorporate these lands would not result in unavoidable adverse impacts under either Alternative B or C. Unavoidable adverse impacts on resources could occur under Alternative A as a result of the RD&D projects. However, the mitigated environmental impacts (including unavoidable adverse impacts) of the RD&D activities are considered minimal, and all the EAs resulted in FONSIs.

Under both Alternatives B and C, the future development of commercial oil shale projects could result in unavoidable adverse impacts on resources. The magnitude of these unavoidable adverse impacts, as well as the degree to which they could be mitigated, would vary by project type and location. Many of the project-specific impacts could be reduced through implementation of the mitigation practices identified in this PEIS (see Chapter 4).

**6.1.6.1.1 Land Use.** No adverse impacts on land use would occur from the identification of lands available for leasing application and the associated land use plan amendments under either Alternative B or C. However, the development of commercial oil shale projects within the areas identified as applicable for leasing would result in unavoidable changes in land use in the areas undergoing project development. Land uses that could be affected by the construction and operation of commercial oil shale projects could include livestock grazing, agriculture, oil and gas leasing, minerals extraction, and recreation.

**6.1.6.1.2 Soil, Geologic, and Paleontological Resources.** No adverse impacts on geologic and paleontological resources would occur under either Alternative B or C from the identification of lands available for lease application and associated land use plan amendments. Unavoidable adverse impacts could be incurred under Alternatives B and C as a result of future commercial project construction in the lease areas. Project construction could result in unavoidable impacts on natural topography, soil erosion, drainage patterns, and slopes, as well as

damage or destroy paleontological resources within project footprints. Project construction could also result in the compaction, excavation, and removal of soil from the project area. The likelihood, magnitude, and extent of unavoidable impacts could be reduced under all three alternatives through the implementation of appropriate project- and location-specific mitigation measures.

**6.1.6.1.3 Water Resources.** The identification under Alternatives B and C of lands available for lease application and associated land use plan amendments would not adversely impact water resources (either surface water or groundwater). Unavoidable adverse impacts could be incurred under Alternatives B and C as a result of future commercial oil shale development in the lease areas. Impacts on water quality could occur as a result of soil erosion from construction sites; runoff from oil shale mine, processing, and waste storage locations; and accidental spills of hazardous liquids (such as fuels, lubricating oils, solvents, and other industrial liquids), and accidental oil spills from project-related pipelines. Although there is a potential for unavoidable adverse impacts on water resources from construction under all three alternatives, the likelihood, magnitude, and extent of these impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

**6.1.6.1.4 Air Quality and Ambient Noise Levels.** No adverse impacts on air quality or ambient noise would occur from the identification of lands available for leasing application and associated land use plan amendments under either Alternative B or C. Unavoidable impacts could occur as a result of the potential future development of commercial oil shale projects in the areas identified under Alternatives B and C. Construction, clearing and grading, trenching, excavation and blasting, and construction vehicle traffic would result in fugitive dust and vehicle emissions, as well as increase ambient noise level in construction locations. During project operations, unavoidable air impacts would occur primarily during operation of mining and oil shale-processing facilities and equipment and associated vehicular traffic. Noise impacts could also be incurred by these activities, as well as by the operation of pipeline compressor stations. The likelihood, magnitude, and extent of unavoidable adverse impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

**6.1.6.1.5 Ecological Resources.** No adverse ecological impacts would occur as a result of the identification of lands available for leasing application and the associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts would occur under Alternatives B and C as a result of potential future commercial development of oil shale projects. The construction and operation of project facilities, as well as maintenance of project-related utility, pipeline, and transportation ROWs, under each alternative could result in unavoidable temporary and permanent changes in aquatic resources, plant communities and habitats, wildlife, and threatened and endangered species.

Ecological resources immediately within a project footprint would be destroyed during clearing, grading, and construction activities. Unavoidable impacts on wildlife could include habitat loss, disturbance and/or displacement, mortality, and obstruction to movement. Increased noise during project construction and operation could disrupt local wildlife foraging and breeding of some wildlife. Aquatic biota and habitats could be affected by siltation resulting from runoff from areas of disturbed soils and from accidental releases of hazardous materials from construction and operations equipment (such as fuels) and from an accidental oil pipeline releases. The likelihood, magnitude, and extent of unavoidable adverse impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

**6.1.6.1.6 Visual Resources.** No adverse impacts on visual resources would occur from the identification of lands available for leasing application and the associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts on visual resources could occur as a result of the future development of commercial oil shale projects in areas identified as available for leasing application under Alternatives B and C. Short-term impacts would occur during construction. Fugitive dust and the presence of construction equipment and crews would be visible in the vicinity of the construction site, potentially affecting local viewsheds and recreational experiences. Because project-specific ROWs and infrastructure (e.g., electricity transmission towers, pipelines and compressor stations, surface mines, oil shale-processing facilities) would be visible throughout the life span of any project, there could be long-term unavoidable impacts on some viewsheds and the recreational experiences of visitors in those viewsheds. The likelihood, magnitude, and extent of unavoidable adverse impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

**6.1.6.1.7 Cultural Resources.** No adverse impacts on cultural resources would occur from identification of lands available for leasing application and associated land use plan amendments under either Alternative B or C. However, leasing itself has the potential to impact cultural resources to the extent that the terms of the lease could limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed commercial oil shale development on cultural properties. Cultural resources could also incur unavoidable adverse impacts as a result of the future development of commercial oil shale projects in areas identified as available for leasing application under Alternatives B and C. Cultural resources could be destroyed by construction activities, such as clearing and grading, mining, facility construction, and pipeline trenching. Development of new ROWs could also increase access to previously inaccessible areas, which could lead to vandalism of both known and undiscovered cultural sites. The likelihood, magnitude, and extent of unavoidable adverse impacts on cultural resources could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

**6.1.6.1.8 Socioeconomics and Environmental Justice.** No adverse socioeconomic or environmental justice impacts would occur from the identification of lands available for leasing application and associated land use plan amendments under either Alternative B or C. Unavoidable adverse social and environmental justice impacts could occur under Alternatives B and C as a result of the future construction and operation of commercial oil shale projects and associated power plants, coal mines, and employer-provided housing. Rapid population growth could occur following the in-migration of construction and operations workers into communities; this could lead to the undermining of local community social structures with contrasting beliefs and value systems among the local population and in-migrants and, consequently, to a range of changes in social and community life, including increases in crime, alcoholism, drug use, etc. Impacts could also occur in association with the degradation of air quality, water quality, and visual resources, and the removal of land from traditional uses during commercial project development. Many of these impacts would affect quality of life for the general population in many communities, in addition to that of low-income and minority populations residing in the vicinity of oil shale developments. Many locations of cultural significance to tribal groups may have been protected or identified. Nevertheless, with the alteration of, or restricted access to, water and visual resources and the degradation or migration of particular animal species, oil shale developments would have impacts on subsistence and traditional landscape-based activities important to tribal groups.

**6.1.6.1.9 Hazardous Materials and Waste Management.** No adverse impacts from hazardous materials and waste management would occur from the identification of lands available for leasing application and associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts could occur as a result of the potential future development of commercial oil shale projects in the areas identified under Alternatives B and C. Construction and operations of oil shale projects would result in the use of hazardous materials and the generation of hazardous and nonhazardous wastes, including materials typically utilized during construction and operations (e.g., fuels, lubricating oils, hydraulic fluids, glycol-based coolants and solvents, adhesives, corrosion control coatings, and herbicides for vegetation clearing). During construction, nonhazardous landscape wastes would be generated. In general, the appropriate management of these materials would result in only minor impacts. Disposal of spent shale within the leased area could result in unavoidable adverse impacts. The likelihood, magnitude, and extent of unavoidable adverse impacts from hazardous materials and waste management could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

**6.1.6.1.10 Health and Safety.** No adverse impacts on health and safety would occur from the identification of lands available for leasing application and associated land use plan amendment under either Alternative B or C. Unavoidable adverse impacts could occur as a result of the potential future development of commercial oil shale projects in the areas identified under Alternatives B and C. Hazards for workers at oil shale development facilities include risks of accidental injuries or fatalities, lung disease caused by inhalation of particulates and other hazardous substances, and hearing loss. A comprehensive facility health and safety plan and worker safety training would be required as part of the Plan of Development for every proposed

commercial oil shale project. The likelihood, magnitude, and extent of unavoidable adverse impacts on health and safety could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

#### 6.1.6.2 Short-Term Use of the Environment and Long-Term Productivity

The amendment of land use plans to identify lands available for application for leasing for commercial oil shale development would not affect the short-term uses or long-term productivity of the environment. The impacts (short and long term) from utilization of resources associated with project development under Alternatives B and C are presented in Chapter 4, while such impacts under Alternative A are presented in Section 6.1.1. For this PEIS, *short term* refers primarily to the period of construction of a commercial oil shale project; generally it is during this time that the most extensive environmental impacts would occur. *Long term* refers primarily to the 20-year time frame considered within this PEIS.

Within the 20-year time frame considered in the PEIS, the development of oil shale projects would not require the short-term disturbance or long-term alteration of a major amount of federal and nonfederal land under any of the three alternatives. Future development of commercial oil shale projects under Alternatives B and C would result in the local, short- and long-term disturbance of most resources. There would be little difference in the types of impacts that could result from project development under either of these alternatives. Under each of these alternatives, land clearing and grading and construction activities would disturb surface soils, wildlife and their habitats, and affect local air and water quality, visual resources, noise levels, and recreational activities within individual project footprints. Similar effects could be expected on other federal and nonfederal lands where project-related infrastructure (such as power plants, utility and pipeline ROWs, and worker residences) would be located. Short-term construction-related disturbance of biota (and their habitats) could result in long-term reductions in biological productivity within the project areas.

The long-term presence of commercial oil shale projects and associated ROWs could affect long-term land use within and in the vicinity of the lease areas, as well as on both federal and nonfederal lands where support infrastructure (power plants, ROWs, and employee housing) would be located, especially if previous land use activities in those areas are determined to be incompatible with commercial oil shale projects. The lands and surrounding areas associated with Alternatives B and C currently support a variety of land uses (depending on their specific locations), including livestock grazing, agriculture, recreation, oil and gas leasing, and minerals extraction. Under Alternatives B and C, commercial oil shale projects could also affect long-term quality and use of visual resources and recreational use on federal and nonfederal lands. While some recreational activities (such as OHV use) could experience long-term increases in activity as a result of new ROWs into previously inaccessible areas, changes in the types and patterns of recreational usage can be positive or negative, depending on the subjective values of the interested and affected public.

#### 6.1.6.3 Irreversible and Irretrievable Commitment of Resources

This section describes the irreversible and irretrievable commitments of resources associated with the implementation of the three alternatives evaluated in this PEIS. A resource commitment is considered *irreversible* when direct and indirect impacts from its use limit future use options. Irreversible commitments apply primarily to nonrenewable resources, such as cultural resources, and to those resources that are renewable only over long periods of time, such as soil productivity or forest health. A resource commitment is considered *irretrievable* when the use or consumption of the resource renders it neither renewable nor recoverable for future use. Irretrievable commitments apply to loss of production, harvest, or use of natural resources.

The amendment of land use plans to identify lands available for application for leasing for commercial oil shale development would not result in the irreversible or irretrievable commitment of resources. However, irreversible and irretrievable commitments of resources could occur as a result of future commercial oil shale projects that are authorized, constructed, and operated. The nature and magnitude of these commitments would depend on the specific location of the project development as well as its specific design and operational requirements. The commitment of resources would be identical for any specific project located in the same lease area under either Alternative B or C.

The construction of future commercial oil shale projects under Alternative B or C could result in the consumption of sands, gravels, and other geologic resources, as well as fuel, structural steel, and other materials. Water resources could also be consumed during construction, although water use would be temporary and largely limited to on-site concrete-mixing and dust abatement activities.

In general, the impact on biological resources from future project construction and operation would not constitute an irreversible and irretrievable commitment of resources. During project construction and operation, individual animals would be impacted. Site- and species-specific analyses and mitigation conducted at the project level during authorization would make adverse impacts on entire populations unlikely.

The clearing of project areas (including off-lease locations where utility and pipeline ROWs, power plants, and employee housing) would result in the direct loss of vegetation and habitats within the construction footprints, which would be irretrievable in areas where project infrastructure would be constructed and operated. While habitat would be impacted during project construction, implementation of project-specific mitigation measures (such as habitat restoration) would reduce these impacts over time. However, habitats within project infrastructure footprints (such as buildings and surface mines) would be irretrievably committed to the development and operation of commercial oil shale projects.

Cultural and paleontological resources are nonrenewable, and any disturbance of these resources would constitute an irreversible and irretrievable commitment of resources. However, consideration and implementation of mitigation could minimize the potential for impacts on these resources. Access to previously inaccessible areas could lead to vandalism of both known and unknown cultural and paleontological resources, thereby rendering them irretrievable.

Impacts on visual resources could constitute an irreversible and irretrievable commitment of resources, but these impacts could also be lowered somewhat through the consideration and implementation of the mitigation measures.

#### 6.1.6.4 Mitigation of Adverse Effects

Following amendment of land use plans to identify areas available for lease application for commercial oil shale development, any future development of commercial oil shale projects within the lease areas could result in adverse impacts on many resources (see Chapter 4 and Sections 6.1.2 and 6.1.3). The nature, extent, magnitude, and duration of any project-related impacts would be directly determined by (1) the project location, (2) the nature and quality of resources at and in the vicinity of project site (and its associated infrastructure), (3) the technology used and the plan of development for the project. Many of the impacts could be reduced or avoided through the implementation of appropriate site- and project-specific mitigation measures. Development of individual commercial oil shale projects would require additional project-specific NEPA analyses and the identification of location-, project- and resource-specific mitigation measures. Mitigation measures would be identified as lease stipulations by the BLM for any authorized commercial development. Chapter 4 of this PEIS identifies many types of resource-specific mitigation measures that could be implemented during project construction and operation.

## 6.2 TAR SANDS ALTERNATIVES

This section presents the impacts associated with the three tar sands alternatives. Alternative A, the no action alternative, is discussed in Section 6.2.1. The impacts of Alternatives B and C are discussed in Sections 6.2.2 and 6.2.3, respectively. Section 6.2.4 presents a comparison of the tar sands alternatives. Discussions of the cumulative impacts and other NEPA considerations associated with Alternatives B and C are presented in Sections 6.2.5 and 6.2.6, respectively.

### 6.2.1 Impacts of Alternative A, No Action Alternative

As discussed in Section 2.3.2, under Alternative A, the BLM has assumed that there would be no commercial leasing or development of tar sands on public lands in the next 20 years. Although a number of CHLs were issued in the mid-1980s and there are additional pending applications to convert oil and gas leases or tar sands claims to CHLs, there has been no tar sands development on public lands in the last 20 years or more. Furthermore, at the time this PEIS was drafted, no commercial tar sands project proposals had been submitted to the BLM. On this basis, the BLM has determined that it is unlikely that commercial tar sands development would occur under the existing CHL Program. Under Alternative A, land use plans would not be amended to allow for leasing for commercial tar sands development under any program other than the CHL Program. Commercial tar sands leasing would occur in the future only under the

auspices of the CHL Program. Such leasing would be subject to additional NEPA analyses and the existing CHL regulations in 43 CFR Part 3140.

Under Alternative A, because no commercial tar sands development is projected, there would be no environmental or socioeconomic impacts. If commercial tar sands development in the past has been impeded by constraints imposed by the existing CHL regulations, under Alternative A, no action would be taken to alleviate those constraints and, therefore, there could be adverse impacts on the level and pace of future commercial tar sands development.

### 6.2.2 Impacts of Alternative B

Under Alternative B, the BLM would amend six BLM land use plans to make 431,224 acres of public land in Utah available for application for leasing for commercial development of tar sands within 10 designated STSAs: Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, Sunnyside, Tar Sand Triangle, and White Canyon (see Figure 2.4.3-1 and Table 2.4.3-1). (The eleventh designated STSA, Circle Cliffs, would not be available for leasing under any alternative because the portion administered by the BLM is located entirely within the GSENM.) The public lands that would be available under Alternative B consist of 360,115 acres of BLM-administered lands and 71,110 acres of split estate lands. The six land use plans that would be amended include:

- Book Cliffs RMP (BLM 1985a);
- Diamond Mountain RMP (BLM 1994);
- Henry Mountain MFP, issued 1982;
- Price River Resource Area MFP, as amended (BLM 1989);
- San Rafael Resource Area RMP (BLM 1991b); and
- San Juan Resource Area RMP (BLM 1991a).

The amendment of land use plans would have no direct impacts on the environment or socioeconomic setting in the study area. However, the development of commercial tar sands projects made possible by these land use plan amendments would impact these resources. The following sections describe the impacts of Alternative B on the environment and socioeconomic setting (including the effects of land use plan amendments on the level and pace of commercial tar sands development).

Under Alternative B, the BLM would conduct additional NEPA analyses prior to the issuance of any commercial leases. Additional NEPA analyses would also be conducted during the review and approval of project-specific plans of development. At the time of these NEPA analyses, the BLM would be able to determine the potential impacts of development at a specific site and/or resulting from a specific project. The BLM also would be able to (1) determine which

mitigation measures would be applicable and (2) establish appropriate lease stipulations and/or constraints for incorporation into the project plan of operations.

The total amount of public land within the 10 designated STSAs is 598,572 acres (Table 2.3-1). When calculated across all the STSAs, Alternative B would make about 72% (431,224 acres) of these lands available for application for commercial leasing. Table 6.2.2-1 lists the acreages and percentages per STSA. The public lands that would not be available for application for leasing include all those areas that are excluded from leasing and development by virtue of existing laws and regulations, Executive Orders, land use plan designations, and other administrative designations or withdrawals. These excluded lands (e.g., Wilderness Areas, WSAs, National Monuments, WSRs, and ACECs) encompass many of the areas where special resources are known to exist. In addition, the BLM has decided to exclude all lands within the Circle Cliffs STSA (which is located inside the GSENM) and corridors along potentially eligible WSR segments, in order to protect certain resources.

At the time of preparation of this PEIS, industry has given no firm indication when commercial tar sands production may begin. Likewise, the location where commercial production may first occur also is not known, but, for purposes of analysis, it is reasonable to assume that development may begin at the Asphalt Ridge, P.R. Spring, or Sunnyside STSAs. This is based on USGS information (USGS 1980a–k) indicating that the quality of tar sands

**TABLE 6.2.2-1 Amount of Land Available for Application for Commercial Tar Sands Leasing under Alternatives B and C and the Corresponding Percentage of Total Public Lands by STSA[a]**

| | Lands Available for Application for Leasing and Percentage of Total Public Lands | | | |
|---|---|---|---|---|
| | Alternative B | | Alternative C | |
| STSA | Acres Available | Percentage | Acres Available | Percentage |
| Argyle Canyon | 11,226 | 86 | 0 | 0 |
| Asphalt Ridge | 5,435 | 100 | 1,464 | 27 |
| Hill Creek | 56,506 | 100 | 19,934 | 35 |
| Pariette | 10,161 | 82 | 830 | 7 |
| P.R. Spring | 153,003 | 79 | 56,728 | 29 |
| Raven Ridge | 14,364 | 100 | 9,950 | 69 |
| San Rafael Swell | 70,475 | 61 | 54,492 | 47 |
| Sunnyside | 78,116 | 80 | 62,741 | 64 |
| Tar Sand Triangle | 24,938 | 30 | 22,511 | 27 |
| White Canyon | 7,001 | 87 | 386 | 5 |
| Total | 431,224 | 72 | 229,038 | 38 |

[a] Acreage estimates and percentages were derived from GIS data.

resources is higher in these three areas and in the Tar Sand Triangle than in the other STSAs, and on the existence of current activity on private land at Asphalt Ridge. Even though the tar sands resources at Tar Sand Triangle are of high quality, it is not expected to be an early candidate for commercial development because of anticipated constraints imposed by the CAA, and its close proximity to Canyonlands National Park.

#### 6.2.2.1 Land Use

The identification of approximately 430,000 acres of public land in Utah for application for leasing for commercial development of tar sands (approximately 72% of the study area) is expected to have no direct impacts on other land uses. The identification of these lands does not authorize or approve any ground-disturbing activities that could affect land uses; however, existing land uses could be adversely affected by future commercial tar sands development on these lands.

Lands where commercial tar sands development might occur are currently used for a wide variety of activities, including recreation, mining, hunting, oil and gas production, livestock grazing, wild horse and burro management, communication sites, and ROW corridors (e.g., roads, pipelines, and transmission lines). Commercial tar sands development would have a direct effect on these uses, displacing them from areas that are being developed.

Indirect impacts of tar sands development would be associated with changing existing land uses, including conversion of land in and around local communities from existing agricultural, open space, or other uses to provide services and housing for employees and families that move to the region in support of commercial tar sands development. Increases in traffic, increased access to previously remote areas, and development of tar sands facilities in currently undeveloped areas would continue to change the overall character of the landscape. The value of private ranches and residences in the vicinity of tar sands developments or ROWs may be reduced because of perceived noise, traffic, or human health or aesthetic concerns.

Tar sands development will require off-lease construction of certain infrastructure, such as transmission and pipeline ROWs and possibly employer-provided housing. Such infrastructure would most directly impact uses of nonfederal lands but could have indirect impacts on some uses of federal lands.

Transmission and pipeline ROWs associated with commercial tar sands development would not preclude other land uses but would result in both direct and indirect impacts. Direct impacts, such as the loss of available lands to physical structures, maintenance of ROWs free of major vegetation, maintenance of service roads, and noise and visual impacts on recreational users along the ROW, would last as long as the transmission lines and pipelines were in place. Indirect impacts of ROW development could include the introduction of new or increased recreational use to an area due to improved access, avoidance of the area for residential or recreational use for aesthetic reasons, and increased traffic.

The specific impacts on land use and the magnitude of those impacts would depend on project location; project size, technology employed and scale of operations; and proximity to roads, transmission lines, and pipelines. Impacts on various land uses that could be caused by commercial development of tar sands are discussed in some detail in Section 5.2 and are summarized as follows:

- Commercial tar sands development, using any technology under consideration in this PEIS, is largely incompatible with other mineral development activities because they dominate the land area in which they are located. Oil and gas development is ongoing in many parts of the study area, and conflict between tar sands projects and oil and gas projects would be expected. While it is possible that undeveloped portions of a tar sands lease area could be available for other mineral development, such development would be unlikely to occur on a widespread basis, except possibly in areas where a single company is developing multiple resources.

- Where existing agricultural water rights are acquired to support tar sands development, existing irrigation-based agricultural uses of the land from which the water is acquired would be modified to support lower-value dry land use of the lands and/or may result in a complete loss of agricultural uses in some areas. Some areas could be converted to nonfarm uses depending upon local zoning decisions.

- Grazing activities would be precluded by commercial tar sands development in those portions of the lease area that were (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing restoration after development; or (4) occupied by long-term surface facilities, such as surface mine excavations, production facilities, office buildings, retorts, and parking lots. Depending on conditions unique to the individual grazing allotment, temporary reductions in authorized grazing use may be necessary because of loss of a portion of the forage base. It is possible, depending upon how commercial leases would be developed, that some grazing uses might be accommodated on parts of the leases at various times during the lease period.

  The level of impact of the removal of acreage from individual grazing leases would depend on site-specific factors regarding the grazing allotment(s) affected. There is a large variation in size and productivity of BLM grazing allotments across the PEIS study area, and the loss of up to 5,760 acres for individual tar sands facilities from larger allotments would not be as significant as from smaller allotments. Some allotments could become completely unavailable for grazing use. Others would lose varying percentages of grazing area that may affect their overall economic viability.

- Commercial tar sands development activities are largely incompatible with recreational land use (e.g., hiking, biking, fishing, hunting, bird-watching,

OHV use, and camping). Recreational uses, including OHV use, would be precluded from those portions of commercial lease areas involved in ongoing development and restoration activities. Impacts on vegetation, development of roads, and displacement of big game could degrade the recreational experiences and hunting opportunities near commercial tar sands projects. The impact of displacement of recreation uses from tar sands development lease areas would be highly dependent upon site-specific factors, especially the nature of existing uses on the site.

- Specially designated areas, including all designated Wilderness Areas, WSAs, other areas that are part of the NLCS (e.g., National Monuments, NCAs, WSRs, and National Historic and Scenic Trails) and existing ACECs managed by the BLM and units of the NPS managed by the NPS would not be available for application for tar sands leasing and commercial development and would not be directly affected. They might, however, incur indirect impacts (e.g., dust and degraded viewshed) resulting from commercial tar sands development on adjacent lands or on areas within the general vicinity.

- Lands available for application for lease contain all or portions of areas that have been recognized by the BLM in Utah as having one or more characteristics of wilderness. Table 6.2.2-2 lists these areas. Should commercial development of tar sands occur on these lands, the identified wilderness characteristics in both the areas that are developed and those that border the developed areas would be lost. Alternative B includes approximately 100,000 acres of these lands that could be subject to potential development.

- In Utah there are areas that have been identified as being eligible for designation as ACECs. These areas are being reviewed as part of ongoing land use planning activities that may or may not be complete before this Draft PEIS is published. Table 6.2.2-3 lists the areas and the number of acres of overlap by field office that would be available for application for commercial tar sands leasing. If tar sands development occurs on these lands, depending on the nature of resources present on the lands, it is likely these resources would be lost. The decisions regarding designation of these lands would be made at the field office level and not in this PEIS. Should designation as ACECs be completed before the PEIS is issued, these lands would not be available for lease. If this PEIS is issued before the land use planning process is completed, the field offices still would make the decisions regarding the future management of these lands and would determine whether they would be available for application for leasing for commercial tar sands development. Alternative B includes approximately 180,000 acres of these lands that could be subject to potential development.

**TABLE 6.2.2-2 Areas with Wilderness Characteristics That Overlap with Lands Made Available for Application for Commercial Tar Sands Leasing under Alternatives B and C and the Amount of Overlap[a,b]**

| Name of Area with Wilderness Characteristics | Amount of Overlap (acres) | |
|---|---|---|
| | Alternative B | Alternative C |
| ***Hill Creek STSA*** | | |
| Wolf Point | 937 | 0 |
| ***P.R. Spring STSA*** | | |
| Bitter Creek | 12,252 | 4,854 |
| Hideout Canyon | 993 | 0 |
| Lower Bitter Creek | 514 | 509 |
| Mexico Point | 739 | 0 |
| Wolf Point | 5,147 | 790 |
| ***San Rafael STSA*** | | |
| Devils Canyon | 968 | 254 |
| Hondu Country | 4,207 | 4,203 |
| Mexican Mountain | 13,430 | 10,665 |
| Muddy Creek–Crack Canyon | 10,826 | 8,750 |
| San Rafael Knob | 5,412 | 3,871 |
| San Rafael Reef | 3,991 | 3,991 |
| Sids Mountain | 4,244 | 772 |
| ***Sunnyside STSA*** | | |
| Desolation Canyon | 6,832 | 6,739 |
| ***Tar Sand Triangle STSA*** | | |
| Dirty Devil–French South | 24,255 | 22,210 |
| ***White Canyon STSA*** | | |
| Dark Canyon | 218 | 91 |
| Fort Knocker Canyon | 71 | 0 |
| Gravel and Long Canyon | 1,727 | 0 |
| Red Rocks Plateau A | 69 | 0 |
| White Canyon | 2,751 | 251 |
| Total | 99,583 | 67,951 |

[a] The key characteristics of wilderness that may be considered in land use planning include an area's appearance of naturalness and the existence of outstanding opportunities for solitude or primitive and unconfined types of recreation.

[b] Totals may be off due to rounding. Acreage estimates were derived from GIS data.

**TABLE 6.2.2-3 Potential ACECs That Overlap with Lands Made Available for Application for Commercial Tar Sands Leasing under Alternatives B and C and the Amount of Overlap[a]**

| | Amount of Overlap (acres) | |
|---|---|---|
| Potential ACEC | Alternative B | Alternative C |
| ***Argyle Canyon STSA*** | | |
| Nine Mile Canyon | 325 | 40 |
| ***Hill Creek STSA*** | | |
| Main Canyon | 5,592 | 4,637 |
| ***Pariette STSA*** | | |
| Coyote Basin–Myton Beach | 2,621 | 631 |
| ***P.R. Spring STSA*** | | |
| Bitter Creek | 20,715 | 8,782 |
| Bitter Creek/P.R. Spring | 47,951 | 7,942 |
| Main Canyon | 40,665 | 17,831 |
| ***Raven Ridge STSA*** | | |
| Coyote Basin–Snake John | 6,774 | 5,855 |
| ***San Rafael STSA*** | | |
| Lucky Strike | 575 | 2 |
| Wild Horse | 610 | 566 |
| ***Sunnyside STSA*** | | |
| Desolation Canyon | 3,355 | 3,177 |
| Nine Mile Canyon | 27,182 | 13,663 |
| Range Creek | 936 | 933 |
| ***Tar Sand Triangle STSA*** | | |
| Dirty Devil–North Wash | 22,684 | 21,021 |
| Total | 179,985 | 85,801 |

[a] Totals may be off due to rounding. Acreage estimates were derived from GIS data.

### 6.2.2.2 Soil and Geologic Resources

The amendment of land use plans to make approximately 430,000 acres of public land available for application for leasing for commercial tar sands development under Alternative B would not have any direct impacts on soil or geologic resources. Soil and geologic resources within the area could, however, be affected by future commercial tar sands development on these lands.

Soil and geologic resources could be affected during project construction as a result of removal or compaction (e.g., during site clearing and grading, foundation excavation and preparation, and pipeline trenching), and by erosion during project construction and operation (e.g., erosion of exposed soils in construction areas or of topsoil stockpiles (see Section 5.3.1). Erosion of exposed soils could also lead to increased sedimentation of nearby water bodies and to the generation of fugitive dust, which could affect local air quality. Project areas would remain susceptible to erosion until completion of construction, mining, tar sands processing, and site stabilization and reclamation activities (e.g., revegetation of pipeline ROWs and surface mine reclamation). Impacts on soil and geologic resources would be limited to the specific project location as well as to areas where associated off-lease infrastructure (e.g., access roads, utility ROWs, and power plants) would be located.

Under Alternative B, impacts on soil and geologic resources could occur wherever individual projects are located within the 430,000 acres identified for leasing application. For any project, the erosion potential of the soils would be a direct function of the lease and project location, and also the soil characteristics, vegetative cover, and topography (i.e., slope) at that location. Development in areas that have erosive soils and steep slopes (e.g., in excess of 25%) could lead to serious erosion problems at those locations.

#### 6.2.2.3 Paleontological Resources

The identification of approximately 430,000 acres of public land for application for leasing for commercial development of tar sands the amendment of land use plans to incorporate these lease areas would not have direct impacts on paleontological resources. Of the 431,224 acres identified under Alternative B as being available within the STSAs, a total of 335,395 acres (approximately 78%) have been identified as having the potential to contain important paleontological resources (Murphey and Daitch 2007). Paleontological resources within these areas could be adversely impacted if leasing and future commercial development occurs. Impacts could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development area, and increased potential for loss of resource from looting or vandalism as a result of increased human presence/activity in the sensitive areas (see Section 5.4).

#### 6.2.2.4 Water Resources

The amendment of land use plans to make approximately 430,000 acres of public land in Utah available for application for leasing for commercial development of tar sands (approximately 66% of the federal lands in the STSAs) would not have direct impacts on water resources. Surface water and groundwater resources could, however, be adversely affected by future commercial tar sands development made possible by these land use plan amendments. The amount of water that may be required for future commercial development and the potential mix between surface water, groundwater, and treated process water is unknown.

The inability to predict specific locations for potential future commercial development and the lack of information regarding the type of technology that might be employed make it impossible to predict the specific impacts on water resources that could occur with commercial development. Quantification of such impacts would depend on the specific location of the lease area being developed, as well as the design of the project and associated infrastructure.

Section 5.5 of this PEIS provides a generic description of the potential impacts on water resources. These impacts could occur anywhere within the 430,000 acres available for application for leasing under this alternative. The following is a summary of these generic impacts:

- Degradation of surface water quality caused by increased sediment load or contaminated runoff from project sites;
- Surface disturbance that may alter natural drainages by both diverting and concentrating natural runoff;
- Surface disturbance that becomes a non-point source of sediment and dissolved salt to surface water bodies;
- Withdrawal of water from a surface water body that reduces its flow and degrades the water quality of the stream downgradient from the point of the withdrawal;
- Withdrawals of groundwater from a shallow aquifer that produce a cone of depression and reduce groundwater discharge to surface water bodies or to the springs or seeps that are hydrologically connected to the groundwater;
- Construction of reservoirs that might alter natural streamflow patterns, alter local fisheries, temporarily increase salt loading, cause changes in stream profiles downstream, reduce natural sediment transport mechanisms, and increase evapotranspiration losses;
- Discharged water from a project site that could have a lower water quality than the intake water that is brought to a site;
- Mine tailings that might be sources of salt, metal, and hydrocarbon contamination for both surface and groundwater;
- Dewatering operations of a mine, or dewatering through wells that penetrate multiple aquifers, that could reduce groundwater discharge to seeps, springs, or surface water bodies if the surface water and the groundwater are connected;
- Degradation of groundwater quality resulting from the injection of lower quality water, from contributions of residual hydrocarbons or chemicals from

retorted zones after recovery operations have ceased, and from spent shales replaced in either surface or underground mines; and

- Reduction or loss of flow in domestic water wells from dewatering operations or from production of water for industrial uses.

As noted above in Section 6.2.2.2, lands made available for application for leasing under Alternative B include lands that have been identified in BLM land use plans as having high potential for erosion due to steep slopes and/or highly erosive soils. Surface water quality could be adversely impacted by erosion from these lands and similar lands throughout the STSAs that would contribute to increases in sediment and salinity loads.

In addition, lands made available for application for leasing under Alternative B overlap with sensitive hydrologic areas identified by the BLM, including about 6,100 acres of watershed, floodplains, and other sensitive water resources in Utah. Impairment of the function of these areas by increased sedimentation from disturbance of sensitive soil areas or from runoff of contaminated water from project sites would also contribute to overall adverse effects on water quality.

There are approximately 107 mi of perennial stream miles in the STSAs. Alternative B contains approximately 28 mi (26%) of these perennial streams that could be adversely impacted, either directly or indirectly, by future commercial tar sands development.

#### 6.2.2.5 Air Quality

Air resources would not be affected by the amendment of land use plans to allow application for leasing for commercial tar sands development in these areas. However, air resources in and around these areas could be affected by future commercial development of tar sands. Under Alternative B, local, short-term air quality impacts could be incurred as a result of (1) PM releases (fugitive dust and diesel exhaust) during construction activities such as site clearing and grading in preparation for facility construction, and (2) exhaust emissions ($SO_2$, CO, and $NO_x$) from construction equipment (see Section 5.6). These types of impacts would be largely limited to specific project locations and the immediate surrounding area. Similar short-term impacts could also occur in other areas where electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located and developed.

Similar but longer-term impacts on local air quality could occur during normal project operations such as mining and processing of the tar sands. Processing activities may also result in regional impacts on air quality that could extend beyond the boundaries of the lease areas. These regional impacts would be associated with operational releases of CO, $NO_x$, and other pollutants (VOCs and $SO_2$) during tar sands excavation and processing (see Section 5.6). Operational releases of hazardous air pollutants (such as benzene, toluene, and formaldehyde) as well as diesel PM could also affect workers and nearby residences (if any are present); these impacts, however, would be localized to the immediate project location and subject to further analyses prior to implementation.

#### 6.2.2.6 Noise

Under Alternative B, approximately 430,000 acres of public land in Utah would be made available for application for leasing for commercial development of tar sands. Ambient noise levels in these areas would not be affected by the amendment of land use plans to incorporate these lease areas. However, ambient noise levels could be affected by future commercial development of tar sands. Under Alternative B, local, short-term changes in ambient noise levels could occur during the construction, operation, and reclamation of tar sands projects (see Section 5.7.1). Project-related increases in noise levels could disturb or displace wildlife and recreational users in nearby areas. Impacts on wildlife and recreational users are discussed in Sections 5.8.1.3 and 5.2.1.3, respectively. Noise levels could be affected as a result of the operation of construction equipment (graders, excavators, and haul trucks) and as a result of any blasting activities. Increases in ambient noise levels during operations would be associated with mining and tar sands processing activities and would be more long-term than construction-related noise. These types of impacts would be largely limited to specific project locations and the immediate surrounding area. Similar short-term and long-term impacts could also occur in other areas where electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located, developed, and operated. For example, ambient noise levels could also be increased in the immediate vicinity of any pipeline pump stations, and could also be affected by project-related vehicular traffic at the project site and related locations such as access roads to the site.

Construction-related noise levels could exceed EPA guidelines. Similarly, operational noise associated with mining and retort activities could, in the absence of mitigation, exceed EPA guidelines at some project locations. Noise generated as a result of project-related (but nonconstruction) vehicular traffic is not expected to exceed EPA guideline levels except for short durations and very close to road or high traffic areas.

In the absence of lease- and project-specific information, it is not possible at the level of this PEIS to identify the duration and magnitude of any project-related changes in noise levels. Changes to ambient noise levels from project development could occur wherever a project is located within the 430,000 acres identified for lease application under Alternative B.

#### 6.2.2.7 Ecological Resources

Under Alternative B, approximately 430,000 acres of public land would be made available within Utah for application for leasing for commercial tar sands development. These lands support a wide variety of biota and their habitats (Section 3.7). Ecological resources in these areas would not be affected by the amendment of six land use plans to incorporate these areas (Section 6.2.2). However, ecological resources could be affected by future commercial development of tar sands in and around the 430,000 acres of available lands. The following sections describe the potential impacts on ecological resources that may result with commercial tar sands development within the lease areas identified under Alternative B.

The impacts on specific ecological resources that could occur from commercial tar sands development of the Alternative B lease areas, as well as their magnitude and locations, would depend on the specific location of the future commercial projects as well as on the specific project design.

