APPENDIX D:

IMPACT ASSESSMENT METHODOLOGIES

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APPENDIX D:

IMPACT ASSESSMENT METHODOLOGIES

This appendix summarizes the methodologies used in evaluating the various environmental resource areas discussed in this draft programmatic environmental impact statement (PEIS). The environmental resource areas evaluated are as follows:

- Air quality;
- Acoustical environment;
- Geology and soils;
- Water resources;
- Human health;
- Ecological resources;
- Socioeconomics;
- Environmental justice;
- Land use;
- Transportation;
- Cultural resources;
- Visual resources; and
- Waste management.

In addition to these resource areas, the U.S. Department of Energy (DOE) has evaluated cumulative impacts that could result from implementation of the Uranium Leasing Program (ULP) proposed action in combination with past, present, and planned activities (including Federal and non-Federal activities) at or in the vicinity of the DOE ULP lease tracts.

D.1 AIR QUALITY

Potential air quality impacts under each alternative were evaluated by estimating air pollutant emissions from two phases: (1) mine development and operations; and (2) reclamation. (Air emissions from the exploration phase were not estimated because of its short duration and the negligible amount of emissions it would generate in comparison with the other phases.) Air emissions were estimated for criteria pollutants, volatile organic compounds (VOCs), and carbon dioxide (CO_2, a primary greenhouse gas [GHG]) that would result from the activities associated with engine exhaust and fugitive dust emissions from heavy equipment and vehicles, wind erosion from the disturbed areas, and explosives use. Air emissions from traffic due to workers commuting were not included because only a small number of workers would be involved (typically 12 to 24 people) and the amount of any associated emissions would thus be small in comparison to the amount of air emissions generated from heavy equipment and other related activities. Detailed emission inventory tables, including data on emission factors, activity levels, fugitive dust control efficiencies, and total emissions, are presented in Appendix C.

To determine the annual emissions, emission factors for each activity were multiplied by activity-level data and the estimated number of items of equipment required for development, operations, and reclamation. Emission factors available in the standard references, which are most commonly used in emission inventories, were employed for these estimates. Except for the following, emission factors were taken from the WebFIRE database (EPA 2012a):

- For operations under average conditions, an emission factor of 0.22 ton/acre-month was used for uncontrolled emissions of particulate matter of less than or equal to 10 µm (PM_{10}) (Jones & Stokes Associates 2007). $PM_{2.5}$ emissions were assumed to be 21% of PM_{10} emissions (AQMD 2012).

- For wind erosion, an emission factor of 0.38 ton/acre-yr was used for uncontrolled emissions of total suspended particulates (TSP). PM_{10} and $PM_{2.5}$ emissions were assumed to be 50% and 7.5%, respectively, of TSP emissions (EPA 2012b).

- For blasting, emission factors of 92 and 10 lb/ton for uncontrolled emissions of PM_{10} and $PM_{2.5}$, respectively, were used (QDEH 1999).

- For diesel combustion from heavy equipment, an emission factor of 22.23 lb/gal for CO_2 emissions was used (EPA 2008).

For operations and wind erosion, a fugitive dust control efficiency of 50% was assumed by spraying water on the exposed area twice a day. Projected activity-level data were based on assumptions discussed in Appendix C and the alternatives discussed in Chapter 2.

The significance of project-related emissions with regard to overall air quality was determined by comparing estimated annual project-related emissions of criteria pollutants and VOCs with annual emissions in the three counties that encompass the DOE ULP lease tracts (Mesa, Montrose, and San Miguel Counties) in 2008 and by comparing annual project-related emissions of CO_2 with annual GHG emissions in Colorado in 2010 and in the United States in 2009 (CDPHE 2011; EPA 2011; Strait et al. 2007).

D.2 ACOUSTIC ENVIRONMENT

Potential noise impacts under each alternative were assessed by estimating the combined noise levels from noise-emitting sources associated with ULP activities and then performing noise propagation modeling. These levels were compared with the Colorado noise limit and the U.S. Environmental Protection Agency (EPA) guideline level to estimate the distance from the noise source area or haul routes at which noise would attenuate to these limits or guideline levels.

Primary sources of noise over the life of ULP activities would include operations of aboveground and underground heavy equipment, on-road and off-road vehicle traffic, and, if necessary, blasting. Aboveground equipment includes backhoes, dozers, graders, power generators, and scrapers, while underground equipment includes rock drills; various types of loaders and trucks would be used both above and under the ground. The average noise levels from most of this heavy equipment range from 80 to 90 dBA, with the exception of 98 dBA for a rock drill at a distance of 50 ft (15 m) (Hanson et al. 2006). In general, the dominant noise source from most construction equipment is the diesel engine, which is continuously operating around a fixed location or has limited movement. Except for rock drills, noise levels for the type of construction equipment that would probably be used at the ULP lease tracts range from about 80 to 90 dBA at a distance of 50 ft (15 m) from the equipment. To estimate noise levels associated with ULP activities, a composite noise level of 95 dBA at a distance of 50 ft (15 m) from the mine site was conservatively assumed, if noisy equipment (such as rock drills) was not being used. Typically, this level could be reached when several pieces of noisy heavy equipment were operating simultaneously near each other at peak load. For impact analysis along the haul routes, a peak “pass-by” noise level of 84 dBA at a reference distance of 50 ft (15 m) from a heavy-duty truck traveling at 55 mph (88 km/h) was estimated (Menge et al. 1998).

Several important factors affect the propagation of sound in the outdoor environment, such as source characteristics, geometric spreading, ground effects, air absorption, meteorological effects (due to turbulence and variations in vertical wind speed and temperature), and screening by topography, structures, dense vegetation, and other natural or human-made barriers. At this programmatic level, no detailed information (e.g., types and capacities of heavy equipment, work schedules, specific locations of projects) was available, so screening-level estimates were made by considering only geometric spreading and ground effects, as shown here (Barry and Reagan 1978; Hanson et al. 2006):

$$L_p = L_{p,ref} - (20 + 10\,G)\log_{10}(D/D_{ref}) \text{ for point sources}$$

and

$$L_p = L_{p,ref} + 10\log_{10}(N\pi D_{ref}/(5280 \times ST)) - (10 + 10\,G)\log_{10}(D/D_{ref}) \text{ for line sources,}$$

where

L_p = A-weighted sound pressure level at a given distance (dBA),
$L_{p,\,ref}$ = A-weighted sound pressure level at a reference distance (dBA),
G = Ground factor that accounts for ground effects (unitless),
D = Distance from the noise to the receptor (ft),
D_{ref} = Reference distance (ft; assumed to be 50 ft [15 m]),
N = Number of vehicles per hour,
5,280 = Conversion factor from miles to feet,
S = Average vehicle speed (mph) (assumed to be 55 mph [88 km/h]), and
T = Time period over which noise level is computed (assumed to be 1 hour).

For hard ground, $G = 0$. For soft ground, G depends on the effective path height (H_{eff}), as follows:

$G = 0.66$ if H_{eff} is <5 ft (1.5 m);

$G = 0.75\ (1 - H_{eff}/42)$ if H_{eff} is ≥5 ft [1.5 m] and <42 ft [12.8 m];

and

$G = 0$ if H_{eff} is ≥42 ft (13 m).

For this analysis, the ground was assumed to be soft based on the land cover around the ULP lease tracts. The effective path height (H_{eff}) is the average of the source height and the receptor height. The source height for heavy equipment was assumed to be 7.9 ft (2.4 m), which is the average height of drivetrain and exhaust contributions (Wayson 1993). The receptor height was set at 5 ft (1.5 m), which is the approximate height of human ears from the ground.

Noise levels at receptor locations were estimated by using the above formulas. Day-night average noise levels (L_{dn}, or DNL) were derived by assuming a work schedule of 10 hours per day. For ULP activities, the distances at which noise levels reach the Colorado daytime maximum permissible limit of 55 dBA[1] and the EPA guideline level of 55 dBA L_{dn} for residential areas (EPA 1974) were estimated. In addition, the residences within this distance range were counted, based on the assumption that the ULP activities would occur at the ULP lease tract boundaries. During operations, the distances at which noise levels from heavy-duty trucks along the haul routes would approach the Colorado limit and EPA guideline were estimated.

There are several specially designated areas (e.g., Dolores River Special Recreation Management Area [SRMA], Dolores River Canyon Wilderness Study Area [WSA]) and other nearby wildlife habitats around the DOE ULP lease tracts and haul routes where noise might be a concern. Negative impacts on wildlife begin between 55 and 60 dBA, a range that corresponds to the onset of adverse physiological impacts (Barber et al. 2010). Distances up to the lower threshold level from the mine sites and from the haul routes were estimated to identify the range of noise impacts on wildlife.

D.3 GEOLOGY AND SOILS

The geologic setting established for the ULP lease tracts was based on a review of aerial maps, topographic maps, geologic maps, and the scientific literature. Geologic map data (shapefiles) were obtained from the U.S. Geological Survey (USGS; see Stoeser et al. 2007). References to the geologic time scale were based on the age ranges compiled by Walker and Geissman (2009).

[1] Colorado Revised Statutes, Title 25, "Health," Article 12, "Noise Abatement," Section 103: "Maximum permissible noise levels are source-oriented regulations (e.g., daytime level shall not exceed 55 dBA at 25 ft or more from the residence's property boundary)." For this analysis, the Colorado limit for residential areas was applied as a receptor-oriented regulation (e.g., daytime level shall not exceed 55 dBA at a residence) like other noise guidelines or regulations.

The impact assessment for soil resources relied on field observations, consultations with DOE ULP management staff, and reviews of the academic and professional literature to characterize site-specific soil conditions and identify the types of impact-producing activities related to mining within the lease tracts.

