5 EFFECTS OF TAR SANDS TECHNOLOGIES

This chapter of the PEIS contains summary information on current and emerging tar sands technologies and their potential environmental and socioeconomic impacts. Some of the information on the environmental consequences of tar sands development in this chapter was based on past tar sands development efforts. For the purposes of analysis, in the absence of more specific information on the tar sands technologies to be implemented in the future and the environmental consequences of implementing those technologies, information derived from other types of mineral development (oil and gas, and underground and surface mining of coal) were used in preparing this chapter. The BLM has taken this approach because it anticipates, to the best of its knowledge, that the surface-disturbing activities involved with these other types of mineral development are comparable to those that may result from oil shale and tar sands development.

This chapter also includes a brief description of mitigation measures the BLM may consider using if warranted by the results of NEPA analysis undertaken prior to issuance of site-specific tar sands commercial leases and/or approval of detailed plans of development. Use of the mitigation measures will be evaluated at that time.

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

5.1 ASSUMPTIONS AND IMPACT-PRODUCING FACTORS FOR INDIVIDUAL FACILITIES FOR COMMERCIAL TAR SANDS TECHNOLOGY

Although no tar sands development is currently taking place on public lands in Utah, for the purposes of analysis in this PEIS, it is assumed that development is possible in any of the 11 STSAs listed in Table 2.3-1. This section summarizes some of the assumptions and potential impact-producing factors related to the different commercial tar sands technologies being considered, as well as the potential impacts associated with establishing transmission line and crude oil pipeline ROWs and building employer-provided housing. Impact-producing factors are defined as activities or processes that cause impacts on the environmental or socioeconomic setting, such as surface disturbance, water use, numbers of employees hired, and generation of solid and liquid waste. Specifically, this section identifies the data used and assumptions made to define potential impact-producing factors for hypothetical tar sands development facilities. The information presented here is summarized, in part, from more detailed discussions contained in Appendix B (the tar sands development background and technology overview), as well as previous environmental documents. In those instances where specific data are not available to define a potential impact-producing factor, best professional judgments have been made to establish reasonable assumptions. Discussions relating to air emissions are presented in Section 5.6.

The technologies considered in this PEIS for tar sands development include surface mines with surface retorts or solvent extraction, and in situ facilities using steam injection or combustion. The application of underground mining technologies for commercial tar sands development was not considered because, at this time, they do not appear to be commercially viable. Available information on impact-producing factors that would be applicable to Utah tar sands development is very limited. Many of the assumptions used to estimate tar sands development impacts in this PEIS are based on published information for a proposed 20,000-bbl/day-capacity plant designed for recovery of oil from a diatomaceous earth tar sands deposit in California (Daniels et al. 1981), or on the Utah Combined Hydrocarbon Leasing Regional Final EIS (BLM 1984).[1] In general, the information provided in Sections 5.1 and 5.2 is based on an assumed production rate of 20,000 bbl/day. However, values for some variables (e.g., acres disturbed, water use, and employment levels) were not considered to have a direct linear relationship to production levels. Alternate assumptions for these variables are discussed, where applicable, in Sections 5.1.1 and 5.1.2. In addition, for purposes of analysis, this assessment looks at the potential impacts from a single facility, although the actual level of development that could occur in the future is not known. Subsequent NEPA analysis will occur prior to both leasing and approval of plans of development when more information on specific technologies and production levels is available.

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

5.1.1 Surface Mine with Surface Retort or Solvent Extraction Projects

The information presented in Table 5.1.1-1 identifies the key assumptions associated with surface mining with surface retorting or solvent extraction of tar sands for a facility sized to support production levels of 20,000 bbl/day of oil. These data may be used to extrapolate

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[1] Although more recent data exist from tar sands development ongoing in Canada, those data are not applicable to Utah tar sands because of the different chemical characteristics of the tar sands (i.e., the Canadian tar sands have an aqueous layer between the sand and the bitumen, making separation easier).