**6.2.2.7.1 Aquatic Resources.** Nine perennial streams totaling about 28 mi occur within the lands that would be made available for application for leasing under Alternative B (Table 6.2.2-4). These streams, as well as numerous unnamed streams and other surface waters (such as ponds) provide habitat for a variety of aquatic resources.

**TABLE 6.2.2-4 Perennial Streams Occurring in Utah within the Lease Areas Identified under Alternative B**

| Stream | Length of Stream (mi) |
|---|---|
| Tabyago Canyon | 2.0 |
| Bitter Creek | 0.7 |
| Center Fork | 1.9 |
| Sand Wash | 0.5 |
| Sweetwater Canyon | 6.0 |
| Wells Draw | 1.1 |
| Cottonwood Canyon | 5.1 |
| Dry Creek | 5.9 |
| Nine-Mile Creek | 5.2 |
| Total | 28.4 |

The development of commercial tar sands projects in lease areas identified under Alternative B could affect the aquatic biota and their habitats in these streams during project construction and operations (Sections 5.8.1.1). Impacts on aquatic resources from tar sands development projects and associated facilities could occur because of (1) direct disturbance (pipeline trenching and vehicle crossings) of aquatic habitats within the footprint of construction or operation activities; (2) sedimentation of nearby aquatic habitats as a consequence of soil erosion from operational areas; (3) decreased habitat quality because of changes in water quantity or water quality as a result of construction (e.g., grading that affects surface runoff patterns and siltation) and operations (e.g., reductions or increases in discharges of water into nearby aquatic habitats), or releases of chemical contaminants (accidental spills of fuels, industrial chemicals, and oil) into nearby aquatic systems; or (4) development of infrastructure such as roads and ROWs that increase public access to fishery resources. These impacts could occur to some degree during the construction period and throughout the operational life of the projects. In addition, some impacts could continue to occur beyond the operational life of the project.

Potential impacts on aquatic resources from future project construction and operation could result in short- and/or long-term changes (disturbance or loss) in the abundance and distribution of affected biota and their habitats. The nature and magnitude of these impacts, as well as the specific resources affected, would depend on the locations of the areas where project construction and facilities occur, the aquatic resources present in those areas, and the mitigation measures implemented.

**6.2.2.7.2 Plant Communities and Habitats.** The development of commercial tar sands projects in lease areas identified under Alternative B could affect plant communities and habitats during future project construction and operations. Under Alternative B, approximately 430,000 acres of land are identified in Utah as being available for lease application, and these

areas support a wide variety of plant communities and habitats (see Section 3.7.2). These areas include approximately 2,085 acres that are currently identified in BLM land use plans for protection because of the known presence of sensitive plants and relict vegetation populations. Direct and indirect impacts could be incurred during project construction and operation, extending over a period of several decades (especially within facility and infrastructure footprints) (see Section 5.8.1.2). Some impacts (e.g., habitat loss) may continue beyond the termination of commercial tar sands operations.

Direct impacts from future construction and operation activities would include the destruction of vegetation and habitat during land clearing on the lease site and where ancillary facilities such as access roads, pipelines, transmission lines, and employer-provided housing would be developed. Soils disturbed during construction would be susceptible to the introduction and establishment of non-native invasive species, which in turn could greatly reduce the success of establishment of native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. Plant communities and habitats could also be adversely affected by changes in water quality or availability, resulting in plant mortality or reduced growth, with subsequent changes in community composition and structure and declines in habitat quality. Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. These impacts could lead to changes in the abundance and distribution of plant species and changes in community structure, as well the introduction or spread of invasive species.

Affected plant communities and habitats could incur short- and/or long-term changes in species composition, abundance, and distribution. While many impacts would be local in nature (occurring within construction and operation footprints and in the immediate surrounding area, the introduction of invasive species could affect much larger areas. The nature and magnitude of these impacts, as well as the communities or habitats affected, would depend on the location of the areas where project construction and facilities would occur, the plant communities and habitats present in those areas, and the mitigation measures implemented to address impacts.

**6.2.2.7.3 Wildlife.** Under Alternative B, about 430,000 acres of land in Utah would be identified as available for lease application for commercial tar sands development. These areas and surrounding locations support a diverse array of wildlife and habitats (see Section 3.7.3). Important areas identified for protection (in BLM land use plans) within the Alternative B lease areas include grouse habitat and lek areas; raptor nest, roost, and concentration areas; big game winter and summer ranges and calving, fawning, and lambing areas. Table 6.2.2-5 identifies the amount of each of these habitats that would be included in the Alternative B lease areas and that could be impacted by future commercial tar sands development in these areas.

The Alternative B lease areas also overlap areas identified by state natural resource agencies as important for sage grouse and big game species. These areas include sage grouse habitat and lek sites (Figure 6.2.2-1), and mule deer and elk winter and summer ranges (Figures 6.2.2-2 and 6.2.2-3). Table 6.2.2-6 presents the amounts of these habitats identified by

the State of Utah that would occur in the Alternative B lease areas and could be impacted by potential future commercial tar sands development in these areas.

Several wild horse HMAs overlap with the lands that would be available for application for leasing, including the Hill Creek HMA (about 18,725 acres), which overlaps the Hill Creek STSA; the Muddy Creek and Sinbad HMAs (about 3,500 and 39,675 acres, respectively), which overlap with the San Rafael STSA; the Range Creek HMA (about 13,875 acres), which overlaps the Sunnyside STSA; and the Canyon Lands HMA (about 265 acres), which overlaps with the Tar Sand Triangle STSA (Figure 6.2.2-4).

**TABLE 6.2.2-5 Acres of Important Wildlife Habitat Identified for Protection in BLM Land Use Plans That Would Be Present in the Alternative B Lease Areas in Utah**

| Wildlife Resource | Utah |
|---|---|
| Sage grouse habitat | 5,645 |
| Raptor habitat | 13,987 |
| Big game winter range[a] | 12,166 |
| Big game calving, fawning, or lambing habitat[b] | 19,366 |
| Pronghorn antelope and desert bighorn sheep crucial habitat | 9,737 |

[a] Elk and mule deer acreage may be overestimated because of unknown degree of habitat overlap among the species.

[b] Applies to elk, mule deer, and desert bighorn sheep.

Impacts on wildlife (including wild horses and burros) from the construction and operation of future commercial tar sands projects could occur in a number of ways and would be related to (1) habitat loss, alteration, or fragmentation (as a result of construction); (2) disturbance and displacement of biota (by construction and operation activities and the presence of project infrastructure); (3) mortality (from construction activities and collisions with project infrastructure and vehicles); (4) exposure to hazardous materials; and (5) increase in human access. These impacts can result in changes in habitat use; changes in behavior; collisions with structures or vehicles; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminant exposures.

Wildlife could also be affected by human activities not directly associated with commercial tar sands projects or workforces but instead associated with the potentially increased human access to BLM-administered lands that had previously received little use. The construction of new access roads or improvements to old access roads may lead to increased human access into the area. Potential impacts associated with increased access include (1) the disturbance of wildlife from human activities, including an increase in legal and illegal harvest and an increase of invasive vegetation, and (2) an increase in the incidence of fires.

**6.2.2.7.4 Threatened and Endangered Species.** There is a potential for commercial tar sands development projects to adversely affect many of the threatened, endangered, and sensitive species that occur in the counties where development could occur (Tables 5.8.1-3 and 5.8.1-4). This potential for adverse impacts results from a lack of specificity on the locations of lease areas, lack of project specifications, and the often incomplete information on species distributions.

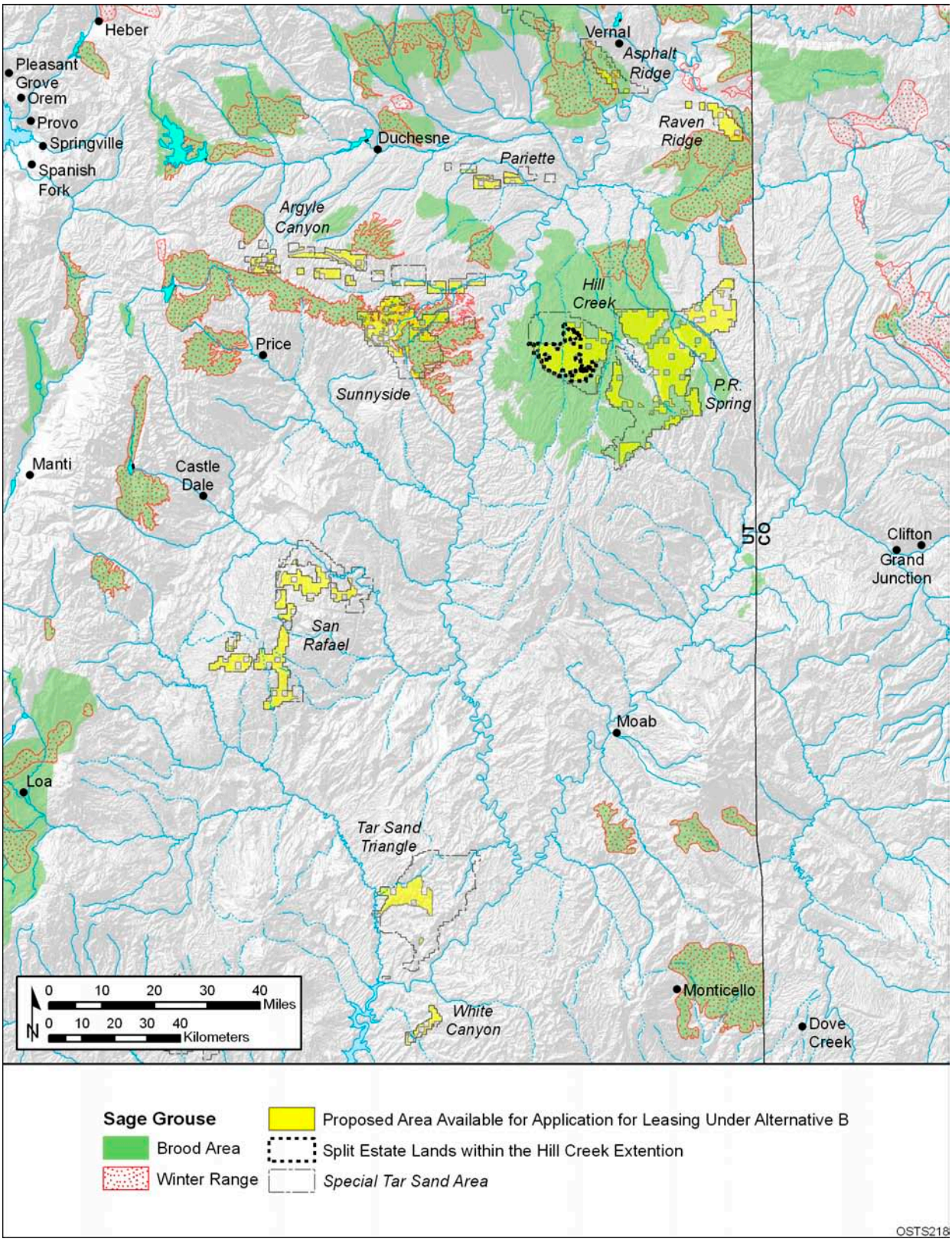


**FIGURE 6.2.2-1 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Known Distribution of the Greater Sage-Grouse**

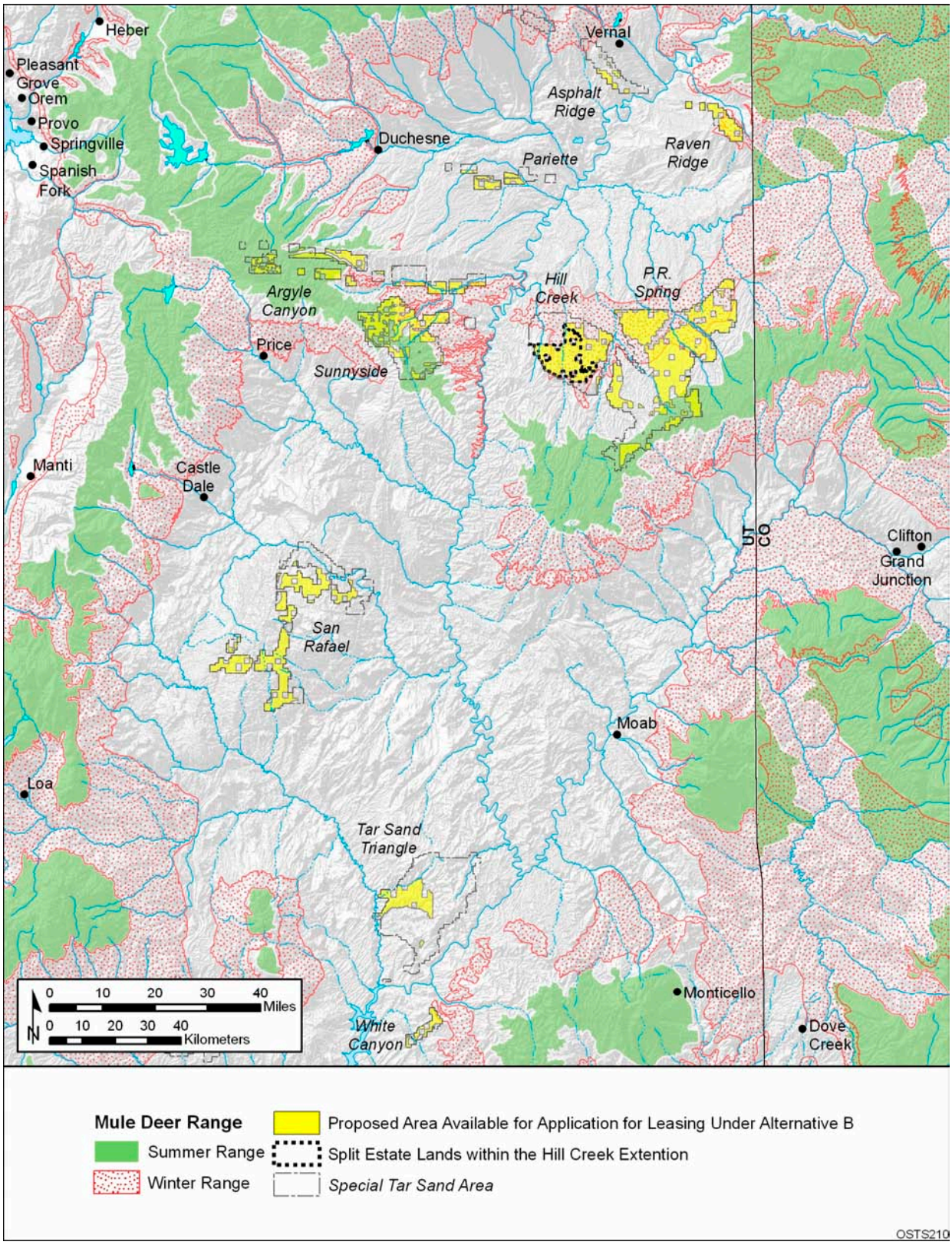


**FIGURE 6.2.2-2 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Mule Deer**

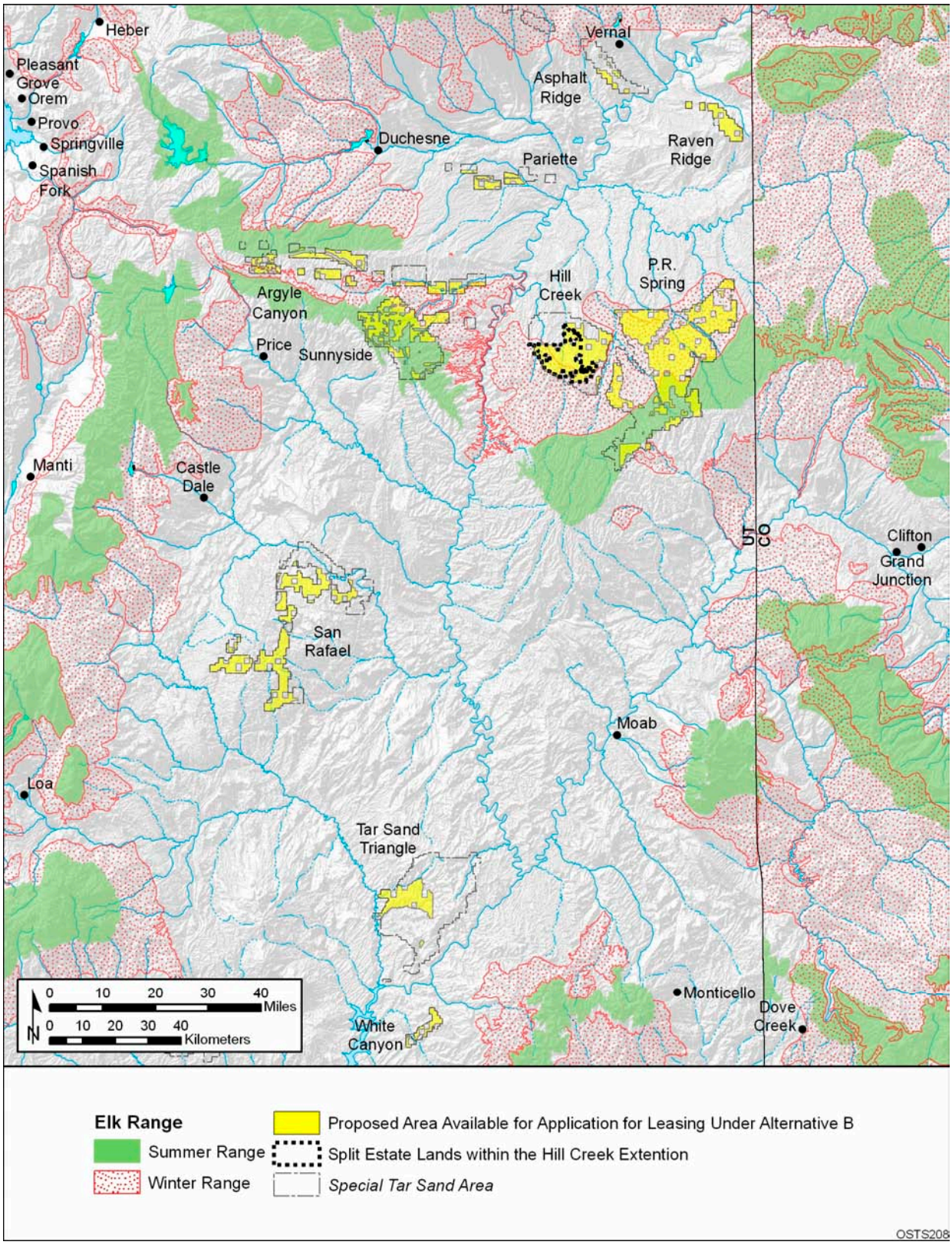


**FIGURE 6.2.2-3 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Elk**

Twenty federally listed threatened or endangered species could occur in areas that would be made available for leasing under Alternative B (see Table 5.8.1-4). No critical habitat for Colorado River endangered fishes in Utah (Figure 6.2.2-5) would be located within the lands that would be made available under Alternative B for application for leasing and where commercial tar sands development could occur in the future.

**TABLE 6.2.2-6 Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in the Alternative B Lease Areas**

| Wildlife Resource | Utah |
|---|---|
| Sage grouse habitat | 227,700 |
| Mule deer winter habitat | 147,200 |
| Mule deer summer habitat | 67,100 |
| Elk winter habitat | 161,300 |
| Elk summer habitat | 65,400 |
| Big game calving, fawning, or lambing habitat[a] | 18,000 |
| Crucial pronghorn habitat | 5,900 |

[a] Applies to elk and mule deer.

The potential for impacts on threatened, endangered, and sensitive species (and their habitats) by future commercial tar sands development would be directly related to the amount of land disturbance that would occur with a project (including its ancillary facilities such as utility and pipeline ROWs), the duration and timing of construction and operation periods, and the habitats affected by development (i.e., the location of the project). Indirect effects such as impacts resulting from the erosion of disturbed land surfaces and disturbance and harassment of animal species are also considered, but their magnitude also is considered proportional to the amount of land disturbance.

Impacts on threatened and endangered species (see Section 5.8.1.4) are fundamentally similar to or the same as those described for impacts on aquatic resources; plant communities and habitats; and wildlife in Sections 5.8.1.1, 5.8.1.2, and 5.8.1.3, respectively. The most important difference is the potential consequence of the impacts. Because of low population sizes, threatened and endangered species are far more vulnerable to impacts than more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development.

#### 6.2.2.8 Visual Resources

Under Alternative B, land use plans would be amended to identify approximately 430,000 acres of public land in Utah as being available for application for leasing for commercial development of tar sands. While these lands support a wide variety of visual resources (Section 3.8), these resources would not be affected by the amendment of land use plans to incorporate these lease areas. However, visual resources in and around the proposed lease areas could be affected by future commercial development of tar sands.

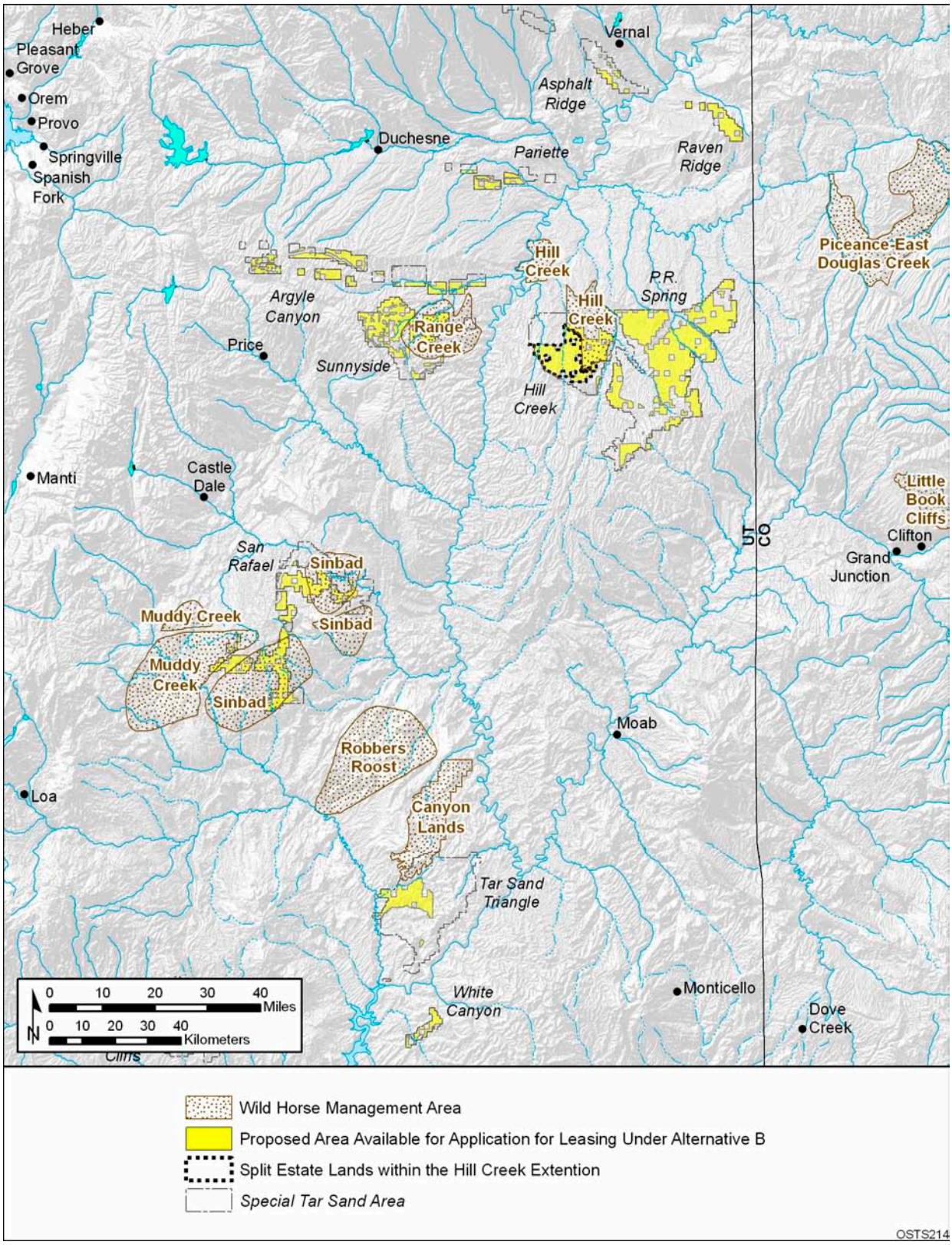


**FIGURE 6.2.2-4 Overlap of Lands Made Available for Application for Leasing under Alternative B with Wild Horse Herd Management Areas**

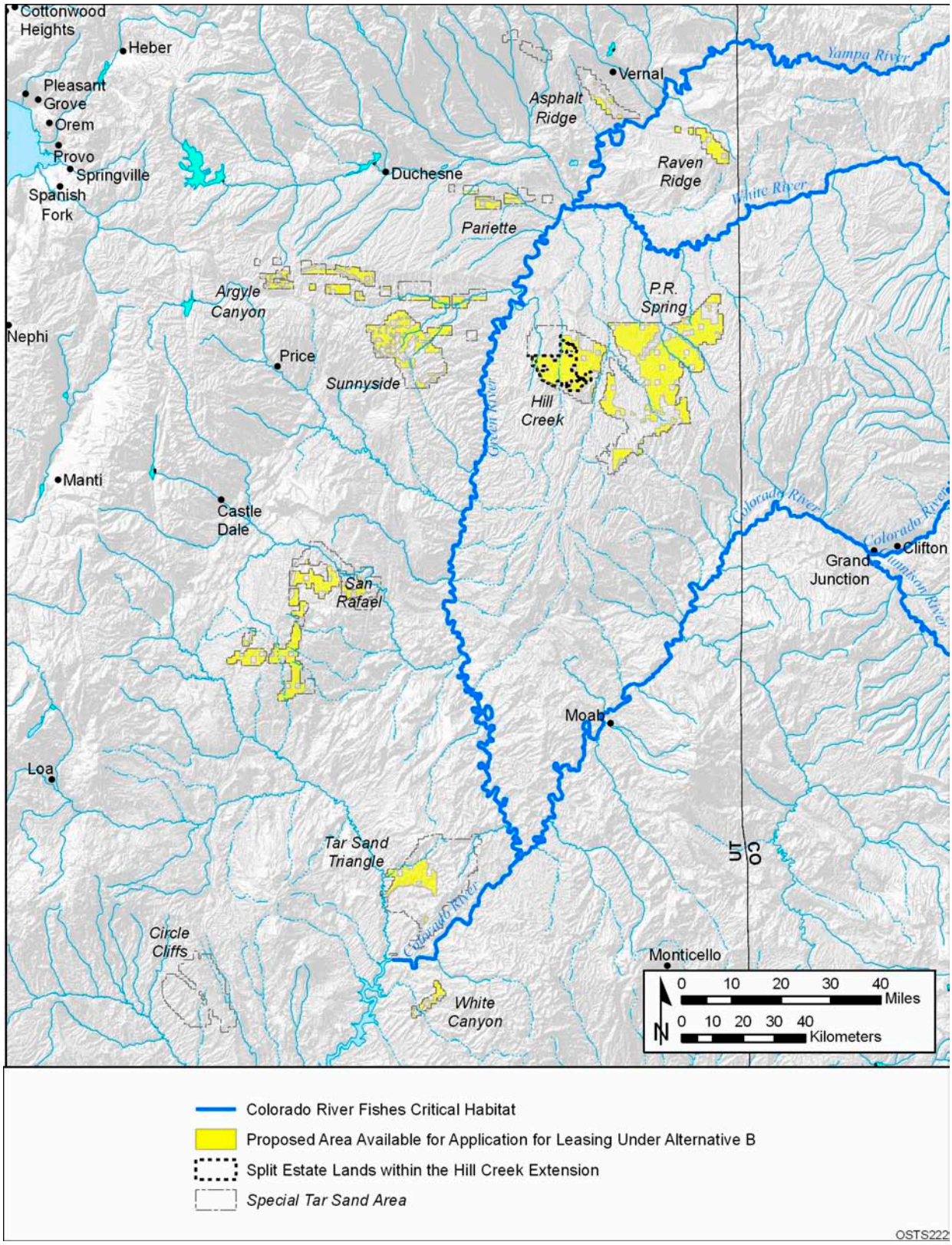


**FIGURE 6.2.2-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative B**

Several scenic resource areas are located within the lease areas identified under Alternative B (Figures 6.2.2-6 through 6.2.2-9). These scenic resource areas include:

- The Bitter Creek, Bitter Creek–P.R. Spring, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Dirty Devil–North Wash, Lucky Strike, Main Canyon, Nine Mile Canyon, Range Creek, and Wild Horse Potential ACECs;

- Segments of the Nine Mile Creek determined to be eligible for WSR designation; and

- A portion of the Dinosaur Diamond Prehistoric National Scenic Highway.

Additional scenic resource areas are located within 5 or 15 mi of the Alternative B proposed lease areas (Figures 6.2.2-6 through 6.2.2-9). The 5-mi zone corresponds to the BLM's VRM foreground-middleground distance limit, and the 15-mi zone corresponds to the BLM's background distance limit. Assuming an unobstructed view of a commercial tar sands project, viewers in these areas would be likely to perceive some level of visual impact from the project, with impacts expected to be greater for resources within the foreground-middleground distance, and lesser for resources within the background distance. Beyond the background distance, the project might be visible but would likely occupy a very small visual angle and create low levels of visual contrast such that impacts would be minor to negligible. Table 6.2.2-7 presents the scenic resource areas that fall within these zones.

Visual resources could be affected at and near the lease areas where commercial tar sands projects would be developed and operated, and at areas where supporting infrastructure (such as utility and pipeline ROWs) would be located. Visual resources could be affected by ROW clearing, project construction, and operation (see Section 5.9.1). Potential impacts would be associated with construction equipment and activity, cleared project areas, and the type and visibility of individual project components such as tar sands processing facilities, utility ROWs, and surface mines. The nature, magnitude, and extent of project-related impacts would depend on the type, location, and design of the individual project components.

#### 6.2.2.9 Cultural Resources

Under Alternative B, the amendment of land use plans to identify about 430,000 acres of public land as being available for commercial tar sands development would not result in impacts on cultural resources. The lands made available overlap with lands specifically identified as having cultural resources (O'Rourke et al. 2007). More than 10%[1] of public lands that would be made available for application for leasing in the STSAs under Alternative B have been surveyed for cultural resources (more than 42,620 acres in addition to 460 linear miles). In those areas that have been surveyed, 183 sites have been identified. Additional resources are likely in unsurveyed

[1] This percentage was calculated using block acre surveys only and does not include approximately 460 linear miles of survey.

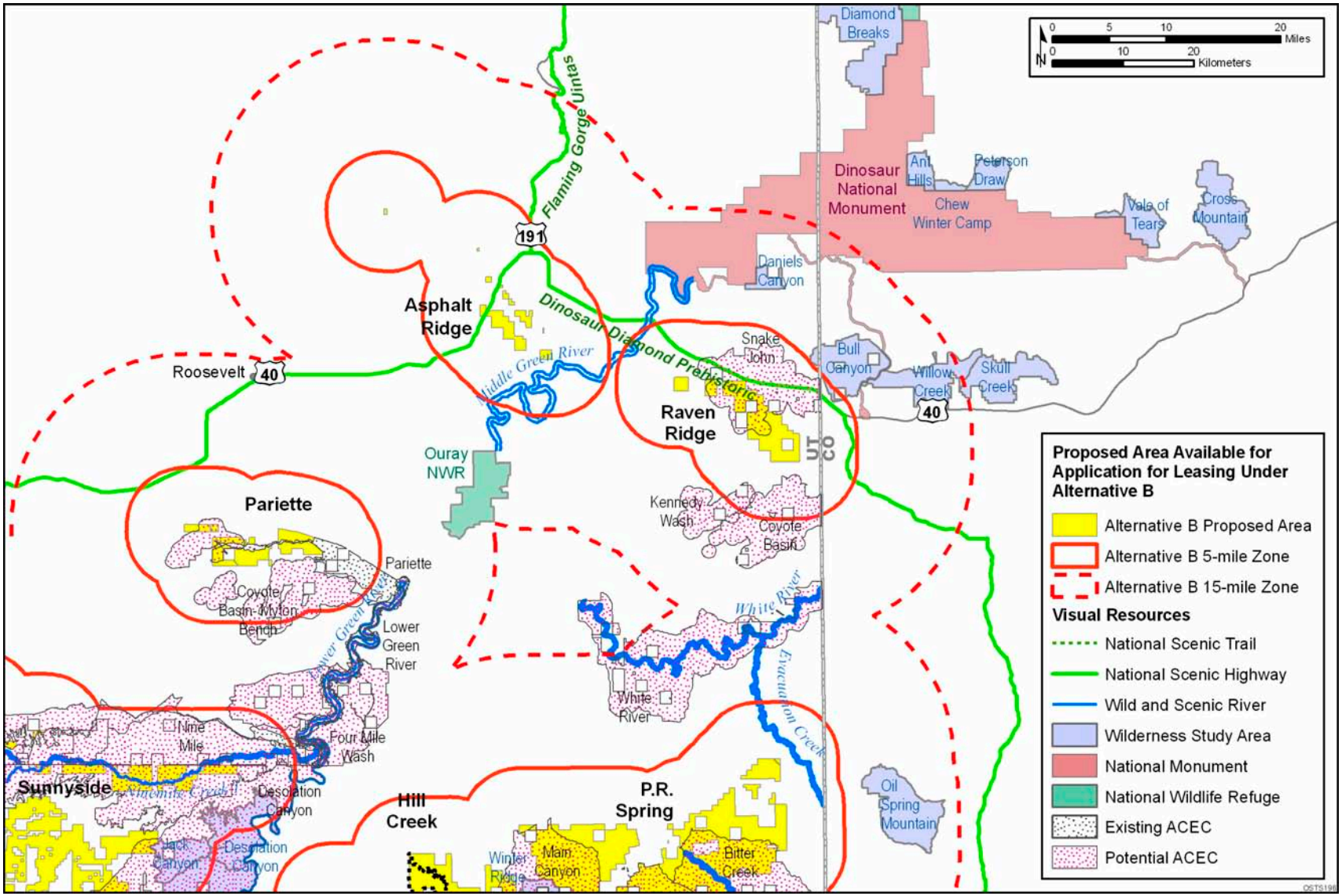


**FIGURE 6.2.2-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the Asphalt Ridge, Pariette, and Raven Ridge STSAs**

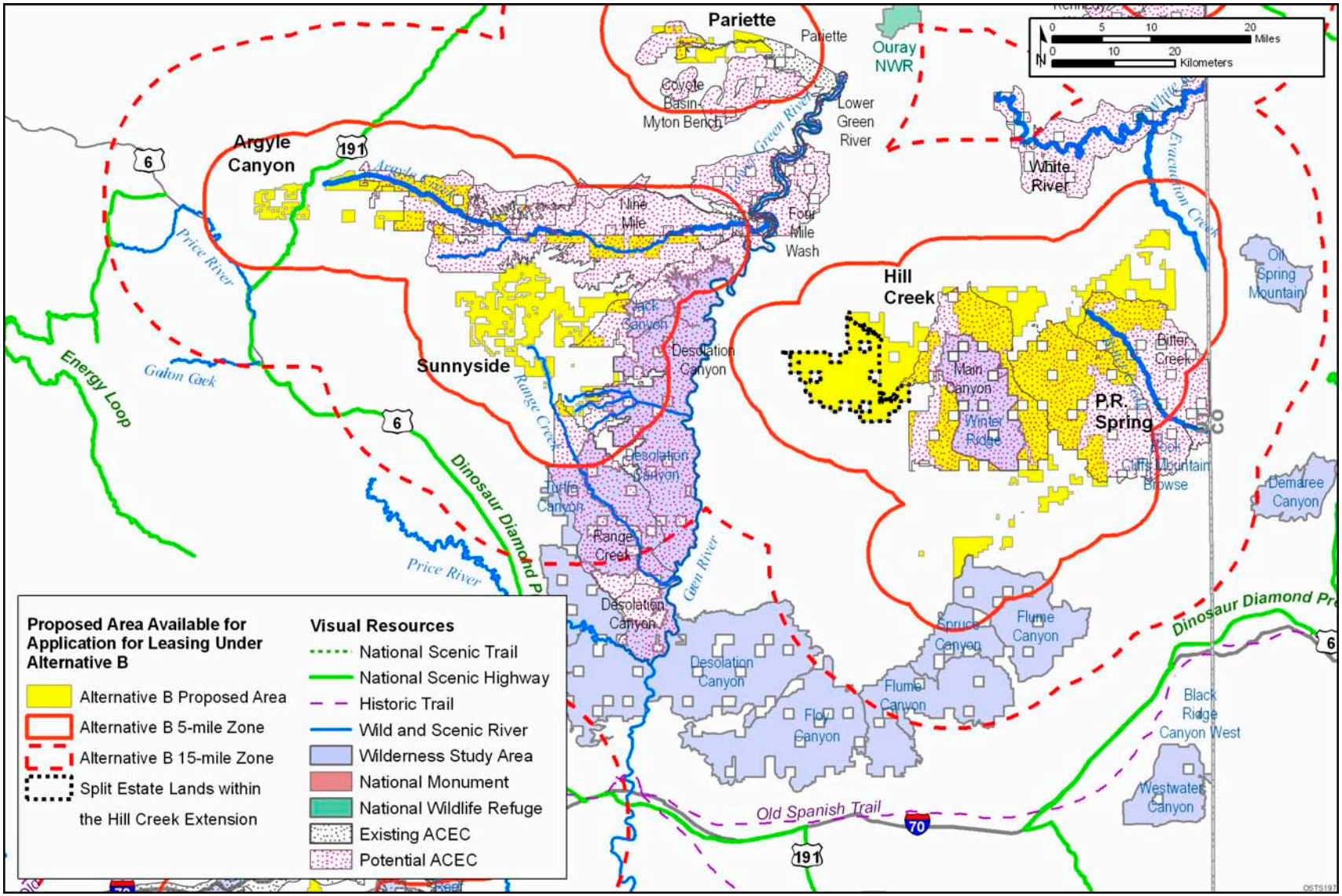


**FIGURE 6.2.2-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the Argyle Canyon, Hill Creek, P.R. Spring, and Sunnyside STSAs**