Soil conditions within each of the ULP lease tracts were characterized by using customized map data from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) web soil survey (NRCS 2012) as a starting point and supplementing it with information provided by state and local agencies, as available. Data on various factors, such as soil texture and composition, parent materials, landforms on which the soils developed, drainage class, permeability, surface runoff potential, rutting potential, whole soil erodibility factor (K factor), wind erodibility group/index, and land classification, were gathered to gain a general understanding of the soil's susceptibility to impacts that could result from ground-disturbing activities. Information on special soil features, such as biological crusts, was also obtained. Chapter 3 (on the affected environment) provides general soil maps and map unit descriptions for each of the four lease tract groupings (Gateway, Uravan, Paradox Valley, and Slick Rock). These maps are based on the soil units delineated on county soil surveys at scales of 1:12,000 to 1:100,000 (USDA 1999). The types of potential soil impacts are described in detail in Section 4.2.3.1, and information on the areas of potential disturbance (subject to these impacts) is provided in the soil resources discussion under each alternative in Chapter 4.

D.4 WATER METHODOLOGY

The analysis of water resources considered impacts on surface water features and groundwater within the ULP lease tracts, the surrounding valleys, the entire groundwater basins, as well as upstream/upgradient and downstream/downgradient valleys and groundwater basins (if it was determined that there was connectivity and the potential for indirect impacts). The surface water features considered were streams, lakes, wetlands, surface springs and seeps, ephemeral washes/drainages, dry lakes, and floodplains.

Impacts on surface water and groundwater resources were mainly related to the alteration of natural hydrologic conditions (e.g., surface runoff, infiltration, and groundwater recharge/flow), degradation of water quality, and water usage. The ROI for the impacts on surface water is within the Upper Dolores, San Miguel, and Lower Dolores basins (USGS HUC-8 basins) where local surface runoff and groundwater discharge flows from the lease tracts to Dolores River, San Miguel River, and their tributaries. ROI for impacts on groundwater resource would be primarily on the lease tracts and would not exceed 5 mi (8 km) downgradient from mining activities in the lease tracts or any rivers and tributaries that local groundwater discharges to. ROI for impacts on water usage is primarily within Montrose, Mesa, and San Miguel Counties. The assessment of impacts related to hydrologic alterations and water quality was performed by using a variety of data sources (e.g., geologic maps, aerial photographs, professional reports on standard mine practices, and the scientific literature) to characterize water features and by exercising professional judgment to identify potential direct and indirect impacts from mining operations. For impacts related to water usage, water use during mine development and operations of the underground mines and for the JD-7 surface open-pit mine was mainly for the workers' potable water supply and for dust control activities. Water volumes assumed are discussed in Section 2.2 and Appendix C.

D.5 HUMAN HEALTH RISK

Potential human health impacts were analyzed for the mine exploration, development and operations, reclamation, and post-reclamation phases. The region of influence (ROI) for human health impacts was a 50-mi (80-km) radius of the lease tracts. Potential impacts to individuals are typically estimated to be at low levels (<2 mrem/yr) at distances greater than about 5 mi (8 km) from the source, a larger radius of 50 mi (80 km) was selected as the ROI to assess the potential impacts to the population as a whole (i.e., for collective dose evaluation). The maximum distance from the source that state-of-the art computer models can evaluate is also 50 mi (80 mi). At this distance, the individual doses would have dropped to negligible levels (<0.1–0.2 mrem/yr), which supports the selection of 50 mi (80 km) as the ROI. With regard to the exploration phase, any impacts that might result during that phase were expected to be minor, because exploratory drillings would disturb only small areas and because most of the mineralized cutting excavated from drilling would be placed back to fill the drill holes. Furthermore, the exploration phase would last for only a short period of time (i.e., a few weeks); therefore, potential impacts would be limited to only a few workers. For these reasons, potential human health impacts associated with the exploration phase were not quantified.

D.5.1 Impact Assessment for the Operational Phase

For this phase, potential impacts on the workers and the general public living near the uranium lease tracts as well as within 50 mi (80 km) of the lease tracts were analyzed. Because the impacts would primarily result from radiation exposures, they (especially radon exposures) were the focus of the analyses conducted for this phase.

Potential impacts assessed for the workers (i.e., uranium miners) included physical hazards and radiation exposures. Physical hazards included nonfatal injuries and illnesses as well as fatal injuries. Statistical data for the mining industry published by the U.S. Department of Labor, Bureau of Labor Statistics (BLS 2011a,b) were used for assessing physical hazards. The potential radiation exposures of the workers, on the other hand, were assessed by using historical data compiled by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 2010).

Radiation exposures of the general public would result primarily from radon emissions from the exhaust vents of the uranium mines. The radon emission rates for three hypothetical underground mines whose sizes ranged from small to medium to large were estimated on the basis of their respective uranium ore production rates, as assumed in the working assumptions. There is a linear correlation between the radon emission rate and the cumulative uranium ore production (EPA 1985). For radon emission rates, an operational period of 10 years was assumed for the uranium mines under consideration when human health impacts under Alternatives 3, 4, and 5 were assessed. This operational period corresponds roughly to the assumed mining periods of operation for Alternatives 3, 4, and 5 evaluated in Chapter 4. The emission rates from the same mines would be lower if the operational period was shorter. An emission rate of 600 Ci/yr was assumed for a very large open-pit mine, which, according to the working assumptions, would be located on Lease Tract 7. This 600-Ci/yr emission rate was determined on the basis of the emission rates of actual open-pit mines compiled by the EPA in its background report on National Emission Standards for Hazardous Air Pollutants (NESHAP) and is at the upper end of the emission rates for the open-pit mines included in the report (EPA 1989a).

The computer code, CAP88-PC (Trinity Engineering Associates, Inc. 2007), which is supported and maintained by the EPA for demonstrating compliance with regulations, was used to estimate radon concentrations at various downwind locations. Potential maximum radiation doses resulting from radon emissions associated with different sizes of uranium mines were calculated. These calculation results were tabulated as functions of the distance from the emission point and can be used for inferring the potential radiation dose to an individual living close to the ULP lease tracts.

The collective dose to the general public living within 50 mi (80 km) of the lease tracts was also calculated by using CAP88-PC (Trinity Engineering Associates, Inc. 2007). However, rather than the radon emission rate from a single uranium mine, the total radon emission rate from all the uranium mines that would be operated at the same time was used. Because the actual number of mines that would be operated at any time is not known, potential human health impacts were analyzed only for the peak year of operations as defined in the working assumptions (Chapter 2). It is expected that potential collective exposures in any other year would be lower than those estimated for the peak year of operations. Because the exact locations of the active mines during the peak year of operations are not known, the potential range of the collective dose was inferred by placing the radon emission point at four alternative locations. These four alternative locations were selected to be the center points of four lease tract groups, which were formed by aggregating the uranium lease tracts whose geographic locations are close to each other. Figure D.5-1 depicts the four lease tract groups used for analyzing the population exposure. Population distributions within 50 mi (80 km) of the center of each lease tract group were developed by using 2010 Census Bureau data.

D.5.2 Impact Assessment for the Reclamation Phase

For the reclamation phase, potential human health impacts were analyzed for the reclamation workers and the general public living close to the uranium lease tracts. Both chemical and radiological risks were analyzed. The major radiation sources of concern were the uranium isotopes and their decay products contained in the waste-rock piles. In addition to emitting radiation, the uranium compounds could pose chemical hazards to human health. The vanadium content in the uranium ores is about 5 to 10 times higher than the uranium content. As a result of intermixing from mining, the waste-rock piles could also contain vanadium, which, if inhaled or ingested, could have adverse effects on human health. To account for the possible range of radionuclide concentrations in waste rocks, maximum sampling data (reported as

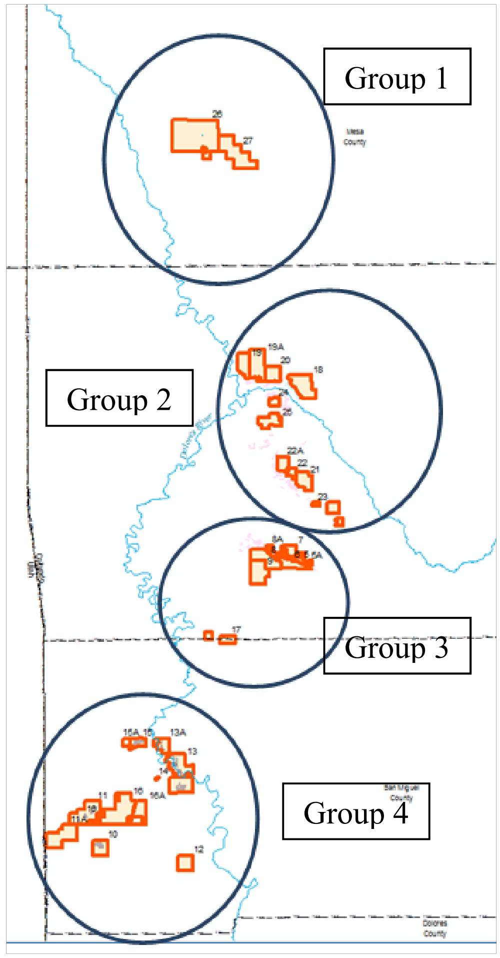

FIGURE D.5-1 Designated Grouping of the ULP Lease Tracts Used as a Basis for Human Health Impacts Evaluation

212 mg/kg total uranium which would result in 70 pCi/g uranium and Ra-226 assuming secular equilibrium between uranium isotopes and their decay products) for Lease Tracts JD-6 and JD-8 ((Whetstone Associates 2011, 2012) was considered along with the possibility that the waste rock could contain up to 0.05% uranium (which is calculated to equate to 168 pCi/g uranium).

The reclamation workers were assumed to incur radiation exposures from working on top of the waste-rock pile through three pathways: external radiation; inhalation of radioactive dust particles and radon; and accidental soil ingestion. The exposures were analyzed by using Version 6.7 of the RESRAD computer code (Yu et al. 2001). For chemical exposures, the potential exposure pathways considered were inhalation of dust particles and incidental soil ingestion. The EPA guidance on human health risk assessment (EPA 1989b) was followed to evaluate the potential chemical risks that could result from exposures to uranium and vanadium compounds.