TABLE 5.1.1-1 Assumptions Associated with a Surface Mine with Surface Retort or with Solvent Extraction for Production Levels of 20,000 bbl/day of Syncrude[a,b]

Impact-Producing Factor	Value Used in Impact Analyses
Footprint of development area (acres)[c]	2,950
Surface disturbance (acres)[c]	5,760
Water use for mining (bbl/day)[d]	25,000
Water use for retort (bbl/day)[d]	12,000
Water use for solvent extraction (bbl/day)[d]	107,000
Water use for upgrading (bbl/day)[d]	386,000
Noise at mine site (dBA at 500 ft)	61[e]
Noise at retort, solvent extraction, or upgrading sites (dBA at 500 ft)	73–88
Spent (processed) sand (tons/day)	52,000
Direct employment for surface mining	
Construction	1,200
Operations	480
Total employment[f]	
Mine and retort/extraction facility construction	1,800
Mine and retort/extraction facility operations	750

[a] Values based on a 20,000-bbl/day facility using a diatomaceous earth deposit (see Appendix B; Daniels et al. 1981), unless otherwise noted.

[b] bbl = barrel; 1 bbl syncrude = 42 gal, 1 bbl water = 55 gal.

[c] These acreages represent the assumed area of surface disturbance that could occur at any given time during the life of the project once commercial production levels are reached. Development is expected to occur with a rolling footprint so that, ultimately, the entire lease area would be developed and then restored. The assumed lease area of 5,760 acres is based on provisions of the MLA as revised by Section 369(j) of the Energy Policy Act of 2005.

[d] See Appendix B for sources for water use values. Approximately 3.5% of the process water used for mining, 100% of that used for a retort, and 22% of that used for solvent extraction would need to be fresh water (Daniels et al. 1981).

[e] Noise level for a 20,000-bbl/day facility is from Daniels et al. (1981).

[f] The total employment values include both direct and indirect jobs. The values are based on average data for both a surface mine and an in situ facility (BLM 1984). The methodology is discussed in Appendix G.

assumptions for facilities with higher production levels (see Appendix B). Development is assumed to occur with a rolling footprint so that, at any given time, portions of the lease area would be (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing restoration after development; and (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. The mine area and spent tar sands disposal areas would be reclaimed on an ongoing basis. Spent tar sands may be disposed of by being returned to the mine as operations would permit; there also would be some spent tar sands disposal on other parts of the lease area. The amount of land used for spent tar sands disposal would vary from project to project but is expected to be encompassed within the estimated development area identified in Table 5.1.1-1.

Water sources for tar sands surface mine facilities would be varied but may include a combination of groundwater, surface water, and treated process water. Groundwater pumped from the mine or from dewatering wells would be of variable quality; the higher quality water would most likely be used for industrial processes, dust control, and revegetation. Water of lower quality would be reinjected or otherwise disposed of pursuant to state requirements.

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

Surface Mining

- Surface mining would occur only in areas where the overburden thickness is equal to or less than the thickness of the mined tar sands.

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

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

- Explosives would be used in the mining process to remove overburden and fracture the tar sands.

- Raw tar sands would be loaded by shovel into trucks for delivery to the crusher that would be adjacent to the retort and would feed the retort by conveyor belt.

- Strip mine development would provide for disposal of spent tar sands in previously mined areas of the mine, to the extent that the disposal can be accommodated by available capacity.

- Reclamation would be conducted contemporaneously with mining activities.

Surface Retorts

- In the absence of additional data, it is assumed the emissions from the surface retorts would be consistent with those from the Lurgi-Ruhrgas retort (see Appendix B).

- Surface retorts would be operated continuously for maximum energy efficiency, and mining and other processing activities that support the retorts would be scaled to provide a relatively constant supply of material to allow the retort to operate continuously at its rated capacity; multiple, simultaneous mining and crushing operations may therefore be required.

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

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

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

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

- Indirect heat sources for surface retort would be provided by external combustion sources fueled by natural gas delivered to the site by pipeline, propane stored in pressure tanks on-site, or diesel fuel provided by commercial suppliers and stored in on-site aboveground tanks. Each commercial fuel source would be supplemented by combustible gases recovered from the retort.

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

Upgrading Activities Associated with Surface Retorting

- All bitumen recovered from the tar sands facilities would require some degree of upgrading.