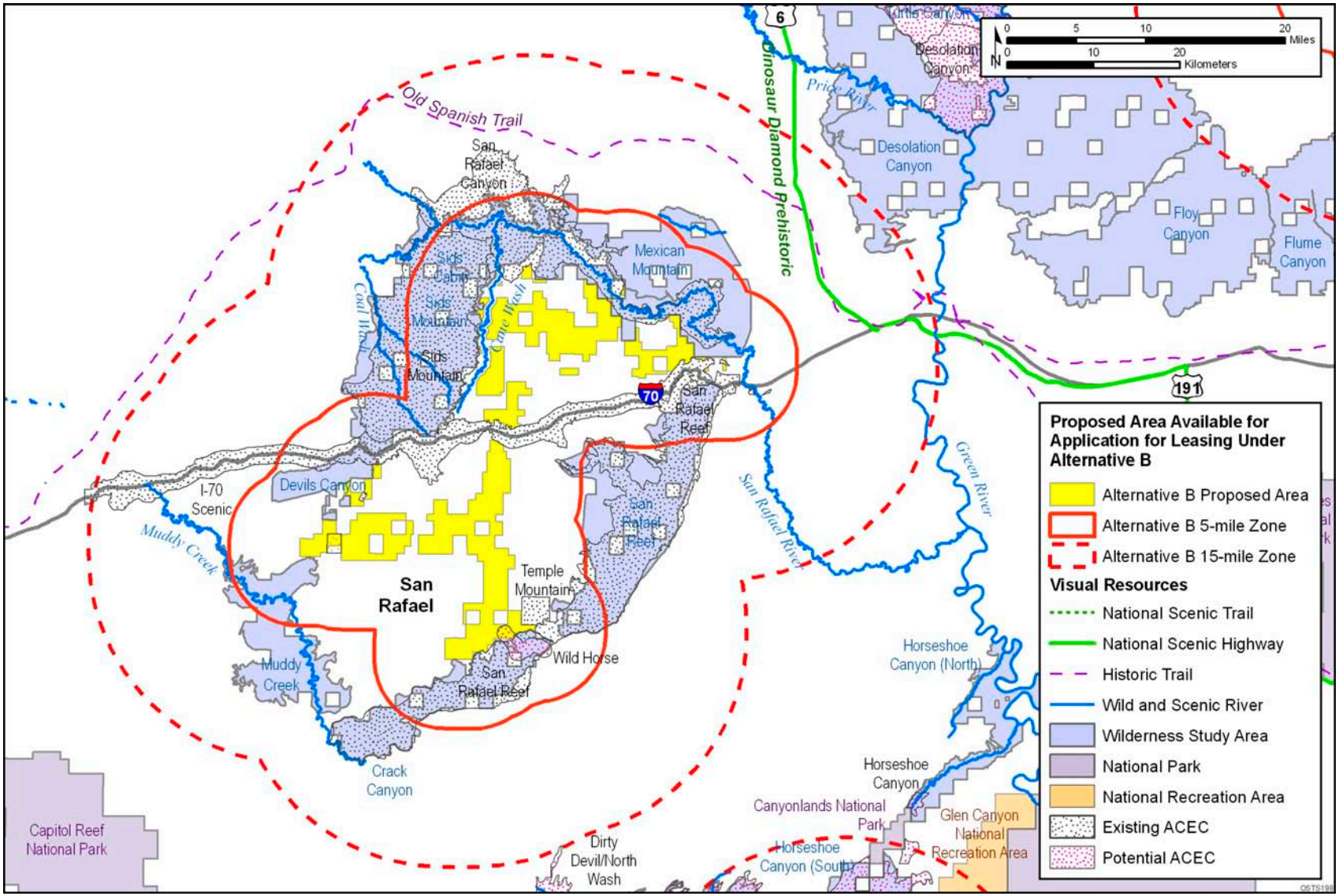


**FIGURE 6.2.2-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the San Rafael STSA**

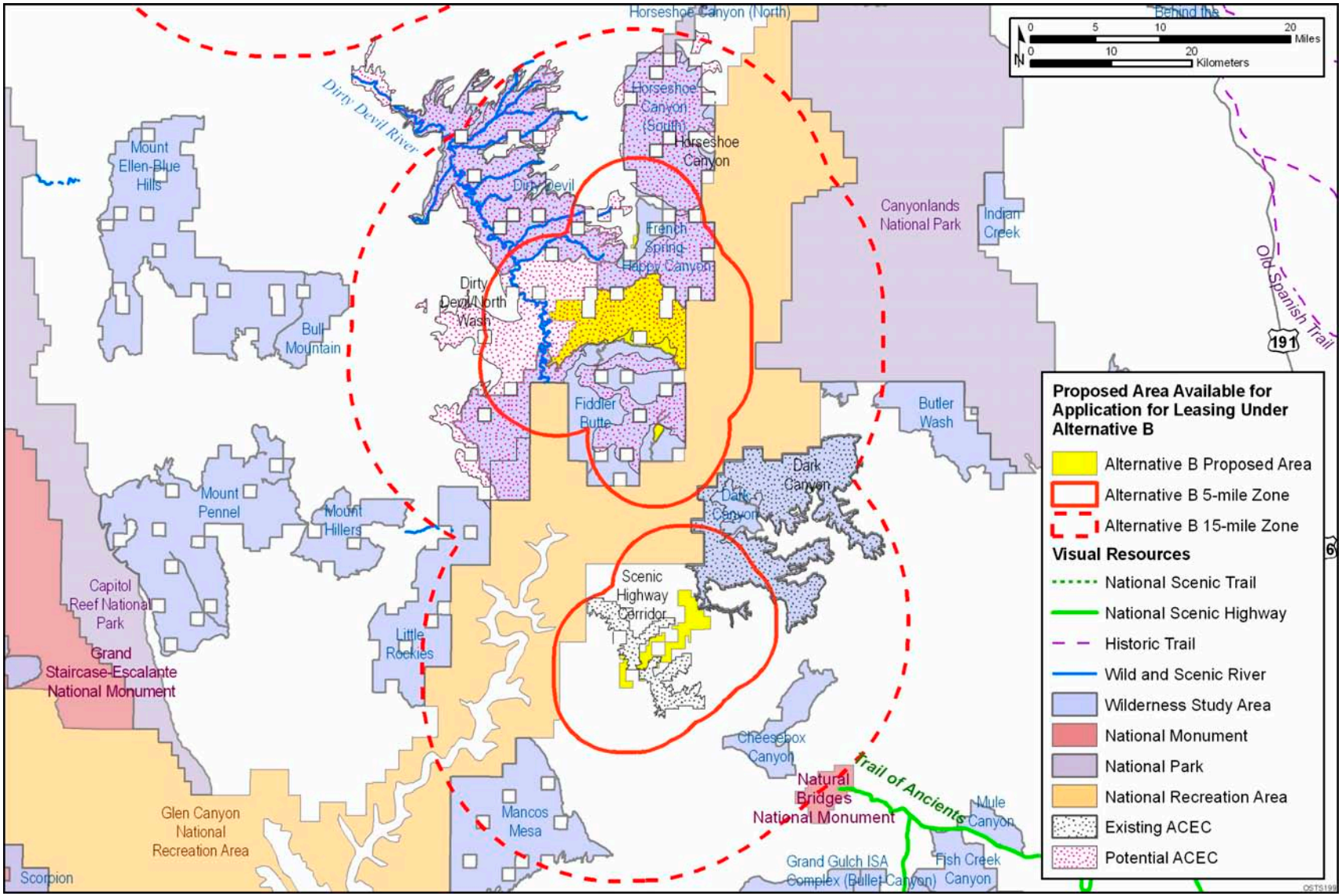


**FIGURE 6.2.2-9 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the Tar Sand Triangle and White Canyon STSAs**

**TABLE 6.2.2-7 Visually Sensitive Areas That Could Be Affected by Commercial Tar Sands Projects Developed in Lease Areas under Alternative B**

| Scenic Resources within 5 mi of Alternative B Lease Areas | Scenic Resources between 5 and 15 mi of Alternative B Lease Areas |
|---|---|
| Bull Canyon, Crack Canyon, Dark Canyon, Desolation Canyon, Devils Canyon, Dirty Devil, Fiddler Butte, Flume Canyon, French Spring–Happy Canyon, Horseshoe Canyon (South), Jack Canyon, Link Flats, Mexican Mountain, Muddy Creek, San Rafael Reef, Sid's Cabin, Sid's Mountain, Spruce Canyon, and Winter Ridge WSAs. | Book Cliffs Mountain Browse, Bull Canyon, Butler Wash, Cheesebox Canyon, Crack Canyon, Dark Canyon, Daniels Canyon, Demaree Canyon, Desolation Canyon, Dirty Devil, Fiddler Butte, Floyd Canyon, Flume Canyon, French Spring–Happy Canyon, Horseshoe Canyon, Jack Canyon, Little Rockies, Mancos Mesa, Mexican Mountain, Mount Hillers, Muddy Creek, Oil Spring Mountain, San Rafael Reef, Sid's Mountain, Skull Creek, Spruce Canyon, Turtle Canyon, and Willow Creek WSAs. |
| Copper Globe, Dark Canyon, I-70 Scenic Highway, Lears Canyon, Nine Mile Canyon, Pariette, San Rafael Canyon, San Rafael Reef, Scenic Highway Corridor, Sid's Mountain, and Temple Mountain ACECs. | Dark Canyon, I-70 Scenic Highway, Lower Green River, Nine Mile Canyon, Pariette, San Rafael Canyon, San Rafael Reef, Seger's Hole, and Sid's Mountain ACECs. |
| Bitter Creek, Bitter Creek–P.R. Spring, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Dirty Devil–North Wash, Four Mile Wash, Horseshoe Canyon, Lower Green River, Lucky Strike, Main Canyon, Nine Mile Canyon, Nine Mile Canyon Expansion, Range Creek, Shepards End, and Wild Horse potential ACECs. | Bitter Creek, Bitter Creek–P.R. Spring, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Desolation Canyon, Dirty Devil–North Wash, Four Mile Wash, Horseshoe Canyon, Lower Green River, Nine Mile Canyon, Nine Mile Canyon Expansion, Range Creek, and White River potential ACECs. |
| Segments of Argyle Creek, Bear Canyon, Bitter Creek, Buckskin Canyon, Cane Wash, Dirty Devil River, Evacuation Creek, Middle Green River, Muddy Creek, Ninemile Creek, North Fork Coal Wash, Price River, Range Creek, Rock Creek, Sams Mesa Box Canyon, San Rafael River, South Fork Coal Wash, and Twin Corral Box Canyon determined to be eligible for WSR designation. | Segments of Argyle Creek, Beaver Wash, Bitter Creek, Coal Wash, Cottonwood Wash, Dirty Devil River, Evacuation Creek, Fish Creek, Gordon Creek, Green River, Larry Canyon, Lower Green River, Maidenwater Creek, Middle Green River, Muddy Creek, Nine Mile Creek, No Mans Canyon, North Fork Coal Wash, North Salt Wash, Price River, Range Creek, Robbers Roost Canyon, Robbers Roost Canyon White Roost, Robbers Roost Middle Fork, Robbers Roost North Fork, Robbers Roost South Fork, Rock Creek, San Rafael River, South Fork Coal Wash, Twin Corral Box Canyon, and White River determined to be eligible for WSR designation. |
| Dinosaur Diamond Prehistoric and Flaming Gorge Uintas National Scenic Highways. | Dinosaur Diamond Prehistoric, Energy Loop, and Flaming Gorge Uintas National Scenic Highways. |
| Canyonlands National Park and Glen Canyon National Recreation Area. | Canyonlands National Park, Glen Canyon National Recreation Area, Dinosaur National Monument, and Natural Bridges National Monument. |
| | Old Spanish Trail National Historic Trail. |

portions of the study area. On the basis of a sensitivity analysis conducted for the Class I Cultural Resources Overview (O'Rourke et al 2007), nearly 220,650 acres of the STSA Alternative B footprints have been identified as having a medium or high sensitivity for containing cultural resources.[2]

Cultural resources within these areas could be adversely impacted if leasing and future commercial development occur. Leasing itself has the potential to impact cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development on cultural properties. Impacts from future development could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development area, increased potential of loss of resources from looting or vandalism of resources as a result of increased human presence/activity in the sensitive areas, and visual degradation of cultural setting (see Section 5.10). Special lease stipulations may be developed for specific lease parcels based on this information and consultation with interested Tribes. The cultural resources in the Circle Cliffs STSA would not be impacted by tar sands leasing and development as no leasing and development would occur in this STSA. The cultural resources in Argyle Canyon, Hill Creek, Pariette, Raven Ridge, San Rafael, Tar Sand Triangle, and White Canyon STSAs are less likely to be impacted by tar sands leasing and development than those resources present in the Asphalt Ridge, P.R. Spring, and Sunnyside STSAs.

#### 6.2.2.10 Socioeconomics

The socioeconomic impacts described in Section 5.11 and summarized in this section are for hypothetical individual commercial tar sands projects. These represent the types of impacts that could occur as a result of development made possible by the proposed land use plan amendments under Alternative B. The specific socioeconomic impacts would depend on the technologies employed, the project size or production level, and development time lines and mitigation measures. The designation of lands as available for leasing and the amendment of land use plans would not have socioeconomic impacts.

- Under Alternative B, a single tar sands facility would produce 1,831 jobs in the ROI (1,187 direct jobs at tar sands facilities and 644 indirect jobs in the remainder of the local economy) during the peak construction year. During commercial production, 747 employees (482 direct and 265 indirect) would be required in the ROI.

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2 Argyle Canyon, Circle Cliffs, and San Rafael STSAs and portions of Pariette and Tar Sand Triangle STSAs had not been surveyed sufficiently to derive sensitivity information; therefore, these acreages have not been included in this percentage calculation. Out of 431,224 acres available under Alternative B, sensitivity information is available for 341,536 acres; therefore, 220,650 acres represent 65% of the STSAs for which sensitivity information is available.

- Construction of housing for tar sands workers and families would create 552 jobs (432 direct and 119 indirect in the remainder of the local economy) in the ROI.

- Population in-migration associated with tar sands construction would represent an increase of 1.0% over the projected ROI population baseline.

- In-migrating population associated with tar sands facilities would absorb 3.2% of the projected vacant housing stock in the ROI.

- Provision of additional local public services for in-migrant workers would require an increase in 1.0% in local expenditures during the peak construction year and 0.7% during operations.

- The number of new residents from outside the producing regions and the pace of population growth associated with the commercial development of tar sands resources, including large-scale production facilities and housing developments, could lead to substantial demographic and social change in small rural communities. These communities could be required to adapt to a different quality of life, with a transition away from a more traditional lifestyle in small, isolated, close-knit, homogenous communities with a strong orientation toward personal and family relationships, toward a more urban lifestyle, with increasing cultural and ethnic diversity, and increasing dependence on formal social relationships within the community.

- Substantial changes in access to water by agriculture could have large impacts on the economy of each ROI, which would depend on the amount of agricultural production lost, the extent of local employment in agriculture, the reliance of other industries in each ROI on agricultural production, the extent of local procurement of equipment and supplies by agriculture, and the local spending of wage and salaries by farmers, ranchers, and farm workers. Loss of property tax revenues on agricultural land could also impact local government expenditures and consequently impact the provision of public services in local communities in each ROI. Changes in agricultural activity would likely change the character of community life in each ROI, with a movement away from activities that historically represent small rural communities.

- The impact of tar sands development on recreational visitation, assuming a 10% reduction in recreation employment in the ROI, would be the loss of 388 jobs in the ROI, and 776 jobs lost assuming a 20% reduction.

- Tar sands developments and their associated ancillary facilities could affect property values in ROI communities located nearby. Property values could decline in some locations as a result of the deterioration in aesthetic quality, increases in noise, real or perceived health effects, congestion, or social

disruption. In other locations, property values could increase as a result of access to employment opportunities associated with tar sands development.

#### 6.2.2.11 Environmental Justice

The designation of lands as available for leasing and the amendment of land use plans would not have environmental justice impacts. The environmental justice impacts described in Chapter 5 and summarized in this section for individual commercial tar sands projects represent the types of impacts that would occur as a result of development made possible by the proposed land use plan amendments under Alternative B. As with the environmental impacts discussed elsewhere in Section 6.2.2, the specific environmental justice impacts of future commercial tar sands projects would be dependant upon specific project locations, the technologies employed, the project size or production level, and development time lines and mitigation measures.

Since tar sands development projects and associated facilities would lead to rapid population growth in many of the communities in each ROI, it is possible that social disruption would occur, leading to the undermining of local community social structures with contrasting beliefs and value systems among the local population and in-migrants, and consequently, to a range of changes in social and community life, including increases in crime, alcoholism, drug use, etc. Impacts on property values of property owned by minority and low-income individuals would depend on the range of alternate uses of specific land parcels, current property values, and the perceived value of costs (traffic congestion, noise and dust pollution, and visual, air quality, and EMF effects) and benefits (infrastructure upgrades, employment opportunities, and local tax revenues) associated with proximity to oil shale-related facilities.

Tar sands development would produce surface disturbance, fugitive dust, vehicle emissions, and activity that could generate visual impacts. Emissions associated with construction activities would consist primarily of particulate matter ($PM_{2.5}$ and $PM_{10}$), criteria pollutants, VOCs, $CO_2$, and certain hazardous air pollutants released from heavy construction equipment and vehicle exhaust. Because of the limited surface water and groundwater, the amount of water needed in Utah for the project sites and associated population growth would mean that additional water resources would be needed. Tar sands facilities might impact certain animals or vegetation types that may be of cultural or religious significance to certain population groups, or that form the basis for subsistence agriculture. Similarly, land used for these facilities that has additional economic uses might affect access to resources by low-income and minority population groups.

Given the location of environmental justice populations in Utah, construction and operation of tar sands facilities and employer-provided housing required for the operation of tar sands development projects could produce impacts that would be experienced disproportionately by minority and low-income populations. Of particular importance would be social disruption impacts of large increases in population in small rural communities, the undermining of local community social structures, and the resulting deterioration in quality of life. The impacts of facility operations on air and water quality and on the demand for water in the region could also be important. Land use and visual impacts could be significant depending on the locations of

land parcels for tar sands projects and the associated housing facilities, their importance for subsistence, their cultural and religious significance, and alternate economic uses. Depending on the locations of low-income and minority populations, impacts would also occur with the development of transmission lines associated with power development and the supply of power to tar sands facilities in each state.

#### 6.2.2.12 Hazardous Materials and Waste Management

The amendment of land use plans to identify about 430,000 acres of land as available for application for leasing for commercial tar sands development would not result in any hazardous material or waste management concerns. Impacts related to hazardous materials and wastes could occur during the construction and operation of commercial tar sands projects within the Alternative B lease areas. Such impacts would generally be independent of location and would be unique to the technology combinations used for tar sands development. Hazardous materials and wastes would also be associated with ancillary support activities that would be required for development of any tar sands facility regardless of the technology used. These include the impacts from development of energy transmission or pipeline ROWs and employer-provided housing.

Hazardous materials impacts associated with project construction would be minimal and limited to the hazardous materials typically utilized in construction, such as fuels, lubricating oils, hydraulic fluids, glycol-based coolants, and solvents, adhesives, and corrosion control coatings. Construction-related wastes would include landscape wastes from clearing and grading of the construction sites, and other wastes typically associated with construction, none of which are expected to be hazardous (Section 5.13.1).

During project operations, hazardous materials would be utilized and a variety of wastes (some hazardous) would be generated. Hazardous materials used include fuels, solvents, corrosion control coatings, flammable fuel gases, and herbicides (for vegetation clearing and management at facilities or along ROWs). The types and amounts of hazardous waste generated during operations would depend on the specific design of the commercial tar sands project (surface mining, various surface retorting technologies, and in situ processes). Waste materials produced during operations could include waste engine fuels and lubricants, flammable gases, volatile and flammable organic liquids, and heavier molecular weight organic compounds (Section 5.13.1).

Because the use of hazardous materials and the generation of wastes are directly related to the specific design of a commercial tar sands project, it is not possible to quantify project-related impacts of these materials. Under Alternative B, individual facilities could be located anywhere within the areas identified as available for leasing, pending project review and authorization. Accidental releases of the hazardous materials or wastes could affect natural resources (such as water quality or wildlife) and human health and safety (see Sections 5.14 and 6.2.2.13) at locations wherever the individual projects are sited within the Alternative B lease areas.

#### 6.2.2.13 Health and Safety

The amendment of land use plans to identify about 430,000 acres of land as available for application for leasing for commercial tar sands development would not result in any direct health and safety concerns. However, a number of health and safety concerns would be associated with the commercial development of tar sands projects within the Alternative B lease areas. The level of health and safety impacts would be mainly dependent on the extent of tar sands development, the extent of health and safety precautions imposed by the operators, and the design of each project (as related to the level of air and water emissions associated with a facility).

Potential health and safety impacts from the construction and operation of commercial tar sands projects would be associated with the following activities: (1) constructing project facilities and associated infrastructure; (2) surface mining (if processing is not in situ) the tar sands; (3) obtaining and upgrading the syncrude, either through surface retorting or in situ processing; (4) transporting construction and raw materials to the upgrading facility and transporting product from the facility; and (5) exposure of the general public to water and air contamination associated with tar sands development. Hazards from tar sands development (summarized in Table 5.14-1) could include physical injury from construction, tar sands processing, and vehicle transportation accidents, and exposure to fugitive dust and hazardous materials such as retort emissions and industrial chemicals (Section 5.14). Health and safety impacts would be largely restricted to the immediate workforce of each facility. Accidents may also affect members of the general public that could be present in the immediate vicinity of an accident (e.g., project-related truck accident on a public road or recreational users in areas adjacent to the project lease area).

Workers would be exposed to different hazards depending on the type of jobs they do. Workers at all types of tar sands development facilities could be exposed to high noise levels, resulting in hearing loss. The health and safety of miners could be impacted by injuries or deaths due to accidents (e.g., highwall bank failures or cave-ins, uncontrolled explosions, accidents involving heavy machinery), or heat exposures. Workers operating surface retorts also could be injured or die due to accidental explosions, heat stress, or accidents involving heavy machinery. Physical hazards from well drilling, use of explosives, and operation of heavy equipment would be present for in situ workers.

Serious and often fatal lung disease in miners has been associated with inhalation of particulates and volatile compounds containing carcinogenic PAHs; such exposures could be limited by adherence to applicable occupational health and safety standards. Lung disease caused by inhalation of emissions from the retorting process is also of concern for retort operators, although these exposures are generally lower than those associated with mining. For workers at facilities using in situ recovery techniques, hazards associated with inhalation of emissions would also be expected to be lower than those associated with mining.

Estimates of expected injuries and fatalities can be made on the basis of the number of employees and the type of work. Based on the numbers of employees projected to be needed for construction and operation of tar sands facilities, there would statistically be less than 1 death

and about 100 injuries per year expected per facility during construction activities, and less than 1 death and about 30 injuries per year expected per facility during operations (NSC 2006). A comprehensive facility health and safety plan and worker safety training would be required as part of the Plan of Development for every proposed commercial tar sands project.

Health and safety concerns are largely independent of the locations of tar sands development facilities. However, the health and safety impacts on the general public from emissions from these facilities would depend both on the specific characteristics and level of emissions and on the distance of the emissions source from population centers. The level of air and water emissions would be regulated under required permits. Potential impacts on the general public from emissions would be assessed in future site-specific NEPA and permitting documentation.

### 6.2.3 Impacts of Alternative C

Under Alternative C, the BLM would amend the same six BLM land use plans that would be amended under Alternative B (Section 6.2.2), and would make approximately 230,000 acres (approximately 35% of the federal lands in the STSAs) available for application for leasing for commercial development of tar sands within nine designated STSAs: Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, Sunnyside, Tar Sand Triangle, and White Canyon STSAs (see Figure 2.4.3-2 and Table 2.4.3-2). As with Alternative B, leasing would not be allowed in the Circle Cliffs STSA, but in addition, Argyle Canyon STSA would be totally unavailable under Alternative C, and the acreage available in both Pariette and White Canyon STSAs would be so small as to make them practically unavailable for development. The public lands that would be available under Alternative C comprise approximately 209,000 acres of BLM-administered lands and 21,000 acres of split estate lands.

In addition to those public lands that are excluded under Alternative B, the BLM also would exclude lands that are identified as requiring special management or resource protection in existing land use plans under Alternative C. By making these additional exclusions, the BLM is placing a priority on protecting known sensitive resources within each field office. By excluding these lands from future commercial leasing and development, direct impacts on resources on these lands would be avoided. The resources present in these excluded areas still may incur indirect impacts as a result of commercial tar sands development on adjacent lands or within the region.

Under Alternative C, the BLM would conduct additional NEPA analyses prior to the issuance of any commercial leases. Also, additional NEPA analyses would be conducted during the review and approval of project plans of operation. At the time of these NEPA analyses, the BLM would be able to determine the potential impacts of development at a specific site and/or resulting from a specific project. The BLM also would be able to (1) determine which mitigation measures would be applicable and (2) establish appropriate lease stipulations and/or constraints for incorporation into the project plan of operations.

At the time of preparation of this PEIS, industry has given no firm indication when commercial tar sands production may begin. Likewise, the location where commercial production may first occur also is not known; however, for purposes of analysis, it is reasonable to assume that development may begin at the Asphalt Ridge, P.R. Spring, or Sunnyside STSAs. This is based on USGS information (USGS 1980a–k) which indicates that the quality of tar sands resources is higher in these three areas and in the Tar Sand Triangle than in the other STSAs, and on the existence of current activity on private land at Asphalt Ridge. Even though the tar sand resources at Tar Sand Triangle are of high quality, it is not expected to be an early candidate for commercial development because of anticipated constraints imposed by the CAA, and its close proximity to Canyonlands National Park.

The amendment of land use plans would have no direct impacts on the environment or socioeconomic setting in the study area. However, the development of commercial tar sands projects made possible by these land use plan amendments would have impacts on these resources. The following sections describe the impacts of Alternative C on the environment and the socioeconomic setting (including the effects of land use plan amendments on the level and pace of commercial tar sands development).

#### 6.2.3.1 Land Use

Alternative C would amend the same land use plans as Alternative B but would identify approximately 230,000 acres of public land in Utah for application for leasing for commercial development of tar sands (approximately 38% of the study area). The public lands that would be available under Alternative C are composed of approximately 208,000 acres of BLM-administered lands and 22,000 acres of split estate lands. Table 6.2.2-1 lists the acreages and percentages per STSA.

Although Alternative C makes approximately 200,000 fewer acres available for application for commercial leasing, it does not provide for less potential development of commercial tar sands than does Alternative B, and for that reason, many of the potential impacts on land use are the same as those under Alternative B.

The nature of the impacts of Alternative C on land uses would be essentially the same as those listed for Alternative B in Section 6.2.2.1, with the following exceptions:

- Lands available for application for lease contain all or portions of areas that have been recognized by the BLM in Utah as having one or more characteristics of wilderness. Table 6.2.2-2 (in Section 6.2.2.1) lists these areas. Should commercial development occur on these lands, the identified wilderness characteristics in both the areas that are developed and those that border the developed areas would be lost. Alternative C includes approximately 68,000 acres of these lands which would be subject to potential development.

- In Utah, there are areas that have been identified as being eligible for designation as ACECs. These areas are being reviewed as part of ongoing land use planning activities that may or may not be complete before this Draft PEIS is published. Table 6.2.2-3 (in Section 6.2.2.1) lists the areas and the number of acres of overlap that would be available for application for commercial tar sands leasing. If tar sands development occurs on these lands, depending on the nature of resources present on the lands, it is likely these resources would be lost. The decisions regarding designation of these lands will be made at the field office level and not in this PEIS. Should designation as an ACEC be completed before the PEIS is listed, these lands would not be available for lease. If this PEIS is issued before the land use planning process is completed, the field offices still would make the decisions regarding the future management of these lands and would determine whether they would be available for application for leasing for commercial tar sands development. Alternative C includes approximately 86,000 acres of these lands which would be subject to potential development.

#### 6.2.3.2 Soil and Geologic Resources

Under Alternative C, about 230,000 acres of public land in Utah would be identified as available for application for leasing for commercial tar sands development. The amendment of land use plans to incorporate these areas would not have any direct impacts on soil and geologic resources in these lands. Development of commercial tar sands projects could, however, affect soils and geologic resources in these lands. Construction-related activities could directly disturb surface and subsurface soils during clearing and grading activities and construction of project facilities and infrastructure. This disturbance could include soil disturbance, removal, and compaction, and disturbed areas would be more susceptible to the effects of precipitation and wind-driven erosion (see Section 5.3.1). Surface and subsurface mining activities during project operations would directly disturb geologic resources. Erosion of exposed soils could lead to increased sedimentation of nearby water bodies and to the generation of fugitive dust. Soils in project areas would remain susceptible to erosion until completion of construction, mining, and tar sands processing activities, and site stabilization and reclamation (e.g., revegetation of pipeline ROWs and surface mine reclamation). Impacts on soil and geologic resources would be limited to the specific project location as well as to areas where associated off-lease infrastructure (e.g., access roads and utility ROWs) would be located.

Under Alternative C, project-related impacts could occur wherever individual projects are located within the 230,000 acres identified for leasing application under this alternative. For any project, the erosion potential of the soils would be a direct function of the lease and project location, and the soil characteristics, vegetative cover, and topography (i.e., slope) at that location. Development in areas that have erosive soils and steep slopes (e.g., in excess of 25%) could lead to serious erosion problems at those locations.

#### 6.2.3.3 Paleontological Resources

Under Alternative C, 229,038 acres in the STSAs would be identified as being available for application for leasing and potential future commercial development. The identification of these lands as available for leasing, as well as the amendment of land use plans to incorporate these areas, would not affect paleontological resources because it does not authorize or approve any ground-breaking actions. Existing ACECs, some of which have been identified for their paleontological values, would not be made available for application for leasing under this alternative and, therefore, the paleontological resources present in these areas would not be directly impacted under this alternative. However, the lands that are made available for application for leasing also overlap with some lands known to be potentially rich in paleontological resources. Of the acreage identified as available for application for leasing under Alternative C, a total of 147,937 acres (approximately 65%) have been identified as having the potential to contain important paleontological resources (Murphey and Daitch 2007). Resources within these areas could potentially be adversely impacted if future commercial development occurs. Impacts could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development area, and increased potential for loss of resource from looting or vandalism to resources as a result of increased human presence/activity in the sensitive areas (see Section 5.4).

#### 6.2.3.4 Water Resources

The acreage available for application for leasing under Alternative C specifically excludes lands identified in BLM land use plans as sensitive for numerous different resources (see Table 2.2.3-3). Excluding these lands from application for leasing would provide complete protection from direct impacts on water resources found on these lands. To the extent that development could occur adjacent to these excluded lands, there is the potential for indirect adverse impacts on water resources on the excluded lands, as described in Section 5.5. In those areas that are available for application for leasing under Alternative C, the potential impacts would be the same as those described for Alternative B in Section 6.2.2.4, with the exception that under Alternative C, approximately 19 mi (19%) of perennial streams could be impacted by future commercial development (in comparison with 28 mi under Alternative B).

The assessment of impacts on to water resources under Alternative C has the same limitations as referenced under Alternative B. Without site-specific information regarding the location and type of technology to be employed, it is not possible to assess the overall impacts of this alternative.

#### 6.2.3.5 Air Quality

Air resources would not be affected by the amendment of land use plans to identify approximately 230,000 acres of public lands as being available for application for leasing for commercial tar sands development. Air resources in and around these areas could, however, be affected by future commercial tar sands development. Under Alternative C, local, short-term, air

quality impacts may be incurred as a result of (1) PM releases (fugitive dust and diesel exhaust) during construction activities such as site clearing and grading in preparation of facility construction, and (2) exhaust emissions ($SO_2$, CO, and $NO_x$) from construction equipment (see Section 5.6). These types of impacts would be largely limited to specific project locations and immediately adjacent areas, as well as to other areas where project-related electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located and developed.

Similar but longer-term impacts on local air quality could occur during normal project operations such as mining and processing of the tar sands. Processing activities could also result in regional impacts on air quality that could extend beyond the lease areas identified under Alternative C. These regional impacts would be associated with operational releases of CO, $NO_x$, and other pollutants (VOCs and $SO_2$) during tar sands processing (Section 5.6). Operational releases of hazardous air pollutants (such as benzene, toluene, and formaldehyde) as well as diesel PM could also affect workers and nearby residences; these impacts, however, would be localized to the immediate project location.

#### 6.2.3.6 Noise

Ambient noise levels in the Alternative C potential lease areas would not be affected by the amendment of land use plans to identify areas available for leasing for tar sands development. However, ambient noise levels could be affected by subsequent commercial development of tar sands. Under Alternative C, local, short-term changes in ambient noise levels could occur during the construction, operation, and reclamation of tar sands projects (see Section 5.7.1). Project-related increases in noise levels could disturb or displace wildlife and recreational users in nearby areas. Impacts on wildlife and recreational users are discussed in Sections 5.8.1 and 5.2.1.3, respectively.

Increased noise levels could result from the operation of construction equipment (graders, excavators, and haul trucks) and from blasting activities. Increases in noise levels during operations would be associated with mining and tar sands processing activities and would be more long-term than construction-related noise. These types of impacts would be largely limited to specific project locations and the immediate surrounding area. Similar short-term and long-term impacts could also occur in other areas where electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located, developed, and operated. For example, ambient noise levels could also be increased in the immediate vicinity of any pipeline pump station and could also be affected by project-related vehicular traffic at the project site and related locations such as access roads to the site.

Construction-related noise levels could exceed EPA guidelines. Similarly, operational noise associated with mining and retort activities could, in the absence of mitigation, exceed EPA guidelines at some project locations. Noise generated as a result of project-related (but nonconstruction) vehicular traffic is not expected to exceed EPA guideline levels except for short durations and very close to road or high traffic areas.

In the absence of lease- and project-specific information, it is not possible at the level of this PEIS to identify the duration and magnitude of any project-related changes in noise levels. Changes to ambient noise levels from project development could occur wherever a project is located within the acres identified for lease application under Alternative C.

#### 6.2.3.7 Ecological Resources

Under Alternative C, approximately 230,000 acres of public land would be made available within Utah for application for leasing for commercial tar sands development. The ecological resources in these areas (Section 3.7) would not be affected by the amendment of land use plans to identify areas available for leasing for tar sands development. However, ecological resources in and around these areas could be affected by future commercial development of tar sands in these areas. The following sections describe the potential impacts on ecological resources that may result from commercial tar sands development within the Alternative C lease areas.

**6.2.3.7.1 Aquatic Resources.** The lands that would be made available under Alternative C for application for leasing contain 8 perennial streams totaling about 19.4 mi (Table 6.2.3-1). These streams, as well as numerous unnamed streams and other surface waters (such as ponds) provide habitat for a variety of aquatic resources. The development of commercial tar sands projects in lease areas identified under Alternative C could affect local aquatic resources (such as local fish populations) during project construction and operations. Impacts on aquatic resources could occur from the operation of tar sands projects because of (1) direct disturbance of aquatic habitats within the footprint of construction or operation activities; (2) sedimentation of nearby aquatic habitats as a consequence of soil erosion from operational areas; and (3) decreased habitat because of changes in water quantity or water quality as a result of construction (e.g., grading that affects surface runoff patterns), operations (e.g., depletions or discharges of water into nearby aquatic habitats), or releases of chemical contaminants into nearby aquatic systems (see Section 5.8.1.1). Impacts could result in short- and/or long-term changes (disturbance or loss) in the abundance and distribution of affected biota and their habitats. The nature and magnitude of these impacts, as well as the specific resources affected, would depend on the locations of the areas where project construction and facilities would occur, the aquatic resources present in those areas, and the mitigation measures implemented.

**TABLE 6.2.3-1 Perennial Streams in Utah within the Lease Areas Identified under Alternative C**

| Stream | Length of Stream (mi) |
|---|---|
| Bitter Creek | 0.6 |
| Center Fork | 1.4 |
| Sand Wash | 0.2 |
| Sweetwater Canyon | 0.7 |
| Wells Draw | 0.4 |
| Cottonwood Canyon | 5.1 |
| Dry Creek | 5.9 |
| Nine-Mile Creek | 5.2 |
| Total | 19.4 |

**6.2.3.7.2 Plant Communities and Habitats.** The development of commercial tar sands projects in lease areas identified under Alternative C could affect plant communities and habitats during future project construction and operations. Alternative C identifies about 230,000 acres of land in Utah as being available for lease application, and these areas support a wide variety of plant communities and habitats (see Section 3.7.2). Direct and indirect impacts could be incurred by plant communities and habitats on the proposed lease areas during project construction and operation and would extend over a period of several decades (especially within facility and infrastructure footprints) (see Section 5.8.1.2). Some impacts may continue beyond the termination of commercial operations. However, none of the areas identified as being available for leasing under Alternative C have been designated for protection in BLM land use plans because of the known presence of sensitive plants or relict vegetation populations.

Direct impacts on plant communities and habitat from future construction and operation activities would include the destruction of vegetation and habitat during land clearing on the lease site and also where ancillary facilities such as access roads, pipelines, transmission lines, and employer-provided housing would be located. Soils disturbed during construction would be susceptible to the introduction and establishment of non-native invasive species, which in turn could greatly reduce the success of establishment of native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. Plant communities and habitats could also be adversely affected by changes in water quality or availability, resulting in plant mortality or reduced growth, with subsequent changes in community composition and structure, and declines in habitat quality. Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. These impacts could lead to changes in the abundance and distribution of plant species and changes in community structure, as well the introduction or spread of invasive species.