The general public living near the uranium lease tracts would incur radiation and chemical exposures primarily through the airborne release of particulates from the waste-rock piles. In addition, the release of radon could add to the potential radiation exposure. The emission rate of radon was calculated by using Version 6.7 of the RESRAD code (Yu et al. 2001). In the analysis of potential radiation exposures of reclamation workers, RESRAD calculated the radon flux from the surface of a waste-rock pile; this calculated radon flux was multiplied by the surface area of the waste-rock pile to obtain the radon emission rate. The release rate of dust particles was calculated following the guidance from *Regulatory Guide 3.59* (NRC 1987) on emissions from exposed uranium mill tailings sands due to wind erosion. The frequencies of different wind speed groups required in the dust particle emission calculation were calculated on the basis of meteorological data from the lease tracts (Rogers 2011).

On the basis of the emission rates of radon and particulates calculated by the methods discussed in the preceding paragraph, concentrations of radon, uranium isotopes and decay products, total uranium, and vanadium at various downwind locations from the emission point were obtained by using CAP88-PC (Trinity Engineering Associates, Inc. 2007). These concentrations at downwind locations were then used to infer potential radiation and chemical exposures for an individual living close to the uranium lease tracts during the reclamation phase.

D.5.3 Impact Assessment for Post-Reclamation Phase

The receptor considered for analysis of the human health impacts in the post-reclamation phase was a nearby resident and recreationist who unknowingly entered the uranium lease tract. It was assumed that the recreationist would camp on top of a waste-rock pile for 2 weeks, collect wild berries, and hunt wildlife animals for consumption. Potential impacts from camping would result from the inhalation of radon diffusing from the waste-rock pile, inhalation of dust particles, accidental soil ingestion, and the direct external radiation emitted by radionuclides contained in the waste-rock pile. The RESRAD code was used for dose calculations. Although it is expected that a layer of soil materials would be spread on top of the waste-rock pile to facilitate the growth of vegetation, the thickness of the soil materials could vary. Therefore, in the analysis, a thickness ranging from 0 to 1 ft (0 to 0.3 m) was assumed, and the range of potential impact was calculated.

The residents living close to the uranium lease tracts could still be exposed to radon and dust particles emitted from the waste-rock piles. However, because of the cover soils spread on top of the waste-rock piles, the emission rates would be reduced. As a result, the potential dose associated with airborne emissions incurred by a resident after the reclamation phase would be less than the dose incurred during the reclamation phase.

A less likely exposure scenario for residents living close to the uranium lease tracts considers that the residents let their livestock graze in the uranium lease tracts and consume the meat and milk produced by the livestock. The RESRAD code was used for this analysis.

D.5.4 Parameter Values for Modeling Potential Radiation and Chemical Exposures

For the impact analyses, a resident living close to or within 50 mi (80 km) of the uranium lease tracts was assumed to be at his residence for 350 days per year and to spend 8 hours outdoors and 16 hours indoors each day. Because the windows and doors of the residence would be closed most of the time, a dust or radon filtration factor of 0.4 was assumed (i.e., the indoor radon or airborne particulate level was assumed to be 40% of the outdoor level). The average inhalation rate was assumed to be 8,000 m^3/yr (the default value used in CAP88-PC), while the average soil ingestion rate was assumed to be 100 mg/d.

For reclamation workers, an exposure duration of 20 days was used for impact analyses. The inhalation rate was assumed to be 8,000 m^3/yr, and the soil ingestion rate was assumed to be 100 mg/d. An exposure duration of 2 weeks was assumed for the recreationist who camps on a waste-rock pile. This recreationist was assumed to ingest 1 lb (0.45 kg) of wild berries collected from the lease tracts and 100 lb (45.4 kg) of deer meat obtained through hunting activities. This individual was assumed to have the same inhalation and soil ingestion rate as a reclamation worker. For the nearby residents, the inhalation rate and soil ingestion rate were assumed to be the same as those for the recreationist. The ingestion rates of milk (92 L/yr) and meat (63 kg/yr) were set to the RESRAD default values.

For modeling radon emissions from a waste-rock pile, an emanation factor of 0.15 was assumed based on experimental measurement data taken from rock samples (Ferry et al. 2002; Sakoda et al. 2010). The RESRAD default value of 2×10^{-6} m^2/s was assumed for the radon diffusion coefficient, while the porosity in a waste-rock pile was assumed to be 0.4, the RESRAD default value.

For CAP88-PC analysis, the emission of radon from an underground mine was modeled as a stack source, with a release height of 3 ft (1 m) and a diameter of 6.0 ft (2 m), taken from the diameter of the ventilation shaft in the *Final Environmental Assessment for the Whirlwind Mine Uranium Mining Project* (BLM 2008). An exit velocity of 16 ft/s (5 m/s) was assumed for the gas escaping from the exhaust vents. This exit velocity was obtained by considering the average ventilation rate in an underground mine, the number of exhaust vents, and the diameter of the exhaust vents. An average annual precipitation of 1 ft/yr (0.32 m/yr), ambient temperature of 50°F (10°C), and absolute humidity of 8 g/m^3 were selected to reflect site-specific conditions. An average mixing height of 4,900 ft (1,500 m), considering both morning and afternoon conditions, was also assumed for the analyses. For the analysis involving an open-pit mine, the emission of radon was assumed to come from an area source that occupied 100 acres (40 ha)—or 50% of the disturbed area—based on assumptions presented in Chapter 2 for the alternatives. The release height was 0 ft (0 m), and there was no plume rise for release from the open-pit mine.

D.5.5 Dose Conversion Factors and Toxicity Values

The exposure concentration of radon is usually expressed as a working level (WL), which is a measure of the release of alpha energy by the short-lived progenies of radon. The exposures are measured in working level months (WLMs). One WLM is equivalent to an exposure of 170 hours to a concentration of 1 WL. UNSCEAR recommends that an exposure of 1 WLM corresponds to 506 mrem of effective dose for workers (UNSCEAR 2008, 2010). For the general public, the corresponding effective dose of an exposure of 1 WLM is about 388 mrem (UNSCEAR 2008). The difference in the conversion from WLM to effective dose used for workers and the conversion used for the general public lies in the different inhalation rates considered for the conversion. The International Commission on Radiation Protection (ICRP 2011) indicates that, based on the pooled results from studies of radon-exposed miners, a lifetime excess risk of 5×10^{-4} per WLM should be used for estimating radon progeny-induced lung cancer.

Potential radiation doses resulting from exposures to uranium isotopes and their decay products were calculated by using the ICRP 60-based dose conversion factors for inhalation and ingestion. The corresponding cancer risks were calculated by using the slope factors obtained from Federal Guidance Report No. 13 (Eckerman et al. 1999).

Potential chemical risks that could result from exposures to uranium and vanadium compounds were assessed by comparing the estimated exposures with threshold values. The threshold values used are reference concentrations (RfCs) for inhalation exposures and reference doses (RfDs) for ingestion exposures. The RfD used for assessing risks associated with vanadium exposure is 0.009 mg/kg-d, obtained from the EPA Integrated Risk Information System (IRIS) for V_2O_5 (EPA 2012c). The RfC used is 0.0001 mg/m^3 from the Agency for Toxic Substances and Disease Registry (ATSDR 2012). Because no RfC value is provided in IRIS or the Health Effect Assessment Summary Tables (HEASTs) for vanadium, the minimum risk level (MRL) proposed by the ATSDR for chronic exposure was used as a surrogate for RfC. The RfC used for assessing risks associated with uranium exposure is 0.0008 mg/m^3 (ATSDR 2012), which is the MRL proposed by ATSDR for chronic exposure to insoluble uranium compounds. The RfD used for uranium is 0.003 mg/kg-d, obtained from the IRIS database (EPA 2012c).

D.5.6 Comparison of CAP88-PC Results and COMPLY-R Results

According to Title 40 in the *Code of Federal Regulations* (40 CFR Part 61), emissions of Rn-222 to the ambient air from an underground uranium mine must not result in any member of the general public receiving in any year an effective dose of 10 mrem or greater. Owners or operators of uranium mines must use COMPLY-R (EPA 1989c) or a model equivalent to COMPLY-R, provided they have received approval from EPA headquarters, to demonstrate compliance with this requirement. For human health impact analyses, in addition to the use of COMPLY-R, the CAP88-PC computer code (Trinity Engineering Associates, Inc. 2007) was also used for conducting analyses in the ULP PEIS because it has been supported and maintained by the EPA and used extensively in human health risk assessments for evaluating potential radiation exposures resulting from airborne emissions of radionuclides, including radon. Furthermore, the emissions considered by CAP88-PC can originate from point sources, such as the exhaust vents of underground uranium mines, or from area sources, such as the waste-rock piles accumulated from uranium-mining activities. In addition to being used to obtain air concentrations for estimating the radiation dose to an individual, CAP88-PC can also be used to estimate the collective exposures to a population living or working around the emission sources. Consistency in the methodology was maintained by applying CAP88-PC to evaluate the potential exposures of the general public, both as individual members and collectively, associated with the different phases of uranium mine operations considered in the ULP PEIS.

In this section, the calculation results of CAP88-PC and COMPLY-R associated with the release of radon during the operation of a small underground uranium mine (which was defined by the working assumptions described in Chapter 2) are compared. This small uranium mine was assumed to produce 50 tons of uranium ore per day, with an annual production rate of 12,000 tons/yr (10,800 metric tons/yr). The mining activities were assumed to have been conducted for 10 years. Based on the equation proposed by the EPA (EPA 1985) that correlates the radon emission rate with the cumulative uranium ore production, a radon emission rate of 528 Ci/yr was calculated. The volumetric flow rate from the exhaust vent was calculated to be 450 ft^3/s (13 m^3/s), corresponding to an exit speed of 16 ft/s (5 m/s) and a diameter of 6 ft (2 m) as used in the CAP88-PC analysis. The vent was assumed to be vertical with a height of 3 ft (1 m) above the ground. Both the ambient temperature and the temperature of the exhaust stream were 50°F (10°C). By using the joint frequency data (Rogers 2011) collected from a 30-ft (10-m) high meteorological tower installed by Energy Fuels Resources Corp. in the proposed Piñon Ridge Mill site in Montrose County, Colorado, the frequency and average wind speed in each of the 16 directional sectors were calculated (Table D.5-1). These data represent the site-specific conditions from April 2008 to March 2011.