- At a minimum, upgrading would consist of:
  - Dewatering;
  - Filtering of suspended solids;
  - Conversion of sulfur-bearing molecules to H_2S;
  - Removal of H_2S and conversion to elemental sulfur by the use of a conventional Claus process or equivalent;
  - Conversion of nitrogen-bearing compounds to ammonia, recovery of ammonia gas, and temporary storage and sale of ammonia gas as fertilizer feedstock; and

  - Hydrogenation or hydrocracking of organic liquids only to the extent necessary to sufficiently change physical properties (API gravity, pour point) of the resulting syncrude to allow for conveyance from the mine site by conventional means (tanker truck and/or pipeline).

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

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

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

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

Solvent Extraction

- Solvent extraction would occur after tar sands were recovered from a surface mine.

- Solvent extraction facilities would be located near the upgrading operations and could be at some distance from the surface mine.

- Preparation of mined sand, such as crushing or screening, would occur adjacent to the solvent extraction facility.

- Since the temperatures involved are not high (212ºF [100ºC] or less), solvent extraction units would not need to operate continuously but could do so to support upgrading operations.

- Solvent would be recycled after separation from the bitumen.

- Although other processes could be used, solvent recovery would be accomplished by steam stripping and evaporation followed by decanting to separate solvent from water.

- Solvent would be stored on-site in aboveground storage tanks.

- Makeup solvent would be delivered to the site by commercial suppliers in tanker trucks.

- In addition to recovery of the dissolved bitumen, recycling would require, at a minimum:
  - Dewatering, particularly if hot or cold water solvent extraction were used (however, in some processes, some of the solvent/water mixture can be recycled without complete dewatering);
  - Removal of spent sand and suspended solids; and
  - Removal of any dissolved gases.

- Process heat and steam would be provided by external combustion sources fueled by natural gas delivered by pipeline, propane stored in pressurized tanks on-site, and/or diesel fuel stored on-site in aboveground tanks and delivered by commercial suppliers.

- Upgrading of the recovered bitumen would be required.

5.1.2 In Situ Facilities with Steam Injection or Combustion

The information presented in Table 5.1.2-1 identifies the key assumptions associated with in situ steam injection or combustion projects sized to support production levels of 20,000 bbl/day. These data may be used to extrapolate impacting factors for facilities with higher production levels (see Appendix B). Development is assumed to occur with a rolling footprint so that, at any given time, portions of the lease area would be (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing reclamation after development; and (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots.

Water for tar sands facilities using in situ production would come from wells, surface sources, and treated process water. Groundwater and process water would be of variable quality, with the higher-quality water being used for industrial processes, dust control, and revegetation. Water of lower quality would be reinjected or otherwise disposed of pursuant to state requirements.

Additional assumptions regarding in situ combustion or steam injection include the following:

- Some degree of upgrading of the bitumen can be expected to occur within the formation, before product recovery occurs.

- Upgrading of recovered products would be required and is likely to include:
  - Dewatering;
  - Gas/liquid separations;

TABLE 5.1.2-1 Assumptions Associated with In Situ Facilities with Steam Injection or Combustion for Production Levels of 20,000 bbl/day of Syncrude[a]

Impact-Producing Factor	Value Used in Impact Analyses
Footprint of development area (acres)[b]	80–200
Surface disturbance (acres)[b]	5,760
Water use for steam injection (bbl/day)[c]	100,000
Water generated through combustion (bbl/day)[c]	40,000
Water use for upgrading (bbl/day)[c]	386,000
Noise at upgrading site (dBA at 500 ft)[d]	73–88
Direct employment for in situ	
Construction	1,200
Operations	480
Total employment[e]	
Steam injection or combustion facility construction	1,830
Steam injection or combustion facility operations	750

[a] bbl = barrel; 1 bbl syncrude = 42 gal, 1 bbl water = 55 gal.

[b] These acreages represent the assumed area of surface disturbance that could occur at any given time during the life of the project once commercial production levels are reached. Development is expected to occur with a rolling footprint so that, ultimately, the entire lease area would be developed and then restored. Assumed lease area of 5,760 acres is based on provisions of the MLA as revised by Section 369(j) of the Energy Policy Act of 2005.