Affected plant communities and habitats could incur short- and/or long-term changes in species composition, abundance, and distribution. While many impacts would be local in nature (occurring within construction and operation footprints and in the immediate surrounding area), the introduction of invasive species could affect much larger areas. The nature and magnitude of these impacts, as well as the communities or habitats affected, would depend on the locations of the areas where project construction and facilities would occur, the plant communities and habitats present in those areas, and the mitigation measures implemented to address impacts.

**6.2.3.7.3 Wildlife.** Under Alternative C, about 230,000 acres of land in Utah would be identified as available for lease application for commercial tar sands development, and these areas and surrounding locations support a diverse array of wildlife and habitats (see Section 3.7.3). While important areas (such as big game wintering areas, sage grouse habitat, and raptor nesting and concentration areas) are identified for protection in current BLM land use plans, none of these identified areas occur on the Alternative C lease areas.

The Alternative C lease areas do overlap areas identified by state natural resource agencies as important for sage grouse and big game species. These areas include sage grouse

habitat and lek sites (Figure 6.2.3-1), and mule deer and elk winter and summer ranges (Figures 6.2.3-2 and 6.2.3-3). Table 6.2.3-2 presents the amounts of these habitats (as identified by state resource agencies) that would occur in the Alternative C lease areas and that could be affected by future commercial tar sands development in these areas.

Several wild horse HMAs overlap with lands that would be available for application for leasing, including the Hill Creek HMA, which overlaps with the Hill Creek STSA (about 9,980 acres); the Muddy Creek and Sinbad HMAs, which overlap with the San Rafael STSA (about 845 and 37,260 acres, respectively); the Range Creek HMA, which overlaps with the Sunnyside STSA (about 13,645 acres); and the Canyon Lands HMA, which overlaps with the Tar Sand Triangle STSA (about 100 acres) (Figure 6.2.3-4).

Impacts on wildlife (including wild horses and burros) from the construction and operation of future commercial tar sands projects could occur in a number of ways and would be related to (1) habitat loss, alteration, or fragmentation (as a result of construction); (2) disturbance and displacement of biota (by construction and operation activities and the presence of project infrastructure); (3) mortality (from construction activities and collisions with project infrastructure and vehicles); (4) exposure to hazardous materials; and (5) increase in human access. These can result in changes in habitat use; changes in behavior; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminant exposures.

Wildlife could also be affected by human activities that would not be directly associated with commercial tar sands projects or workforces but that instead would be associated with the potentially increased access to BLM-administered lands that had previously received little use. The construction of new access roads or improvements to old access roads could lead to increased human access into the area. Potential impacts associated with increased access include (1) the disturbance of wildlife from human activities, including an increase in legal and illegal harvest and an increase of invasive vegetation, and (2) an increase in the incidence of fires.

**6.2.3.7.4 Threatened and Endangered Species.** There is a potential for commercial tar sands development projects to adversely affect many of the threatened, endangered, and sensitive species that occur in the counties where development could occur (Tables 5.8.1-3 and 5.8.1-4). This potential for adverse impacts results from a lack of specificity on the locations of lease areas, lack of project specifications, and the often incomplete information on species distributions.

Twenty federally listed threatened or endangered species could occur in areas that would be made available for leasing under Alternative C (see Table 5.8.1-4). No critical habitat for Colorado River endangered fishes in Utah (Figure 6.2.3-5) would be located within the lands that would be made available under Alternative C for application for leasing and where commercial tar sands development could occur in the future.

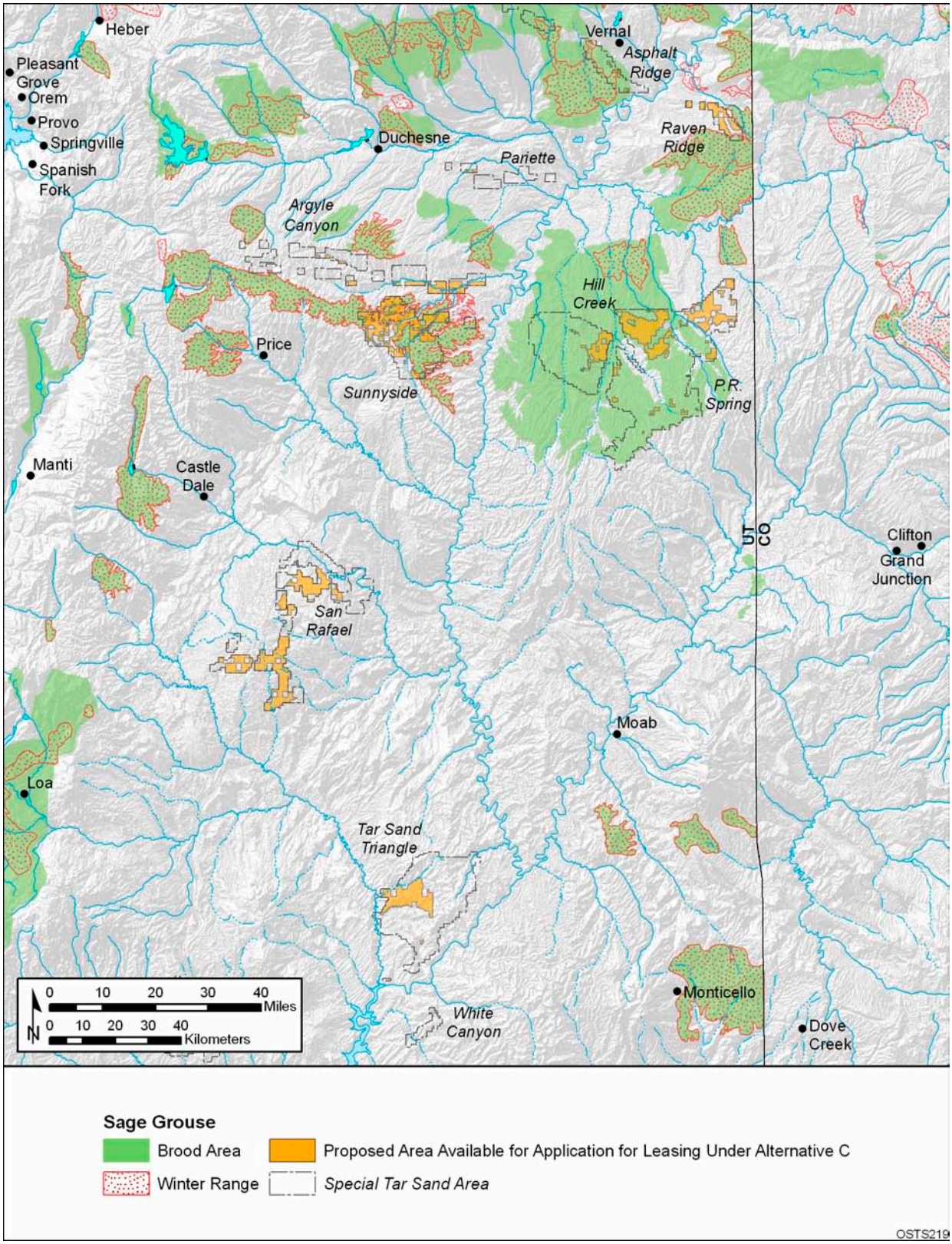


**FIGURE 6.2.3-1 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Known Distribution of the Greater Sage-Grouse**

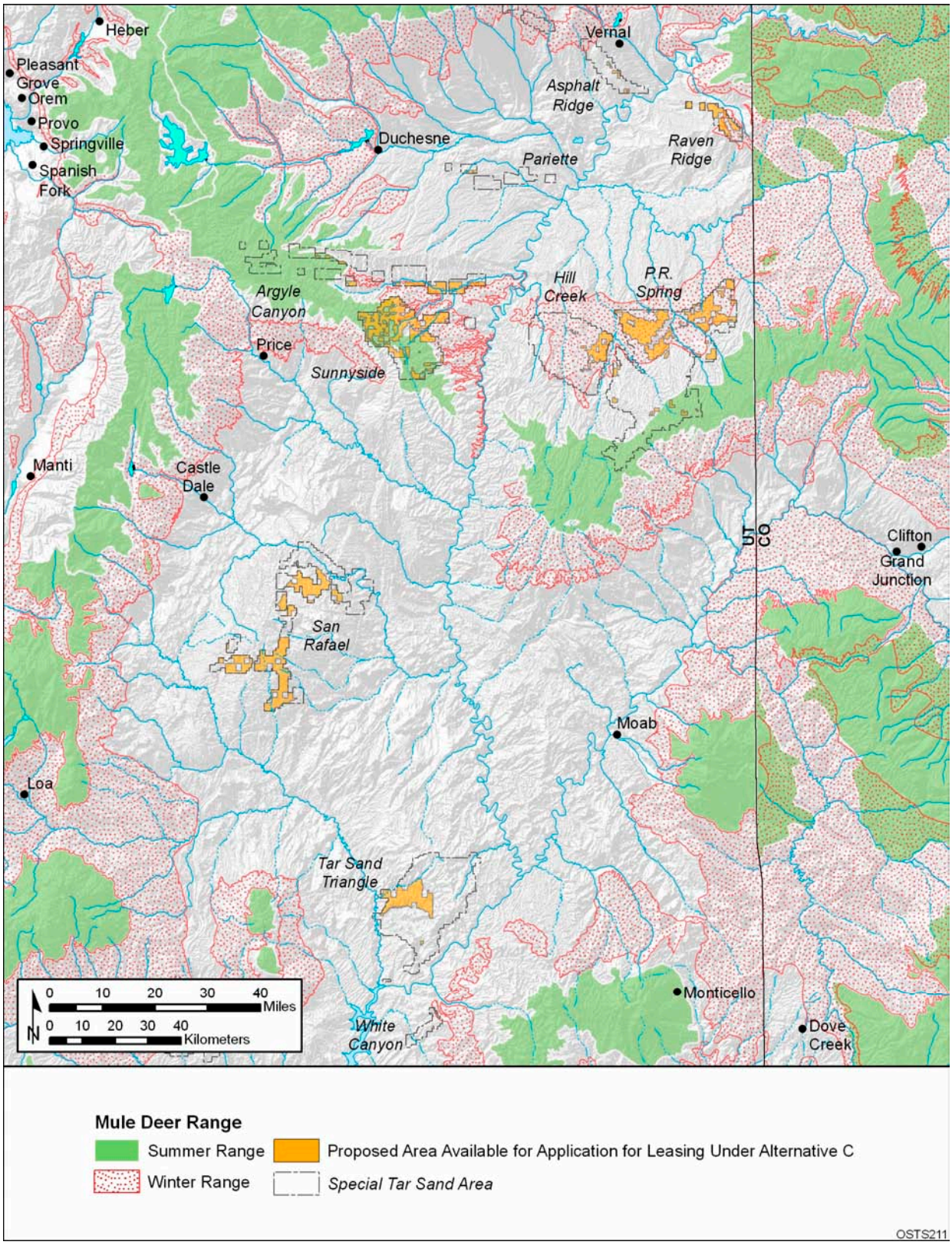


**FIGURE 6.2.3-2 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Mule Deer**

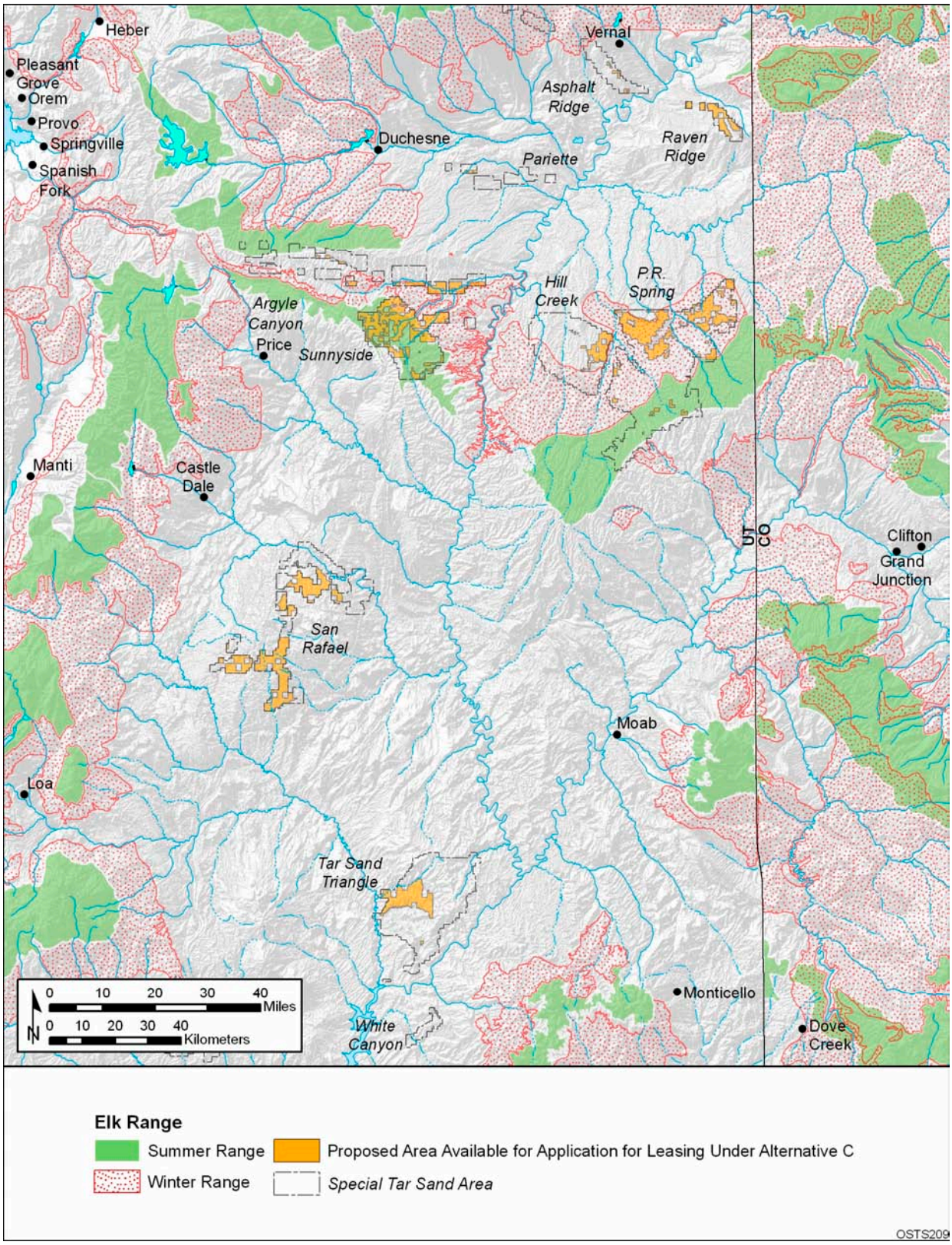


**FIGURE 6.2.3-3 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Elk**

The potential for impacts on threatened, endangered, and sensitive species (and their habitats) by future commercial tar sands development would be directly related to the amount of land disturbance that would occur with a project (including its ancillary facilities such as utility and pipeline ROWs), the duration and timing of construction and operation periods, and the habitats affected by development (i.e., the location of the project). Indirect impacts resulting from the erosion of disturbed land surfaces and disturbance and harassment of animal species would be proportional to the amount of land disturbance.

**TABLE 6.2.3-2 Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in the Alternative C Lease Areas**

| Wildlife Resource | Acres within the Alternative C Lease Areas |
|---|---|
| Sage grouse habitat | 101,300 |
| Mule deer winter habitat | 77,000 |
| Mule deer summer habitat | 30,900 |
| Elk winter habitat | 79,900 |
| Elk summer habitat | 37,600 |
| Big game calving, or fawning habitat[a] | 18,000 |
| Crucial pronghorn habitat | 5,900 |

[a] Applies to elk and mule deer.

Impacts on threatened and endangered species (see Section 5.8.1.4) are fundamentally similar to or the same as those described for aquatic resources; plant communities and habitats; and wildlife in Sections 5.8.1.1, 5.8.1.2, and 5.8.1.3, respectively. The most important difference is the potential consequences of the impacts. Because of low population sizes, threatened and endangered species are far more vulnerable to impacts than more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development.

#### 6.2.3.8 Visual Resources

The lands made available for application for leasing for commercial development of tar sands under Alternative C support a wide variety of visual resources (Section 3.9). These resources would not be affected by the amendment of land use plans to incorporate these lease areas. However, visual resources in and around the proposed lease areas could be affected by subsequent commercial development of tar sands.

Several scenic resource areas are located within the lease areas identified under Alternative C (Figures 6.2.3-6 through 6.2.3-9). These scenic resource areas include:

- The Bitter Creek, Bitter Creek–P.R. Spring, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Dirty Devil–North Wash, Lucky Strike, Main Canyon, Nine Mile Canyon, Range Creek, and Wild Horse Potential ACECs; and

- A segment of the Nine Mile Creek determined to be eligible for WSR designation.

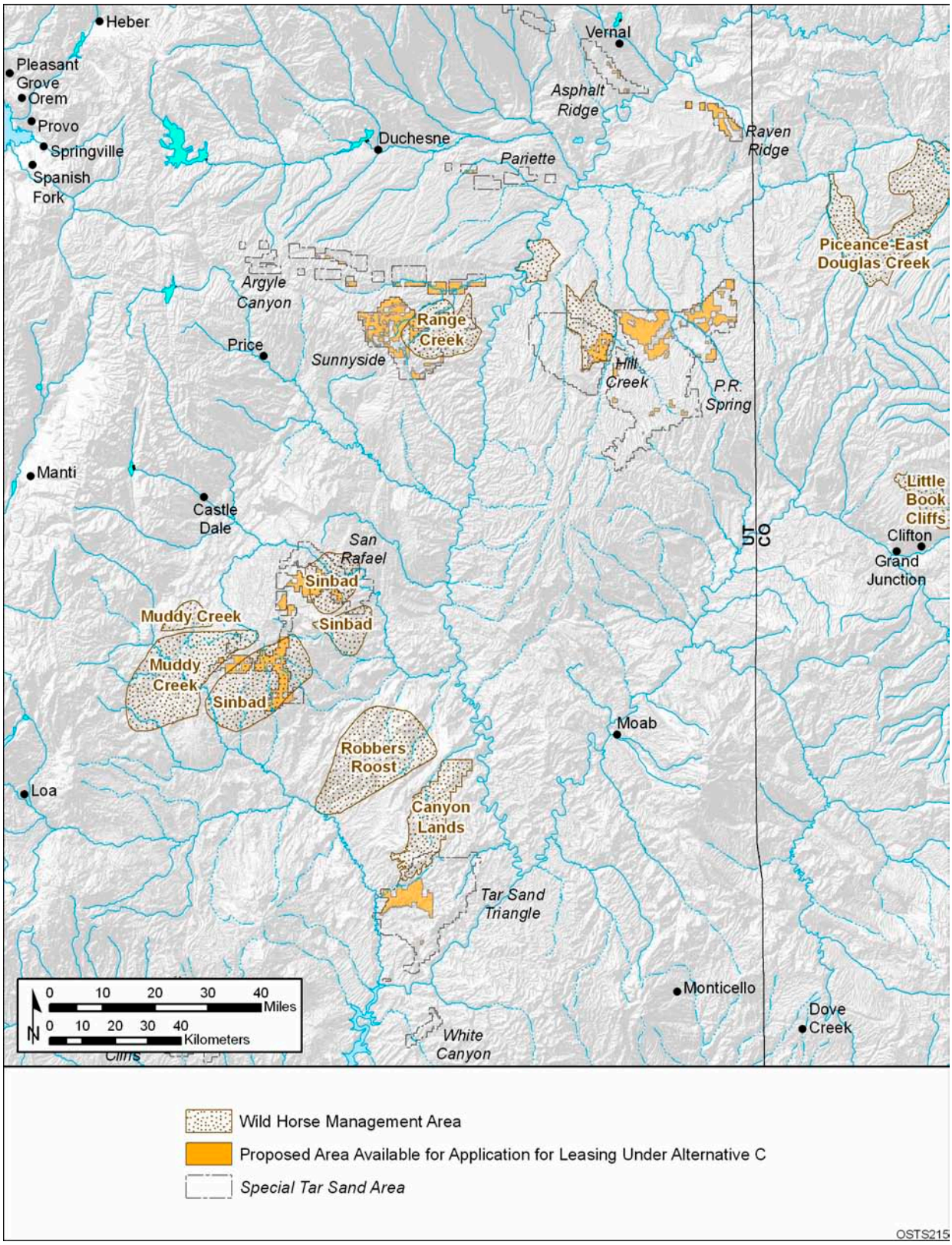


**FIGURE 6.2.3-4 Overlap of Lands Made Available for Application for Leasing under Alternative C with Wild Horse Herd Management Areas**

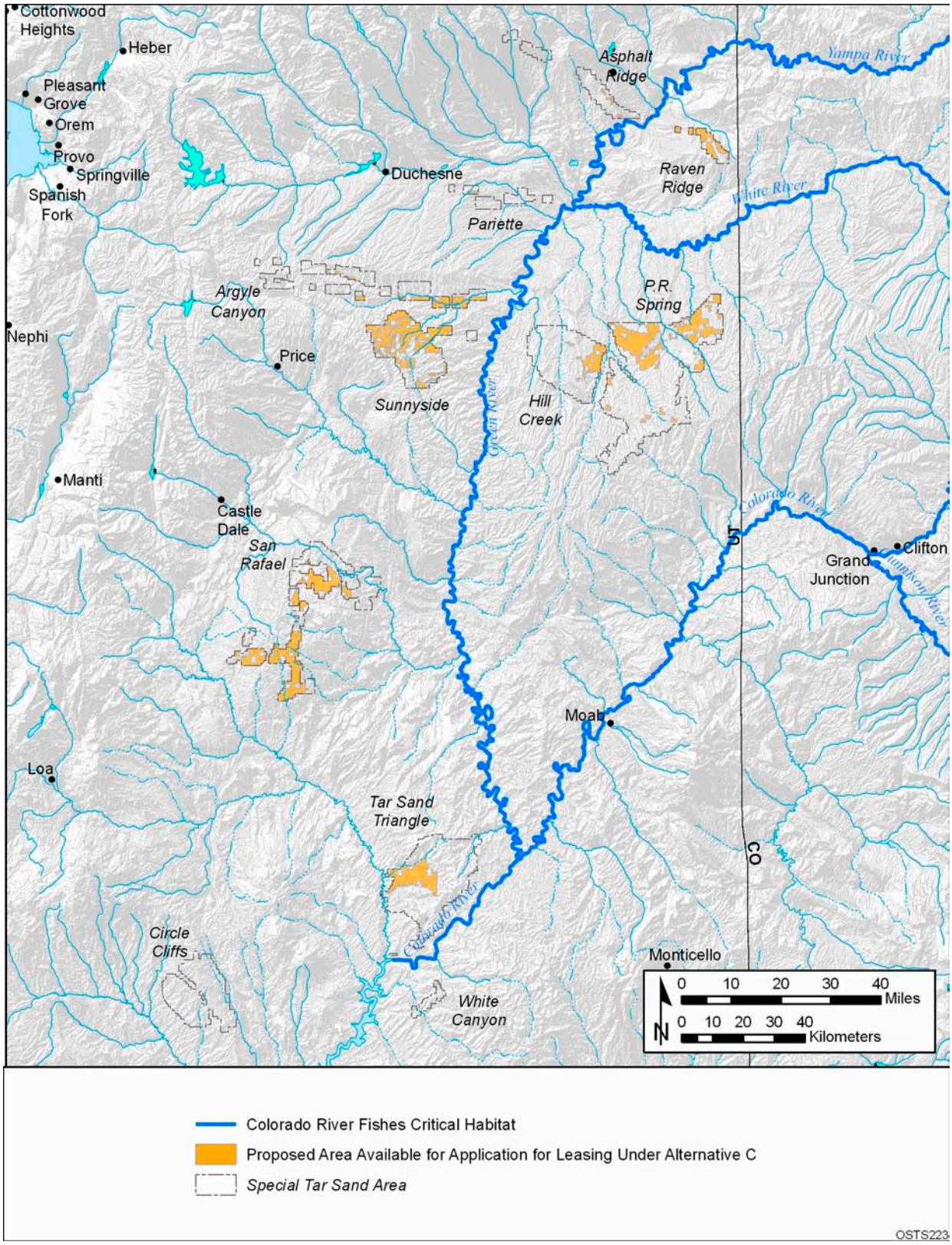


**FIGURE 6.2.3-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative C**

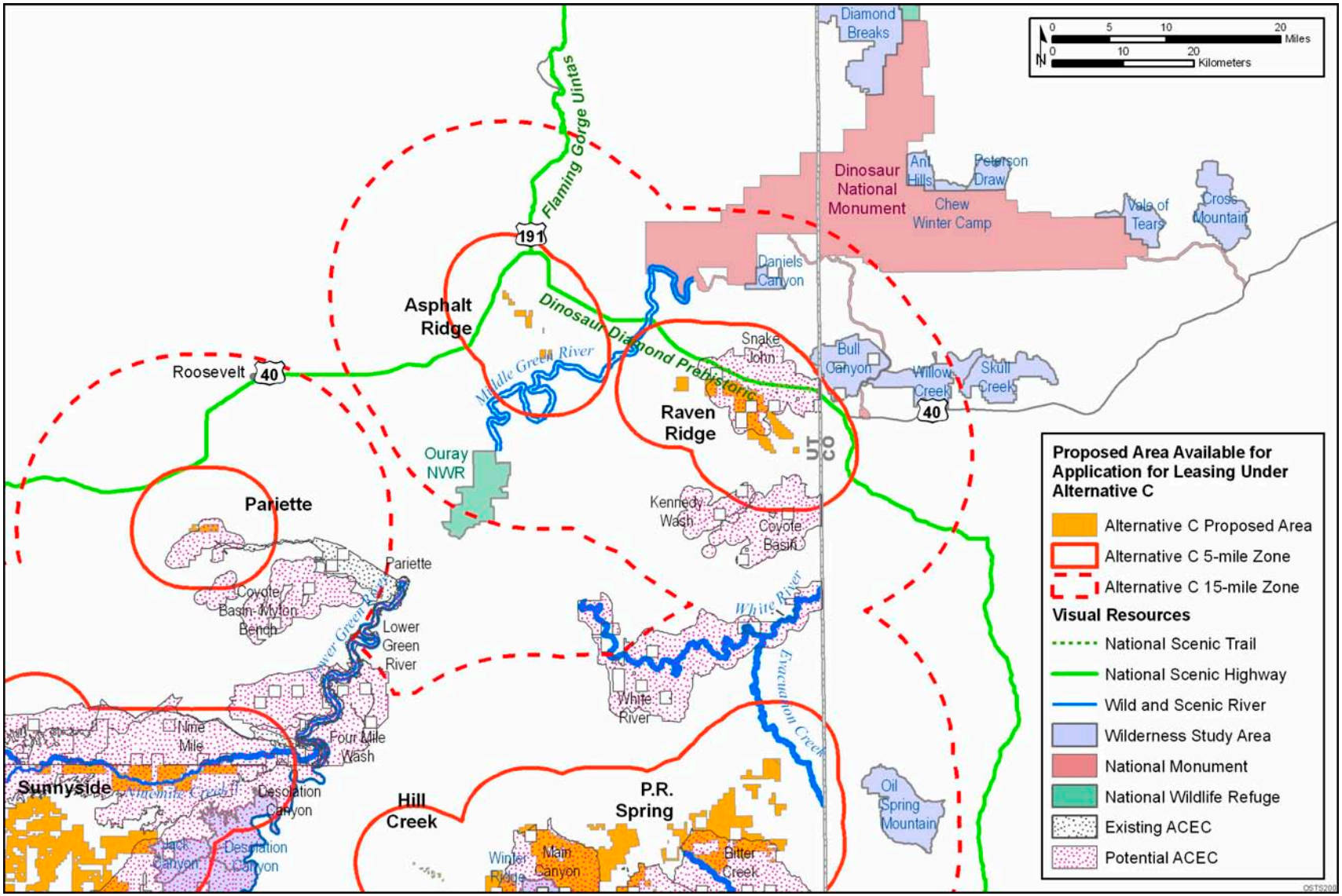


**FIGURE 6.2.3-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the Asphalt Ridge, Pariette, and Raven Ridge STSAs**

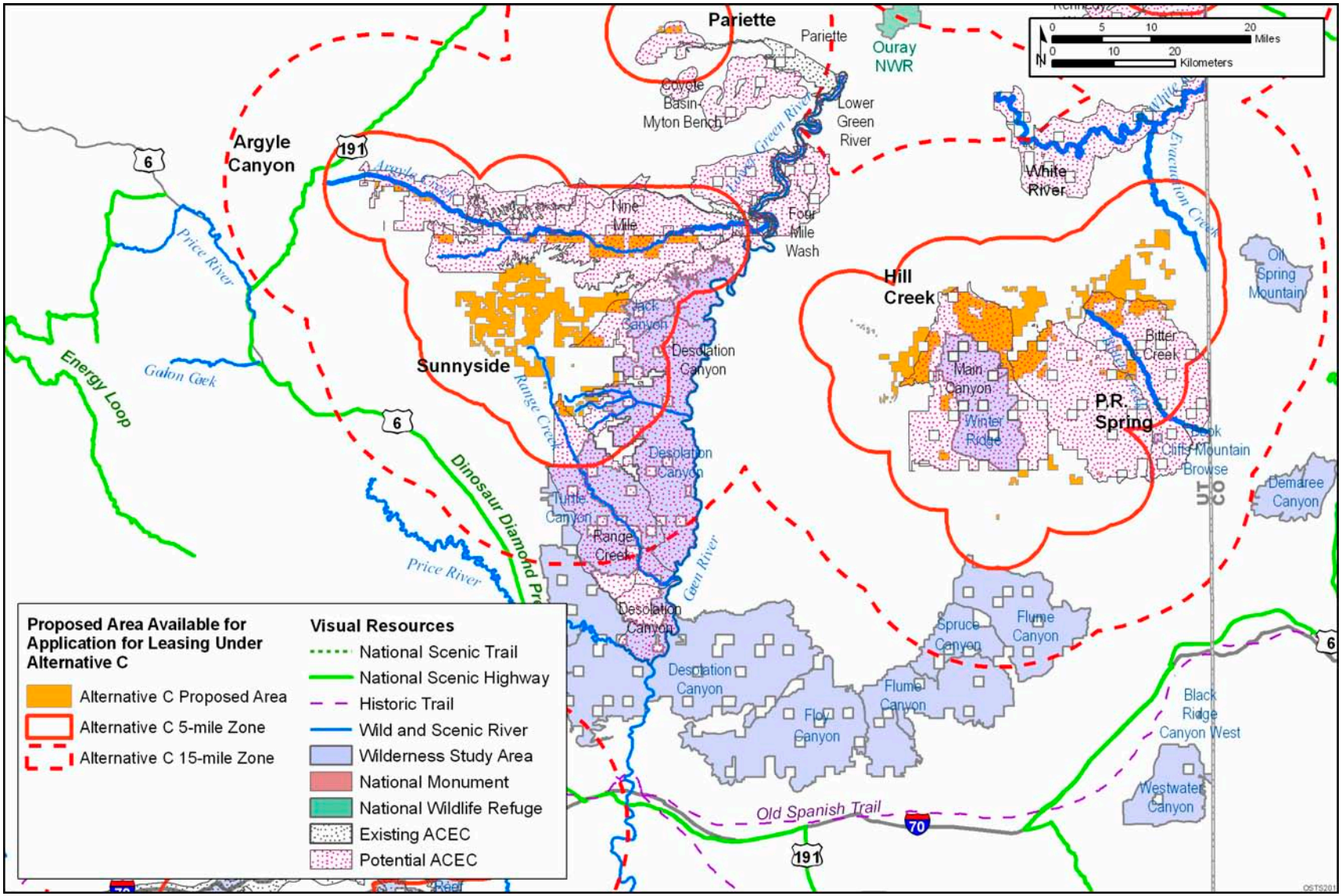


**FIGURE 6.2.3-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the Hill Creek, P.R. Spring, and Sunnyside STSAs**

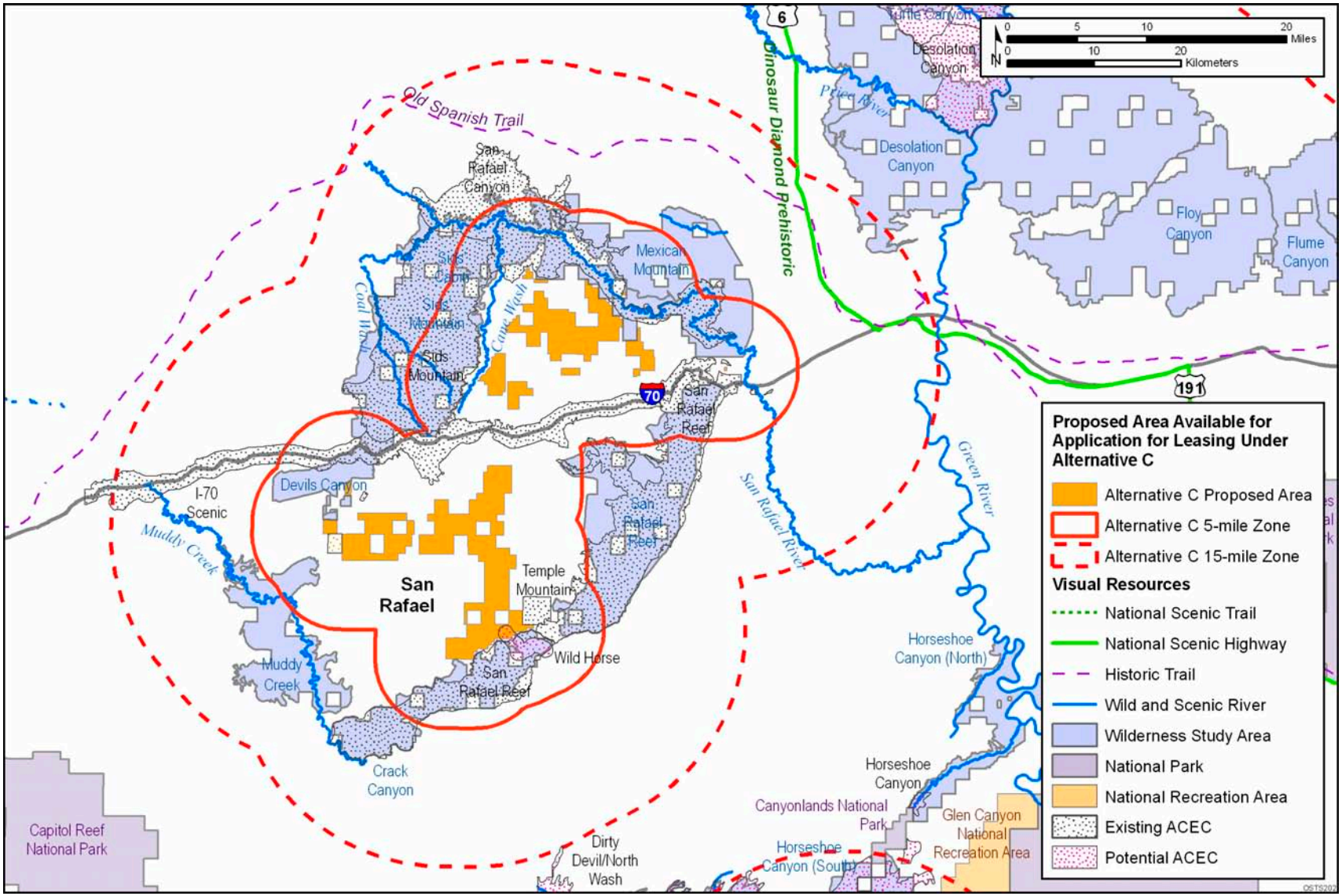


**FIGURE 6.2.3-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the San Rafael STSA**

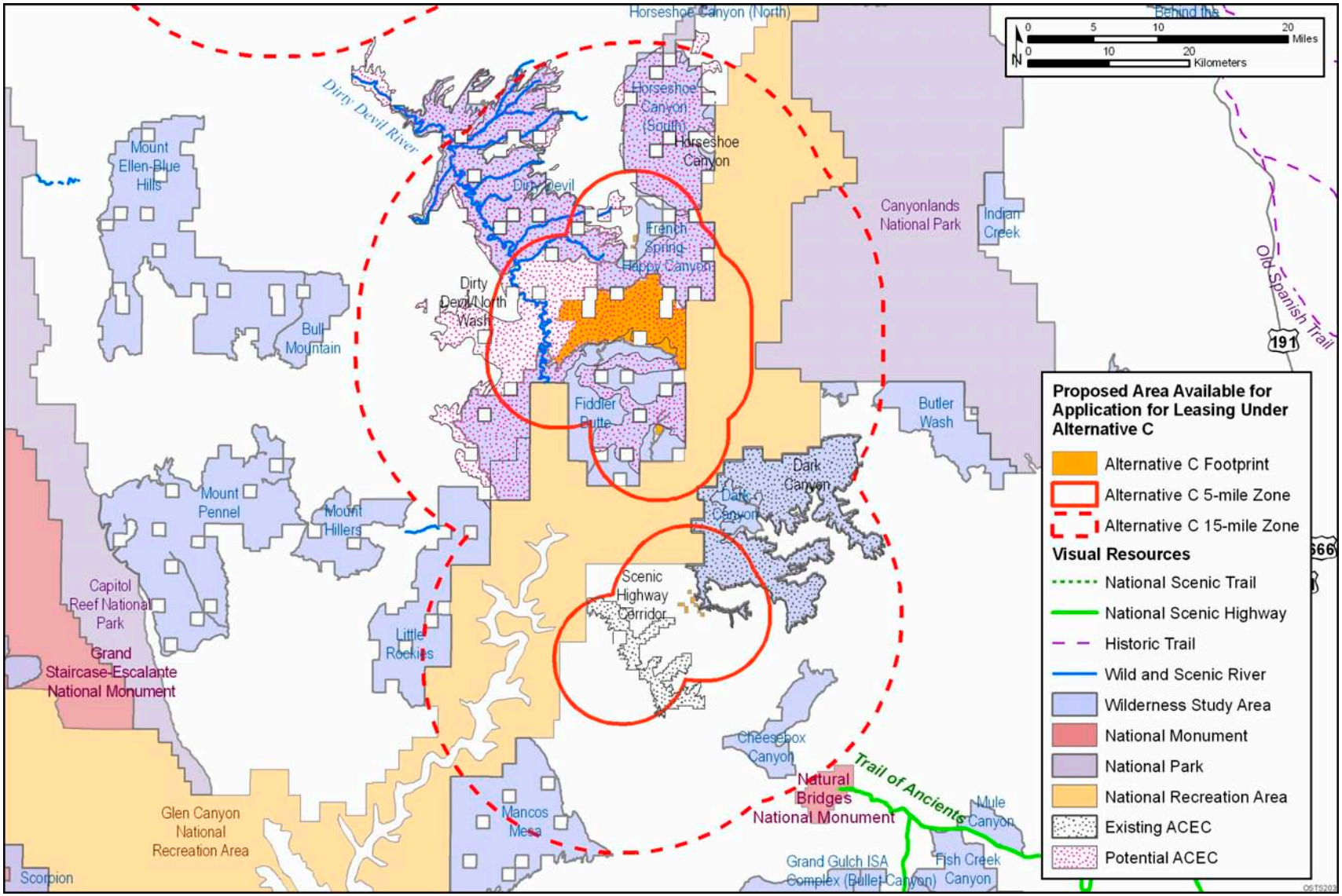


**FIGURE 6.2.3-9 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the Tar Sand Triangle and White Canyon STSAs**

Additional scenic resource areas are located within 5 or 15 mi of the Alternative C proposed lease areas (Figures 6.2.3-6 through 6.2.3-9). The 5-mi zone corresponds to the BLM's VRM foreground-middleground distance limit, and the 15-mi zone corresponds to the BLM's background distance limit. Assuming an unobstructed view of a commercial tar sands project, viewers in these areas would be likely to perceive some level of visual impact from the project, with more impacts expected for resources within the foreground-middleground distance, and fewer expected for resources within the background distance. Beyond the background distance, the project might be visible but would likely occupy a very small visual angle and create low levels of visual contrast such that impacts would be minor to negligible. Table 6.2.3-3 presents the scenic resource areas that fall within these zones.