Table D.5-2 compares the maximum radon doses calculated with CAP88-PC and those calculated with COMPLY-R at different distances from the radon emission point. The radon doses calculated with CAP88-PC were much smaller than those calculated with COMPLY-R for shorter distances, but the difference in calculated doses became smaller as the distance from the emission point increased. According to the users guide (EPA 1989c), COMPLY-R uses a conversion factor of 920 mrem/WLM to convert radon exposures to effective doses, and, by default, a receptor was assumed to spend 75% of the exposure time indoors. For the CAP88-PC results, an updated conversion factor of 388 mrem/WLM (UNSCEAR 2008) was used, and a receptor was assumed to spend 16 hours indoors and 8 hours outdoors each day for 350 days per year at the same location. Furthermore, the indoor radon level was assumed to be 40% of the outdoor level. If the same exposure-to-dose conversion factor is used in both sets of calculations, the radon dose calculated with COMPLY-R would be greater than that calculated with CAP88-PC for an exposure distance of less than 4,900 ft (1,500 m). However, at 4,900 ft (1,500 m) or more, the radon dose calculated with COMPLY-R would be smaller than that calculated with CAP88-PC.

TABLE D.5-1 Meteorological Data Used in the COMPLY-R Calculations

Wind from	Frequency	Speed (m/s)
N	0.026	2.63
NNE	0.015	1.98
NE	0.015	1.53
ENE	0.018	1.43
E	0.04	1.7
ESE	0.137	2.16
SE	0.139	2.01
SSE	0.054	2.01
S	0.047	3.47
SSW	0.077	5.02
SW	0.07	4.54
WSW	0.061	3.1
W	0.07	2.58
WNW	0.094	2.41
NW	0.09	2.87
NNW	0.047	2.85

TABLE D.5-2 Comparison of the Radon Doses Calculated by CAP88-PC and Those Calculated by COMPLY-R

	Radon Dose (mrem/yr)		
Distance (m)	CAP88-PC	COMPLY-R	Ratio[a]
500	7.8	35.7	4.56
1,000	5.6	12.0	2.13
1,500	3.7	6.5	1.75
2,000	2.7	4.3	1.61
3,000	1.6	2.5	1.53
4,000	1.2	1.7	1.39
5,000	1.0	1.3	1.34

[a] The ratio is calculated as COMPLY-R divided by CAP88-PC.

D.6 ECOLOGICAL RESOURCES

D.6.1 Vegetation

This section describes the methodology used to evaluate potential impacts on vegetation within the potentially affected area of the ULP lease tracts.

D.6.1.1 Vegetation Included in the Assessment

Vegetation considered in the assessment included plant communities associated with the ecoregions and land cover types mapped for the potentially affected area (see data sources below). Habitats associated with wetland types, or other water-dependent habitats, known to occur in the potentially affected area were also included.

D.6.1.2 Affected Area

The affected area considered in this assessment included the areas of direct and indirect effects. The area of direct effects was defined as the area that would be physically modified during project development (i.e., where ground-disturbing activities would occur). The area of direct effects encompassed the entire lease tracts, which included all project components and access roads.

The area of indirect effects was defined as the area where ground-disturbing activities would not occur but that could be indirectly affected by activities in the area of direct effects. This indirect effects area was defined as the area outside the lease tracts but within 5 mi (8 km) of the tract boundary. The area of indirect effects could be affected by all phases of project activities, including the construction and use of access roads, in the area of direct effects related to groundwater withdrawals, surface runoff, dust, and accidental spills. The distance from the lease tract boundary used to define this area of indirect effects was based on professional judgment and was considered sufficiently large to bound the area that would potentially be subject to indirect effects. The potential magnitude of indirect effects would decrease with increasing distance from the lease tract.

D.6.1.3 Data Sources

The types of data used to determine the known or potential presence of plant communities in the vicinity of the DOE ULP lease tracts were collected from various sources and at different geographical and organizational levels. Sources of information included, but were not limited to, the following:

- Level III and Level IV ecoregions (Chapman et al. 2006);

- Gap analysis programs—Southwest Regional Gap Analysis Project (SWReGAP) (USGS 2004, 2005);

- State noxious weed lists; and

- National Wetlands Inventory (USFWS 2012).

D.6.1.4 Analysis Approach

Plant communities that were known to occur or could potentially occur within the affected area were included in the impact analysis. A landscape-level analysis was used to determine impacts by quantifying the total number of acres of each land cover type, encompassing a range of similar plant communities, within the area of direct effects.

The magnitudes of impacts on plant communities would depend on the locations of projects, project-specific designs, the mitigation measures applied (including avoidance, minimization, and compensation), and the status of plant communities in project areas.

The analysis of impacts on environmental resources from mining and reclamation activities was based, in part, on a set of assumptions regarding site preparation and reclamation activities. These assumptions were based on management practices at existing mines and current DOE guidance and were used for the evaluation of impacts at the programmatic level.

The actual extent of land disturbance within the footprint of any mine site would be specified in a detailed plan. However, to ensure an upper-bound assumption for the impact analyses, the entire project area was assumed to be cleared of all vegetation during site preparation. Development and operations were assumed to continue for 8 to 15 years. Ground disturbance was assumed to range from 10 acres (4 ha) for small mines to 20 acres (8 ha) for a large mine. In addition, the very large, 210-acre (80-ha) open-pit mine at JD-7 was assumed to resume operations under some of the alternatives.

It was assumed that immediately following the decommissioning of a mine, land surfaces would be recontoured to the greatest extent feasible. The operator would subsequently establish vegetation on the waste-rock area and other disturbed areas. It was assumed that reclamation activities would occur over a 2-year period and would include grading to create landforms conforming to the surrounding area, application of topsoil, and seeding. A seed mix (see Table 4.1-8) has been developed for use on reclamation activities for the ULP. The final determination of successful vegetation establishment would be made by DOE in coordination with the BLM and Colorado Division of Reclamation, Mining, and Safety (CDRMS).

D.6.2 Wildlife and Aquatic Biota

Analysis of potential impacts on terrestrial and aquatic species and their habitats considered mine development, mine operations, and reclamation activities at and in the vicinity of the lease tracts. Direct and indirect impacts on ecological resources were evaluated on the basis of the following:

- The quality and quantity of habitats present;
- The potential magnitude of changes to habitat quality and quantity;
- The season when impacts could occur;
- The expected duration of impacts;
- The sensitivity of biological resources that could be affected by changes in habitat quality or quantity; and
- The rarity and importance of affected resources.

Impacting factors considered in evaluating effects from mining in the lease tracts included the following:

- Habitat loss, modification, and fragmentation;
- Barriers to movement;
- Changes in stream flow and water quality;
- Erosion and sedimentation;
- Air quality and fugitive dust;
- Introduction of invasive species;
- Exposure to contaminants (including radionuclides);
- Mortality and injury; and
- Noise and disturbance.

D.6.2.1 Wildlife

This section describes the methodology used to evaluate impacts on wildlife known to occur, or for which suitable habitat could occur, within the potentially affected area of the ULP lease tracts.

D.6.2.1.1 Wildlife Species Included in the Assessment. Wildlife species considered in the assessment included representative amphibian, reptile, bird, and mammal species. Representative species were selected among those species known to occur, or for which potentially suitable habitat occurs, within the lease tracts. To a large extent, the selection of representative species was based on whether a species (1) has key habitats within or near the lease tracts, (2) is important to humans (e.g., big game, small game, and furbearer species), (3) is representative of other species that share predominant habitats found in the lease tracts, (4) could make use of lease tract mines (e.g., bats), (5) has some type of regulatory protection (e.g., Migratory Bird Treaty Act), and/or (6) is among the species reported in the Environmental Protection Plans (EPPs) provided in Appendix I. To the extent practicable, representative species included wildlife species whose range included the three-county study area or at least extended throughout the region for all or most of the lease tracts.

D.6.2.1.2 Affected Area. For the wildlife impact assessment, the affected area included those portions of Mesa, Montrose, and San Miguel Counties that encompassed the lease tracts. The area of direct effects was defined as the area that would be physically modified during project development (i.e., where ground-disturbing activities would occur). The area of direct effects encompassed the entire lease tracts, which included all project components and access roads. The area of indirect effects was defined as the area where ground-disturbing activities would not occur but that could be indirectly affected by activities in the area of direct effects. This indirect effects area was defined as the area outside the lease tracts but within 5 mi (8 km) of the tract boundary. The distance from the lease tract boundary used to define this area of indirect effects was based on professional judgment and was considered sufficiently large to bound the area that would potentially be subject to indirect effects.

D.6.2.1.3 Data Sources. The types of data used to determine the known or potential presence of wildlife species and life history information on the species were collected from various sources and at different geographical and organizational levels. The most current, location-specific data at the highest resolution were used whenever available. Sources of information included, but were not limited to, the following:

- Colorado National Heritage Program (CNHP 2009) and Colorado Parks and Wildlife (formerly Colorado Division of Wildlife; CPW 2011);

- Gap analysis programs—SWReGAP (USGS 2004, 2005, 2007); and

- NatureServe (2011).

D.6.2.1.4 Analysis Approach. Because of the uncertainty regarding species distributions and the inherent challenges involved with tracking wildlife species in a lease tract, a conservative approach was used to determine the potential for species to occur on or in the vicinity of the lease tracts. The identification of potential wildlife species in the general area of the lease tracts was based on (1) county-level occurrences, (2) locations of species observations as determined by Colorado's wildlife and/or natural heritage agencies, and (3) occurrences of identified land cover for the species listed by SWReGAP (USGS 2005).

Spatial data provided by state natural heritage and regional gap analysis programs were used to determine whether potentially suitable habitat occurred in the affected area. Gap analysis program data consisted of vertebrate animal land cover models. When maps of key habitats for a big game or game bird species (e.g., crucial winter range) were available, the acreages of those habitats within each of the lease tracts were determined by using ESRI ArcGIS Version 9 software.

With regard to the assessment of wildlife, relative impact magnitude categories were as follows:

- *None.* No impacts are expected.

- *Small.* Effects would not be detectable or would be so minor that they would neither destabilize nor noticeably alter any important attribute of the resource. (For this analysis, impacts were considered small if ≤1% of identified habitat for a representative species would be lost in the ROI.)