[c] See Appendix B for sources for water use values. For steam injection, they are based on an estimated 5 bbl of water use per bbl of syncrude produced; for combustion, the basis is 1 to 2 bbl of wastewater produced per bbl of syncrude. For upgrading, the water use represents evaporative losses from the coker unit.

[d] Noise level for a 20,000-bbl/day facility is from Daniels et al. (1981).

[e] The total employment values include both direct and indirect jobs. The values are based on average data for both a surface mine and an in situ facility (BLM 1984). The methodology is discussed in Appendix G.

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

- Temporary storage of recovered and/or upgraded liquid products on-site in aboveground tanks before delivery to market or conventional petroleum refineries by tanker truck or pipeline; and
- Dewatering of 100% of flammable gases recovered from the formation, then filtering of suspended solids, and consumption on-site as supplemental fuel in external combustion sources.

5.1.3 Transmission Line and Crude Oil Pipeline ROWs

Tar sands projects (except those at the Tar Sand Triangle STSA) would need to connect to the existing transmission grid (or to new regional transmission lines) to obtain electricity. The maximum distance from an existing 500-kV transmission line to any of the STSAs is approximately 140 mi. The maximum distance from an existing 230-kV transmission line to any of the STSAs is approximately 80 mi. The greater distance of 140 mi has been assumed for all hypothetical tar sands projects, although some projects would be located at shorter distances from existing transmission lines. Project economics would likely select for sites closest to existing infrastructure.

For the purposes of analyses, it is assumed that one connecting transmission line and ROW would serve any tar sands project and would be 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide (equivalent to a disturbed area of 1,700 acres during operations and 2,500 acres during construction). The 140-mi distance assumption and 100-ft ROW size represent probable maximum sizes. Power needs at the Tar Sand Triangle STSA would be expected to be met by on-site power generation because the remote location of this STSA would likely preclude extensive transmission line construction.

In addition, it is assumed that tar sands projects would need to connect to existing regional crude pipelines (or to new regional pipelines) through the installation of new feeder pipelines. It is assumed that one pipeline and ROW would serve each project. The maximum length from an existing pipeline to any tar sands resource is approximately 95 mi. For purposes of analysis, it is assumed that these pipeline ROWs would be 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (equivalent to a disturbed area of 570 acres during operations and 1,200 acres during construction). The 95-mi distance assumption and 100-ft ROW size represent probable maximum sizes.

5.1.4 Workforce Operational Details and Employer-Provided Housing

A number of assumptions have been made regarding the operations schedule and housing for workers who move into the study area to support future commercial tar sands development. It is assumed that at commercial scale, all projects would operate 24 hours a day, 7 days a week. It is further assumed that about 30% of the construction and operations workers, including those hired directly to work on tar sands projects as well as those hired for jobs indirectly related to the development, would bring families with them, with an average family size of 2.6 (see Section 5.12). Some portion of these incoming people would live in housing provided by the operators. The locations of the employer-provided housing are unknown at this time; however, housing is not expected to be located on public lands. Employer-provided housing would be constructed as needed to house the workforce and provide facilities and infrastructure (e.g., groceries, basic medical care, schools, and recreation). A density of 35 people per acre is assumed for this employer-provided housing.

The BLM has made assumptions regarding what percentage of workers and their families would be housed in employer-provided housing, as opposed to those that would move into existing communities. Section 5.12 provides a more detailed discussion of these and related assumptions. Table 5.1.4-1 provides estimates of the number of people that would be housed in local communities versus employer-provided housing, and the number of acres that would be required to support the employer-provided housing by technology.

5.1.5 Expansion of Electricity-Generating Capacity

Given the limited amount of electrical power needed, power needs for commercial development projects at the STSAs would be met by anticipated expansion of existing coal-fired plants in Utah. Power needs for any projects at the Tar Sand Triangle STSA are expected to be met by on-site power generation because of the remote location of this STSA.