Visual resources at these areas, as well as elsewhere within the lease areas, could be affected at and near the lease areas where commercial tar sands projects are developed and operated, and at areas where supporting infrastructure (such as and utility and pipeline ROWs) would be located. Visual resources could be affected by ROW clearing, project construction, and operation (see Section 5.9.1). Potential impacts would be associated with construction equipment and activity, cleared project areas, and the type and visibility of individual project components such as tar sands processing facilities, utility ROWs, and surface mines. The nature, magnitude, and extent of project-related impacts would depend on the type, location, and design of the individual project components.

#### 6.2.3.9 Cultural Resources

The amendment of land use plans to identify about 230,000 acres of public land as available for future tar sands development would not result in impacts on cultural resources. Existing ACECs, some of which have been identified for their cultural values, would not be made available for application for leasing under this alternative and, therefore, the cultural resources present in these areas would not be directly impacted under this alternative. The remaining lands made available for application for leasing overlap with some lands identified as having cultural resources present (O'Rourke et al. 2007). Approximately 5%[3] of public lands that would be made available for application for leasing in the STSAs under Alternative C have been surveyed for cultural resources (more than 12,537 acres in addition to 175 linear miles). In these areas that have been surveyed, 71 sites have been identified. Additional resources are likely in unsurveyed portions of the study area. On the basis of a sensitivity analysis conducted for the Class I Cultural Resources Overview (O'Rourke et al. 2007), nearly 97,500 acres of the STSA Alternative C footprints have been identified as having a medium or high sensitivity for containing cultural resources.[4]

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[3] This percentage was calculated using block acre surveys only and does not include approximately 175 linear miles of survey.

[4] Argyle Canyon, Circle Cliffs, and San Rafael STSAs and portions of Pariette and Tar Sand Triangle STSAs had not been surveyed sufficiently to derive sensitivity information; therefore, these acreages have not been included in this percentage calculation. Out of 229,038 acres available under Alternative C, sensitivity information is available for 167,132 acres; therefore, 97,500 acres represents 58% of the STSAs for which sensitivity information is available.

**TABLE 6.2.3-3 Visually Sensitive Areas That Could Be Affected by Commercial Tar Sands Projects Developed in Lease Areas under Alternative C**

| Scenic Resources within 5 mi of Alternative C Lease Areas | Scenic Resources between 5 and 15 mi of Alternative C Lease Areas |
|---|---|
| Bull Canyon, Crack Canyon, Dark Canyon, Desolation Canyon, Devils Canyon, Dirty Devil, Fiddler Butte, Flume Canyon, French Spring–Happy Canyon, Horseshoe Canyon (South), Jack Canyon, Link Flats, Mexican Mountain, Muddy Creek, San Rafael Reef, Sid's Cabin, Sid's Mountain, and Winter Ridge WSAs. | Book Cliffs Mountain Browse, Bull Canyon, Butler Wash, Cheesebox Canyon, Crack Canyon, Dark Canyon, Daniels Canyon, Desolation Canyon, Dirty Devil, Fiddler Butte, Flume Canyon, French Spring–Happy Canyon, Horseshoe Canyon, Jack Canyon, Little Rockies, Mancos Mesa, Mexican Mountain, Creek, Oil Spring Mountain, San Rafael Reef, Sid's Cabin, Sid's Mountain, Skull Creek, Spruce Canyon, and Willow Creek WSAs. |
| Copper Globe, Dark Canyon, I-70 Scenic Highway, Lears Canyon, Lower Green River, Nine Mile Canyon, Pariette, San Rafael Canyon, San Rafael Reef, Scenic Highway Corridor, Seger's Hole, Sid's Mountain, and Temple Mountain ACECs. | Copper Globe, Dark Canyon, I-70 Scenic Highway, Lears Canyon, Lower Green River, Nine Mile Canyon, Pariette, San Rafael Canyon, San Rafael Reef, Scenic Highway Corridor, Seger's Hole, Sid's Mountain, and Temple Mountain ACECs. |
| Bitter Creek, Bitter Creek–P.R. Spring, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Dirty Devil–North Wash, Four Mile Wash, Horseshoe Canyon, Lower Green River, Lucky Strike, Main Canyon, Nine Mile Canyon, Nine Mile Canyon Expansion, Range Creek, Shepards End, and Wild Horse potential ACECs. | Bitter Creek, Bitter Creek–P.R. Spring, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Desolation Canyon, Dirty Devil–North Wash, Four Mile Wash, Horseshoe Canyon, Lower Green River, Nine Mile Canyon, Nine Mile Canyon Expansion, Range Creek, and White River potential ACECs. |
| Segments of Argyle Creek, Bear Canyon, Bitter Creek, Buckskin Canyon, Cane Wash, Dirty Devil River, Evacuation Creek, Green River, Middle Green River, Muddy Creek, Ninemile Creek, North Fork Coal Wash, Range Creek, Rock Creek, Sams Mesa Box Canyon, San Rafael River, South Fork Coal Wash, and Twin Corral Box Canyon determined to be eligible for WSR designation. | Segments of Argyle Creek, Beaver Wash, Bitter Creek, Coal Wash, Cottonwood Wash, Dirty Devil River, Evacuation Creek, Green River, Larry Canyon, Lower Green River, Middle Green River, Muddy Creek, Ninemile Creek, No Mans Canyon, North Fork Coal Wash, North Salt Wash, Range Creek, Robbers Roost Canyon, Robbers Roost Canyon White Roost, Robbers Roost Middle Fork, Robbers Roost North Fork, Robbers Roost South Fork, Rock Creek, San Rafael River, South Fork Coal Wash, Twin Corral Box Canyon, and White River determined to be eligible for WSR designation. |
| Dinosaur Diamond Prehistoric and Flaming Gorge Uintas National Scenic Highways. | Dinosaur Diamond Prehistoric and Flaming Gorge Uintas National Scenic Highways. |
| Canyonlands National Park and Glen Canyon National Recreation Area. | Canyonlands National Park, Glen Canyon National Recreation Area, Dinosaur National Monument, and Natural Bridges National Monument. |
| | Old Spanish Trail National Historic Trail. |

Cultural resources within these areas could be adversely impacted if leasing and future commercial development occur. Leasing itself has the potential to impact cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development on cultural properties. Impacts from future development could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development area, increased potential of loss of resource from looting or vandalism as a result of increased human presence/activity in the sensitive areas, and visual degradation of the cultural setting (see Section 5.10). Special lease stipulations may be developed for specific lease parcels based on this information and consultation with interested Tribes. The cultural resources in the Circle Cliffs STSA would not be impacted by tar sands leasing and development because no leasing and development would occur in this STSA. The cultural resources in Argyle Canyon, Hill Creek, Pariette, Raven Ridge, San Rafael, Tar Sand Triangle, and White Canyon STSAs are less likely to be impacted by tar sands leasing and development than those resources present in the Asphalt Ridge, P.R. Spring, and Sunnyside STSAs.

#### 6.2.3.10 Socioeconomics

Although the employment levels for specific technologies and the consequent socioeconomic impacts of Alternative C would not be dependent on the exact locations of specific developments, the types of impacts that would occur as a result of development made possible by the proposed land use plan amendments under Alternative C would be the same as those described in Chapter 5 and summarized in Section 6.2.2.10 for individual commercial tar sands projects. The specific socioeconomic impacts would depend on the technologies employed, the project size or production level, and development time lines and mitigation measures.

#### 6.2.3.11 Environmental Justice

Although the environmental justice impacts of Alternative C would be dependent on the exact locations of specific developments, the types of impacts that would occur as a result of development made possible by the proposed land use plan amendments under Alternative C would be the same as those described in Chapter 5 and summarized in Section 6.1.2.11. As with the environmental impacts discussed elsewhere in Section 6.2.3, the specific environmental justice impacts would depend on the technologies employed, the project size or production level, and development time lines and mitigation measures.

#### 6.2.3.12 Hazardous Materials and Waste Management

The amendment of land use plans under Alternative C to identify about 230,000 acres of land as available for application for leasing for commercial tar sands development would not result in any hazardous material or waste management concerns. Impacts related to hazardous materials and wastes could occur during the future development of commercial tar sands projects

within the Alternative C lease areas. Such impacts are generally independent of location and would be unique to the technology combinations used for tar sands development. Hazardous materials and wastes would also be associated with ancillary support activities that would be required for development of any tar sands facility regardless of the technology used. These include the impacts from development of energy transmission or pipeline ROWs and employer-provided housing.

Hazardous materials impacts associated with project construction would be minimal and limited to the hazardous materials typically utilized in construction, such as fuels, lubricating oils, hydraulic fluids, and glycol-based coolants, solvents, adhesives, and corrosion control coatings. Construction-related wastes would include landscape wastes from clearing and grading of the construction sites, and other wastes typically associated with construction, none of which are expected to be hazardous (Section 5.13.1).

During project operations, hazardous materials would be utilized and a variety of wastes (some hazardous) would be generated. Hazardous materials used include fuels, solvents, corrosion control coatings, flammable fuel gases, and herbicides (for vegetation clearing and management at facilities or along ROWs). The types and amounts of hazardous waste generated during operations would depend on the specific design of the commercial tar sands project (surface or subsurface mining, surface retorting, or in situ processes). Waste materials produced during operations could include waste engine fuels and lubricants, flammable gases, volatile and flammable organic liquids, and heavier molecular weight organic compounds (Section 5.13.1).

Because the use of hazardous materials and the generation of wastes are directly related to the specific design of a commercial tar sands project, it is not possible to quantify project-related impacts of these materials. Under Alternative C, individual facilities could be located anywhere within the area identified as being available for leasing pending project review and authorization. Accidental releases of the hazardous materials or wastes could affect natural resources (such as water quality or wildlife) and human health and safety (see Section 5.14 and 6.2.3.13) at locations wherever the individual projects are sited within the Alternative C lease areas.

#### 6.2.3.13 Health and Safety

The amendment of land use plans to identify about 230,000 acres of land as available for application for leasing for commercial tar sands development would not result in any direct health and safety concerns. However, a number of health and safety concerns would be associated with the commercial development of tar sands projects within the Alternative C lease areas. For commercial tar sands development in Alternative C lease areas, potential health and safety impacts from the construction and operation of commercial tar sands projects would be associated with the following activities: (1) constructing project facilities and associated infrastructure; (2) mining (if processing is not in situ) of the tar sands; (3) obtaining and upgrading the crude oil, either through surface retorting or in situ processing; (4) transporting construction and raw materials to the upgrading facility and transporting product from the facility; and (5) exposure to water and air contamination associated with tar sands development.

Hazards from tar sands development (summarized in Table 5.14-1) could include physical injury from construction, tar sands processing, and vehicle transportation accidents, and exposure to fugitive dust and hazardous materials such as retort emissions and industrial chemicals (Section 5.14). Health and safety impacts would be largely restricted to the immediate workforce of each facility. Accidents could also affect members of the general public that could be present in the immediate vicinity of an accident (e.g., project-related truck accident on a public road, recreational users in areas adjacent to the project lease area).

Hazards for workers at tar sands development facilities include risks of accidental injuries or fatalities, lung disease caused by inhalation of particulates and other hazardous substances, and hearing loss. Estimates of expected injuries and fatalities can be made on the basis of numbers of employees and the type of work. On the basis of the number of employees projected to be needed for construction and operation of tar sands facilities, there would statistically be less than 1 death and about 100 injuries per year expected per facility during construction activities, and less than 1 death and about 30 injuries per year expected per facility during operations (NSC 2006). A comprehensive facility health and safety plan and worker safety training would be required as part of the Plan of Development for every proposed commercial tar sands project.

Health and safety concerns are largely independent of the location of tar sands development facilities. However, the health and safety impacts on the general public from emissions from these facilities would depend both on the specific characteristics and level of emissions, and the distance of the emissions source from population centers. The level of air and water emissions would be regulated under required permits. Potential impacts on the general public from emissions would be assessed in future site-specific NEPA and permitting documentation.

### 6.2.4 Comparison of Tar Sands Alternatives

The three alternatives assessed in this PEIS are a no action alternative (Alternative A) and two alternatives for amending BLM land use plans to (1) designate lands within STSAs available for application for commercial leasing; (2) specify requirements for future NEPA analyses and consultation activities; and (3) specify that the BLM would consider and give priority to land use exchanges, where appropriate and feasible, to facilitate commercial tar sands development pursuant to Section 369(n) of the Energy Policy Act of 2005. These alternatives are described in Sections 2.4.2 and 2.4.3; specific land use plan amendments are provided in Appendix C. The analyses of potential impacts associated with each alternative are presented in Sections 6.2.1, 6.2.2, and 6.2.3 of this chapter.

As noted in the preceding impact analysis sections for Alternatives B and C, the proposed land use plan amendments would not result in any impacts on the environment or socioeconomic setting. However, the development of commercial tar sands projects made possible by these land use plan amendments would have impacts on these resources. As discussed, the potential impacts associated with commercial tar sands development that would be made possible under the land use plan amendments, while described in Chapter 5, cannot be quantified because key

information about the location of commercial projects, the technologies employed, the project size or production level, and development time lines is unknown.

#### 6.2.4.1 Land Use

Under Alternative A, no new leasing of tar sand resources would occur; thus, there would be no effect on land use in the study area under this alternative.

The amendment of the land use plans in both programmatic alternatives would not cause direct impacts on land uses. The identification of lands does not authorize or approve any ground-disturbing activities that could affect these resources. However, under Alternatives B and C, existing land uses could be adversely affected by future commercial tar sand development.

The nature of the impacts of Alternatives B and C on land uses would be the same with the exceptions that are discussed below. It is only at the site-specific level that the impacts of either of the alternatives can be determined. In areas where the potentially leasable area of the alternatives overlaps, the potential impacts would be the same.

The level of development could be the same under Alternative C as it would be under Alternative B, but Alternative C could or could not result in different locations of some of the development projects. Alternative C also would result in opening many discontinuous tracts that might not be attractive for development and make the more continuous areas more attractive for leasing.

Although Alternative C does remove from consideration 200,000 acres of land with sensitive resources that have been identified in current BLM land use plans, the reasons for those exclusions are generally not related to the uses evaluated in this section, and, therefore, there is a small difference between the alternatives in protection of existing land uses. Remaining acreage in Alternative C would be more than adequate to accommodate likely tar sands development over the next 20 years. The following is a summary of the principle differences in impacts on land uses between Alternatives B and C:

- Alternative B includes 100,000 acres of land identified as having wilderness characteristics, while Alternative C includes approximately 68,000 acres of these lands.

- Alternative B includes 180,000 acres that are identified as potential ACECs. Alternative C includes 86,000 acres.

In comparing the overall potential for impact on land uses, Alternative C could result in slightly less impact on land uses for potential ACECs and lands with wilderness characteristics than Alternative B. If a major portion of the development under Alternative B were assumed to occur within the 200,000 acres excluded by Alternative C, the difference between the alternatives could be larger.

#### 6.2.4.2 Soil and Geologic Resources

The identification of public lands under Alternatives B and C as being available for application for leasing for commercial tar sands development, and the associated amendment of appropriate land use plans, would not affect soils or geologic resources in any of the lease areas. Soils and geologic resources could, however, be affected by subsequent development of commercial tar sands projects in these areas under either alternative. Potential impacts, related primarily to construction and operation of project facilities and related infrastructure, could include soil disturbance, removal or compaction, and erosion.

Impacts on soil and geologic resources would be identical between Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). However, soil and geologic resources could be affected by commercial tar sands development in more locations under Alternative B than under Alternative C, with Alternative B having almost twice the number of acres of land available for leasing and subsequent development (about 200,000 additional acres). The lands excluded under Alternative C for lease availability represent environmentally sensitive areas as identified in BLM land use plans, which could be developed in the future under Alternative B. The nature, location, and magnitude of project-related impacts on soil and geologic resources would depend on the specific locations of leases undergoing commercial development as well as on the design of the projects.

#### 6.2.4.3 Paleontological Resources

Table 6.2.4-1 identifies the amount of available acreage that has the potential to contain important paleontological resources under each of the alternatives. Under Alternative A, no leasing and development would occur and no impacts on paleontological resources would occur as a result of development under this alternative.

Under Alternative B, 335,395 acres available for application for leasing have the potential to contain important paleontological resources. Adverse effects on paleontological resources, as described in Sections 5.4 and 6.2.2.3, could occur in these areas.

**TABLE 6.2.4-1 Available Acreage under Each Alternative with the Potential to Contain Important Paleontological Resources**

| | Alternative A | Alternative B | Alternative C | % Difference in Alternatives B and C |
|---|---|---|---|---|
| Acres available for application for leasing and development | 0 | 431,224 | 229,038 | 53 |
| Acres with the potential to contain important paleontological resources | 0 | 335,395 | 147,937 | 44 |

Under Alternative C, the amount of acreage available for application for leasing with the potential to contain important paleontological resources is reduced considerably from that of Alternative B to 147,937 acres. Commercial development made possible by Alternative C potentially could impact approximately 44% of the acreage with important paleontological resources that potentially would be impacted by Alternative B. In addition, under Alternative C, no direct impacts from project development would occur on paleontological resources present within the designated ACECs, but adverse effects could occur within the lands made available for leasing and by future development (see Section 6.2.3.3).

#### 6.2.4.4 Water Resources

Under Alternative A, no development of tar sand resources would occur over the 20-year study period; thus, there would be no effect on land use in the study area under this alternative.

The amendment of the land use plans under both Alternatives B and C also would not cause environmental impacts on water resources. However, water resources could be adversely affected by future commercial tar sands development on these lands.

The nature of the impacts on water resources from potential future commercial development under Alternatives B and C would be the same with the exceptions discussed below. It is only at the site-specific level that the impacts of commercial development under either of the alternatives can be determined. In areas where the potentially leasable area of the alternatives overlaps, the expected impacts on water resources would be the same.

While Alternative C makes considerably fewer acres available for application for commercial leasing, it does not provide for less potential development of commercial tar sands over the 20-year planning period for the PEIS than does Alternative B. For that reason, many of the potential impacts on land use under Alternative C could be the same those under Alternative B. The land available for application for leasing under both Alternatives would be more than adequate to accommodate potential tar sands development over the next 20 years. The following is a summary of the principle differences in potential impacts on water resources between Alternatives B and C:

- Alternative C removes from consideration 200,000 acres of lands identified for resource protection in existing BLM land use plans, including lands having high potential for erosion due to the steep slopes and/or highly erosive soils that if disturbed could adversely affect water resources.

- Under Alternative C, Argyle Canyon STSA would be totally unavailable for consideration for future development, and the acreage available in both the Pariette and White Canyon STSAs would be so small as to make them practically unavailable for development.

- Alternative B contains approximately 28 mi of perennial streams that could be affected by commercial development, while Alternative C contains 19 mi.

In comparing the overall potential for impact of commercial tar sands development on water resources, Alternative C would have less potential impact than Alternative B. If development under Alternative B was assumed to occur within the 200,000 acres excluded by Alternative C, the difference between the alternatives could be much larger.

#### 6.2.4.5 Air Quality

The identification of areas available for application for leasing for commercial tar sands development and associated amendment of appropriate land use plans is not expected to affect air quality under Alternative B or C. However, under both alternatives, local and regional air quality could be affected by the construction and operation of commercial tar sands projects in the lease areas. Under Alternatives B and C, the commercial development of a similar project in an area where the lease areas of the two alternatives overlap would be expected to affect local and regional impacts on air quality in the same manner.

Impacts on air resources of future commercial development would be identical between Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). Because of the difference in the areas identified as available for application for leasing under Alternatives B and C, local air quality could be affected by commercial development in more locations under Alternative B than under Alternative C. Many of the lands identified under Alternative B as being available for application for leasing are excluded from application under Alternative C. Thus, compared with Alternative B, the areas where local air quality could be affected by future commercial tar sands development under Alternative C would be reduced by 47%.

Because of the need for project- and site-specific information, it is not possible to identify the nature and magnitude of regional air quality impacts for future commercial development under either Alternative B or C. Thus, it is not possible to differentiate between these two alternatives regarding regional air quality impacts.

#### 6.2.4.6 Noise

The identification of areas available for application for leasing for commercial tar sands development and associated amendment of appropriate land use plans would not affect noise levels in the available lease areas under either Alternative B or C. However, under both alternatives, local noise levels could be affected by the future construction and operation of commercial tar sands projects in the lease areas.

Impacts on noise levels from future commercial development would be identical between Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). Because of the difference in the areas identified under Alternatives B and C as available for application for leasing, local noise levels could be affected by commercial development at more locations under Alternative B than under Alternative C.

Compared with Alternative B, the areas under Alternative C where local noise levels could be affected by future commercial tar sands development would be reduced by 47%.

#### 6.2.4.7 Ecological Resources

**6.2.4.7.1 Aquatic Resources.** Under Alternative A, the BLM would not identify public lands in Utah as available for application for leasing for commercial development of tar sands. The identification of areas available for application for leasing for commercial tar sands development and associated amendment of appropriate land use plans would not affect aquatic resources in the available lease areas under either Alternative B or C. However, under both alternatives, aquatic resources could be affected if leasing results in the construction and operation of commercial tar sands projects in the future.

Impacts on aquatic resources from future commercial development would be identical between Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). Although there is a relatively large difference between the two alternatives in the amount of land that would be made available for application for leasing, only 1 less perennial stream (and only 9 fewer miles of stream) could be affected by commercial tar sands development under Alternative C than under Alternative B. Under Alternative B, there are 9 perennial streams totaling approximately 28 mi in the proposed lease areas; under Alternative C, there are 8 streams totaling 19.4 mi in the proposed lease areas. Each of the streams within the Alternative C lease areas is also within the Alternative B lease areas, and for several of the streams there is little or no difference in the stream mileage falling within the lease areas (see Tables 6.2.2-5 and 6.2.3-1). Thus, future commercial tar sands development could affect about the same amount of aquatic habitat and associated biota under either alternative.

**6.2.4.7.2 Plant Communities and Habitats.** Under Alternative A, the BLM would not identify public lands in Utah as available for application for leasing for commercial development of tar sands. The identification of areas available for application for leasing for commercial tar sands development and associated amendment of appropriate land use plans would not affect plant communities and habitats in the available lease areas under either Alternative B or C. However, under both alternatives, plant communities and habitats could be affected by future construction and operation of commercial tar sands projects in the lease areas. Potential impacts on plant communities and habitats from future project construction and operation would be identical between Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap).

Because of the difference in the areas identified under Alternatives B and C as available for application for leasing (about a 202,000-acre difference), plant communities and habitats could be affected by future commercial development at more locations under Alternative B than under Alternative C. Plant communities and habitats in Alternative B potential lease areas could be impacted by the construction and operation of commercial tar sands projects. Included in this

acreage are about 2,085 acres of land identified in land use plans as protected because of the presence of sensitive plants and relict vegetation populations. In contrast, about 202,000 acres of land identified under Alternative B (including all of the 2,085 acres identified for protection of sensitive plants and relict populations) would be excluded from availability for leasing under Alternative C.

**6.2.4.7.3 Wildlife.** Under Alternative A, the BLM would not identify public lands in Utah as available for application for leasing for commercial development of tar sands. The identification of areas available for application for leasing for commercial tar sands development and associated amendment of appropriate land use plans would not affect wildlife in the available lease areas under either Alternative B or C. However, under both alternatives, wildlife and their habitats could be affected if leasing leads to future construction and operation of commercial tar sands projects in the lease areas.

Impacts on wildlife and their habitats from future commercial development (see Section 5.8.1.3) would be identical under Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). Because of the difference in the areas identified under Alternatives B and C as available for application for leasing, wildlife and their habitats could be affected by subsequent commercial development at more locations under Alternative B than under Alternative C. Alternative B identifies approximately 200,000 acres more land as being available for lease application, and wildlife and their habitats in these areas could be impacted by the construction and operation of commercial tar sands projects (see Tables 6.2.2-6 and 6.2.2-7 in Section 6.2.2.7.3).

Because of the smaller area of lands potentially available for leasing under Alternative C, thousands of acres of important wildlife habitat would be removed from the lease areas, and thus could not be directly affected by future commercial tar sands development. Table 6.2.4-2 shows the difference between Alternatives B and C in the amounts of wildlife habitat identified for protection in current land use plans. Table 6.2.4-3 shows similar information for important state-identified wildlife habitat. Under Alternative C, there would be about 14,210 fewer acres of wild horse HMA that could be affected by future commercial tar sands development than under Alternative B.

**6.2.4.7.4 Threatened and Endangered Species.** Under Alternative A, the BLM would not amend land use plans to identify public lands in Utah as available for application for leasing for commercial development of tar sands. The amendment of land use plans to identify areas available for application for leasing for commercial tar sands development would not affect threatened and endangered species in the lease areas identified under either Alternative B or C. However, under both alternatives, threatened and endangered species and their habitats could be affected if the construction and operation of commercial tar sands projects occurs in the lease areas in the future.

**TABLE 6.2.4-2 Acreage of Wildlife Habitats Identified for Protection in BLM Land Use Plans That Could Be Impacted by Commercial Tar Sands Development**

| | Total Land Area (acres) Available for Leasing Where Future Commercial Tar Sands Development Could Impact Wildlife Habitat Identified in BLM Land Use Plans | | |
|---|---|---|---|
| Location | Alternative B | Alternative C | Change in Potential Impact Area |
| Sage grouse habitat | 5,645 | 0 | –5,645 |
| Raptor habitat | 13,987 | 0 | –13,987 |
| Big game winter range | 12,166 | 0 | –12,166 |
| Big game calving, fawning, or lambing habitat | 19,366 | 0 | –19,366 |
| Pronghorn antelope and desert bighorn sheep crucial habitat | 9,737 | 0 | –9,737 |

**TABLE 6.2.4-3 Acreage of State-Identified Wildlife Habitat That Could Be Impacted by Commercial Tar Sands Development**

| | Total Land Area (acres) Available for Leasing Where Commercial Tar Sands Development Could Impact State-Identified Wildlife Habitat | | |
|---|---|---|---|
| Location | Alternative B | Alternative C | Change in Potential Impact Area |
| Sage grouse habitat | 227,700 | 101,300 | –126,400 (–55%) |
| Big game winter habitat | 308,500 | 156,900 | –151,600 (–49%) |
| Big game summer habitat | 132,500 | 68,500 | –64,000 (–48%) |
| Big game calving, fawning, or lambing habitat | 18,000 | 18,000 | 0 |
| Crucial pronghorn habitat | 5,900 | 5,900 | 0 |

The same 20 threatened and endangered species could be affected by future commercial tar sands development in either of the Alternative B or C lease areas (see Table 5.8.1-4). Impacts on these species and their habitats (see Section 5.8.1.4) from future commercial development would be identical between Alternatives B and C for similar projects located in lease areas common to the two alternatives (i.e., where the lease areas would overlap). Because of the difference in the areas identified under Alternatives B and C as available for application for leasing, threatened and endangered species and their habitats could be affected by commercial tar sands development at more locations under Alternative B than under Alternative C. Alternative B identifies approximately 202,000 more acres as available for lease application than does Alternative C, and threatened and endangered species and their habitats in these areas could be impacted in the future by construction and operation of commercial tar sands projects.

#### 6.2.4.8 Visual Resources

Under Alternative A, the BLM would not amend land use plans to identify public lands in Utah as available for application for leasing for commercial development of tar sands. Under either Alternative B or C, the amendment of land use plans to identify areas available for application for leasing for commercial tar sands development would not affect visual resources within or in the vicinity of the lease areas identified. However, there are a number of potential sensitive visual resources within, and in the vicinity of, the lease areas identified by both alternatives. These sensitive visual resource areas could be affected if construction and operation of commercial tar sands projects occur in the future in the lease areas.

The visual resources that could be affected by the future construction and operation of commercial tar sands projects would be identical under Alternatives B and C for similar projects located in lease areas common to the two alternatives (i.e., where the lease areas would overlap). Because of the difference in the areas identified under Alternatives B and C as available for application for leasing, visual resources could be affected by commercial tar sands development at more locations under Alternative B than under Alternative C. Alternative B includes approximately 200,000 more acres where visual resources in, and in the vicinity of, these lease areas could be impacted by the construction, presence, and operation of commercial tar sands projects.

While Alternative C has about 200,000 fewer acres of land than Alternative B, there is relatively little difference between the alternatives in the numbers and types of sensitive visual resource areas that could be affected by future commercial development (Table 6.2.4-4).

#### 6.2.4.9 Cultural Resources

Table 6.2.4-5 identifies the amount of available acreage that has the potential to contain important cultural resources under each of the alternatives. Under Alternative A, no leasing and development would occur and no impacts on cultural resources would occur as a result of leasing and development under this alternative.

Under Alternative B, 220,648 acres of the 431,224 acres available for application for leasing have the potential to contain important cultural resources. Adverse effects on cultural resources from future commercial development, as described in Sections 5.10 and 6.2.2.9, could occur in these areas.

Under Alternative C, the amount of acreage available for application for leasing with the potential to contain important cultural resources is reduced considerably from that of Alternative B to 97,492 acres out of 229,038 acres. Future commercial development under Alternative C potentially would impact approximately 29% of the acreage with important cultural resources that could be impacted by Alternative B.

**TABLE 6.2.4-4 Potentially Affected Sensitive Visual Resource Areas Associated with Lease Areas Identified under the Alternative B and C**

| Alternative B | Alternative C |
|---|---|
| Visual Resource Areas within Proposed Lease Areas | |
| 11 Potential ACECs | 11 Potential ACECs |
| 1 River segment eligible for WSR designation | 1 River segment eligible for WSR designation |
| 1 National scenic highway | |
| Visual Resource Areas within 5 mi of the Lease Area Boundary (BLM VRM Foreground-Middleground Distance Limit) | |
| 19 WSA | 18 WSAs |
| 11 ACECs | 13 ACECs |
| 18 Potential ACECs | 18 Potential ACECs |
| 18 River segments eligible for WSR designation | 18 River segments eligible for WSR designation |
| 1 National park | 1 National park |
| 1 National recreation area | 1 National recreation area |
| 2 National scenic highways | 2 National scenic highways |
| Visual Resource Areas within 15 mi of the Lease Area Boundary (BLM VRM Background Distance Limit) | |
| 28 WSAs | 25 WSAs |
| 9 ACECs | 13 ACECs |
| 14 Potential ACECs | 14 Potential ACECs |
| 31 River segments eligible for WSR designation | 28 River segments eligible for WSR designation |
| 1 National park | 1 National park |
| 2 National monuments | 2 National monuments |
| 1 National recreation area | 1 National recreation area |
| 3 National scenic highways | 2 National scenic highways |
| 1 National historic trail | 1 National historic trail |

### 6.2.4.10 Socioeconomics

Under Alternative A the BLM would not amend land use plans to identify public lands available for tar sands leasing, and there would be no socioeconomic impacts. Because it is not possible to quantify the socioeconomic impacts of the commercial development that would be made possible under either Alternative B or C at this time, it is not possible to definitively conclude which of these two alternatives would result in the greatest impacts. However, if Alternative C results in less total commercial development, the resulting socioeconomic impacts, both beneficial and adverse, would be lower under Alternative C.

Alternative A, the no action alternative, would do the least to meet the requirements of the Energy Policy Act of 2005 regarding facilitation of commercial leasing of tar sands. The two land use plan amendment alternatives examined in this PEIS (Alternatives B and C) would be

**TABLE 6.2.4-5 Available Acreage under Each Alternative with the Potential to Contain Cultural Resources**

| Parameter | Alternative A | Alternative B | Alternative C | % Difference in Alternatives B and C |
|---|---|---|---|---|
| Acres available for application for leasing and development | 0 | 431,224 | 229,038 | 53 |
| Acres surveyed[a] | 0 | 42,620 | 12,537 | 29 |
| % of Area surveyed | 100% | 10% | 5% | |
| Number of sites recorded | 0 | 183 | 71 | 39 |
| Acres of high or medium sensitivity to contain cultural resources | NA | 220,648 | 97,492 | 44 |
| % of Area with high or medium sensitivity[b] | NA | 65% | 58% | |

[a] This acreage is from block acre surveys only and does not include linear miles of survey.

[b] Argyle Canyon, Circle Cliffs, and San Rafael STSAs and portions of Pariette and Tar Sand Triangle STSAs had not been surveyed sufficiently to derive sensitivity information; therefore, these acreages have not been included in this percentage calculation. Out of 431,224 acres available under Alternative B, sensitivity information is available for 341, 536 acres; therefore, 220,650 acres represents 65% of the STSAs for which sensitivity information is available (rather than 51%). Out of 229,038 acres available under Alternative C, sensitivity information is available for 167,132 acres; therefore, 97,500 acres represents 58% of the STSAs for which sensitivity information is available (rather than 43%).

more effective at facilitating commercial leasing of tar sands than Alternative A because each one proposes to amend land use plans. By amending land use plans to identify the lands that would be available for application for leasing, the BLM would be removing the first hurdle to future commercial leasing. Alternative B would make the greatest amount of land available for application for leasing (see Table 6.2.4-6). It is possible that Alternative C would limit development to some level below what would occur under Alternative B because Alternative C makes fewer total lands available for leasing.

### 6.2.4.11 Environmental Justice

Because it is not possible to quantify the environmental justice impacts of the commercial development that would be made possible under either Alternative B or C at this time, it is not possible to definitively conclude which of these two alternatives would result in the greatest impacts. However, if Alternative C results in less total commercial development there would be fewer resulting environmental justice impacts under Alternative C.

### 6.2.4.12 Hazardous Materials and Waste Management

The amendment of land use plans to identify areas available for application for leasing for commercial tar sands development would not result in hazardous material and waste issues

**TABLE 6.2.4-6 Estimated Acres Potentially Available for Application for Leasing for Commercial Tar Sands Development by STSA under Each Alternative[a]**

| STSA | Alternative A[b] | Alternative B | Alternative C |
|---|---|---|---|
| Argyle Canyon | 0 | 11,226 | 0 |
| Asphalt Ridge | 0 | 5,435 | 1,464 |
| Circle Cliffs[c] | 0 | 0 | 0 |
| Pariette | 1,066 | 10,161 | 830 |
| P.R. Spring | 6,080 | 153,003 | 56,728 |
| Hill Creek | 0 | 56,506 | 19,934 |
| Raven Ridge | 0 | 14,364 | 9,950 |
| San Rafael | 0 | 70,475 | 54,492 |
| Sunnyside | 0 | 78,116 | 62,741 |
| Tar Sand Triangle | 0 | 24,938 | 22,511 |
| White Canyon | 0 | 7,001 | 386 |
| Total | 7,146 | 431,224 | 229,038 |

[a] Totals may not be exact because of rounding. These estimates were derived from GIS data compiled for the PEIS. The GIS data may contain errors; therefore, these estimates should be considered to be only representative of the proposed leasing area.

[b] Additional lands are involved in a number of pending conversion leases: 8,921.36 in the Circle Cliffs STSA, 27,668.04 in the P.R. Spring STSA, and 41,254.16 in the Tar Sand Triangle STSA. The adjudication process to determine the valid existing rights for pending conversion leases in these STSAs is currently underway.

[c] While the Circle Cliffs STSA is a designated STSA, the BLM-administered portion of it falls entirely within the GSENM and has been excluded from consideration for being designated as open to application for leasing in this PEIS.

within or in the vicinity of the lease areas identified under either Alternative B or C. However, the construction and operation of commercial tar sands projects in the lease areas would use and generate hazardous materials and wastes under both alternatives.