- *Moderate.* Effects would be sufficient to alter noticeably but not destabilize important attributes of the resource. (For this analysis, impacts were considered moderate if ≥1% but <10% of identified habitat for a representative species would be lost in the region.)

- *Large.* Effects would be clearly noticeable and sufficient to destabilize important attributes of the resource. (For this analysis, impacts were considered large if 10% or more of identified habitat for a representative species would be lost in the region.)

Actual impact magnitudes on wildlife species would depend on the locations of projects, project-specific designs, mitigation measures applied (including avoidance, minimization, and compensation), and status of the species and their habitats in the project areas.

D.6.2.2 Aquatic Biota

This section describes the methodology used to evaluate direct and indirect impacts on aquatic habitats and biota known to occur on or within the potentially affected area of the ULP lease tracts.

D.6.2.2.1 Affected Area. For the aquatic biota impact assessment, the affected area is similar to that for the wildlife assessment. The area of direct effects was defined as the area that would be physically modified during project development (i.e., where ground-disturbing activities would occur). The area of direct effects encompassed the entire lease tracts, which included all project components and access roads. The area of indirect effects was defined as the area where ground-disturbing activities would not occur but that could be indirectly affected by activities in the area of direct effects. This indirect effects area was defined as the area outside the lease tracts but within 5 mi (8 km) of the tract boundary. The distance from the lease tract boundary used to define this area of indirect effects was based on professional judgment and was considered sufficiently large to bound the area that would potentially be subject to indirect effects.

D.6.2.2.2 Analysis Approach. Aquatic habitat and communities were assessed by first determining the perennial and intermittent/ephemeral surface water features (streams and other water bodies) within or adjacent to the lease tracts. The occurrences of surface water features were based on data from the USGS national atlas (http://nationalatlas.gov/mapmaker) and available reports.

Descriptions of aquatic communities within the aquatic habitats were derived from state records, reports conducted on aquatic systems in the lease tracts, and existing NEPA documents for the lease tracts. For many of the ephemeral/intermittent washes and rivers, no data were available. Many of the surface water features in the lease tracts are ephemeral and are not expected to contain aquatic habitat or biota. However, with sufficient frequency and flow, ephemeral or intermittent surface water may contain a diverse seasonal community of opportunistic species or habitat specialists adapted to living in temporary aquatic environments. Such specialists may be present in a dormant state even in dry periods. Therefore, aquatic biota could be present at least temporarily. Also, mining activities could affect permanent water features located near some of the lease tracts. To better resolve whether aquatic habitat and biota are present within or near a lease tract, site-specific surveys of aquatic communities are presumed to be required prior to mine development.

It was assumed that impacts on aquatic habitat and communities could potentially result from direct disturbance; surface water and groundwater withdrawals; and changes in water, sediment, and contaminant inputs to surface water features. Based on best professional judgment, much greater weight was given to the magnitude of direct effects, because those effects could be difficult to mitigate. The potential for indirect impacts on surface water outside the lease tracts was evaluated on the basis of their proximity and connectivity to surface water inside the lease tracts. In most cases, it was assumed that mitigation would reduce most indirect effects to negligible levels. Actual impacts on aquatic habitat and biota would depend on the locations of mines relative to surface water, mine-specific designs, and mitigation measures applied (including avoidance, minimization, and compensation). Mitigation was considered if there was a potential for impacts on aquatic habitat and biota.

D.6.3 Threatened, Endangered, and Sensitive Species

D.6.3.1 Species Included in the Assessment

Potential impacts on threatened, endangered, and sensitive species were evaluated in a manner similar to that used for plant communities and habitats and wildlife and aquatic resources (Sections D.6.1 and D.6.2), and impacts on these species and their habitats from mine development, mine operations, and reclamation activities at and in the vicinity of the lease tracts were considered. The following types of species were evaluated in the ULP PEIS as threatened, endangered, or sensitive species:

- Species listed as threatened or endangered under the Endangered Species Act (ESA) or that are proposed or candidates for listing under the ESA;
- Species that are listed by the BLM as sensitive;
- Species that are listed by the U.S. Forest Service (USFS) as sensitive; and
- Species that are listed as threatened or endangered by the State of Colorado.

Data used to determine baseline conditions and evaluate impacts of the ULP on threatened, endangered, and sensitive species were obtained from the following sources:

- USFWS Information, Planning, and Conservation (IPaC) System (USFWS 2011a);
- USFWS Critical Habitat Portal (USFWS 2011b);
- NatureServe Explorer (NatureServe 2011);
- CNHP Rare Plant Guide (CNHP 2011a);
- CNHP element occurrence records (CNHP 2011b);
- CPW Natural Diversity Information Source (CPW 2011); and
- SWReGAP (USGS 2007).

D.6.3.2 Affected Area

The affected area includes areas that may be directly or indirectly affected by activities conducted under the ULP. The area of direct effects for threatened, endangered, and sensitive species includes those portions of Mesa, Montrose, and San Miguel Counties that intersect the lease tracts. The area of indirect effects for threatened, endangered, and sensitive species encompasses a larger area of habitats that could be affected by indirect factors including, but not limited to, groundwater withdrawal; changes in water quality, sedimentation, and erosion; dispersion of contaminants (including radionuclides); and fugitive dust dispersion. The spatial extent for the area of indirect effects was conservatively defined based on the species' biology and potential mechanisms of impacts. For example, the areas of indirect effects for aquatic species are generally larger than those for terrestrial species. The indirect effects area for terrestrial species was defined as the area outside the lease tracts but within 5 mi (8 km) of the tract boundary. However, the indirect effects area for aquatic species was determined to include downstream intermittent streams and water bodies to account for potential impacts of altered water quality and quantity related to ULP activities. For aquatic species, the indirect effects area included downstream portions of the Dolores and San Miguel Rivers, as well as downstream portions of the Colorado River. The distance between the confluence of the Dolores and Colorado Rivers and the Lease Tracts ranges between approximately 35 river miles (56 river km) from the Gateway Lease Tracts and greater than 70 river miles (112 river km) from the Slick Rock Lease Tracts. In general, the magnitude of indirect effects decreases with increasing distance from the lease tracts.

D.6.3.3 Analysis Approach

Because of the uncertainty regarding species distributions and the inherent challenges involved with tracking species in the lease tracts, a conservative approach was used to determine the potential for species to occur on or in the vicinity of the lease tracts. The identification of potential threatened, endangered, and sensitive species in the vicinity of the lease tracts was based on (1) county-level occurrences, (2) locations of species observations as determined by Colorado wildlife and/or natural heritage agencies, and (3) occurrences of potentially suitable habitat for the species listed by SWReGAP (USGS 2007).

Spatial data provided by the CNHP and SWReGAP were used to determine whether potentially suitable habitat occurred in the affected area. The SWReGAP habitat suitability models consisted only of vertebrate animal land cover models.

A spatial analysis was performed by using ESRI ArcGIS 10 software to determine the intersections of the ULP lease tracts with CNHP element occurrences and SWReGAP habitat suitability models. Based on this analysis, a determination was made regarding the species' known or potential occurrence on the lease tract. A lack of data did not preclude a species from potentially occurring in a given area. When there was a lack of CNHP records or SWReGAP habitat suitability models for a species, modeled land cover types were used to determine the potential suitability of the affected area with regard to what is known about the species' biology and habitat preferences.

Relative impact magnitude categories were as follows:

- *None.* No impacts are expected.

- *Small.* Effects would not be detectable or would be so minor that they would neither destabilize nor noticeably alter any important attribute of the resource.

- *Moderate.* Effects would be sufficient to alter noticeably but not destabilize important attributes of the resource.

- *Large.* Effects would be clearly noticeable and sufficient to destabilize important attributes of the resource.

Actual impact magnitudes on threatened, endangered, and sensitive species would depend on the locations of projects, project-specific designs, and mitigation measures applied (including avoidance, minimization, and compensation).

D.7 LAND USE

The area of analysis focused on public and private lands within a 25-mi (40-km) radius of the ULP lease tracts. Existing right-of-way (ROW) authorizations and land designations under BLM's lands and realty program were identified (including specially designated lands with wilderness characteristics). Other information on agriculture, livestock grazing, wild horses and burros, mineral resources (and mining), oil and gas leasing, timber harvest, and recreation were obtained from Federal and state sources. Major sources of information included (1) BLM's resource management plans, the national landscape conservation system, public land statistics, and the Land and Mineral Legacy Rehost 2000 system (LR2000); (2) USDA's 2007 census of agriculture and resource bulletins; and (3) various reports and database searches from web sites sponsored by the Colorado Department of Natural Resources (CDNR), CDRMS, Colorado Oil and Gas Conservation Commission (COGCC), Utah Geological Survey, and Utah Division of Oil, Gas, and Mining.

The impacts analysis for land use considered issues such as land use conflicts within the lease tracts (e.g., mining, oil and gas leasing, livestock grazing, and recreation), whether or not lease tracts would be open to mineral entry (under the various alternatives), and visual impacts at specially designated lands. The main factors considered as part of the land use impacts analysis were the (1) proximity of lease tracts to specially designated areas, (2) nature of the resources and resource values present within the proximate specially designated areas, and (3) quality of the view of the lease tracts from these areas.

D.8 SOCIOECONOMICS

The analysis of socioeconomic impacts from the mining activities at the DOE ULP lease tracts assessed impacts in an ROI. The ROI includes Mesa, Montrose, and San Miguel Counties in Colorado, in which the majority (up to 90%) of employees for the DOE ULP proposed mines would reside. The ROI includes county governments, city governments, and school districts. The assessment of the impacts from mining at the DOE ULP lease tracts covered impacts on employment, income, population, housing, community services, and traffic.

D.8.1 Regional Employment and Income

The assessment of impacts from mining activities on regional employment and income was based on the use of regional economic multipliers in association with project expenditure data for the mine development and operations phase and the reclamation phase. Multipliers captured the indirect (off-site) effects of on-site activities associated with mining operational and reclamation activities. Data on expenditures were derived from numerous sources.