5.1.6 Refining Needs for Tar Sands Development Projects

Factors that would likely impact the incorporation of tar sands–derived crude into the refinery market are discussed in Attachment B1 to Appendix B. This attachment specifically examines the anticipated refinery market response to potential tar sands production over the 20-year time frame assessed in this PEIS. It provides a brief overview of the U.S. petroleum

TABLE 5.1.4-1 Estimated Housing Distribution of Incoming People and Acres Impacted by Employer-Provided Housing for the Construction and Operations Phases of Commercial Tar Sands Development

Parameter	Construction	Operations
Total population (including families)[a]		
Employer-provided housing	1,700	450
Local communities	930	640
Maximum size of employer-provided housing (acres)[b]	49	13

[a] The total population, including families, was calculated on the basis of the total number of new direct and indirect workers that would move into the area, assuming that 30% of them would bring families with an average family size of 2.6 people.

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

refinery market and identifies some of the major factors that would influence decisions regarding construction or expansion of refineries and displacement of comparable volumes of crude. On the basis of the discussion in Attachment B1, it is concluded Utah tar sands–derived crude oil and/or asphalt that might be produced during the 20-year time frame evaluated in this PEIS (up to approximately 300,000 bbl/day) would not trigger significant expansions in either long-range crude transportation pipelines or refineries, either within the region or beyond. Therefore, additional refinery capacity is not considered to be necessary as a result of tar sands development and is not further considered in this PEIS. It is assumed that all processing required to upgrade the product(s) to render them suitable for pipeline transport and acceptance at refineries would be conducted on-site.

5.1.7 Additional Considerations and Time Lines

The above assumptions broadly describe the impact-producing factors for commercial tar sands development. Within these general facility descriptions, many permutations are possible. For example, various surface retort designs exist, and each has a unique set of environmental impacts and resource demands. In addition, indirect impacts may occur. For example, there may be a need for major upgrades to existing road systems; the magnitude of this impact, however, would depend on project site locations. A detailed definition of each possible permutation and a subsequent analysis of its impacts would be impractical and speculative, because there is no means of identifying the precise development schemes that may be proposed by future developers. Furthermore, while it is likely that commercial development would be accompanied by the centralization or consolidation of some services (e.g., product storage, waste management, and equipment maintenance), it is not possible at this time to predict how this would evolve. This PEIS, therefore, provides an analysis of the range of impacts from each of the major technologies that might be deployed in the future, along with an analysis of the supporting services that would be required by each technology, but it does not analyze specific facility configurations or technology combinations. Efficiencies and economies that would be realized from integrated systems or centralized services are not considered. As a result, outcomes from this analysis could inadvertently overstate some impacts, especially if the resulting impacts are added together to accommodate multiple projects.

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

5.2 LAND USE

5.2.1 Common Impacts

As discussed in Section 3.1, lands within Utah where commercial tar sands development might occur are currently used for a wide variety of activities, including recreation, mining, hunting, oil and gas production, livestock grazing, wild horse and burro herd management, communication sites, and ROW corridors (e.g., roads, pipelines, and transmission lines). Commercial tar sands development activities could have a direct effect on these uses, displacing them from areas being developed to process tar sands. Likewise, currently established uses may also prevent or modify tar sands development. Valid existing rights represented by existing permits or leases may convey superior rights to the use of public lands, depending upon the terms of the permits or leases.

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

FLPMA directs the BLM to manage public lands for multiple use, and as a multiple-use agency, the BLM is required to implement laws, regulations, and policies for many different and often competing land uses and to resolve conflicts and prescribe land uses through its land use plans. FLPMA makes it clear that the term "multiple use" means that not every use is appropriate for every acre of public land and that the Secretary can "…make the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use. . ." [FLPMA, Section 103(c) (43 USC §1702(c)]. Like hunting, grazing, oil and gas development, and recreation, commercial tar sands operations are statutorily authorized uses of BLM lands. The BLM is aware that not all authorized uses can occur on the same lands at the same time; conflicts among resource uses are not new, and this PEIS is not intended to solve all potential conflicts involving oil shale and tar sands leasing. The intent of FLPMA is for the Secretary of the Interior to use land use planning as a mechanism for allocating resource use, including energy and mineral development, as well as conserving and protecting other resource values for current and future generations. Future decisions regarding tar sands leasing and approval of operating permits will be informed by NEPA analysis of the conflicting or alternative land uses of individual areas.