Because the use of hazardous materials and the generation of wastes is related to the specific design of a commercial tar sands project rather than project location, it is not possible to differentiate between Alternative B and C the hazardous materials and waste that could be used or generated during commercial tar sands construction and operation. For similar commercial tar sands projects (similar in design and operation), the hazard materials and wastes associated with projects developed in the Alternative B or C lease areas would be similar. Because of the much larger amount of land that would be made available for leasing under Alternative B, the use and/or generation of hazardous materials and wastes could occur at more locations under Alternative B than under Alternative C. In both cases, hazardous material and waste handling

(storage, use, and disposal) would be expected to be similar under the two alternatives regardless of project location (Section 5.13.1).

#### 6.2.4.13 Health and Safety

The amendment of land use plans to identify areas available for application for leasing for commercial tar sands development would not result in health and safety issues within or in the vicinity of the lease areas identified under either Alternative B or C. However, the construction and operation of commercial tar sands projects made possible by land use plan amendments would have identical health and safety concerns between Alternatives B and C for projects with identical Plans of Development located in lease areas common to the two alternatives (i.e., where the lease areas would overlap). Potential impacts could occur from accidents causing injuries and fatalities, possible hearing loss from high noise levels, and inhalation of particulates and/or VOCs emitted from the facilities. Construction and operation of individual facilities under either alternative would statistically be expected to result in less than 1 fatality per year, and approximately 100 injuries per year during construction and 30 injuries per year during operations. The general public could have health impacts associated with exposure to emissions from tar sands facilities, but in the absence of site-specific and process-specific data, no differences between the health and safety impacts of Alternatives B and C can be identified.

Differences in health and safety concerns between the two alternatives would be largely associated with differences in individual project designs and, to a lesser degree, differences in the locations of individual projects. For example, projects requiring longer transportation routes and longer utility and pipeline ROWs would have a greater potential for transportation accidents as well as ROW construction-related accidents. It is not possible to quantify differences in health and safety impacts under Alternatives B and C in this PEIS. Under either of the alternatives, health and safety issues would be evaluated at the project level (i.e., as part of project-specific NEPA analyses), and a comprehensive facility health and safety plan and worker safety training would be required as part of the Plan of Development for every proposed commercial tar sands project.

### 6.2.5 Cumulative Impacts

The purpose of this cumulative impacts assessment is to discuss how the environmental, and socioeconomic economic conditions within the three-state study area might be incrementally affected over the next 20 years (the study period) by tar sands development that would be made possible by land use plan amendments under either Alternative B or Alternative C. The CEQ (1997), in its regulations implementing the procedural provisions of NEPA (40 CFR Parts 1500–1508), defines cumulative effects as follows:

> "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future

actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7).

As stated in Sections 6.2.2 and 6.2.3, there would be no environmental or socioeconomic impacts under Alternatives B and C from the amendment of land use plans to identify lands as available for commercial tar sands leasing. Therefore, there would be no incremental cumulative impacts from these alternatives. However, direct, indirect, and incremental cumulative impacts could occur due to future commercial tar sands development that would be facilitated by such land use plan amendments.

This section describes the impacts of potential commercial tar sands development that could occur over the next 20 years as a result of commercial development under land use plan amendments made under Alternatives B or C. These impacts are in the context of other major activities in the study areas that could also affect environmental resources and the socioeconomic setting. The study areas considered usually include the lands managed by a BLM field office that contain tar sands resources and the ROI counties associated with them as defined in Table 3.10.2-1. Larger areas are considered for certain resources (e.g., land, air, and water). This section considers five major categories of activities that could have cumulative impacts: oil and gas development, coal mining and preparation, other minerals development, energy infrastructure development, and other activities (e.g., tar sands development, grazing, fire management, forestry, and recreation). The assumptions and impact-producing factors for these categories of activities are discussed in Section 6.2.5.1. The projected level of each type of activity in the study area in Utah over the period 2007 to 2027 is described in Section 6.2.5.2. Section 6.2.5.3 presents the cumulative impacts analysis for Alternatives B and C, and addresses the same resources as those analyzed in Sections 5.2 through 5.14.

The current status of resources (including past and present actions) is described in Chapter 3. This section focuses on the incremental impacts of the tar sands alternatives when added to a set of reasonably foreseeable future actions that are projected to occur or that could occur over the next 20 years (as described in Section 6.2.5.2). These projections were drawn from a variety of sources, as indicated in the text. Predictably, the accuracy of such projections is greatest during the first few years of the 20-year period and decreases over the time frame assessed. In particular, future levels of oil shale and tar sands development are unknown. For the purposes of analysis, this cumulative impacts assessment looks at the incremental impacts of a single tar sands facility (as described in Section 5.1) and a single oil shale facility (as described in Section 4.1), recognizing that there may be more than one of each type of these facilities brought into operation during the study period. While the cumulative impacts described in this section represent an initial estimate of impacts for activities projected to occur in the 20-year time frame, the assessment would require reevaluation if the planned level of development changes drastically in the future.

Because of the magnitude of actions on public land, the lack of information about how many projects might be undertaken under either alternative, and the lack of information regarding the likely locations for future development, the cumulative effects discussed in this section are general in nature. The magnitude of the differences between the cumulative effects of Alternatives B and C cannot be identified. The cumulative effects discussion by resource area

presented in Section 6.2.5.3 is intended to place the potential development of tar sands resources into the context of impacts from known ongoing and planned activities, and highlight issues that would be considered in future, site-specific NEPA actions.

### 6.2.5.1 Overview of Assumptions and Impact-Producing Factors of Major Activities with Potential Cumulative Impacts

**6.2.5.1.1 Oil and Gas Development.** Oil and gas development are associated with impact-producing factors in resource areas such as water use, the production of wastes and water, contaminant emissions to air and water, the use and alteration of land, and potential oil spills. The environmental impacts of oil and gas drilling are highly variable, depending on the depth of drilling, drilling methods used, and whether multiple wells per drill pad are constructed. Table 6.2.5-1 summarizes the estimated impacts of oil and gas drilling on a per-well basis for select resource areas.

Rough estimates of overall resource requirements for oil and gas drilling are available from several sources. Estimates of the amount of land disturbed vary from 2.5 to 15 acres per well. The higher end of the range is certainly an overestimate in locations where multiwell pads would be used (e.g., the Roan Plateau amendments call for 17 wells per pad atop the plateau) (BLM 2006i). In addition, only about 60% of the initially disturbed area would have long-term surface disturbance; the other 40% generally would be revegetated within 2 years (BLM 2006i).

**TABLE 6.2.5-1 Assumptions Associated with Oil and Gas Drilling**

| Impact-Producing Factor | Values Used in Impact Analysis (per well drilled) | Reference |
|---|---|---|
| Surface disturbance (acres) | 2.5–15 | McClure et al. 2005; Thompson 2006a; DOE 2006; BLM 1994b, 2002a, 2006i |
| Water use (ac-ft/yr) | 0.55 | BLM 2006i |
| Drilling waste (bbl) | 4,100 | DOE 2006 |
| Regulated emissions (CO, $SO_2$, $NO_x$) (tons) | 0.37 | DOE 2006 |
| $CO_2$ emissions (tons) | 97 | DOE 2006 |
| Other nonregulated emissions ($CH_4$, non-$CH_4$ hydrocarbons) (tons) | 0.17 | DOE 2006 |
| Amount of oil spilled (gal) | 24 | DOE 2006 |
| Employment (direct FTEs) | 3 | BLM 2006i |

#### 6.2.5.1.2 Coal Mining and Preparation

Impact producing factors for coal mining and preparation (e.g., removal of sulfur) include water use, contaminant emissions to air and water, use and alteration of land, and occupational hazards. These factors are discussed in DOE (1988) and summarized for select resource areas in Table 6.2.5-2.

**6.2.5.1.3 Other Minerals Development.** Although several metals and minerals are mined in Utah, most are not mined in the counties that might experience tar sands development. The predominant materials currently mined in these areas are sand and gravel.

Sand and gravel deposits are found in river and stream terraces, floodplains, and channels, both current and ancient. These deposits are also called salable minerals (a category that also includes clays). Extraction of in-stream sand and gravel deposits could result in adverse environmental impacts, such as changes in streamflow and increased turbidity, that would affect fisheries and recreational use. Extraction of sand and gravel from floodplains or low terraces could create new channels and alter sediment deposition, again adversely affecting the ecology of the nearby river or stream. Other general impacts from sand and gravel mining could include land disturbance, changes in groundwater quality, noise, dust, and visual changes. The management of sand and gravel mining could decrease impacts. For example, siting mining locations high up in the landscape (on floodplains and terraces rather than in stream channels) would decrease adverse impacts on stream hydrologic processes (Langer 2002). If in-stream mining was practiced, annual withdrawals would likely be limited to less than the annual bedload.

Other materials mined in on near the potential tar sands development area include clay, gilsonite, gold, sandstone, sodium minerals, and uranium. These metals and minerals may be obtained through underground mining, surface (open pit) mining, or solution mining. Gold is usually open pit mined (EPA 1997). Mining of these substances can cause a variety of adverse environmental impacts, including the production of high volumes of solid and potentially hazardous waste; the contamination of surface water and groundwater; uncontrolled releases of produced water; land subsidence; physical instability of mine units; and air quality degradation, especially from particulate emissions. Uranium has an added potential for radiologically contaminating environmental media, leading to the subsequent possibility of exposures of biota and humans.

Metal mining historically has also caused significant contamination of surface water. The sources of contamination have included waste rock disposal, tailings, leaching sites (locations where valuable metals are collected by running solutions through the ore), and mine water. Depending on the local geology, the waste rock may contain other naturally occurring minerals that could be toxic to biota, including arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, and nickel. In addition, cyanide (a highly toxic substance composed of carbon and nitrogen) is used extensively in the mining industry to aid in metal extraction. Serious adverse impacts on surface water from metal mining have occurred when runoff from waste sources has entered nearby water bodies; these impacts have included degradation of aquatic

**TABLE 6.2.5-2 Assumptions Associated with Coal Mining and Preparation[a]**

| Impact-Producing Factor | Values Used in Impact Analysis (per million tons surface mined) | Values Used in Impact Analysis (per million tons underground mined) |
|---|---|---|
| Surface disturbance (acres) | | |
| Areas for facilities | 4.3 | 4 |
| Strip mining | 20 | NA[b] |
| Waste storage | 2.6 | 1 |
| Water use (million gal) | | |
| Coal preparation | 20 | 20 |
| Dust control | 35 | 35 |
| Air emissions (tons)[c] | | |
| CO | 15 | 6.3 |
| $SO_2$ | 4.9 | 0.59 |
| $NO_x$ | 76 | [d] |
| Particulates | 4 | 0.48 |
| Fugitive dusts[e] | 1,870 | [d] |
| Hydrocarbons | 4.8 | 0.48 |
| Aldehyde | 1.2 | [d] |
| Diesel fuel use ($10^3$ gal) | 3,021 | 38 |
| Electricity use ($10^6$ MWh) | 6 | 39 |
| Employment (direct FTEs) | 180 | 460 |
| Occupational hazards (deaths per 100,000 workers, disabling injuries per 100 workers) | 0.07, 8 | 0.37, 45 |

[a] Coal is prepared to increase its quality and heating value by removing sulfur and ash-forming constituents.

[b] NA = information not available.

[c] Surface mining values are for the western United States; underground values are for the eastern United States.

[d] Unquantified or negligible.

[e] Based on estimates for an Illinois surface mine with the following controls: paved access roads, watered and unpaved haul roads, and enclosed coal dumps with baghouse. Without these controls, estimated fugitive dust emissions would be 3,030 tons.

Source: DOE (1988).

habitat and contamination of drinking water supplies. Additional adverse impacts can occur as a result of erosion and increased sedimentation of surface water.

A very significant environmental impact from metal mining is the large volume of waste that is generated. The product-to-waste ratio can be very high; for example, in gold mining, almost all of the material removed from the earth (99.99%) is waste rock and tailings. Another area of concern is air quality degradation. Many metal mining operations generate large volumes of fugitive dust from ore crushing and loading, blasting, and, over time, from dried-up tailings ponds.

Many of the adverse impacts from mining discussed above occurred primarily in the past, and mitigation measures have been adopted to minimize their occurrence in present practice. Because of the wide variety of possible contaminants and impacts from mining of metals and other minerals, generic impacts (e.g., on a "per-ton-mined" basis) are not discussed in this section. Cumulative impacts are discussed in Section 6.2.4.3 on the basis of the specific types of minerals being developed in each region.

#### 6.2.5.1.4 Energy Infrastructure Development

***Energy Corridors.*** The western states have an extensive infrastructure of oil and gas pipelines and electricity transmission ROWs. Most of the existing ROWs cross public lands (National Energy Policy Development Group 2001). As of 2005, Colorado had 6,177, Utah had 5,120, and Wyoming had 15,775 ROWs crossing public lands (BLM 2001a, BLM 2005k). These ROWS serve as either long-distance paths or subregional and local distribution lines. It is projected that the growing demand for additional energy and electricity will result in an increased number of ROWs across public lands in the future (National Energy Policy Development Group 2001). Other federal agencies authorized to grant ROWs for electric, oil, and gas transmission include the USFS, the NPS (electric only), the USFWS, the BOR, and the Bureau of Indian Affairs.

The BLM, along with DOE, is preparing a PEIS (DOE 2007) to designate public lands for potential use for long-distance energy transmission corridors in the West. This is an an effort to expedite permitting of transmission systems, such as oil and gas pipelines and power lines (DOE 2007). The proposed action of that PEIS designates federal energy corridors on public lands in areas that would be beneficial for energy development, but excludes sensitive lands (such as National Parks and National Monuments, ACECs, and roadless areas) to the extent practicable. Consideration is given to the locations of tar sands deposits, and possible corridor locations have been designated relatively near to these areas for future use if the tar sands resource is developed. The designation of public lands for potential use in energy transmission ROWs as proposed under the Draft West-wide Energy Corridor PEIS (DOE 2007) would not have direct impacts, with the possible exception of affecting current land use within the corridors and property values on private lands adjacent to or between corridor segments.

The eventual construction and operation of energy transmission ROWs, whether within federally designated energy corridors, within energy corridors on federal lands that are currently identified in land use plans, or at locations identified by industry and evaluated and authorized by appropriate federal agencies (BLM, USFS), could result in adverse environmental impacts on federal and nonfederal lands. The specific types, magnitudes, and extent of project-specific impacts would be determined by the project type, that is, transmission line or pipeline, and its length and location on federal and nonfederal lands; thus, the impacts could be evaluated only at the project level. However, general potential impacts typical of project construction and operation include the use of geologic and water resources; soil disturbance and erosion; degradation of water resources; localized generation of fugitive dust and air emissions from construction and operational equipment; noise generation; disturbance or loss of paleontological and cultural resources and traditional cultural properties; degradation or loss of fish and wildlife habitat; disturbance of resident and migratory fish and wildlife species, including protected species; degradation or loss of plant communities; increased opportunity for invasive vegetation establishment; alteration of visual resources; land use changes; accidental release of hazardous substances; and increased human health and safety hazards. Construction and operation of energy-transmission ROWs could also affect minority and low-income populations in the vicinity of the projects on both federal and nonfederal land as well as local and regional economies.

***Electric Power Plants.*** Impacts from electric power generating plants include emissions of air pollutants, water use, production of large volumes of solid waste (e.g., ash and flue-gas cleanup waste), use and alteration of land, emissions and accidents associated with the transportation of raw materials and wastes, and socioeconomic impacts. Air emissions differ depending on the quality of feed coal utilized. Table 6.2.5-3 summarizes the estimated impacts on various resource areas from the construction and operation of electric power plants. In the near term, it is most likely that low-sulfur Wyoming coal would be utilized for power plants in the study area. In this PEIS, it is assumed that the tar sands projects considered under Alternatives B and C would be powered from existing power plants. However, additional electric power might be required over the study period to support new development.

#### 6.2.5.1.5 Other Activities

***Oil Shale Development.*** This PEIS addresses the environmental and socioeconomic impacts of land use plan amendments and potential development for both oil shale and tar sands, and thus potential oil shale development must be considered in the cumulative impact assessment. Because the level of oil shale development over the next 20 years is unknown, this assessment has assumed that one oil shale facility could be constructed and operated in or near any one of the Utah STSAs during the study period. Impact producing factors for such an oil shale facility include surface disturbance, water use, waste generation, and local changes in employment and population density. The assumptions used for these factors are given in Section 4.1.

**TABLE 6.2.5-3 Assumptions Associated with Coal-Fired Power Plants[a]**

| Impact Producing Factor | Assumed Values for a 1,500-MW Plant (BLM 2007d) | Assumed Values for a 360-MW Current Design Plant and a 425-MW NSPS Plant (Spath et al. 1999)[b] |
|---|---|---|
| Land use (acres) | 3,000 total (includes construction acreage) | NA[c] |
| Water use (ac-ft/yr) | 8,000 ac-ft/yr | NA |
| Fuel source and composition | Wyoming-grade low-sulfur coal (0.47% sulfur, 6.4% ash); heat of combustion = 8,220 Btu/lb (Representative data from Powder River Basin coal; Ellis et al. 1999) | Illinois No. 6 bituminous (4% sulfur, 0.1% chlorine, 1.1% nitrogen, 10% ash dry basis); heat of combustion = 10,800 Btu/lb |
| Fuel requirements | 3.75 million tons/yr (2,330 tons/yr/MW)[d] | Current plant: 1.6 million tons/yr (4,320 tons/yr/MW); NSPS plant: 1.7 tons/yr (3,950 tons/yr/MW) |
| Solid waste (ash) | NA | Current plant: ~36,000 kg/GWh; NSPS plant: ~33,000 kg/GWh |
| Solid waste (flue-gas cleanup) | NA | Current plant ~86,000 kg/GWh; NSPS plant: ~92,000 kg/GWh |
| Emissions | | |
| $SO_2$ | Meet NSPS standards: 258 g/GJ heat input (0.6 lb/million Btu) | Current plant: 6,400 kg/GWh; NSPS plant: 2,229 kg/GWh |
| $NO_x$ | Meet NSPS standards: 258 g/GJ heat input (0.6 lb/million Btu) | Current plant: 3,039 kg/GWh; NSPS plant: 2,041 kg/GWh |
| CO | NA | Current plant: 134 kg/GWh; NSPS plant: 123 kg/GWh |
| $CO_2$ | NA | Current plant: ~970,000 kg/GWh; NSPS plant: ~890,000 kg/GWh |
| Particulates | Meet NSPS standards: 13 g/GJ heat input (0.03 lb/MMBtu) | Current plant: 135 kg/GWh; NSPS plant: 123 kg/GWh |
| VOCs | NA | Current plant: 16 kg/GWh; NSPS plant: 14 kg/GWh |
| Employment (direct FTEs) | Construction: 800 average over 4 yr (1,200 peak); Operations: 135 | NA |
| Transportation | 12 trains/week; 100 cars/train; 10,000 tons/train | 13–14 trains/week; 17 cars/train; 1,445 tons/train |

**Footnotes on following page.**

**TABLE 6.2.5-3 (Cont.)**

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[a] Power plants are assumed to operate at 60% efficiency; thus, a 1,500-MW plant generates approximately 7,900 GWh/yr; a 325-MW plant generates 1,900 GWh/yr; and a 425-MW plant generates 2,200 GWh/yr.

[b] NSPS = new source performance standard.

[c] NA = information not available.

[d] Source for fuel requirement and transportation assumptions is Thompson (2006b,c).

Sources: BLM (2007d); Ellis et al. (1999); Spath et al. (1999); Thompson (2006b,c).

***Grazing.*** Public and private lands in the study area are used extensively for livestock grazing. Environmental impacts of note associated with livestock grazing include potential degradation of soil, vegetation, wildlife habitat, and surface water quality (Krueger et al. 2002; BLM 2006k). For example, overgrazing could result in increased rates of erosion and topsoil losses. Allowing grazing during the nesting seasons of some species could result in trampling of the eggs and decreased viability of those species in the study area. Livestock could also degrade surface water quality if their manure and urine were deposited directly into the water or on land nearby. Good management practices could eliminate or mitigate many of these impacts. On BLM lands, grazing permits are required that specify the species allowed to graze, amount of grazing permitted, and other requirements to minimize environmental impacts.

***Fire Management.*** Fire management is used on public and private lands to aid in wildfire suppression. Underbrush is burned at regular intervals to avoid the buildup of large amounts of fuel on these lands. Fire is considered to have a natural role in the ecosystems and is used as a tool in managing those ecosystems. However, fires have potential environmental impacts that should be considered, particularly air quality impacts and impacts on threatened and endangered species (BLM 2005l). In general, impacts would be lower from more frequent, less intense, controlled fires than from infrequent wildfires.

***Forestry.*** About 25% of the 258 million surface acres that the BLM administers is classified as forested land. Forested land is defined as being 10% stocked with live trees and at least 1 acre in size and 120 ft wide. A 2006 report on the status and condition of these forests states that the national priorities for them include “maintaining and restoring forest health, salvaging dead and dying timber, providing high-quality wildlife and fish habitat, and providing economic opportunities in rural communities by making timber and other forest products, including biomass, available from vegetation management treatments” (BLM 2006l). Management techniques that the BLM uses for forest lands include grazing restrictions, selective thinning of undergrowth and dead wood, prescribed burns, and selective harvesting of trees. Adverse environmental impacts on air quality, water quality, habitat, and threatened and endangered species could occur as a result of these management practices. For example, increased erosion after land clearing could cause siltation in streams and decrease water quality.

***Recreation.*** One mission of the BLM is to accomodate recreational use of public lands, such as fishing, hiking, horseback riding, mountain biking, camping, and OHV use. However, these uses can have adverse environmental impacts. For example, OHV use can result in soil compaction, increased erosion, and the proliferation of non-native plant species. Overuse of trails in primitive areas can also result in erosion and disturbance of threatened and endangered species habitat. Other ways by which recreational visitors could affect the environment include producing waste, emitting air pollutants from motorized vehicles, and using water. However, recreational use also has benefits, including allowing visitors to enjoy outdoor wilderness areas and to reduce their stress, and stimulating economic growth in the area. The BLM works to minimize the adverse environmental impacts of recreational use by managing the activity. Examples of plan requirements include habitat improvement projects in recreational areas, construction of recreational use facilities that lead to decreased random use and degradation of wild areas, and waste management (BLM 2006m).

#### 6.2.5.2 Projected Levels of Major Activities in the Study Area

Data on past, current, and planned future activities on BLM-administered lands and also nonfederal lands were obtained from various BLM RMPs and EISs available through the field offices. Also, because projected developments have been changing rapidly, particularly for oil and gas development, field office staff were contacted to obtain their best current estimates for projected activities in the areas of oil and gas development (both on public and private lands), coal development, other minerals development, energy development, and other activities (e.g., grazing, fire management, forestry, and recreation) over the 20-year time period between 2007 and 2027. The projected levels of major activities in Utah are summarized in Table 6.2.5-4.

**6.2.5.2.1 Oil and Gas Development.** The largest amount of oil and gas development is projected for the Vernal Planning Area, for which about 440 wells per year are predicted; the total projected maximum number of new oil and gas wells for applicable field offices in the state is 620 per year (see Table 6.2.5-4).

**6.2.5.2.2 Coal Mining.** The largest coal reserves are in the Henry Mountain Planning Area, with smaller amounts in the San Rafael Planning Area (Table 6.2.5-4). Predicted production for all field offices combined is about 30 to 34 million tons per year. About half of this production would be from surface mines, and half would be from underground mines.

**6.2.5.2.3 Other Minerals Development.** Metals produced in Utah include copper (one mine), iron (two mines), phosphate (one mine), molybdenum (one mines), potash (three mines), silver (four mines), and uranium (one mine) (EPA 1997). In the ROI counties (Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, and Wayne), only sand and gravel, gilsonite, clay, gypsum, dimension sandstone, lime, helium, and gold are produced (USGS 2004b). Phosphate production occurs in the Diamond Mountain area, and gilsonite in the

**TABLE 6.2.5-4 Projected Levels of Major Activities for Seven Planning Areas Considered in the Cumulative Impacts Assessment for Tar Sands Development in Utah[a]**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Oil and Gas*** | | | | |
| Recoverable oil and gas reserves | NA | NA | NA | NA |
| Potential oil wells drilled/yr over next 20 yr (2007–2027)[b] | 76 wells (based on 2,055 total in VPA, 1,130 in DM only over 15 yr [2003–2017] as projected by BLM [2005b]). | 62 wells (based on 2,055 total in VPA, 925 in BC only over 15 yr [2003–2017] as projected by BLM [2005b]). | 30 wells total in RPA; 3 in HM only (includes oil, gas, and CBNG; based on 454 total over 15 yr [2005–2020]; 3/yr in HM only, as projected by BLM [2005c]). | Few oil wells drilled (based on only 8 currently producing wells); discussion that no significant oil production is expected in the future (BLM 2004b; Appendix 21). |
| Potential gas wells drilled/yr over next 20 yr (2007–2027)[b] | 147 wells (based on 4,035 total in VPA, 2,195 in DM only over 15 yr [2003–2017] as projected by BLM [2005b]). | 143 wells (based on 4,035 total in VPA, 2,150 in BC only over 15 yr [2003–2017] as projected by BLM [2005b]). | Included with potential oil wells drilled for HM PA. | 55–95 wells (includes CBNG; based on 1,100–1,900 over 20 yr [2005–2024] as projected by BLM (2004b; Table 4-2). |
| Potential CBNG wells drilled/yr over next 20 yr (2007–2027)[b] | 4 wells (based on 130 total in VPA, 50 in DM over 15 yr [2003–2017] as projected by BLM [2005b]). | 6 wells (based on 130 total in VPA, 80 in BC over 15 yr [2003–2017] as projected by BLM [2005b]). | Included with potential oil wells drilled for HM PA. HM coal field not likely to be developed for CBNG in the next 15 yr (2005–2020) (BLM 2005d). | Included with potential gas wells drilled for San Rafael PA. Numbers above include Price Project: 545 wells/10 yr on 1,609 acres, 20–70 jobs; Ferron Project: 335 wells/ 5 yr, acres unknown. Impacts on mule deer populations and winter habitat (BLM 2004b). |
| Annual surface disturbance over next 20 yr (2007–2027) (acres/yr)[c] | 570–3,400 acres/yr total (190–1,100 oil; 370–2,200 gas; 10–60 CBNG). | 540–3,200 acres/yr total (160–930 oil; 360–2,100 gas; 15–90 CBNG). | 75–450 acres/yr RPA total; 9–45 HM (includes oil, gas, and CBNG). | 140–1,400 acres/yr (includes gas and CBNG). |

**TABLE 6.2.5-4 (Cont.)**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Oil and Gas (Cont.)*** | | | | |
| Wells to be abandoned annually over next 20 yr (2007–2027)[d] | 57 wells total (19 oil; 37 gas; 1 CBNG). | 54 wells total (16 oil; 36 gas; 2 CBNG). | 8 wells in RPA total, 1 in HM (includes oil, gas, and CBNG). | 14–24 wells (includes gas and CBNG). |
| Seismic exploration projects[e] | 2–3 projects/yr (based on 45–75 total for Vernal, assume half in DM) over 15 yr [2003–2015] [BLM 2002a]); 200–300 acres/yr disturbance. | 2–3 projects/yr (based on 45–75 total for Vernal, assume half in BC) over 15 yr [2003–2015] [BLM 2002a]); 200–300 acres/yr disturbance. | 340 acres/yr disturbance (based on 5,100 total over 15 yr as projected by BLM [2005c]). | 150 acres/yr disturbance (based on 2,236 total over 15 yr as projected by BLM [2004b]). |
| ***Coal*** | | | | |
| Recoverable reserves (million tons) | Tabby Mountain coal field: ~320 million tons (BLM 2002a). | No known reserves (BLM 2002a). | Includes south part of Wasatch Formation: ~6,000 million tons; HM coal field: 20 million tons (Jackson 2006). | Includes northern part of Wasatch Formation: ~690; Book Cliffs coal field: ~280; Emery Coal Field: ~240 (all 3 in million tons) (BLM 2004b; Section 3.3.5.2). |
| Predicted production over next 20 yr (2007–2027) (million tons/yr) | None (BLM 2002a) | None (BLM 2002a) | Wasatch Formation: 25; no production planned for HM (Jackson 2006). | Lila Canyon: 0.8–1; North Horn: 2–4; Willow Creek: 2–4 (BLM 2004b; Chapter 4). |
| Surface area potentially leasable (acres) | NA | None | NA | NA |
| Surface mining area potentially disturbed annually (acres/yr) | None | None | None | None |

**TABLE 6.2.5-4 (Cont.)**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Coal (Cont.)*** | | | | |
| Surface area potentially disturbed for underground mining support facilities (total acres, 2007–2027)[f] | None projected | None projected | 500 acres | Most coal would be mined through underground mining methods (BLM 2004b; Section 3.3.5.2); 500 acres. |
| Other coal impacts | None known | None known | None known | Lila Canyon: 5-mi road, 550 round-trips/day on US 6, 150–200 jobs; North Horn: road, power line, and infrastructure construction, EIS ongoing, start of operations unknown; Willow Creek: not currently leased, if operations begin, 250–300 jobs, surface disturbance, safety issues (BLM 2004b; Chapter 4). |
| ***Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals)*** | | | | |
| Phosphate production over next 20 yr (2007–2027) | 5,800 acres on BLM-administered land; 14,000 acres on private land (BLM 1993; 2002a); assume 50% surface mining (i.e., 10,000 acres). | None (BLM 2002a) | None | None |

**TABLE 6.2.5-4 (Cont.)**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals) (Cont.)*** | | | | |
| Gilsonite production rate over next 20 yr (2007–2027) (tons/yr) | None (BLM 2002a) | 60,000 (based on BLM projections for 2003–2017) (BLM 2002a). | None | None |
| Locatable minerals (e.g., precious metals/gems, uranium, bentonite, gypsum, limestone, salt) | Minor to no activity (BLM 2002a). | Minor to no activity (BLM 2002a). | Uranium, vanadium, gold, copper: high potential for occurrence and development in HM area; exploration for economic quantities is continuing (BLM 2005d). One salt mine on west side of RPA to continue operations. Gypsum and salt production unlikely in next 15 yr, especially in HM area (BLM 2005d). | Gypsum: Fairly large areas in south and central parts of PA have high potential for development over next 15 yr (2005–2020) (BLM 2004b; Section 3.3.5.1). Number of acres: NA. |

**TABLE 6.2.5-4 (Cont.)**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals) (Cont.)*** | | | | |
| Salable minerals (gravel, sand, clay) | Stone: 30 tons/yr (based on 60 tons/yr total for VPA, 2003–2017 (BLM 2002a); Limestone: 30,000 tons/yr (based on FS land production, most in DM (BLM 2002a); Sand and gravel: some production, quantity unknown (BLM 2002a). | Stone: 30 tons/yr (based on 60 tons/yr total for VPA, 2003–2017 (BLM 2002a); Sand and gravel: some production, quantity unknown (BLM 2002a). | For planning period of 2006–2020: 57 active sand and gravel disposal sites on BLM-administered land; likely to continue producing ~20,000 $yd^3$/yr, additional sites on public land (BLM 2005d). Assume 2 permits at 6 acres/permit, 12 acres/yr. Clay: only small-scale development. Stone: continue at current rate of about 1–1,000 tons/yr (BLM 2005d). Humate production to continue on small scale at Factory Butte in HM (BLM 2005d). | Clay: current areas of active mining would continue over next 15 yr (2005–2020), unlikely that new deposits would be developed (BLM 2004b; Section 3.3.5.1). Sand and gravel, stone, and humate: high potential areas near major paved roads would be developed 2005–2020 (BLM 2004b; Section 3.3.5.3). |
| ***Energy Development*** | | | | |
| Energy corridors | NA | NA | NA | NA |
| Electric generating utilities | NA | NA | NA | NA |

**TABLE 6.2.5-4 (Cont.)**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Energy Development (Cont.)*** | | | | |
| Existing power plants | NA | NA | NA | Hiawatha Cogeneration Plant, Questar Pipeline Dewpoint Plant, Sunnyside Cogeneration Facility, coal-fired PacifiCorp Hunter, Huntington and Carbon plants: all provide employment, emit $NO_X$, use water, and decrease water quality. Planned PacifiCorp Hunter expansion: add 350 long-term jobs, increase $NO_X$, and $SO_X$ emissions, use and degrade water (BLM 2004b). |
| ***Other*** | | | | |
| Forestry | NA | NA | NA | Logging on private lands (not quantified) (BLM 2004b; Section 4.2.2). |
| Fire management | 5,500–7,800 acres/yr prescribed burns annually, based on 11,000 acres total in VPA as projected by BLM for 2002–2006 (BLM 2005b; Section 3.4) or 156,425 acres/decade total in VPA (BLM 2005b; Table 2.3). | 5,500–7,800 acres/yr prescribed burns annually (based on no action of 11,000 acres total in VPA projected by BLM for 2002–2006 (BLM 2005b; Section 3.4) and 156,425 acres/decade total in VPA (BLM 2005b; Table 2.3). | NA | One prescribed burn of 5,000 acres every 2 yr (based on last 20 yr data) (BLM 2004b; Section 3.2.10.4). |

**TABLE 6.2.5-4 (Cont.)**

| Activity | Diamond Mountain (Western Half of Vernal PA) | Book Cliffs (Eastern Half of Vernal PA) | Henry Mountain (Southeast Portion of Richfield PA) | San Rafael (Area Similar to Price PA) |
|---|---|---|---|---|
| ***Other (Cont.)*** | | | | |
| Land and realty | NA | NA | NA | Utah Department of Transportation: road improvements between 2006 and 2025 on US 6 between Green River and Spanish Fork (~3-mi widening, 12 mi of new asphalt). Also SR 10 corridor (5 mi) (BLM 2004b; Section 4.2.2). |
| Livestock | NA | NA | NA | NA |
| Special management areas, recreation | 4–27 mi/yr nonmotorized recreational trails and 54 mi/yr motorized trails would be developed total in VPA (between 2006 and 2020; BLM 2005b; Table 2.3); assume half in DM. | 4–27 mi/yr nonmotorized recreational trails and 54 mi/yr motorized trails would be developed total in VPA (between 2006 and 2020; BLM 2005b; Table 2.3); assume half in BC. | NA | NA |
| Vegetation | 2,300–3,400 acres/yr vegetation treated total in VPA (between 2006 and 2020; BLM 2005b; Table 4.18.2); assume half in DM. | 2,300–3,400 acres/yr vegetation treated total in VPA (between 2006 and 2020; BLM 2005b; Table 4.18.2); assume half in BC. | NA | NA |
| Soils/watersheds | NA | NA | NA | NA |
| Miscellaneous | NA | NA | NA | NA |

**TABLE 6.2.5-4 (Cont.)**

| Activity | San Juan (Area Similar to Monticello PA) | Grand Staircase–Escalante NM | Moab PA | Summary for Utah PAs and GSENM |
|---|---|---|---|---|
| ***Oil and Gas*** | | | | |
| Recoverable reserves | NA | >270 million bbl (Allison 1997) | NA | NA |
| Potential oil wells drilled/yr over next 20 yr (2007–2027)[b] | 5–21 wells (includes gas, average of 13/yr, 195 total from 2006–2020 (BLM 2005e). | Few (only 47 exploratory wells currently in GSENM; ~ 200,000 acres of old leased land are under review) (BLM 1999b). | 12–40 wells (includes gas, average of 26/yr, 390 total from 2006–2020 (BLM 2005a). | 190–230 oil wells drilled/yr |
| Potential gas wells drilled/yr over next 20 yr (2007–2027)[b] | Included with potential oil wells drilled for San Juan PA. | None (BLM 1999b) | Included with potential oil wells drilled for MOAB PA. | 350–390 gas wells drilled/yr |
| Potential CBNG wells drilled/yr over next 20 yr (2007–2027)[b] | None (BLM 2005f) | None (BLM 1999b) | 1 well (based on three 5-spot well clusters between 2006 and 2020 (BLM 2005g); assume same annual rate). | 11 CBNG wells drilled/yr |
| Annual surface disturbance over next 20 yr (2007–2027) (acres/yr)[c] | 13–320 acres/yr (includes oil and gas). | NA | 33–620 acres/yr total (30–600 [oil and gas]; 3–15 CBNG (similar to 225 total acres CBNG between 2006 and 2020) (BLM 2005g). | 1,400–9,400 acres/yr |
| Wells to be abandoned annually over next 20 yr (2007–2027)[d] | 2–8 wells (includes oil and gas) (BLM 2005e). | NA | 6–20 wells (BLM 2005a). | 140–170 wells abandoned/yr |
| Seismic exploration projects[e] | 150 acres/yr disturbance (based on 2,236 total over 15 yr as projected by BLM [2005e]). | NA | 240 acres/yr disturbance (based on 3,600 total over 15 yr [2006–2020] as projected by BLM [BLM 2005a]). | NA (~1,500–2,100 acres/yr of temporary vegetation and habitat disturbance)[d] |

**TABLE 6.2.5-4 (Cont.)**

| Activity | San Juan (Area Similar to Monticello PA) | Grand Staircase–Escalante NM | Moab PA | Summary for Utah PAs and GSENM |
|---|---|---|---|---|
| ***Coal*** | | | | |
| Recoverable reserves (million tons) | San Juan coal field (530,000 acres; 60% privately owned) (BLM 1991a), 77 million tons available to surface mining; no current production because of poor quality/lack of rail transport (BLM 2005f). | NA | NA (Sego Formation produced ~3 million tons up through the 1950s) (BLM 2005g). | ~7.6 billion tons |
| Predicted production over next 20 yr (2007–2027) (million tons/yr) | None (BLM 2005f) | None (BLM 1999b) | None (BLM 2005g) | 30–34 million tons/yr |
| Surface area potentially leasable (acres) | NA | NA | NA (Sego Formation may be attractive for future production because of low sulfur content, close to railway). | NA |
| Surface mining area potentially disturbed annually (acres/yr) | NA | NA | NA | NA |
| Surface area potentially disturbed for underground mining support facilities (total, 2007–2027, acres)[f] | None projected | None projected | None projected | 1,000 acres total 2007–2027 |
| Other coal impacts | None known | None known | None known | See San Rafael PA. |