Cost data for each cost category were then mapped into the relevant North American Industry Classification System (NAICS) codes for use with multipliers from an IMPLAN model specified for each state (MIG 2011). IMPLAN input-output economic accounts show the flow of commodities to industries from producers and institutional consumers. The accounts also show consumption activities by workers, owners of capital, and imports from outside the region. The IMPLAN model contains 528 sectors representing industries in agriculture, mining, construction, manufacturing, the wholesale and retail trade, utilities, finance, insurance and real estate, and consumer and business services. The model also includes information for each sector on employee compensation; proprietary and property income; personal consumption expenditures; Federal, state, and local expenditures; inventory and capital formation; and imports and exports.

Impacts on employment were described in terms of the total number of jobs created in the ROI in the peak years for mine development, mine operations, and reclamation. The relative impact of the increase in employment in the ROI was calculated by comparing the total mining employment (without considering ULP-related activities), over the same period, with the employment that was assumed in order to estimate the number of jobs created by the ULP exploration, mine development and operations, and reclamation activities. Impacts were expressed in terms of the percentage point difference in the average annual employment growth rate with and without the DOE ULP mining activities. Forecasts were based on data provided by the U.S. Department of Commerce.

D.8.2 Population

An important consideration in the assessment of the impacts from DOE ULP mining and reclamation activities was the number of workers, families, and children who would migrate into the ROI, either temporarily or permanently. The capacity of regional labor markets to supply a sufficient number of workers in the occupations required for mining and reclamation is closely related to the occupational profile of the ROI and occupational unemployment rates. To estimate the in-migration that would occur to satisfy direct labor requirements, the analysis developed estimates of the available labor in each direct labor category based on ROI unemployment rates applied to each occupational category. In-migration associated with indirect labor requirements was derived from estimates of the available labor supply in the ROI economy as a whole that would be able to satisfy the demand for labor by industry sectors in which mining and reclamation spending initially occurred. The national average household size (2.6) was used to calculate the number of additional family members who would accompany direct and indirect in-migrating workers. Based on other analyses of energy project labor in-migration (Fahys-Smith 1983), it was assumed that 28% of the workers in-migrating into each ROI would bring their family members with them.

Impacts on population were described in terms of the total number of in-migrants arriving in the ROI in the peak year(s) of DOE ULP mining and reclamation. The relative impact of the increase in population in the ROI was calculated by comparing total DOE ULP in-migration over the period in which mining and reclamation was assumed to occur with baseline ROI population forecasts over the same period. Impacts were expressed in terms of the percentage point difference in the average annual population growth rate with and without the DOE ULP mining and reclamation activities. Forecasts were based on data provided by the Colorado State Demography Office.

D.8.3 Housing

The in-migration of workers occurring during mine development and operations has the potential to affect the housing market in the ROI. The analysis considered these impacts by estimating the increase in demand for rental housing units in the peak year(s) of operations and reclamation that would result from the in-migration of both direct and indirect workers into the ROI. The impacts on housing were described in terms of the number of rental units required in the peak year of operations. The relative impact on the existing housing in the ROI was estimated by calculating the impact of mining-related housing demand on the number of vacant rental housing units in the peak year of operations.

D.8.4 Community Services

In-migration associated with mining activities could translate into an increased demand for educational and public services (schools, police, firefighters, health services, and so on) in the ROI. Impacts of mining activities on community service employment were also calculated for the ROI in which the majority of new workers would locate. The analysis used estimates of the number of in-migrating workers and families to calculate the number of newly sworn police officers, firefighters, and general government employees who would be required to maintain the existing levels of service for each community service. Calculations were based on the existing number of employees per 1,000 persons for each community service. The analysis of the impact on educational employment estimated the number of teachers in each school district who would be required to maintain existing teacher-student ratios across all student age groups. Information on existing employment and levels of service was collected from the individual jurisdictions providing each service.

D.8.5 Recreation

Mining activities could have impacts on recreation. Providing quantitative estimates of these potential impacts is difficult as it is unclear how mining operations and reclamation would affect visits by recreationists. An approach to quantify the magnitude of the potential impacts on the economy (for tourism and recreation) was developed for the ULP PEIS in order to provide some perspective. The approach examined the impact of a 1%, 5%, and 10% reduction in ROI employment and income in the recreation sector. Impacts were estimated by using IMPLAN data for the ROI (MIG 2011). Impacts on employment were described in terms of the total number of jobs that would be lost in the ROI from a reduction in the recreation sector. The relative impact of the decrease in employment in the ROI was calculated by comparing total recreation employment over the period assumed for the proposed mining activities with recreation employment forecasts for the ROI (without the proposed action) for the same period.

D.9 ENVIRONMENTAL JUSTICE

Exploration, mine development and operations, and reclamation of uranium mines at the DOE ULP lease tracts could affect environmental justice if any adverse human health and environmental impacts resulting from any phase were significantly high and if these impacts would disproportionately affect minority and low-income populations. If the analysis determined that human health and environmental impacts were not significant and if the analysis accounted for any cumulative or multiple adverse exposures from environmental hazards and unique factors associated with the populations that might result in differential routes of exposure, or other unique ecological, cultural, human health or socioeconomic impacts, then there could not be any disproportionately high and adverse impacts on minority and low-income populations. If the analysis determined a potential for human health or environmental impacts to be significant, disproportionality would be determined by comparing the proximity of any high and adverse impacts with the locations of low-income and minority populations. For example, the analysis would consider whether potentially significant human health risks would appreciably exceed the risk to the general population.

The analysis of environmental justice issues associated with the development of uranium mines considered impacts within the ULP lease tracts and an associated 50-mi (80-km) radius around the boundary of the proposed lease tracts. The geographic distribution of minority and low-income groups in the 50-mi (80-km) radius was based on demographic data from the U.S. Bureau of the Census (2011a,b). The following definitions were used to define minority and low-income population groups:

- *Minority.* Persons are included in the minority category if they identify themselves as belonging to any of the following racial groups: (1) Hispanic; (2) Black (not of Hispanic origin) or African American; (3) American Indian or Alaska Native; (4) Asian; or (5) Native Hawaiian or Other Pacific Islander.

  Beginning with the 2010 Census, where appropriate, the census form allows individuals to designate multiple population group categories to reflect their ethnic or racial origin. In addition, persons who classify themselves as being of multiple racial origins may choose up to six racial groups as the basis of their racial origins. The term minority includes all persons, including those classifying themselves in multiple racial categories, except those who classify themselves as not of Hispanic origin and as White or "Other Race" (U.S. Bureau of the Census 2011a).

The CEQ guidance proposed that minority populations should be identified where either (1) the minority population of the affected area exceeds 50% or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

The ULP PEIS applied both criteria in using Census Bureau data for census block groups, wherein consideration was given to minority populations that were both greater than 50% and 20 percentage points higher than they were in the state (the reference geographic unit).

- *Low-income.* These are individuals who fall below the poverty line. The poverty line takes into account family size and the ages of individuals in the family. In 2009, for example, the poverty line for a family of five with three children younger than 18 was $26,023. For any given family below the poverty line, all family members are considered as being below the poverty line for the purposes of analysis (U.S. Bureau of the Census 2011b).

D.10 TRANSPORTATION

This section provides the methodology and key input parameters used for the transportation risk analysis performed in support of the ULP PEIS. The methodology followed the common approach identified in the DOE Handbook (DOE 2002). The analysis evaluated the transportation of mined uranium ore from the lease tracts to the uranium mills. Transportation impacts were estimated for shipment by truck because, historically, all such shipments in the area have been by truck. Shipment by rail would not be practical, because there are no rail lines located at or near any of the lease tracts or the uranium mills.

D.10.1 Overview

The transportation risk assessment considered human health risks from routine (normal, incident-free) transport of radiological materials and from accidents. The risks associated with the nature of the cargo itself ("cargo-related impacts") were considered for routine transport. Risks related to the transportation vehicle regardless of type of cargo ("vehicle-related impacts") were considered for potential accidents. Radiological cargo-related accident risks were not quantified, as discussed in Section D.10.1.2. The transportation of hazardous chemicals was not quantified, because hazardous chemicals utilized are similar in types and volumes typical of general small industrial activity (e.g., use of diesel fuel to operate equipment).

D.10.1.1 Routine Transportation Risk

The radiological risk associated with routine transportation would be cargo-related and result from the potential exposure of people to low levels of external radiation near a loaded shipment. No direct physical exposure to radioactive material would occur during routine transport, because the uranium ore would be covered by a tarp during transport. No significant unintended releases would occur.

D.10.1.2 Accident Transportation Risk

The cargo-related radiological risk from transportation-related accidents would come from the potential release and dispersal of radioactive material into the environment during an accident and the subsequent exposure of people through multiple exposure pathways (e.g., exposure to contaminated soil, inhalation, or the ingestion of contaminated food). However, the bulk of the uranium ore, with an approximate uranium concentration range of about 0.2% U_3O_8 by weight, would be in cobbles and stones, which would minimize the potential for any significant release of uranium to the surrounding air, soil, or water. Thus, the radiological accident transportation risk from the shipment of uranium ore was not explicitly quantified, because the short-term dose to an individual involved in an accidental spill or the cleanup would be minimal (e.g., a small fraction of that received by a uranium miner, as discussed in Section 4.3.5.1). A miner is estimated to receive an *annual* dose of 433 mrem, primarily from radon inhalation because of the confined nature of the mine. Such confinement would be absent from an accident spill location, and a worker involved in cleanup might therefore be expected to receive a dose on the order of 1 mrem or less.

"Vehicle-related accident risks" refers to the potential for transportation-related accidents that would result in injuries and fatalities caused by physical trauma unrelated to the cargo.

D.10.2 Routine Risk Assessment Methodology

The RADTRAN 5 computer code (Neuhauser and Kanipe 2003; Weiner et al. 2006) was used in the routine risk assessment to estimate the radiological impacts on collective populations. RADTRAN 5 was developed by Sandia National Laboratories to calculate population risks associated with the transportation of radioactive materials by truck, rail, air, ship, or barge. The code has been used extensively for transportation risk assessments since it was originally issued in the late 1970s as RADTRAN (RADTRAN 1) and has been reviewed and updated periodically. RADTRAN 1 was originally developed to facilitate the calculations presented in NUREG-0170 (NRC 1977).