Although transmission and pipeline ROWs associated with commercial tar sands development would not necessarily preclude other land uses, they would result in both direct and indirect impacts. Direct impacts (e.g., the loss of available lands to physical structures, maintenance of ROWs free of major vegetation, maintenance of service roads, and noise and visual impacts on recreational users along the ROW) would last as long as the transmission lines and pipelines were in place. Indirect impacts, such as the introduction of or increase in recreational use to new areas due to improved access, or alternatively, avoidance of existing recreation use areas near transmission corridors for aesthetic reasons and because of increased traffic, could occur and be long-term.

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

5.2.1.1 Other Mineral Development Activities

As discussed in Section 1.4.2, in May 2006, in response to Section 350 of the Energy Policy Act of 2005, the BLM issued a final rule on leasing in STSAs (71 FR 28779). The final rule replaced the CHL Program that was established in 43 CFR Part 3140 in 1983. Under the new rule, within the designated STSAs, the BLM is authorized to issue separate leases for tar sands development, leases for oil and gas development, and CHLs in any areas that contain tar sands and oil or gas resources. This rule paves the way for tar sands development to coincide with oil and gas development in the future, as deemed appropriate at the time of leasing.

It is the BLM's policy to optimize recovery of natural resources to secure the maximum return to the public in revenue and energy production; prevent avoidable waste of the public's resources utilizing authority under existing statutes, regulations, and lease terms; honor the rights of lessees, subject to the terms of existing leases and sound principles of resource conservation; protect public health and safety; and mitigate environmental impacts. Conflicts among competing resource uses are generally considered and resolved when processing potential leasing actions or evaluating requests for approvals of plans of development on existing leases.

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

5.2.1.2 Acquisition, Conversion, or Transfer of Water Rights

Demand for reliable, long-term water supplies to support commercial tar sands development could lead to acquisition of unallocated water supplies (depending on availability) or to the conversion of existing water rights from current uses. Water would be needed to support direct tar sands operations, additional population, and electric power plant operation. While it is not currently known how much surface water may be needed to support future development of a tar sands industry or the role that groundwater or reclaimed water would play in future development, it is likely that in some areas agricultural water rights could be acquired to provide water supplies. Depending on the locations and magnitude of such acquisitions, there could be reductions in local agricultural production and land use when the water is converted to supporting tar sands development.

5.2.1.3 Grazing Activities

Grazing activities would be precluded by commercial tar sands development in those portions of the lease area that were (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing restoration after development; or (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. Grazing might be possible in the remaining undeveloped portions of the lease area or on portions that were successfully restored after development. On the basis of assumptions discussed above regarding the amount of land that would be disturbed at any given time for different technologies, it is possible that 2,810 to 5,680 acres within a 5,760-acre lease area would remain available for grazing. Depending on conditions unique to the individual grazing allotment, temporary or long-term reductions in authorized grazing use may be necessary because of loss of a portion of the forage base.

Once established, transmission line and pipeline ROWs would not prevent the use of any land for grazing other than the areas physically occupied by aboveground facilities. The establishment of employer-provided housing might preclude grazing activities, depending on how the housing is developed and the location, although this development is not expected to occur on public lands.

5.2.1.4 Recreational Land Use

Commercial tar sands development is incompatible with recreational use (e.g., hiking, biking, fishing, hunting, bird-watching, OHV use, and camping). Recreational land use would be excluded from areas leased for tar sands production once development activity begins. Recreational use may be reestablished once tar sands operations have ceased and restoration has been completed. The change in the overall character of undeveloped BLM-administered lands to a more industrialized, developed area would displace people seeking more primitive surroundings in which to hunt, camp, and ride OHVs, for example. Many BLM field offices have designated lands as open, closed, or available for limited OHV use. Areas that would be open to application for commercial tar sands development may be currently available for some level of OHV use, and commercial tar sands development in these areas would displace this use. Even if access could be granted to portions of tar sands lease areas for recreational use, visitors might find the recreational experience to be compromised by the nearby development activities. Such impacts could also occur on recreational users of adjacent, off-lease lands. Impacts on vegetation, development of roads, and displacement of big game would degrade the recreational experiences and hunting opportunities near commercial tar sands projects. To the extent that commercial developments might be clustered together, the effect on recreational uses would be magnified by changing the overall character of a larger area and by tar sands development dominating a larger portion of the landscape.