**TABLE 6.2.5-4 (Cont.)**

| Activity | San Juan (Area Similar to Monticello PA) | Grand Staircase–Escalante NM | Moab PA | Summary for Utah PAs and GSENM |
|---|---|---|---|---|
| ***Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals)*** | | | | |
| Phosphate production over next 20 yr (2007–2027) | None (BLM 2005f) | None (BLM 1999b) | None (BLM 2005g) | 10,000 acres surface disturbance (see DM) |
| Gilsonite production rate over next 20 yr (2007–2027) (tons/yr) | None (BLM 2005f) | None (BLM 1999b) | None (BLM 2005g) | 60,000 tons/yr gilsonite (see BC) |
| Locatable minerals (e.g., precious metals/gems, uranium, bentonite, gypsum, limestone, salt) | Uranium/vanadium: 4.2 million tons in reserves in Four Corners area—estimated disturbance of 20 acres/yr for next 15 yr (2005–2020) (BLM 2005f). Gold: 5–20 acres total disturbed for next 15 yr in Recapture Creek and Johnson Creek (BLM 2005f). Limestone: 20,000–30,000 tons/yr, 20–50 acres total disturbed for next 15 yr (BLM 2005f). | Uranium/vanadium: deposits present (Allison 1997), not to be developed (BLM 1999b). Alabaster: ongoing production of 300 tons/yr—from surface, not usually quarried. | Uranium/vanadium: >1 million tons ore reserves—estimated disturbance of 10 acres/yr for next 15 yr (2005–2020) (BLM 2005g). Copper: Lisbon Valley Project—produce for 10 yr (2006–2015); disturb 110 acres/yr (1,103 total, includes 266-acre pad for leaching, processing plant, ponds, and 11-mi power line). Salt/potash: 3.3 acres/yr (50 acres disturbance total over next 15 yr [2006–2020] BLM 2005g). | Uranium/vanadium: high potential for development with at least 30 acres/yr surface disturbance; Gold: at least 5 acres/yr disturbed; Limestone: at least 20 acres/yr disturbed; Gypsum: high potential for development, acres NA; Alabaster: 300 tons/yr, acres NA; Salt: at least 3 acres/yr disturbed; Copper: at least 110 acres/yr disturbed. Total: at least 170 acres/yr disturbed. |

**TABLE 6.2.5-4 (Cont.)**

| Activity | San Juan (Area Similar to Monticello PA) | Grand Staircase–Escalante NM | Moab PA | Summary for Utah PAs and GSENM |
|---|---|---|---|---|
| ***Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals) (Cont.)*** | | | | |
| Salable minerals (gravel, sand, clay) | Sand and gravel: 4 permits/yr producing ~127,000 $yd^3$/yr, 6 acres/permit, thus 24 acres/yr disturbed over next 15 yr (2005–2020) (BLM 2005f). Building stone: 5–10 acres/yr over next 15 yr (2005–2020) (BLM 2005f). | Sand and gravel: limited production for local use (Allison 1997). | Sand and gravel: 4 permits/yr producing ~60,000 $yd^3$/yr, 6 acres/permit, thus 24 acres/yr disturbed over next 15 yr (2005–2020) (BLM 2005g). Building stone: ~0.5 acres/yr over next 15 yr (1 new facility, producing 5,000–10,000 tons/yr for 5 yr between 2006 and 2020) (BLM 2005g). | Sand and gravel: at least 60 acres/yr disturbed; Stone: at least 6 acres/yr disturbed; Clay: no new deposits to be developed. |
| ***Energy Development*** | | | | |
| Energy corridors | NA | NA | NA | Estimated 640 mi (271,000 acres) in Utah; a portion of the corridor is expected to be sited near the tar sands resources (DOE 2007). |
| Electric generating utilities | NA | NA | NA | ~3,200 MW currently produced in region (98% from coal) (EIA 2007). Three new plants proposed in Utah (~1,570 MW capacity [EPA 2002]). |
| Existing power plants | NA | None | NA | See San Rafael PA. |

**TABLE 6.2.5-4 (Cont.)**

| Activity | San Juan (Area Similar to Monticello PA) | Grand Staircase–Escalante NM | Moab PA | Summary for Utah PAs and GSENM |
|---|---|---|---|---|
| ***Other*** | | | | |
| Forestry | NA | NA | NA | See San Rafael PA. |
| Fire management | NA | NA | NA | NA (at least 13,500 acres/yr prescribed burn) |
| Land and realty | NA | NA | NA | See San Rafael PA (road planned). |
| Livestock | About 2.1 million acres used for grazing (BLM 1986d). | NA | NA | NA (about 2.1 million acres used for grazing in Monticello PA). |
| Special management areas, recreation | About 1.3 million acres used for recreation (BLM 1986d) | ~6 acres/yr disturbed (total of 85 acres over 15 yr [2000–2014] for recreation and campsites (BLM 1999b). | NA | NA (some motorized and nonmotorized trails and campsites to be developed). |
| Vegetation | NA | 1,000–3,000 acres/yr for vegetation restoration through burning (20,000 acres total for 2000–2014). | NA | At least 3,300 acres/yr vegetation treatment or burning for restoration. |
| Soils/watersheds | NA | <1 acre/yr (10 sites at 1 acre/site) (BLM 1999b). | NA | NA (at least 1 acre/yr disturbance) |
| Miscellaneous | NA | ~17 acres/yr for utility and road ROWs and communications sites (260 acres total over 15 yr [2000–2014] (BLM 1999b). | NA | NA (at least 17 acres/yr disturbance) |

**Footnotes on following page.**

**TABLE 6.2.5-4 (Cont.)**

Abbreviations: ACEC = Area of Critical Environmental Concern; BC = Book Cliffs; BCF = billion cubic feet; CBNG = coal bed natural gas; DM = Diamond Mountain; FS = Forest Service; GSENM = Grand Staircase–Escalante National Monument; HM = Henry Mountain; NA = information not available; PA = planning area; RPA = Richfield Planning Area; SM = surface mining; SR = surface retort; UM = underground mining; VPA = Vernal Planning Area.

[a] The activities listed are those considered in addition to tar sands development on federal lands as described for Alternatives B and C. In general, values are rounded to two significant figures.

[b] Includes projections for federal lands, and, where available, nonfederal lands.

[c] Assumes a range of 2.5 to 15 acres/well for well pads, roads, and pipelines (representative range based on 2.5 acres from DOE [2006]), 3 acres from Vernal Mineral Potential Report (BLM 2002a), and 15 acres from Moab PA (BLM 2005a). The 2.5- to 15-acre range encompasses estimates for San Rafael of 7.9 acres/well + 20 acres/ancillary facility (BLM 2004b; Appendix 21); Henry Mountain (4 acres/well + 8 acres/well for roads) (BLM 2005c); and Monticello (9.6 acres/well) (BLM 2005e).

[d] Generally assumes that 25% of new wells would be abandoned (based on estimate provided for the Rawlins Wyoming Field Office [Allison 2006]). Assumes 50% for Moab (BLM 2005a) and 40% for Monticello (BLM 2005e). All surface disturbance is assumed to be reclaimed within 10 years of abandonment.

[e] If information is not available, assume approximately 1 to 2 geophysical exploration projects/50 wells drilled annually (based on Wyoming estimates); 100 acres disturbed/project (this is short-term disturbance such as crushed vegetation, uprooted brush, and minor soil disturbance; disturbance is generally unidentifiable within 1 yr). At 550 to 630 wells drilled/yr, expect 11 to 26 projects/yr for Utah overall.

[f] For areas where coal mining is ongoing and subsurface, a limited amount of surface disturbance over the 20-year planning period was assumed (i.e., 500 acres).

Henry Mountain area. Uranium/vanadium has a high potential for development in the Henry Mountain and San Juan Planning Areas; it would result in at least 30 acres per year of surface disturbance. A limited amount of other minerals development is expected (Table 6.2.5-4).

**6.2.5.2.4 Energy Development.** The DOE estimates that 640 mi of corridors could be sited on public lands in Utah, with a total surface area of 356,000 acres (DOE 2007). This development would be in addition to the existing 5,120 ROWs crossing public lands in Utah as of 2005.

Table 6.2.5-5 summarizes the electric generating units operating in oil shale ROI counties in Utah in 2005, including the primary fuel source for each plant and its electric power generating capacity. Of the 3,220 MW of nameplate power available from 14 generating units, 98% was from eight coal-fired generators. As of 2000, there were also three new generating plants proposed for Utah, with a total capacity of 1,570 MW (EPA 2002).

**6.2.5.2.5 Other (Oil Shale Development, Grazing, Forestry, Fire Management, and Recreation).** Potential oil shale development in Utah could affect development of tar sands resources. The assumptions used for impact-producing factors for a single oil shale facility are given in Section 4.1.

Although information is not available for every planning area, at least 13,500 acres per year are planned to be used for prescribed burns under current management practices. Large tracts of land are used for grazing in the Monticello Planning Area.

**TABLE 6.2.5-5 Electric Power Generating Units in ROI Counties in Utah in 2005[a]**

| State | Primary Fuel | No. of Generating Units | Combined Power (MW-nameplate) |
|---|---|---|---|
| Utah | Coal | 8 | 3,157 |
| | Waste coal | 1 | 58 |
| | Water | 5 | 5.4 |
| | Total | 14 | 3,220 |

[a] ROI counties include Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, and Wayne.

Source: EIA (2007).

The BLM manages more than 8 million acres of forest lands in Utah; the majority are in the southern half of the state, including the planning areas addressed in this PEIS. Most (more than 90%) of the forests are woodlands. The net annual growth in forest lands has been estimated as 9.2 million $ft^3$ (BLM 2006l). The major cause of tree mortality has been fires, followed by insect damage.

#### 6.2.5.3 Cumulative Impacts Assessment for Alternatives B and C

**6.2.5.3.1 Land Use.** Potential land use impacts associated with a single commercial tar sands facility include the exclusion of grazing, recreation, other mineral development land uses from lands used for tar sands development facilities and associated off-lease facilities (e.g., employer-provided housing, and ROWs). Tar sands development could also alter the quality of lands with wilderness characteristics. Tar sands development facilities would disturb up to 5,760 acres of public lands for the facilities themselves, and up to an additional 3,750 acres of lands for ROWs and employer-provided housing (locations where these facilities would be sited are unknown, but are not expected to be on public lands). While the total amount of ground disturbance for a tar sands facility using in situ technology could equal that of a facility using surface mining, surface acreage disturbed at any one time might be considerably less for in situ facilities depending on the cycle of preparation, production, and reclamation.

Table 6.2.5-6 presents estimates of the amount of land needed for other major industrial activities in the study area over the 20-year study period. These lands may be federal or non-federal lands. As this table shows, land use in Utah is characterized by an extensive amount of industrial activity that is expected to continue into the future. Depending on the number and types of tar sands facilities constructed and operating, future commercial tar sands development could contribute a substantial increment to the cumulative land use and disturbance impacts. Over a 20-year time horizon, a single tar sands facility could contribute an approximately 5 to 42% increase in land disturbance (i.e., up to about 9,500 acres for a single tar sands project compared with the range of other disturbances of 42,000 to 202,000 acres). ). If several tar sands leases are eventually granted within relatively close proximity to one another, this amount of leasing within a relatively small area would result in substantial changes in land use in that area. Oil shale development, if it occurs, would also contribute to cumulative land disturbance impacts. It should be noted that the projections given in Table 6.2.5-6 are very sensitive to the amount of disturbance due to oil and gas development that would occur, with the large range of possible disturbance making the estimates quite uncertain.

As discussed in Section 6.2.5.2, many public lands are currently used as ROWs for short- and long-distance energy transmission. The Draft West-Wide Energy Corridor PEIS (DOE 2007) may designate additional regional corridors on public lands for long-distance energy transmission ROWs. Under the proposed action of that PEIS, the proposed corridors include about 360,000 acres in Utah, a portion of which would fall within the tar sands development area. Not all lands designated as energy corridors would be developed and/or disturbed;

**TABLE 6.2.5-6 Summary of Cumulative Long-Term Land Use for Tar Sands Development and Other Major Industrial Activities**

| Activity | Estimated Acres Disturbed[a] |
|---|---|
| Commercial tar sands development on federal or nonfederal lands[b] | Up to 9.500 per project |
| Commercial oil shale development on federal lands or nonfederal lands[b] | Up to 14,000 per project |
| Oil and gas development (acres/yr) | 1,400–9,400 |
| Coal development (acres/yr) | 50 |
| Sodium minerals (nahcolite and dawsonite) development (acres/yr) | 0 |
| Phosphate production | 10,000 |
| Proposed power plants[c] | 3,100 |
| Annual total excluding tar sands and oil shale development | 14,600–22,600 |
| 20-year totals, excluding tar sands and oil shale development | 42,000–202,000 |
| Single tar sands facility percent of 20-year total | 5–42 |

[a] Except where otherwise indicated, average estimates are the maximum projected totals from Table 6.2.5-4.

[b] Acreage estimates represent the maximum possible disturbance for individual tar sands facilities (Section 5.1) and oil shale facilities (Section 4.1).

[c] The acreages represent the estimated footprint of projected new power plant development as discussed in Section 6.2.5.2, assuming all would be coal-fired plants requiring 3,000 acres per 1,500 MW of capacity.

however, the percent of potential disturbance is currently unknown. Should these proposed corridors be developed for energy-related ROWs, additional land use impacts in the region could be substantial.

**6.2.5.3.2 Soil and Geologic Resources.** Tar sands development could result in impacts on soil and geologic resources by increasing soil removal, soil compaction, and erosion. Erosion of exposed soils could also lead to increased sedimentation of nearby water bodies, and to the generation of fugitive dust which could affect local air quality. Project areas would remain susceptible to these impacts until completion of construction, mining, tar sands processing, and site stabilization and reclamation activities (e.g., revegetation of pipeline ROWs and surface mine reclamation). Impacts on soil and geologic resources would be limited to the specific project location as well as areas where associated off-site infrastructure (such as access roads and utility ROWs) would be located.

Oil and gas development, other minerals development, oil shale development, and construction of additional power plants would cause similar impacts on soil and geologic resources in the Utah study area. Table 6.2.5-6 gives estimates of the amount of land that could be disturbed for these activities over the 20-year study period. Additional types of land use could also disturb soil. These would include, but not be limited to, agricultural development, grazing, recreation, forestry, and residential development. The potential impacts from these have not been quantified. Also as discussed in Section 6.2.5.2.4, large areas might be designated as energy corridors, and their development would also contribute to total soil disturbance. All these activities may result in soil being displaced, stockpiled, eroded, or compacted through various site activities. The disturbance could yield increased sediment to surface waters, and, in areas with high salinity in the soils, the salt content in surface water may also increase.

Impacts on soil and geologic resource from tar sands development could add a substantial increment to cumulative impacts on this resource. Impacts would increase with increasing numbers of tar sands facilities. A single facility could be associated with soil disturbance of up to about 9,500 acres.

**6.2.4.3.3 Paleontological Resources.** Disturbances from tar sands development, combined with other surface-disturbing development activities, could uncover and/or destroy fossils on BLM-administered land and on other lands. Given the surface disturbance projected from tar sands development and from other activities (Table 6.2.5-6) in the study area during the 20-year study period, it is likely that many sites will require paleontological evaluations and mitigations. Assuming that these evaluations and mitigations are conducted in accordance with existing regulations, there would be increased knowledge of paleontological resources in the region and increased protection of resources based on this knowledge. However, there would inevitably be some loss of information from individual sites, and some impacts. Resources lost from tar sands leasing and development would be in addition to those losses from other activities discussed in this section. Unless a concentration of unique resources is found to exist within a small area, and that area was the location of tar sands development, these individual site losses

from construction and operation of a tar sands facility would be unlikely to have a major incremental adverse impact on paleontological resources in the study area.

**6.2.4.3.4 Water Resources.** Many activities projected to occur in the study area could increase sediment and dissolved solid loads in streams downstream of disturbed sites (e.g., ROW construction and other construction projects, mining, and construction of access roads and river crossings). After the protective layers of soils are disturbed, the soils become vulnerable to erosion by surface runoff. Leaching from mine tailings and waste, overburden piles, and source rock piles would potentially bring organic and metal contaminants to nearby streams. Potential leaks (or spills) of oil or other petroleum products from pipelines would be additional risks for contamination of surface water resources. Modification of surface drainage and water extraction could also cause flow regime and morphological changes of stream channels. Most of the impacts would occur in the vicinity of the water bodies close to project sites and would be incremental.

If oil and gas development, mining activities, and power plant construction continue to grow as projected from 2007 to 2027, the disturbed areas are estimated to increase by a total of 42,000 to 202,000 acres in Utah (Table 6.2.5-6). If a single tar sands facility is developed, it will contribute about 5 to 42% additional ground disturbance in Utah. Some of the impacts near construction sites and mining sites would be local and could be managed and mitigated. The incremental impacts on water resources caused by tar sands and ancillary facilities development could be significant relative to the other activities. The incremental and cumulative impacts would depend on the location and size of tar sands development and would be evaluated in future environmental assessments.

The water uses and losses in the Upper Colorado River Basin are shown in Figures 6.1.5-1 through 6.1.5-4. From the 1970s to the 1990s, the water uses increased, reflecting growth in agricultural and in municipal and industrial water uses (Figures 6.1.5-1 and 6.1.5-4). The export of Colorado River water to outside the Upper Colorado River Basin also increased gradually with time (Figure 6.1.5-3). From 1990 to 2000, the combined water use and losses in Colorado, Utah, and Wyoming within the Upper Colorado Basin fluctuated between 3,580 and 4,400 thousand ac-ft (Figure 6.1.5-4). This includes water losses from major and minor reservoirs, agricultural and municipal and industrial water uses, and water transfers out of the basin. From 2001 to 2004, the combined water uses and losses dropped from 4,280 to 3,400 thousand ac-ft (primarily through declining agricultural water uses) because of drought conditions (BOR 2004, 2005, 2006.)

To preliminarily assess cumulative water use in the study area over the next 20 years and the potential incremental impacts of tar sands development, water use projections for oil and gas development, coal mining, and power generation are compared with water use for individual tar sands facilities and with available water in the Upper Colorado River Basin (see Table 6.2.5-7). The sustainable, annually available water in the Upper Colorado River Basin was assumed to be 6,000 thousand ac-ft/yr (SWCA 1997) (a prolonged drought condition may decrease this water availability). The total amount of legally apportioned water available to Colorado, Utah, and Wyoming is 5,280 thousand ac-ft/yr. The water transfer out of the Upper Colorado River Basin

**TABLE 6.2.5-7 Major Water Uses in the Next 20 Years in the Three-State Study Area Compared with Use for Potential Tar Sands Development (× 1,000 ac-ft/yr)**

| Available Water and Water Use | Annual Volume |
|---|---|
| Amount of legally available water from the Colorado River | 5,280 |
| Consumption uses, including export, agricultural, M&I, and evaporation | 4,140–5,200 |
| Range of net amount available | 80–1,140 |
| Water use estimates | |
| Commercial tar sands development on federal or nonfederal lands (individual 20,000 bbl/day tar sands facility)[a] | <1–7.1 |
| Commercial oil shale development on federal or nonfederal lands (individual 200,000 bbl/day in situ facility and ancillary facilities, including power plant)[a] | 21–41 |
| Commercial oil shale development on federal or nonfederal lands (individual 50,000 bbl/day surface mine/surface retort or underground mine/surface retort facility and ancillary facilities)[a] | 7–10 |
| Other development | |
| Oil and gas[b] | 1.6 |
| Coal mining[c] | 0.7 |
| Power plants[d] | 53 |
| Total other development | 55.3 |

[a] Includes processing and human consumption.

[b] Assumes that 3,000 wells are drilled per year and that each uses 0.55 ac-ft of water.

[c] Assumes 82 million tons of production per year; 20 million gal of water per million tons of coal mined is assumed for coal preparation, and 35 million gal of water per million tons of coal mined is assumed for dust control.

[d] Assumes a total of 9,940 MW new production from coal-fired power plants; water consumption of 8,000 ac-ft/yr per 1,500 MW (see Section 6.1.5.2-4).

Sources: SWCA (1997); BOR (2004, 2005, 2006).

fluctuates, but was assumed to remain in the same range (540 to 800 thousand ac-ft/yr) as for 1970 to 2004 (Figure 6.1.5-3). Also, the currently combined water uses for agricultural, municipal, and industrial activities were assumed to remain at the same level as those found in 1990 to 2000 (i.e., 3,600 to 4,400 thousand ac-ft/yr; Figure 6.1.5-4). This could occur as water is transferred from agricultural to municipal and industrial use. The available water for tar sands development consumption, therefore, would be between 80 and 1,140 thousand ac-ft/yr over the next 20 years in the three states. Each tar sands development facility is assumed to require from <1 to 7.1 thousand ac-ft/yr of water, depending on the technologies being used (i.e., each facility,

including ancillary facilities, would require from less than 1 to 12% of available water). This assessment shows that although demands on Colorado River water are high and growing, between available supplies and those that could be purchased or transferred, the available water would likely be able to support some level of tar sands development over the next 20 years, depending on the type of technology used, the level of development, and the other competing uses of water at the time of development.

Meeting the water requirements also depends on how many facilities are constructed, the technologies being used, and the locations of the sites. Using water conservation practices and transferring agricultural water rights to industrial rights (including tar sands development) could make more water available if extensive tar sands development is desired. Currently, most of the water use in the Upper Colorado River Basin is for agricultural purposes. The agricultural component ranges from 55% in the Upper Main Stem (Colorado River and its tributaries above the mouth of the Green River) to 87% in the San Juan–Colorado area (Colorado River and its tributaries below the mouth of the Green River and above Lee Ferry, Arizona) (BOR 2004, 2005, and 2006).

**6.2.5.3.5 Air Quality.** Air resources in and around the study area would be affected by subsequent commercial development of tar sands. Local, short-term air quality impacts could be incurred as a result of PM and exhaust emission releases during construction activities. Similar short-term impacts could also occur in other areas where electric transmission or oil pipeline ROWs and other infrastructure would be developed. Longer-term impacts on local and regional air quality could occur during normal project operations, such as mining and processing of the tar sands, and construction and operation of off-lease infrastructure, resulting in emissions of criteria pollutants and hazardous air pollutants.

Oil and gas development, other minerals development, and other activities (e.g., agricultural development and residential development) would all involve impacts on local air quality during land clearing and construction because of increased PM emissions and exhaust emission from construction equipment. There could also be regional air quality impacts if these activities involved long-term emissions of criteria pollutants or hazardous air pollutants at substantial levels. The incremental impact of tar sands development activities to total cumulative impacts would be assessed during future site-specific NEPA analyses.

**6.2.5.3.6 Noise.** Noise is a transient problem; its impacts do not accumulate in the environment as do air and water pollutants. Dissipation mechanisms, such as geometric spreading, ground effects, and air absorption, dissipate noise energy within short distances form noise sources. However, cumulative noise impacts could occur with oil shale and tar sands development on federal and nonfederal lands, oil and gas development, surface and underground mining of coal, production of other minerals, and energy development (see Table 6.2.5-4); such impacts would depend critically on site-specific considerations and the proximity of the operations being considered to each other. The cumulative impacts of sufficiently separated noise sources are essentially the same as the noise impacts of each source considered separately. For example, the cumulative impacts of a tar sands production facility and a gas or oil well field

could be considerably different if the pumps and wells associated with the two facilities were only a mile apart than if they were separated by even a few miles.

Cumulative impacts also depend upon which phases in the lifetime of the sources being considered are occurring simultaneously. For example, construction associated with a tar sands facility would cause only a slight cumulative increase in the preexisting noise levels associated with a pumping station on an oil pipeline, while operation of the tar sands facility could cause a large increase over the preexisting levels around the facility and along nearby roads.

The construction noise impacts discussed in Section 5.7 are based on general considerations and are applicable to a wide range of construction projects. For many tar sands development projects, the leased area would be large enough that noise levels would be below EPA guideline levels at the site boundaries. Because of the probable large distance between projects, it is unlikely that construction of tar sands facilities would cause a substantial incremental increase in noise impacts over those associated with existing and reasonably foreseeable future projects. However, the construction of large-scale commercial tar sands projects involving the drilling of many wells could produce higher noise levels, with cumulative impacts. Also, if tar sands development is close to other projects and construction and worker vehicles from both projects use the same roads, there could be cumulative noise increases due to increased traffic on local roads. An estimate of cumulative impacts must be made during the assessment of site-specific impacts.

As noted in Section 5.7, adverse noise impacts could be associated with commercial tar sands facilities. Drilling and pumping in oil and gas recovery fields could also contribute to high cumulative noise levels, and mining operations could cause high noise levels in the vicinity of the mine. If these other activities occur in close proximity to tar sands development operations, the possibility of substantial cumulative impacts exists. However, these impacts cannot be estimated at this time given the lack of quantitative estimates for tar sands facilities and the lack of data on specific locations of other development activities. An estimate of cumulative impacts must be made during the assessment of site-specific impacts.

**6.2.5.3.7 Ecological Resources.** Cumulative impacts of commercial tar sands development on ecological resources in the three-state study area would result from the past, present, and future impacts of a wide variety of human activities, including agricultural development and production, grazing activities, range management, timber harvest and management, residential and commercial development, recreational activities, water resource development projects, mineral resource development, and energy development. The current status of ecological resources as described in Section 3.7 reflects the cumulative impacts of past and present activities. This section focuses on the incremental impacts of the tar sands development alternatives and a set of reasonably foreseeable future actions that are expected to occur or that could occur over the next 20 years if commercial tar sands projects are developed. Reasonably foreseeable future projects include oil and gas development, coal mining, mining of metals and minerals, energy transmission, electrical generation, and other activities, including grazing, fire management, forestry, and recreation as described in Section 6.2.4.2.

The cumulative impacts of greatest concern on ecological resources in the study area include loss or degradation of habitat and habitat fragmentation related to land disturbance, loss of individuals in populations (especially those of rare species), and changes in the availability and quality of surface water resources. All other factors described in Sections 4.8.1 and 5.8.1 have the potential to contribute to cumulative impacts, but their contributions would be relatively minor and more localized.

Section 6.2.4.2 presents available information on the projected levels of development for major activities in the study area. Major increases in land disturbance from reasonably foreseeable projects total approximately 200,000 acres for the projected 20-year study period (Table 6.2.5-6). Land disturbance associated with individual commercial tar sands facilities could be up to about 9,500 acres.

Water depletions associated with reasonably foreseeable future actions over the next 20 years represent significant increases in cumulative water use in the study area (more than 55,000 ac-ft/yr of the 80,000 to 1.1 million ac-ft/yr potentially available). Existing water uses represent about 4.1 to 5.2 million ac-ft/yr. Water consumption associated with individual commercial tar sands development facilities would range from less than 1,000 to 7,100 ac-ft/yr; water consumption associated with individual commercial oil shale development facilities would range from 7,000 to 41,000 ac-ft/yr (see Table 6.2.5-6).

Cumulative impacts on aquatic resources; plant communities and habitats; wildlife; and threatened, endangered, and sensitive species are discussed below.

***Aquatic Resources.*** The analysis of cumulative impacts on aquatic habitats and the organisms that inhabit those habitats considered the potential impacts of tar sands development in Utah together with impacts from other anticipated development activities as described in Section 6.2.4.2. The types of impacting factors associated with these activities would be similar to those described for the direct and indirect effects of tar sands development, including (1) direct disturbance of aquatic habitats; (2) sedimentation of aquatic habitats as a consequence of soil erosion from nearby areas; (3) changes in water quantity or water quality as a result of changes in surface runoff patterns, depletions or discharges of water into nearby aquatic habitats, or releases of contaminants into nearby aquatic systems; or (4) changes in human access to aquatic habitats.

Direct disturbance of aquatic habitats can result from activities that occur within water bodies or within the active channel of streams and rivers. Such disturbance can occur as a result of mineral (e.g., gravel) extraction from streambeds; construction of stream crossings for pipelines, transmission lines, and roads; driving vehicles through or using heavy machinery within active channels; and from livestock that walk through waterways. There is a potential for all of these activities to occur within STSAs, although it is generally anticipated that the related impacts would be relatively small and localized. Activities such as oil and gas development, mining, energy development, grazing, fires and fire management, and logging all affect erosion potential by disturbing soils and removing or altering vegetated cover. Such activities associated with other future projects are expected to result in a considerable increase in land disturbance in

the vicinity of STSAs over the 20-year project time frame and could result in a considerable increase in sediments entering aquatic habitats.

As described in Section 5.8.1.1, construction activities for tar sands development could also directly disturb aquatic habitats and alter the potential for erosion and sedimentation within affected areas, depending upon the specific locations of leased parcels; the routes selected for transmission lines, roads, and pipelines; and the configuration of structures used for crossing those habitats. Although the direct disturbance and sedimentation of aquatic habitats resulting from tar sands development would likely be somewhat localized, such development could contribute substantially to the cumulative level of such impacts within affected watersheds.

In the absence of project-specific information, it was assumed that the potential for direct habitat disturbance and soil erosion and the resulting sediment loading of nearby aquatic habitats would be proportional to the amount of surface disturbance, the condition of disturbed lands at any given time, the proximity to aquatic habitats, and measures implemented to control impacts of erosion and sedimentation. Individual tar sands projects may contribute substantially to additional surface disturbance over the 20-year development period as compared with other activities planned within the study area, depending on location and size.

From a cumulative perspective, water quality within the vicinity of STSAs could also be affected by many human activities that introduce excess nutrients or contaminants into water bodies, including oil and gas development, coal mining, the construction of additional power plants, and grazing of livestock. Tar sands development has the potential to contribute to the degradation of water quality through the introduction of contaminants, either as leachate from spent tar sands or from spills or releases of oil, lubricants, and herbicides.

Within the arid regions of Utah where proposed tar sands development would occur, water availability is of great concern and results in conflicts over balancing water needs for current and future development with water needed to maintain ecological conditions in aquatic habitats. The anticipated water needs for individual tar sands facilities would range from less than 1,000 to 7,100 ac-ft/yr. One or more tar sands facilities utilizing amounts of water at the higher end of the range could contribute to adverse cumulative impacts on water availability.

Cumulative impacts on fisheries could result from increased public access to remote areas via newly constructed access roads and utility corridors and due to the increased population levels that are likely to occur over the 20-year project period as a combined result of the reasonably foreseeable actions. The BLM has some limited means of mitigating the effects of increased fishing pressure, The State of Utah routinely monitors the condition of specific fisheries within the state and establishes and enforces regulations to maintain or improve the condition of those fisheries. Examples of regulations include limits on open fishing seasons and on the numbers, sizes, and species of fish that can be harvested from specific bodies of water. The state can also close streams to fishing. Assuming that the effects of such regulations are monitored and adjusted effectively, the overall incremental and cumulative impacts on fishery resources associated with increased access under the tar sands development alternatives are expected to be minor.

***Plant Communities and Habitats.*** Since the 1700s, wetland habitats have been severely impacted throughout the lower 48 states as a result of drainage and fill activities associated with agriculture, resource extraction, urban development, and other human activities; however, the rate of loss throughout the United States is currently much lower than historic levels (Dahl 1990). Losses of wetland habitat have been fairly high in the states of Colorado, Utah, and Wyoming. From the 1780s to 1980s, wetland losses in Colorado have been estimated to be approximately 50%, losses in Utah about 30%, and losses in Wyoming about 38% (Dahl 1990). Over the past several decades, federal agencies, such as the BLM, and state and private organizations have made considerable efforts to protect and restore wetlands and riparian habitats, and ongoing and planned wetland and riparian management programs are expected to continue to contribute to the improvement in wetland and riparian habitat function (BLM 2005j).

Human activities have also been impacting terrestrial habitats in Colorado, Utah, and Wyoming for many years. Species composition and diversity have been affected by fire suppression, heavy grazing, introduction of invasive species, and other factors (BLM 2005j). Habitat losses, fragmentation, and degradation have historically resulted from oil and gas development, mining, and other resource extraction activities that disturb surface soils. Although the BLM and other land management agencies have made considerable advances in habitat protection and restoration, ongoing resource extraction and other land uses are expected to continue to result in losses or changes to plant communities and habitats.

The factors that would affect plant communities and habitats as a result of tar sands development activities are also associated with a number of other activities that occur both within and outside of the STSAs. The ecoregions and associated plant communities that include the STSAs extend well beyond the STSA boundaries, and activities that occur outside the STSAs can also affect these habitats. Direct losses of habitat can occur as a result of oil and gas development, coal mining, mining of metals and minerals, energy development, and other activities. Approximately 200,000 acres could be directly impacted in Utah. Native plant communities can also be indirectly impacted or degraded by these activities. Impacts on water quality, surface water or groundwater flows, or air quality, could adversely affect terrestrial or wetland plant communities, and changes in community characteristics, such as species composition or distribution, could result from vegetation disturbances related to some activities, such as grazing. Commercial tar sands development would constitute a substantial incremental increase to the impacts associated with other foreseeable activities.

***Wildlife.*** This section evaluates the potential cumulative impacts of tar sands development on wildlife, including wild horses and burros. The focus is on the incremental impacts of tar sands development alternatives and a set of reasonably foreseeable federal and nonfederal activities as described in Section 6.2.5.2 that could occur over the 20-year study period. In addition to these activities, natural events (e.g., floods, droughts, and fires), disease, predation, and fluctuations in prey are among the natural phenomena that contribute to cumulative impacts on wildlife.

In general, the types of cumulative impacts on wildlife would be similar to the direct and indirect impacts associated with tar sands development (Section 5.8.1.3). Thus, cumulative

impacts on wildlife resources would include (1) habitat loss, alteration, fragmentation, or enhancement; (2) disturbance or displacement; (3) mortality; (4) obstruction to movement; and (5) exposure to contaminants. The effects of these actions may include (1) immediate physical injury or death; (2) increased energy expenditures or changes in physiological condition that may reduce survival or reproduction rates; or (3) long-term changes in behavior, including the traditional use of ranges. Potential differences between cumulative impacts on wildlife and the impacts arising from the tar sands development activities alone would depend on the intensity (magnitude), scale (geographic area), duration, timing, and frequency of development activities. Although habitat protection and restoration activities are incorporated into most projects, some losses or modifications to habitats are expected from most activities.

Cumulative impacts of greatest concern on wildlife and their habitats include loss or degradation of habitat and habitat fragmentation related to land disturbance and changes in the availability and quality of surface water resources. The cumulative effects of numerous land use activities (e.g., livestock grazing, crop production, and energy development and associated infrastructure) have caused widespread habitat loss and fragmentation of sagebrush ecosystems (Knick et al. 2003). The avoidance by wildlife of areas near industrial developments that might otherwise be usable habitat (i.e., functional habitat loss) would also contribute to the cumulative loss of habitat associated with facility development. Also, developments could further obstruct wildlife movements. Habitat loss and fragmentation can be particularly devastating to sagebrush-dependent species such as sage grouse and to big game species or other wildlife that have large home ranges or that make annual migrations among various habitats. Impacting factors can act synergistically and compound the importance of cumulative impacts. For instance, developments can result in extensive fragmentation that may leave only small, isolated areas of native vegetation. These areas are often more prone to invasive plant species and grazing by livestock, wild horses, or feral animals (BLM 2005i; Hobbs 2001).

Wildlife disturbance and mortality associated with activities such as recreation also could have significant and widespread impacts because of the high number of recreation use days. For example, more than 1.3 million visitor days were spent hunting, and nearly 1.6 million visitor days were spent snowmobiling or other winter motorized traveling on BLM-administered lands within Colorado, Utah, and Wyoming during FY 2004 (BLM 2005i). The other impacting factors discussed above have the potential to contribute to cumulative impacts, but their contribution would be relatively minor and more localized.

Other industrial developments could result in more workers within remote areas and increased public access because of new roads and ROWs. Increased access could result in increased hunting pressure and illegal poaching, depending on the locations and extent of development projects. Repeated intrusions (e.g., from recreationists) within a specific area have been shown to cause progressive declines in avian richness and abundance (Riffell et al. 1996). Traffic associated with industrial activities and recreation could result in additional roadkills. Also, structures associated with other industrial activities could increase the number of bird collisions. Increased densities of predators and scavengers attracted to areas of human activity may result in increased predation pressure on prey populations. Increased predation would be in addition to impacts associated with habitat loss, displacement, roadkills, collisions with structures and transmission lines, and other factors.

Site-specific mitigation, standard operating procedures, wildlife-related stipulations, reclamation and rehabilitation, and monitoring would minimize cumulative impacts and/or benefit wildlife and their habitats (BLM 2005i, 2006q; DOI and USDA 2006; WGFD 2004). These would reduce the contribution of tar sands impacts to cumulative impacts throughout the project area. Also, implementation of state comprehensive wildlife conservation strategies and regional conservation plans would provide means of proactively minimizing cumulative impacts on wildlife and their habitats. For example, the *Heart of the West Conservation Plan* (Jones et al. 2004) identifies areas where habitat is critical for the continued viability of key species and communities and areas where development can occur with low risk to the welfare of ecosystems. The plan also presents means of restoring and maintaining the health and function of lands within the study region. Management of game populations and enforcement of hunting laws have reduced the risk of declines in the number of game species compared with historic levels (BLM 2005i).

***Threatened, Endangered, and Sensitive Species.*** In general, the cumulative impacts on threatened, endangered, and sensitive species would be similar to those described for other ecological resources. However, for many of the species, there would be a difference in the potential consequence of the impacts. Because of their small populations, threatened, endangered, and sensitive species are far more vulnerable to impacts than more common and widespread species.