D.10.2.1 Collective Population Risk

The radiological risk associated with routine transportation would result from the potential exposure of people to low-level external radiation in the vicinity of loaded shipments.

Even under routine transportation, some radiological exposure could occur. Because the radiological consequences (dose) would occur as a direct result of normal operations, the probability of routine consequences is taken to be 1 in the RADTRAN 5 code. Therefore, the dose risk is equivalent to the estimated dose.

For routine transportation, the RADTRAN 5 computer code considers major groups of potentially exposed persons. The RADTRAN 5 calculations of risk for routine highway transportation include exposures of the following population groups:

- *Persons along the route (off-link population).* Collective doses were calculated for all persons living or working within 0.5 mi (0.8 km) of each side of a transportation route. The total number of persons within the 1-mi (1.6-km) corridor was calculated separately for each route considered in the assessment.

- *Persons sharing the route (on-link population).* Collective doses were calculated for persons in all vehicles sharing the transportation route. This group included persons travelling in the same or the opposite direction in which the shipment was going, as well as persons in vehicles passing the shipment.

- *Persons at stops.* Collective doses can be calculated for people who might be exposed while a shipment was stopped en route. For truck transportation, these stops would include those for refueling, food, and rest. Truck stops were not considered in the ULP PEIS because of the relatively short shipment distances being considered.

- *Crew members.* Collective doses were calculated for truck drivers involved in the actual shipment of material. Workers involved in loading or unloading were not considered in the transportation analysis.

The doses calculated for the first three population groups were added together to yield the collective dose to the public. The dose calculated for the fourth group represents the collective dose to workers.

The RADTRAN 5 calculations for routine doses generically compute the dose rate as a function of distance from a point source or line source (Neuhauser and Kanipe 2003). Associated with the calculation of routine doses for each exposed population group are parameters such as the radiation field strength, source-receptor distance, duration of exposure, vehicle speed, stopping time, traffic density, and route characteristics (such as population density). The RADTRAN manual contains derivations of the equations used and descriptions of these parameters (Neuhauser and Kanipe 2003).

D.10.2.2 Highest-Exposed Individual Risk

In addition to the routine collective population risk, the risks to individuals receiving the highest impacts were estimated for a number of hypothetical exposure scenarios by using the RISKIND model (Yuan et al. 1995; Biwer et al. 1997). Receptors included members of the public exposed while standing along the route, during traffic delays, or while living near a facility, as summarized in Table D.10-1.

RISKIND was used to calculate the dose to each individual considered for an exposure scenario defined by an exposure distance, duration, and frequency specific to that receptor. The distances and durations of exposure were similar to those given in previous transportation risk assessments (DOE 1995, 1996, 1997, 1999, 2011). The scenarios were not meant to be exhaustive but were selected to provide a range of potential exposure situations.

The RISKIND external dose model considers direct external exposure and exposure from radiation scattered from the ground and air. RISKIND was used to calculate the dose as a function of distance from a shipment on the basis of the dimensions of the shipment (millirems per hour for stationary exposures and millirem per event for moving shipments). The code approximates the shipment as a cylindrical volume source, and the calculated dose includes contributions from secondary radiation scattering from buildup (scattering by the material contents), cloudshine (scattering by the air), and groundshine (scattering by the ground). As a conservative measure, credit for potential shielding between the shipment and the receptor was not considered.

D.10.3 Accident Assessment Methodology

“Vehicle-related accident risk” refers to the potential for transportation accidents that could directly result in injuries and fatalities not related to the nature of the cargo in the shipment. This risk represents injuries and fatalities from physical trauma. Route-specific rates or county-wide average rates for transportation injuries and fatalities were used in the assessment (see Section D.10.4.1.3). Vehicle-related accident risks were calculated by multiplying the total distance travelled by the rates for transportation injuries and fatalities. In all cases, the vehicle-related accident risks were calculated on the basis of distances for round-trip shipments, because the presence or absence of cargo would not be a factor in accident frequency.

TABLE D.10-1 Individual Exposure Scenarios

Receptor	Exposure Event
Person at roadside	2 m
Person in traffic jam	1.2 m for 30 minutes
Resident near route	30 m

D.10.4 Input Parameters and Assumptions

The principal input parameters and assumptions used in the transportation risk assessment are discussed in this section. These shipments are subject to regulation by the U.S. Department of Transportation (DOT) and other entities, as appropriate. The Hazardous Materials Transportation Act of 1975, as amended in Volume 49 of the *United States Code* (49 USC 5105 *et seq.*), requires DOT to establish regulations for safely transporting hazardous materials (including radioactive materials) in commerce. Title 49 of the CFR contains DOT standards and requirements for packaging, transporting, and handling radioactive materials for all modes of transportation. DOT's hazardous materials regulations (HMRs) on the transportation of hazardous and radioactive materials can be found in 49 CFR Parts 171–180. Natural uranium ore is classified as a low-specific activity (LSA) material with no activity limit and no specific packaging requirements, as covered under 49 CFR Part 173 (Shippers – General Requirements for Shipments and Packaging). Requirements for motor carrier transportation can also be found in 49 CFR Parts 350–399.

D.10.4.1 External Dose Rate

For input to RADTRAN and RISKIND calculations, the dose rate at a distance of 7 ft (2 m) from the side of a uranium ore haul truck was estimated to be approximately 0.1 mrem/h. An ore content of 0.2% U_3O_8 by weight was modeled by using the MicroShield code (Grove 2006) with 25 tons of ore.

D.10.4.2 Route Characteristics

Uranium ore shipments would travel from the lease tracts to a uranium mill for processing. These shipments would not necessarily go to the mill that is nearest to a given lease tract. At the time of actual shipment, many factors (e.g., existing road conditions, traffic, weather, road maintenance or repairs, and mill capacities and costs) would be the criteria used to determine which mill should receive a given ore shipment. The transportation route selected for a shipment determines the total population of potentially exposed individuals and the expected frequency of transportation-related accidents.

D.10.4.3 Routine Impacts

For truck transportation, the route characteristics most important for a risk assessment include the total shipping distance between each origin site and destination site and the population density along the route. Shipping distances between the lease tracts and the proposed Piñon Ridge Mill and White Mesa Mill are presented in Section 4.3.10 and Table 4.3-10.

The population density in the uranium lease tracts is very low, less than one person per square kilometer in most locations. Higher population densities are encountered in the small towns of Naturita, Colorado, and Monticello, Utah—the only population centers along any of the potential uranium shipment routes. For the ULP PEIS analysis, representative unit risk factors were developed on a per-kilometer basis for the collective population and worker (truck driver) doses. These factors were calculated by assuming that the longest potential route would be used.

For the lease tracts and uranium mills under consideration, the longest route is 266 km (165 mi), from New Verde Mine on Lease Tract 26 to White Mesa Mill. The route runs from New Verde Mine on local roads to State Highway (SH) 141, then through Naturita, traveling south to US 491, west into Utah to US 191, through Monticello, and south on US 191 to the White Mesa Mill. This route uses roads typical of most potential routes and runs through both rural and populated areas representative of the region. Population densities at the lease tract level from the 2010 Census were used in RADTRAN 5 to estimate the collective population risks along the route. The average collective dose to the public from uranium ore in the region was estimated to be approximately 1.54×10^{-7} person-rem/km. The average dose to a truck driver was estimated to be approximately 8.08×10^{-7} rem/km.

D.10.4.4 Injury and Fatality Rates

Injury and fatality rates for use in estimating potential injuries and fatalities from truck accidents during the shipment of uranium ore were developed by using route-specific and county-specific data. The injury and accident fatality rates used in the analysis were 1.85×10^{-7}/km for injuries and 1.66×10^{-8}/km for fatalities. These rates were generated based on injuries, fatalities, and vehicle miles travelled as reported by the Colorado Department of Transportation (CDOT) for the years 2002 through 2007 for SH 90, SH 141, and SH 491 (CDOT 2002, 2003, 2004, 2005, 2006a, 2007a) in the vicinity of the lease tracts and along any potential route to either of the two uranium mills considered. These rates are high for heavy truck travel because they include all vehicle types. For comparison, a rate of 1.80×10^{-8}/km for fatalities was estimated from data on all large-truck vehicle miles (CDOT 2006b, 2007b, 2008, 2009, 2010) and all traffic fatalities (DOT 2010a–d) in Dolores, Mesa, Montrose, and San Miguel Counties for the years 2006 through 2010. This second value is in relatively good agreement with (within <10% of) the value of 1.66×10^{-8}/km for fatalities for all vehicles on the roads considered in the analysis.

For Utah, injury and fatality rates were derived from the available data for 2005 through 2009 for San Juan County. Data on vehicle miles travelled in the county for all vehicles were used in conjunction with the number of injuries and fatalities recorded (Utah 2005, 2006, 2007, 2008, 2009) to obtain rates of 2.77×10^{-7}/km for injuries and 2.41×10^{-8}/km for fatalities. Because these rates included contributions from vehicles other than heavy trucks as well as all roads in the county and not just US 491 and US 191 on the route to the White Mesa Mill (which represent relatively short distances), the Colorado injury and fatality rates were used for the analysis of all shipments to White Mesa Mill.