Once established, transmission line and pipeline ROWs would have fewer impacts on recreational users than would the actual commercial development projects. Access to the land in the ROWs would not be precluded; however, depending on the type of recreation, the overall recreational experience could be adversely affected by the visual disturbance to the landscape and potential noise impacts associated with overhead transmission lines. The establishment of employer-provided housing, although not likely to be located on public lands, would preclude recreational land use of the occupied land and might cause indirect impacts on recreational land use on adjacent lands depending on where the housing is developed.

5.2.1.5 Specially Designated Areas, Potential ACECs, and Areas with Wilderness Characteristics

As discussed in Section 1.2, the BLM has determined that certain designated areas are excluded from commercial tar sands leasing. These areas include all designated wilderness areas, WSAs, other areas that are part of the NLCS (e.g., National Monuments, NCAs, WSRs, and National Historic and Scenic Trails), and existing ACECs that are closed to mineral development. Because of these exclusions, these designated areas would not incur direct impacts associated with commercial tar sands development. However, these areas and those managed by other federal or state agencies (e.g., units of the National Park System, state parks) within the viewshed of commercial tar sands development and associated transmission line and pipeline ROWs may be adversely affected (e.g., degraded viewsheds, reduction in night sky viewing opportunities) by development on nearby public lands. Section 5.9 discusses impacts on visual resources in greater detail.

Existing ACECs that are not closed to mineral development may be available for application for commercial tar sands leasing. Tar sands and transmission or pipeline development of any ACEC would result in a loss of all or a part of the resources or values for which the area was originally designated. Tar sands development within the viewshed of these areas may also result in adverse impacts on scenic values of these areas.

Another category of lands that may be available for application for commercial leasing are those that have been recognized by the BLM as having wilderness characteristics. Lands currently identified as possessing wilderness characteristics are discussed in Section 3.1. Commercial tar sands development and the development of transmission line and pipeline ROWs within areas with wilderness characteristics would cause a loss of those characteristics in and around the disturbed areas. Commercial development of tar sands on nearby lands within the viewshed of an area with wilderness characteristics could result in adverse impacts on the wilderness characteristics.

All specially designated areas, potential ACECs, and areas with wilderness characteristics that are located in the vicinity of the STSAs are identified in Section 3.1.

5.2.1.6 Wild Horse and Burro Herd Management Areas

As discussed in Section 3.1.1, the STSAs coincide with a number of designated Wild Horse and Wild Burro HMAs. Specifically, the following HMAs overlie the STSAs: the Muddy Creek, Sinbad, and Range Creek Wild Horse HMAs and the Sinbad Wild Burro HMA in the Price Field Office; the Canyon Lands Wild Burro HMA in the Richfield Field Office; and the Hill Creek Wild Horse HMA in the Vernal Field Office. At least some portion of each of these HMAs coincides with lands proposed to be available for application for leasing under the tar sands alternatives.

As discussed in Section 5.2.1.2 regarding grazing activities, the management of wild horse and burro herds is not compatible within those portions of commercial tar sands lease areas that are (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing reclamation after development; or (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. Animals would likely be displaced from the areas of commercial development, and, depending on the conditions in the individual HMA, it might be necessary to reduce herd numbers to match forage availability on the undisturbed portion(s) of the HMA. If horses emigrate out of HMA boundaries because of the disturbance within the HMA, they could be removed via the capture and adoption program. Transmission line and pipeline facilities would not prevent use of the land by horses or burros other than in the areas physically occupied by aboveground facilities, although they could be subject to disturbance or harassment from people using the ROWs for access. For more information about impacts on wild horses, see Section 5.8.1.3 and Table 5.8.1-3.

5.2.1.7 Different Tar Sands Development Technologies

For the most part, impacts on land use would be the same regardless of the development technology used. However, the amount of potential land disturbance would vary by technology. Assuming a rolling footprint of development for in situ projects involving either steam injection or combustion, the acreage disturbed at any given time is expected to range from 80 to 200 acres. For surface mining projects coupled with either surface retorting or solvent extraction, the estimated area of disturbance at any given time is 2,950 acres.