The current status and distribution of ESA-listed species, BLM-designated sensitive species, and state-listed species are presented in Section 3.7. Current status and distribution reflect the cumulative effects of past and present human activities and natural limiting factors. Some species are considered threatened, endangered, or sensitive in the area because cumulative impacts have resulted in a reduction in numbers that have increased the chances the species would be come extinct in the near future (e.g., black-footed ferret, bald eagle, and whooping crane). Other species (e.g., Graham beardtongue) are considered vulnerable because their specific ecological requirements result in limited distributions and smaller population sizes that are less resilient. For either group of species, any incremental addition to cumulative impacts could be considered significant.

The potential direct and indirect impacts of commercial tar sands on threatened, endangered, and sensitive species are presented in Section 5.8.1.4. The evaluation in that section indicates the potential for negative impact (BLM-designated sensitive, state-listed, and ESA candidate species) or adverse effects (ESA-listed or proposed species). Even without the potential impacts of commercial tar sands development, the projected major increases in land disturbance and water depletions resulting from reasonably foreseeable future activities, taken together with the impacts of past and present actions, could result in significant cumulative impacts on these species.

Tar sands development would require adherence to BLM policy on the protection of sensitive species and project-specific ESA Section 7 consultation with the USFWS. These latter consultations must include a consideration of cumulative effect. Adherence to BLM policy and

consultation with the USFWS could reduce the incremental contribution of commercial tar sands development to cumulative impacts.

**6.2.5.3.8 Visual Resources.** Visual impacts associated with construction and operation of commercial tar sands projects that may occur on federal lands in Utah would likely have cumulative impacts in the context of other development activities underway or planned in the affected areas, as described in Section 6.2.5.2. These development activities could have large visual impacts where concentrated development activity occurred. Where construction and operation of a commercial tar sands project on federal lands occurred in the same areas as these other development activities, the visual absorption capability of some landscapes could be exceeded. Incremental visual impacts may be of particular concern where tar sands projects, related infrastructure, and other development activities would be located near sensitive visual resources in landscapes with low visual absorption capability, and/or where the tar sands and other development would be located in the viewsheds of visually sensitive linear features such as scenic and historic trails, highways, or scenic rivers. Careful facilities siting and application of mitigation measures along with conformance with BLM VRM classes would protect visual values in more sensitive areas from large impacts associated directly with the tar sands projects. However, the addition of the impacts from the tar sands projects to the impacts from other development activities could considerably degrade visual qualities. For VRM Classes I through III, the classifications would likely change; Class IV areas would likely degrade further. Also, the VRM classes of surrounding areas within view of the facilities may change.

Further cumulative visual impacts could occur because the presence of the tar sands projects would likely bring workers and their families to live in local communities and to recreate in the surrounding areas. Also, the roads and other infrastructure associated with the projects could cause increased visitation and usage of remote areas (e.g., OHV use). The increases in population and access could result in urbanized development that would contrast sharply with more natural-appearing existing landscapes; add to visual clutter around existing urbanized areas; increase visible human and vehicular activity in remote areas; degrade air quality (thereby negatively affecting long-distance views); and result in litter, erosion, and other visual changes that would not harmonize with the naturally occurring forms, lines, colors, and textures of existing landscapes.

**6.2.5.3.9 Cultural Resources.** Disturbances from tar sands development, combined with other surface-disturbing development activities, could uncover or destroy cultural resource sites on BLM-administered land and on other lands. Given the large areas of surface disturbance projected from tar sands development and from other activities (Table 6.2.5-6) in the study area during the 20-year study period, it is likely that many sites would require cultural resource evaluations and subsequent mitigative actions. Conducted according to professional standards, these evaluations and mitigations would increase knowledge about cultural resources in the region. However, there would inevitably be some loss of information about individual sites. Unless a concentration of unique resources is found to exist within a small area and that area was the location of tar sands development, these individual site losses from construction and

operation of an oil shale facility would be unlikely to have a major incremental adverse impact on cultural resources in the area.

**6.2.5.3.10 Socioeconomic and Sociocultural Impacts.** Economic impacts can be measured in terms of changes in employment in the study area in which tar sands resources are located. Because of the relative economic importance of tar sands developments in small rural economies and the consequent lack of available local labor and economic infrastructure, tar sands developments may mean a large influx of population. As population increases are likely to be rapid, with local communities unable to quickly absorb new residents, there would also be impacts on housing in the study area.

The impacts of tar sands development include wage and salary expenditures associated with the construction and operation of the facilities, material procurement and wage and salary expenditures associated with the construction of temporary housing in the ROI for workers and family members, and wage and salary spending associated with indirect workers required to provide goods and services resulting from increases in economic activity in the ROI. Overall, tar sands development could produce a substantial number of jobs, depending on the scale of development (e.g., for an individual facility, about 550 jobs during the construction of temporary housing, and about 1,800 jobs during construction. Operations would create about 750 jobs [see Table 5.11.1-1.])

Population in-migration would occur also with tar sands resource development, with workers required to move into the region during construction and operation of tar sands facilities, and to facilitate the demand for goods and services resulting from the spending of tar sands worker and housing construction worker wages and salaries.

A substantial number of oil and gas wells are projected for the area beginning in 2008, producing about 8,900 direct jobs, and an estimated 23,000 total (direct and indirect) jobs in each year through 2027 (Minnesota IMPLAN Group, Inc. 2007). Development of coal resources in the three-state area is also expected to produce 15,000 direct jobs, and 33,000 total jobs each year between 2008 and 2027. Oil and gas and coal development alone could result in an increase of about 10 to 20% in total employment in the region over 20 years, and in a population increase of about 2 to 4%, if these activities would require population in-migration. It is not known whether development of oil and gas and coal resources in the three-state region would require the in-migration of construction and operations workers, or the construction of additional temporary housing.

If oil shale development occurs, it could produce a substantial number of jobs, depending on the scale of development (e.g., for an individual facility, about 600 jobs during the construction of temporary housing, and a range of 2,100 to 2,900 jobs during construction. Operations would create between 780 and 3,300 jobs, depending on the technology used [see Table 4.11.1-1].)

Rapid population growth in small rural communities hosting large resource development projects could also produce social and psychological disruption, together with the undermining

of established community social structures (see Section 5.11.1.2). Various studies have suggested that social disruption may occur in small rural communities when annual population increases are between 5 and 15%.

On the basis of the employment estimates given above, reasonably foreseeable oil and gas and coal production in the study area is estimated to have a larger socioeconomic impact than a single tar sands facility would have. However, depending on the future level of tar sands development and given the estimated population increases due to construction and operation of a single tar sands facility, there may be substantial incremental socioeconomic impacts (e.g., interruption of community services, impacts on availability of housing, social disruption, decreases in property value and loss of employment and income in the recreation sector) from tar sands development when considered in conjunction with the other ongoing and reasonably foreseeable activities in the study area.

**6.2.5.3.11 Environmental Justice.** Construction and operation of tar sands facilities and employer-provided housing could impact environmental justice if any adverse health and environmental impacts resulting from either phase of development were high, and if these impacts would disproportionately affect minority and low-income populations. Disproportionality is determined by comparing the proximity of high and adverse impacts with the location of low-income and minority populations. As described in Sections 6.2.5.3.1 through 6.2.5.3.10, tar sands development in conjunction with other ongoing and reasonably foreseeable activities, may potentially have high and adverse effects on several resources, including local demographics, social disruption, property values, noise and visual impacts, and land use and water quality, and air quality.

There are a number of census block groups in Utah with low-income and minority populations, where the minority population exceeds 50% of the total population in each block group. There are also block groups in the state where the minority share of total block group population exceeds the state average by more than 20 percentage points (see Section 3.10). Given the potential for high and adverse incremental impacts on a number of resource areas from tar sands development in conjunction with oil, gas, coal, and potential oil shale development, and given the existence of environmental justice populations in the state, impacts on these resources could disproportionately affect minority and low-income populations. Of particular importance would be the impact of large increases in population in small rural communities on social disruption, the undermining of local community social structures, and the resulting deterioration in quality of life. The impacts of facility operations on air and water quality and on the demand for water in the region could also be important. Impacts on low-income and minority populations may also occur with the development of transmission lines associated with tar sands facilities in each state, depending on the location of these infrastructures. Land use and visual environmental justice impacts might be significant depending on the locations of land parcels impacted by all these activities. Cumulative impacts on environmental justice would be evaluated in future NEPA analyses when the locations and sizes of the projects in relation to low-income and minority populations are known.

#### 6.2.5.3.12 Hazardous Materials and Waste Management

***Wastes Associated with Oil and Gas Development.*** Table 6.2.5-4 estimates that an average maximum of 230 oil wells would be drilled per year among the seven Utah study areas addressed in this analysis. Oil and gas development can involve three basic stages: exploration, well development, and production. Exploration and locating and characterizing the petroleum resource can involve the installation of a relatively small number of small-bore wells to collect geologic cores for inspection and analysis. Increasingly, exploration is conducted with nonintrusive technologies, and wastes associated with exploration are limited and inconsequential.

Well development produces the greatest volume and array of wastes. Wells drilled on BLM-administered lands would be subject to the requirements and BMPs contained in the BLM's Gold Book (DOI and USDA 2006) and any additional requirements established as lease stipulations by the BLM field office. Waste management for wells installed on private property is expected to be in accordance with accepted industry practice. Each well installed would generate well development fluid wastes and waste cuttings, some of which may have oil contamination from the formation being exploited. However, unless the well progresses through previously contaminated subsurface zones or encounters contaminated groundwater, the waste typically associated with well installation would not exhibit hazardous character and can be expected to be managed according to standard practices. Well development fluids[9] would be collected on-site for reuse and/or disposal; free water separated from development fluids and drilling muds would be verified as being free of unexpected contamination and released to the ground surface; drilling muds such as bentonite clays would be accumulated on-site for recovery and reuse; and drill cuttings would be verified as being free of contamination and disposed of at the land surface, usually in the vicinity of the well.[10] Special management would be required for development fluids, drilling muds, and produced water that exhibit contamination from NORM or brackish character. All NORM-contaminated wastes would be collected and delivered to properly permitted treatment and disposal facilities. Brackish water would either be reinjected down the well (or an injection well) or collected for delivery to treatment facilities. Likewise, downhole equipment removed from the well and found to have NORM contamination would be managed in the same manner. It is assumed that all of the drill rigs used for well development would be portable and would not undergo routine servicing (except for maintenance of fluid levels) at the well site. No wastes associated with drill rig operation and maintenance

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9 Well development fluids are water-based (most frequently used), petroleum-based (used primarily in very deep wells where high temperatures may be encountered [usually > 10,000 ft], or in directional drilling where greater lubricity is required for the drill bit), or composed entirely of synthetic chemicals (e.g., linear alkyl olefins, synthetic paraffins, and alkybenzenes). They perform a number of functions, including cooling and lubricating the drill bit, carrying cuttings up the borehole to the surface, and temporarily filling the well bore with material that is sufficiently dense to prevent the premature inflow of groundwater, other fluids (e.g., oil), or subsurface materials that would collapse the borehole before casings are installed. Development fluids will also typically contain various other chemicals, such as naturally occurring clays (referred to as drilling muds), dispersants, corrosion inhibitors, flocculants, surfactants, and biocides, to enhance their overall performance.

10 Although drill cuttings will, in most cases, be nonhazardous, care must nevertheless be exercised in their disposal so as not to significantly alter surface drainage patterns or release sediments to area surface waters.

(e.g., maintenance of the rig's diesel engine) are expected to be generated at wellheads, but may be generated elsewhere in the study area where the rigs are serviced.

Products recovered from oil and gas wells are typically complex mixtures of oil, hydrocarbon gases, other gases such as $H_2S$, water, suspended solids such as sand and silt, chemicals injected to enhance recovery, and water/oil emulsions. Actions to separate these phases are performed at the wellhead or at a central processing facility.

Produced water (water recovered from the oil- or gas-bearing formations or other subsurface formations) is by far the largest volume of waste produced during well production. Produced water will typically be discharged back down the well or through a second injection well completed in the same formation. Produced water can also be used for nonpotable purposes such as fugitive dust control, provided it is free of contamination from polar organics (e.g., benzene, naphthalene, toluene, and phenanthrene), inorganics (e.g., lead, arsenic, and sulfide), or NORM and exhibits no brackish character. Produced water may also need special management because of high concentrations of sodium, chloride, calcium, or magnesium. Discharge of high salinity waters to the ground surface or surface waters would be prohibited, and capture and treatment or reinjection would be required.

The exact natures and volumes of well development–related wastes would depend on numerous site-specific factors; however, reliable approximations are possible. Over the study period, it is projected that about 3,000 wells per year would be installed in the study area, resulting in the generation of large volumes of development fluids and produced water. Some tar sands facilities might also generate large volumes of produced water. If all the wastes are managed appropriately, incremental cumulative impacts from disposal of these wastes should be minimal. All of the wastes are expected to be managed in much the same manner as are the wastes of these types currently being generated within the study area.

***Wastes Associated with Mining of Coal and Other Minerals.*** Wastes associated with coal mining include landscape wastes from clearing active mine areas, solid industrial wastes resulting from the maintenance and repair of mining equipment, overburden soils (topsoils and subsoils) removed to gain access to the coal resource,[11] and domestic solid wastes resulting from support of the workforce,[12] produced water, and wastes from coal preparation (e.g., shale, coal fines, and other impurities). Produced water would likely require treatment because of the leaching of metals from the coal resource or to adjust its pH. Treatment might result in the generation of metal-bearing sludge that would require off-site disposal in most instances. Coal

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[11] Although overburden must be managed carefully to avoid adverse impacts (primarily increased sediment loading to area surface water bodies due to erosion), it is not considered a waste; it is typically stockpiled over the active life of the coal mining operation and replaced (in the order of the original soil horizon) as part of mine reclamation.

[12] It is assumed that the workforce would not be quartered at or near the coal mine but instead would live in nearby communities. Consequently, wastes related to workforce support would be minimal, consisting primarily of kitchen/food preparation solid wastes, small amounts of administrative (office) solid wastes, and small amounts of sanitary wastes.

preparation wastes are typically disposed of on-site or stockpiled for later use in mine reclamation.

Recoverable coal deposits exist primarily in two study areas, Henry Mountain and San Rafael. Projected coal production within those two study areas over the entirety of the study period (2007 to 2027) is projected to be 25 million tons per year at Henry Mountain and anywhere between 4.8 to 9 million tons per year from deposits with the San Rafael Study area. The amounts of solid wastes generated are proportional to total coal mined, but would vary significantly with the particular mining techniques employed and the extent of coal preparation occurring at the mine site. Tar sands development using surface mining would generate similar waste streams to those produced during coal mining. At the PEIS level it is not possible to equate the nature or volumes of solid wastes with tons of coal or tar sands mined. . Cumulative impacts of hazardous materials generation and waste management would be evaluated in future NEPA analyses when the locations and sizes of the projects are known.

Only limited production of noncoal minerals is projected to occur. Phosphate mining is expected to occur only in the Diamond Mountain study area; gilsonite is expected to occur within the Book Cliffs area only (at 60,000 tons/yr). Although there is high potential for occurrence of uranium, vanadium, gold, and copper in the Henry Mountain study area, no significant production is predicted; gypsum production is expected to occur only in the San Rafael study area. However, stone, sand, and gravel would occur throughout all of the study areas.

Mineral (e.g., copper, gold, and silver) mining and processing can generate wastes during recovery (i.e., mining), beneficiation (separation of mined material), and processing. Recovery can result in large volumes of overburden materials needing management, as discussed above for coal mining. Although those materials are generally not considered waste they must be managed properly to avoid adverse impacts. Beneficiation can result in the generation of relatively large volumes of potentially hazardous material. This material, referred to as tailings, is processed through dump leaching, in which solutions containing strong acids or cyanides are sprayed onto the tailings to “leach” the metal of interest for capture. The tailings can be voluminous (EPA 1994) and hazardous. Processing of the mineral ore involves a variety of chemical and physical manipulations that produce a wide variety of wastes, many of them capable of producing significant adverse environmental impacts if not managed properly. In 1985, the EPA published Reports to Congress on the environmental aspects of noncoal-mining activities; the reports provide relatively comprehensive discussions of possible environmental impacts, including the types of wastes resulting from typical recovery, beneficiation, and processing schemes for selected metals (EPA 1985).

Phosphate mining involves a complex array of washing, flotation, and separation actions to produce the desired product, each step also resulting in waste. The EPA has published a report in which typical phosphate mining and beneficiation activities are defined (EPA 1994). After brush and overburden removal to expose the phosphate deposit known as a matrix ore (mixture of clays and phosphate), draglines excavate the matrix ore and deliver it for beneficiation and processing. This is accomplished through a series of washing steps, followed by a floatation step, augmented by the addition of a mixture of fatty acids and re-refined oil and ammonium

hydroxide (for pH adjustment). Sulfuric acid and amines are used to further separate and purify products recovered from the initial floatation steps. The solids recovered from initial floatation steps are technically "tailings." However, clays and other minerals such as magnesium oxide are also recovered from floatation steps and are typically sold as by-product materials rather than disposed of as wastes. Solids recovered from final floatation steps are typically managed as wastes, although some beneficial uses (e.g., construction materials and fill) have been identified. The phosphate solution recovered from the final floatation steps is dewatered to produce the final product. Most chemicals added to enhance floatation can be recovered for reuse, but many become contaminants in tailings wastes. Those tailings not put to beneficial use are typically disposed of on the mine site.

Similar to development of metallic ores and phosphate, tar sands development could generate produced water and large volumes of overburden; however, tailings would not be generated. Cumulative impacts of hazardous materials generation and waste management would be evaluated in future NEPA analyses when the locations and sizes of the projects are known.

***Wastes Associated with Designation and Development of Energy Corridors.*** The designation of energy corridors within the study area would not, in and of itself, have any waste consequences. Waste would however, be generated during actual corridor development for gas and liquid pipelines and for electric power transmission systems on public and private lands.

Solid wastes associated with gas and liquid pipelines and with power transmission systems would be generated during construction, operation, and decommissioning. The majority of wastes would be generated during the construction phases. Construction wastes would include wastes generated during preparation of the ROW (consisting primarily of removed vegetation) and during installation of the pipeline or cables (primarily, maintenance-related wastes for vehicles and equipment, dunnage, packaging, some chemical cleaner wastes). Support of the workforce would result in the production of domestic solid wastes and sanitary wastewaters. It is expected that the majority of construction-related wastes would be nonhazardous and would be managed in existing local landfills or in existing municipal or specially built sewage treatment facilities.

Operational wastes result from the maintenance of equipment (e.g., change-outs of lubricating oils, coolants, and hydraulic fluids from equipment utilizing such materials, and sludge from the periodic cleaning of the insides of the pipelines through the use of pigs. The frequency of cleaning and the amount of waste generated is a function of the commodity being transported, with the greatest amounts of pipeline cleaning–related wastes generated for pipelines conveying crude oil.

Solid wastes associated with the decommissioning of pipelines or power transmission systems include wastes from the cleaning of equipment, as well as some of the pipeline components. For pipelines, it is expected that much of the underground pipeline may be abandoned in place and for those pipeline components that are removed, the majority would be put into service in other pipeline systems or sold for scrap. As during the construction phase, solid domestic and sanitary wastes would be generated (albeit in lesser amounts since

decommissioning is expected to take substantially less time than initial construction) in support of the workforce, and all such wastes would likely be managed or disposed of in existing facilities. Finally, a certain volume of remedial wastes can be expected to result from the cleanup of spills or leaks that were not removed during operation or occurred during decommissioning.

The construction of gas and liquid pipeline ROWs and transmission ROWs to support tar sands development would generate similar types of waste to those discussed above. Large numbers of gas and liquid ROWs are already present on public lands in the study area, and many more areas may be designated as corridors for ROWs during the study period (see Section 6.2.4.2). Incremental impacts from waste generation and disposal would depend on the level of tar sands development and would be assessed in future site-specific environmental evaluations.

***Wastes Associated with Oil Shale Development.*** Wastes that would be generated from oil shale development would be of the same nature as those described in Section 4.13 Incremental impacts from waste generation and disposal due to tar sands development would depend on the level of tar sands development and would be assessed in future site-specific environmental evaluations.

**6.2.5.3.13 Health and Safety.** Given the large amount of development for oil and gas, coal mining, and other mineral production projected in the study area over 20 years, many workers will be needed. The types of industries being developed, especially mining, have been associated with relatively high numbers of worker injuries and fatalities in the past (see Section 5.14). Tar sands production activities would add to worker injuries and fatalities in proportion to the level of development. Without more detailed information on future production levels for tar sands as well as the other industries, quantitative estimates of incremental health and safety impacts due to tar sands development are not possible. However, all these industries are required by law to protect worker health and safety using adequate engineering controls and personal protective devices.

## 6.2.6 Other NEPA Considerations

### 6.2.6.1 Unavoidable Adverse Impacts

The identification of public lands available for application for leasing for commercial development of tar sands and the amendment of land use plans to incorporate these lands would not result in unavoidable adverse impacts under either Alternative B or C. Under both Alternatives B and C, the future development of commercial tar sands projects could also result in unavoidable adverse impacts on natural resources. The magnitude of these unavoidable adverse impacts, as well as the degree to which they could be mitigated, would vary by project type and location. Many of the project-specific impacts could be reduced through implementation of the mitigation practices identified in this PEIS (see Chapter 5).

**6.2.6.1.1 Land Use.** No adverse impacts on land use would occur from the identification of lands available for application for leasing and associated land use plan amendments under either Alternative B or C. However, the future development of commercial tar sands projects within the areas identified as applicable for leasing would result in unavoidable changes in land use in the areas undergoing project development. Land uses that could be affected by the construction and operation of commercial tar sands projects may include livestock grazing agriculture, oil and gas leasing, minerals extraction, and recreation.

**6.2.6.1.2 Soil, Geologic and Paleontological Resources.** No adverse impacts on geologic and paleontological resources would occur under either Alternative B or C from the identification of lands available for lease application and associated land use plan development. Unavoidable adverse impacts could occur in the future under either alternative as a result of commercial project construction and operation. Project construction could result in unavoidable impacts on natural topography, soil erosion, drainage patterns, and slopes, as well as damage or destroy paleontological resources within project footprints. Project construction could also result in the compaction, excavation, and removal of soil from the project area. The likelihood, magnitude, and extent of unavoidable impacts could be reduced under both alternatives through the implementation of appropriate project- and location-specific mitigation measures.

**6.2.6.1.3 Water Resources.** The identification of lands available for application for leasing and associated land use plan amendments would not adversely impact water resources (either surface water or groundwater) under either alternative. Unavoidable adverse impacts could occur only as a result of construction and operation of commercial tar sands projects in the lease areas. Water quality could be impacted as a result of soil erosion from construction sites; runoff from mine areas, tar sands processing, and waste storage locations; and accidental spills of hazardous liquids (such as fuels, lubricating oils, solvents, and other industrial liquids) and accidental oil spills from project-related pipelines. Although there is a potential for unavoidable adverse impacts on water resources from future commercial development under both alternatives, the likelihood, magnitude, and extent of impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

**6.2.6.1.4 Air Quality and Ambient Noise Levels.** No adverse impacts on air quality or ambient noise would occur from the identification of lands available for application for leasing and associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts could be incurred during the construction and operation of future commercial tar sands projects in the lease areas under either alternative. Construction, clearing and grading, trenching, excavation and blasting, and construction vehicle traffic would result in fugitive dust and vehicle emissions as well as increase ambient noise level in construction locations. During project operations, unavoidable air impacts would occur primarily during operation of mining and tar sand processing facilities and equipment and associated vehicular traffic. Noise impacts could also be incurred as the result of these activities, as well as from the operation of pipeline compressor stations. The likelihood, magnitude, and extent of unavoidable adverse impacts could

be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

**6.2.6.1.5 Ecological Resources.** No adverse impacts on ecological resources would occur as a result of the identification of lands available for application for leasing and associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts would occur under Alternatives B and C as a result of commercial development of tar sands projects. The construction and operation of project facilities, as well as the maintenance of project-related utility, pipeline, and transportation ROWs under each alternative could result in unavoidable temporary and permanent changes in aquatic resources, plant communities and habitats, wildlife, and threatened and endangered species.

Ecological resources immediately within a project footprint would be destroyed during clearing, grading, and construction activities. Unavoidable impacts on wildlife could include habitat loss, disturbance and/or displacement, mortality, and obstruction to movement. Increased noise during project construction and operation could disrupt local wildlife foraging and breeding of some wildlife. Aquatic biota and habitats could be affected by siltation resulting from runoff from areas of disturbed soils and from accidental releases of hazardous materials from construction and operations equipment (such as fuels) and from an accidental oil pipeline release. The likelihood, magnitude, and extent of unavoidable adverse impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

**6.2.6.1.6 Visual Resources.** No adverse impacts on visual resources would occur from the identification of lands available for application for leasing and associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts would occur under both alternatives during the construction and operation of future commercial tar sands projects. Under both alternatives, short-term impacts could occur during construction. Fugitive dust and the presence of construction equipment and crews would be visible in the vicinity of the construction site, potentially affecting local viewsheds and recreational experiences. Because project-specific ROWs and infrastructure (e.g., electricity transmission towers, pipelines and compressor stations, surface mines, and tar sands processing facilities) would be visible throughout the lifespan of any project, there could be long-term unavoidable impacts on some viewsheds and the recreational experiences of visitors in those viewsheds. The likelihood, magnitude, and extent of unavoidable adverse impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

**6.2.6.1.7 Cultural Resources.** No adverse impacts on cultural resources would occur from identification of lands available for leasing application and associated land use plan amendments under either Alternatives B or C. However, leasing itself has the potential to impact cultural resources to the extent that the terms of the lease would limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed commercial tar sands development on cultural properties. Unavoidable adverse impacts could occur as a result of the development of

commercial tar sands projects in areas identified as available for leasing application under Alternatives B and C. Under both alternatives, cultural resources could be destroyed by construction activities such as clearing and grading, mining, facility construction, and pipeline trenching. Development of new ROWs could also increase access to previously inaccessible areas, which could lead to vandalism of both known and undiscovered cultural sites. The likelihood, magnitude, and extent of unavoidable adverse impacts on cultural resources could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

**6.2.6.1.8 Socioeconomic and Environmental Justice.** No adverse socioeconomic or environmental justice impacts would occur from the identification of lands available for application for leasing and associated land use plan amendments under either Alternative B or C. Unavoidable adverse social and environmental justice impacts could occur under Alternatives B and C as a result of construction and operation of commercial tar sands facilities and the associated employer-provided housing. Rapid population growth following the in-migration of construction and operations workers associated with tar sands and ancillary facilities into communities could lead to the undermining of local community social structures with contrasting beliefs and value systems among the local population and in-migrants, and consequently, to a range of changes in social and community life, including increases in crime, alcoholism, drug use, etc. Impacts may also occur in association with the degradation of air and water quality, visual resources, and removal of land from traditional uses during commercial project development. Many of these impacts would affect quality of life for the general population in many communities, in addition to that of low-income and minority populations residing in the vicinity of commercial tar sands developments. Although many locations of cultural significance to tribal groups may have been protected or identified, impacts of commercial tar sands developments may also occur with the alteration of, or restricted access to, water and visual resources, and the degradation or migration of particular animal species and the resulting impacts on subsistence and traditional landscape-based activities important to tribal groups.

**6.2.6.1.9 Hazardous Materials and Waste Management.** No adverse impacts from hazardous materials and waste management would occur from the identification of lands available for leasing application and associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts could occur as a result of the potential future development of commercial tar sands projects in the areas identified under Alternatives B and C. Construction and operations of tar sands projects would result in the use of hazardous materials and the generation of hazardous and nonhazardous wastes, including materials typically utilized during construction and operations (e.g., fuels, lubricating oils, hydraulic fluids, glycol-based coolants and solvents, adhesives, corrosion control coatings, and herbicides for vegetation clearing). During construction, nonhazardous landscape wastes would be generated. In general, the appropriate management of these materials would result in only minor impacts. Disposal of spent tar sands within the leased area could result in unavoidable adverse impacts. The likelihood, magnitude, and extent of unavoidable adverse impacts from hazardous materials and waste management could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

**6.2.6.1.10 Health and Safety.** No adverse impacts on health and safety would occur from the identification of lands available for leasing application and associated land use plan amendment under either Alternative B or C. Unavoidable adverse impacts could occur as a result of the potential future development of commercial tar sands projects in the areas identified under Alternatives B and C. Hazards for workers at tar sands development facilities include risks of accidental injuries or fatalities, lung disease caused by inhalation of particulates and other hazardous substances, and hearing loss. A comprehensive facility health and safety plan and worker safety training would be required as part of the Plan of Development for every proposed commercial tar sands project. The likelihood, magnitude, and extent of unavoidable adverse impacts on health and safety could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

#### 6.2.6.2 Short-Term Uses of the Environment and Long-Term Productivity

The amendment of land use plans to identify lands available for application for leasing for commercial tar sands development would not affect the short-term uses or long-term productivity of the environment. The impacts (short- and long-term) from utilization of resources associated with project development under Alternatives B and C are presented in Chapter 5. For this PEIS, *short-term* refers primarily to the period of construction of a commercial tar sands project; generally it is during this time that the most extensive environmental impacts would occur. *Long-term* refers primarily to the 20-year time frame considered within this PEIS.

Within the 20-year time frame considered in the PEIS, the development of tar sands projects would not require the short-term disturbance or long-term alteration of a major amount of federal and nonfederal land under either of Alternatives B or C. Future development of commercial tar sands projects under Alternative B or C would result in the local, short- and long-term disturbance of most resources. There would be little difference in the types of impacts that could result from future project development under either of the two alternatives. Under these alternatives, land clearing and grading and construction activities would disturb surface soils, wildlife and their habitats, and affect local air and water quality, visual resources, noise levels, and recreational activities within individual project footprints. Similar effects could be expected on other federal and nonfederal lands where project-related infrastructure (such as utility and pipeline ROWs, and worker residences) would be located. Short-term construction-related disturbance of biota (and their habitats) could result in long-term reductions in biological productivity within the project areas.

The long-term presence of commercial tar sands projects and associated ROWs could affect long-term land use within and in the vicinity of any commercially developed lease areas, as well as on both federal and nonfederal lands where support infrastructure (e.g., ROWs and employer-provided housing) would be located, especially if previous land use activities in those areas are determined to be incompatible with commercial tar sands projects. The lands and surrounding areas associated with Alternatives B and C currently support a variety of land uses (depending on their specific locations), including livestock grazing, agriculture, recreation, oil and gas leasing, and minerals extraction. Commercial tar sands projects under both alternatives could also affect long-term quality and use of visual resources and affect recreational use on

federal and nonfederal lands. While some recreational activities (such as OHV use) could experience long-term increases in activity as a result of new ROWs into previously inaccessible areas, changes in the types and patterns of recreational usage can be positive or negative, depending on the subjective values of the interested and affected public.

#### 6.2.6.3 Irreversible and Irretrievable Commitment of Resources

This section describes the irreversible and irretrievable commitments of resources associated with the implementation of the two tar sands alternatives evaluated in this PEIS. A resource commitment is considered *irreversible* when direct and indirect impacts from its use limit future use options. Irreversible commitments apply primarily to nonrenewable resources, such as cultural resources, and to those resources that are renewable only over long periods of time, such as soil productivity or forest health. A resource commitment is considered *irretrievable* when the use or consumption of the resource renders it neither renewable nor recoverable for future use. Irretrievable commitments apply to the loss of production, harvest, or use of natural resources.

The amendment of land use plans to identify lands available for application for leasing for commercial tar sands development would not result in the irreversible or irretrievable commitment of resources. However, irreversible and irretrievable commitments of resources could occur as a result of future commercial tar sands projects that are authorized, constructed, and operated. The nature and magnitude of these commitments would depend on the specific location of the project development as well as its specific design and operational requirements. The commitment of resources would be identical for any specific project located in the same lease area under either of the two alternatives.

The construction of future commercial tar sands projects under either of the alternatives could result in the consumption of sands, gravels, and other geologic resources, as well as fuel, structural steel, and other materials. Water resources could also be consumed during construction, although water use would be temporary and largely limited to on-site concrete mixing and dust abatement activities.

In general, the impact on biological resources from future project construction and operation would not constitute an irreversible and irretrievable commitment of resources. During project construction and operation, individual animals would be impacted. Site-specific and species-specific analyses and mitigation conducted at the project level during authorization would make adverse impacts on entire populations unlikely.

The clearing of project areas (including off-lease locations where utility and pipeline ROWs, and employer-provided housing would be located) would result in the direct loss of vegetation and habitats within the construction footprints, which would be irretrievable in areas where project infrastructure would be constructed and operated. While habitat would be impacted during project construction, implementation of project-specific mitigation measures (such as habitat restoration) would reduce these impacts over time. However, habitats within

project infrastructure footprints (such as buildings and surface mines) would be irretrievably committed with the development and operation of commercial tar sands projects.

Cultural and paleontological resources are nonrenewable, and any disturbance of these resources would constitute an irreversible and irretrievable commitment of resources. However, consideration and implementation of mitigation could minimize the potential for impacts on these resources. Access to previously inaccessible areas could lead to vandalism of both known and unknown cultural and paleontological resources, thereby rendering them irretrievable. Impacts on visual resources could constitute an irreversible and irretrievable commitment of resources, but these impacts could also be lowered somewhat through the consideration and implementation of the mitigation measures.

#### 6.2.6.4 Mitigation of Adverse Impacts

Following amendment of land use plans to identify areas available for lease application for commercial tar sands development, future development of commercial tar sands projects within the lease areas could result in adverse impacts on many resources (see Chapter 5). The nature, extent, magnitude, and duration of any project-related impacts would be directly determined by (1) the project location, (2) the nature and quality of the resources at and in the vicinity of project site (and its associated infrastructure), and (3) the technology used and the plan of development for the project. Many of the impacts may be reduced or avoided through the implementation of appropriate site- and project-specific mitigation measures. Development of individual commercial tar sands projects would require additional project-specific NEPA analyses and the identification of location-, project- and resource-specific mitigation measures, and mitigation measures would be identified as lease stipulations by the BLM for any authorized commercial development. Chapter 5 of this PEIS identifies many types of resource-specific mitigation measures that could be implemented during project planning, construction, and operation.

## 6.3 ENDANGERED SPECIES ACT SECTION 7 REQUIREMENTS

Section 7 of the ESA directs each federal agency, in consultation with the USFWS or the National Marine Fisheries Service (NMFS), as appropriate, to ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any listed threatened or endangered species or result in the destruction or adverse modification of critical habitat.[13] Under Section 7 of the ESA, those agencies that authorize, fund, or carry out the federal action are commonly known as “action agencies.” If an action agency determines that its federal action “may affect” listed species or critical habitat, it must consult with the USFWS and/or NMFS, depending on the species that could be affected by the action.[14] If an action agency determines that the federal action will have no effect on listed species or critical habitat,

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[13] See ESA § 7; 16 USC 1536.

[14] See 50 CFR 402.2, 402.13-14.

the agency will make a "no effect" determination. In that case, the action agency does not initiate consultation with the NMFS and its obligations under Section 7 are complete.

In complying with its duty under Section 7, the BLM, as the action agency, has examined the potential effects on listed species and designated critical habitat of amending land use plans to identify lands as available for application for commercial leases for oil shale or tar sands development. As a result of this examination, the BLM has determined that its proposed action of amending land use plans would have no effect on these species or on critical habitat. This determination is based on the following:

1. The amendment of land use plans to identify lands as available for application for commercial leasing for oil shale or tar sands development would have no impact on the environment. The amendments do not commit the BLM to a particular course of action; they merely allow the BLM to consider granting leases—in the future—for oil shale or tar sands development

2. The amendment of land use plans for such purpose does not create any legal right that would allow ground-disturbing activities without further agency review and compliance with applicable statutes, including the ESA and NEPA.

3. Before the BLM issues a lease or approves any ground-disturbing activity, the BLM will analyze the effects of the proposed action and assure compliance with the ESA.

The BLM did not reach its "no effect" determination because listed species and critical habitat are unlikely to be present in lands described in the land use plan amendments. To the contrary, Tables 4.8.1-4 and 5.8.1-4 identify the listed species that occur in the States of Colorado, Utah, and Wyoming where the land use plan amendments would be completed for either oil shale or tar sands leasing. Portions of the designated areas are occupied by listed species or contain designated critical habitat. The BLM considered preparing a biological assessment (BA) through a consultation with the USFWS. After discussing various approaches, the BLM determined, however, that the administrative action of amending land use plans would not affect listed species or designated critical habitat.

Preparing a BA before a lease or site-specific project had been proposed would be based largely on conjecture and speculation. There would be simply no way to know before such a proposal is made whether the impacts to be assessed would be those that would actually occur as a result of a proposal by a future proponent. Further, without knowing the specifics of when and where a project would occur, it would be impossible to know what species, if any, would be affected by the project. The BLM considered whether it made sense to make assumptions for the purposes of a BA, but determined such assumptions would be speculative and not linked to the federal action of amending land use plans. Any BA would be a speculative assessment of effects from future *site-specific projects*, not of the current proposed action.

This is not to say that there would be no Section 7 consultations (including preparation of BAs or biological opinions (BOs) where appropriate) on future actions that may affect listed species or critical habitat. On the contrary, the BLM fully expects that Section 7 consultations will be appropriate as future leases and projects are proposed. That is, if an application for a lease, permit, or other authorization is received by the BLM for oil shale or tar sands development within lands identified as available for application, procedures to comply with Section 7 of the ESA would be initiated at that time. This may take the form of consultation with the USFWS; preparation of a BA by the BLM; issuance of a BO by the USFWS; a "may affect, not likely to adversely affect" determination with USFWS concurrence; or a "no effect" determination by the BLM. At such time, any BA, BO, concurrence, or "no effect" determination would be made based on a full record describing the proposed lease, project, site, method of construction, and other relevant information, all features lacking at the present time.

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