D.10.4.5 Ore Production Rates and Shipment Capacities

Because of the uncertainties associated with the actual locations and sizes of uranium mines that could operate in the future, the transportation analysis conducted for Alternatives 3 through 5 used an assumed mine size, which determines the number of ore shipments, for each lease tract listed in Table D.10-2. The mine sizes used (small, medium, large, and very large) with assumed uranium ore production rates (50, 100, 200, and 300 tons/d, respectively) are

TABLE D.10-2 Mine Size for Each Lease Tract as Assumed for the Transportation Analysis for Alternatives 3, 4, and 5

Lease Tract	Assumed Mine Size	Ore Production Rate (tons/d)	Ore Shipments per Day[a]
C-JD-5	Large	200	8
C-JD-5A	Small	50	2
C-JD-6	Large	200	8
C-JD-7	Very large	300	12
C-JD-8	Medium	100	4
C-JD-8A	Small	50	2
C-JD-9	Medium	100	4
C-SR-10	Medium	100	4
C-SR-11	Medium	100	4
C-SR-11A	Medium	100	4
C-SR-12	Small	50	2
C-SR-13	Medium	100	4
C-SR-13A	Medium	100	4
C-SR-14	Medium	100	4
C-SR-15	Small	50	2
C-SR-15A	Small	50	2
C-SR-16	Small	50	2
C-SR-16A	Small	50	2
C-WM-17	Small	50	2
C-SM-18	Medium	100	4
C-AM-19	Large	200	8
C-AM-19A	Medium	100	4
C-AM-20	Small	50	2
C-LP-21	Medium	100	4
C-LP-22	Small	50	2
C-LP22A	Medium	100	4
C-LP-23	Medium	100	4
C-CM-24	Small	50	2
C-CM-25	Small	50	2
C-G-26	Small	50	2
C-G-27	Small	50	2

[a] Assumes an ore haul truck capacity of 25 tons.

discussed further in Section 2.2. The size of a mine on a specific lease tract was first selected roughly on the basis of past uranium ore production. If no previous ore production had occurred, the assumed mine sizes for those lease tracts were assigned so as to distribute uranium ore production in a generally even manner across the entire region considered, if all mines were to operate at the same time. In reality, such an occurrence would generate 2,900 tons of ore per day. The ore production was averaged over the region to highlight the general level of traffic that could occur in various areas.

D.11 CULTURAL RESOURCES

The following procedures were employed to estimate the potential impacts of the alternatives proposed in the ULP PEIS. The process began with a review of available documentation of known cultural resources, including archaeological sites, historic structures, and traditional cultural properties. It began with a Class I cultural resource review of the lease tracts conducted by Alan Reed in 2006, the ethnographic background study and potential for traditional cultural properties analysis of the lease tracts conducted by J.N. Fritz in 2006, and the discussion of the historic mines on the lease tracts by E. Twitty in 2008. Information on cultural resource surveys conducted within the tracts since 2006 was obtained as geographic information system (GIS) layers from Colorado's Office of Archaeology and Historic Preservation (OAHP). For purposes of comparison, GIS data were also obtained for a 15-mi (24-km) buffer surrounding the lease tracts. Since some lease tracts were closer than 15 mi (24 km) from the Utah border, buffer information was requested from the Utah State Historic Preservation Office (SHPO) as well. The data obtained from the Colorado OAHP and the Utah SHPO were used to update the description of known cultural resources within the lease tracts.

The most recent GIS data from the OAHP were used to compare the number of acres surveyed within each lease tract with the area of each lease tract, to determine the percentage of each lease tract that had been surveyed. Then, for purposes of analysis, the lease tracts were grouped into the four proximity-based clusters used for visual resource analysis: North; North Central; South Central; and South. The total acreage surveyed and the number of sites recorded for each cluster were tallied and used to determine site densities for each cluster. On the basis of the assumption that the site densities in the unsurveyed areas would be similar to those of the surveyed areas for each cluster, the number of potential sites was projected for each cluster.

Two types of potential impacts were considered. Direct impacts are those in which the resource is directly destroyed, altered, or damaged by mining operations. Impacts such as vandalism and unpermitted collecting are considered indirect when they do not result from mining itself or the construction of access roads to the mines but are instead the result of increased human presence due to mine operations or increased access due to the construction of or improved maintenance on roads to the mines. On the basis of the site density within each cluster and the number of acres that would be disturbed by a mine in each mine category (small, medium, large, and very large), the number of sites likely to be directly affected by a mine in each category was projected. Under each alternative, a different number of small, medium, large, and very large mines would likely be developed. The number of direct impacts for each alternative was projected, based on the acreage likely to be disturbed. For indirect impacts, it was assumed that all the sites projected for each cluster would have the potential to be indirectly affected. These were, of course, projections only. Pedestrian surveys would be necessary to determine the actual locations of sites. The number of sites directly affected could be reduced by changing the location of mining activities.

The GIS data from the Colorado OAHP does not identify traditional cultural properties. Unless already documented, the presence of such properties can be determined only by communications with the relevant cultural groups. Federally recognized Native American tribes are being contacted, but to date, none of them have identified any culturally important properties on or near the lease tracts.

D.12 VISUAL RESOURCES

The visual impact analysis for the ULP PEIS utilizes distance zones specified within the Bureau of Land Management's (BLM's) visual resource management (VRM) system to identify potentially sensitive visual resource areas (SVRAs) that might be affected by one or more of the five alternatives. In order to assess these impacts, reverse viewshed analyses were conducted to identify which lands surrounding the lease tracts would have views of infrastructure and activities in at least some portion of the lease tracts. Reverse viewshed analyses were conducted for Alternatives 1, 3, and 4. A separate analysis was not conducted for Alternatives 2 and 5 because of the similarities in the visual impacts associated with Alternatives 1 and 4, respectively.

A primary component considered in conducting this analysis was the impact of distance on determining what could be seen from within a lease tract. The distance between the viewer and the mining activities (during exploration, mine development and operations, and reclamation) that are the source of visual contrast is a critical element in determining the level of perceived impact. For this analysis, the BLM distance zones in the VRM system were utilized. These zones are as follows:

- *Foreground–middleground* (0 to 5 mi [0 to 8 km]). This zone includes areas where management activities may be seen in detail. For instance, the outer boundary of this distance zone is defined as the point at which the texture and form of individual plants are no longer apparent in the landscape.

- *Background* (5 to 15 mi [8 to 24 km]). This zone includes the area beyond the foreground–middle ground up to 15 mi (24 km) and the area where some detail beyond the form or outline of the project is visible. For example, vegetation should be visible at least as patterns of light and dark.

- *Seldom seen* (beyond 15 mi [24 km]). This zone includes areas beyond 15 mi (24 km) (BLM 1986).

A GIS-based impact analysis was used to identify locations within the SVRAs from which some portions of the lands containing the lease tracts would be visible. Assuming an unobstructed view of the ULP lease tract, viewers in these areas would be likely to perceive some level of visual contrast from the mining activities.

The “spatial analyst extension” of the ESRI ArcGIS 10 software was used to calculate viewsheds. (A viewshed is an area of landscape visible to the human eye from a fixed vantage point.) The viewshed analyses determined the potential visibility of the four lease tract groups or portions of these groups from lands within 25 mi (40 km). The ROI for visual resource analysis was set at 25 mi (40 km) because it is the approximate limit at which non-negligible visual contrasts from the structures and landforming activities in the proposed action could reasonably be expected to be visible in this region, assuming favorable viewing conditions and strong contrast between an object and its background. Viewshed calculations were performed by using National Elevation Dataset (NED) 10-meter Digital Elevation Model (DEM) with the earth curvature set to a refractivity coefficient of 0.13.

Because each of the four groups or a portion of the groups of lease tracts represents a large geographic area rather than specifically located points, a grid-based sample of points was used to calculate visibility.

Viewsheds were calculated based on an assumed height of 30 ft (9 m) to represent the mining sites and 5 ft (1.5 m) to represent the observer height.

The selected SVRAs included in the analysis were as follows:

- National Parks, National Monuments, National Recreation Areas, National Preserves, National Wildlife Refuges, National Reserves, National Conservation Areas, National Historic Sites;
- Congressionally authorized Wilderness Areas;
- Wilderness Study Areas;
- National Wild and Scenic Rivers;
- Congressionally authorized Wild and Scenic Study Rivers;
- National Scenic Trails and National Historic Trails;
- National Historic Landmarks and National Natural Landmarks;
- All-American Roads, National Scenic Byways, State Scenic Highways, and BLM-designated and U.S. Forest Service-designated Scenic Highways and Byways;
- BLM-designated Special Recreation Management Areas; and

- Areas of Critical Environmental Concern (ACECs) designated because of outstanding scenic qualities.

Although the viewshed analysis showed areas that may be subject to visual impacts from mining-related activities conducted within the lease tracts, the actual acreage that would be affected would likely be smaller than that indicated by the analysis, because of potential screening of views of the lease tracts by vegetation or structures. The viewshed analyses also did not account for the heights of vegetation or existing structures that might screen views. The analyses conducted for the ULP PEIS were limited to data available in GIS format at the time of analysis. They did not analyze any of the additional scenic resources that exist at the national, state, or local levels. Furthermore, although a GIS-based analysis is capable of having extremely high spatial accuracy, it is limited by the accuracy of the data used in the analysis, which were obtained from many sources and are subject to error.

After the GIS-based analysis was completed, views to the lease tracts from the SVRAs were simulated by using Google Earth software. Keyhole Markup Language (KML) files of the lease tracts and the SVRA boundaries were imported from ArcGIS. Analysts then selected a variety of viewpoints within the SVRAs that were depicted as having potential views of the lease tracts. The intent of this analysis was to evaluate the apparent size and viewing angle of the lease tracts from a potential viewing location and thereby determine the potential level of contrast that could be observed from the various activities associated with each alternative.

D.13 WASTE MANAGEMENT

Wastes (other than waste rock) generated during the three phases of uranium mining (exploration, mine development and operations, and reclamation), such as liquids and solids from the treatment of water, spent oil, grease, and lubricant, and other trash were evaluated in terms of how this additional waste would affect the existing practices or availability of the disposal capacity for similar waste.

D.14 CUMULATIVE IMPACTS

The methodology for cumulative impacts analysis is consistent with guidance provided by the CEQ (CEQ 1997; Connaughton 2005). It includes defining the ROI for cumulative impacts; identifying past, present, and reasonably foreseeable projects and activities (Federal and non-Federal) within the region; summarizing the impacts associated with those projects and activities (if available); and determining the magnitude and significance of the cumulative impacts.

The ROI for cumulative impacts was defined as 50 mi (80 km) for all resource areas, which is considered conservative. Past, present, and reasonably foreseeable projects and activities within the ROI for cumulative impacts were identified from a variety of sources, including NEPA assessments performed by various Federal and state agencies for nearby projects. Projects and activities within the ROI for cumulative impacts were also identified by using NEPA registers from regional BLM field offices and schedules of proposed actions from nearby National Forests.

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