5.2.2 Mitigation Measures

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

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

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

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

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

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

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

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

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

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

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

5.3 SOIL AND GEOLOGIC RESOURCES

5.3.1 Common Impacts

The potential impacts on soil and geologic resources would vary somewhat according to the two different technologies under consideration. There would also be some STSA-specific impacts. However, many of the impacts would be common to each technology and common to project phases. This section discusses the common impacts on soil and geologic resources, including phase-specific impacts.

5.3.1.1 Soil Resources

Tar sands operations could have an impact on soil resources. A significant concern is increased soil erosion because of ground disturbance. This problem pertains to each technology considered in this PEIS.

Soil erosion varies with location within and among the STSAs, generally ranging from moderate to high, depending on local conditions of soil properties and slope. Individual project sites would need to be assessed to determine their erosion potential. The San Rafael STSA is the only STSA with a very high level of erosion over a significant portion of its land area. Cryptobiotic soils are present in some portions of Utah and may be present in the study area. These biological crusts, when intact, serve to reduce wind and water erosion of these soils.

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

The construction or installation of other facilities in addition to buildings and of utilities would require disturbance of soil. These activities would include, but not be limited to, utility tower installation, telephone pole installation, parking area construction, buried utility installation (e.g., water mains, wastewater lines, and electrical or communication cables), drilling to prepare for in situ operations, drilling for resource evaluation, and drilling for groundwater monitoring well installation. Some of these activities, such as exploratory drilling and road grading, may also take place during preliminary site assessment.

ROWs for transmission lines would be built to connect all project sites with regional utilities except those located at the Tar Sand Triangle STSA, where power needs are expected to be met by on-site generation. These ROWs would cause up to 1,700 acres of longer-term disturbance and 2,500 acres of disturbance during construction (see Section 5.1.3). A pipeline ROW is also assumed to be constructed for each project site (up to 570 acres of longer-term disturbance and 1,200 acres disturbed during construction). Likewise, employer-provided housing would likely be built, which would have a limited longer-term disturbance (e.g., housing would occupy approximately 49 acres during construction of a commercial tar sands facility). The locations of employer-provided housing are unknown at this time; however, housing is not expected to be located on public lands.

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

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

Soil and geology impacts would differ during tar sands operations depending on the technological approach. All techniques would affect ongoing situations with soil erosion and runoff management in areas of disturbed soil (water and wind erosion, rutting, potential salinity impacts, etc.) as described above. Both technologies would result in widespread ground disturbance and associated problems related to erosion and increased sediment and salinity input to streams. The use of pesticides and herbicides and accidental spills or leaks of product, fuels, or chemicals could result in soil contamination. The potential soil contamination would be localized in extent and could be addressed with appropriate remediation measures.

The surface mining approach requires removing and stockpiling the overburden, source rock, and waste rock, thereby creating a potentially large source of sediment and salinity in site runoff. Up to 2,950 acres would be disturbed at any one time during commercial operations, with a total of 5,760 acres potentially disturbed. The various stockpiles are also susceptible to wind erosion. Much of the spent sands could be returned to the mine, but some overflow would be placed in disposal areas outside the excavation. Ongoing stabilization of the waste piles would likely be required.

In situ techniques would result in rolling operations areas, with continuous ground disturbance areas and reclamation areas. In situ techniques are estimated to result in smaller disturbed land areas than surface mining techniques, with 80 to 200 acres disturbed at any one time. A total of 5,760 acres would potentially be disturbed and subject to erosion and sediment runoff.

During reclamation, potential geologic and soil impacts would be similar to those during the construction phase. The replacement of stockpiled topsoil on former work or support areas, roads, or in reclaimed surface mines would require time for reestablishment with stabilizing vegetation, and these areas may be a source of erodible material depending on factors such as slope and weather conditions. Monitoring of soil reclamation areas for erosion and ecological recovery are also part of a reclamation phase (DOI and USDA 2007).

Tar sands development may have a significant associated impact on surface water quality in the greater Colorado River Basin because of ground disturbance. As discussed in Section 5.5, soil erosion increases both the sediment load to streams and the salinity of runoff reaching these streams. Increases in surface water salinity due to project site runoff could be high. The sensitivity of the surface water throughout the PEIS study area makes soil management a key factor in environmentally acceptable energy development. The infiltration of precipitation through stockpiled tar sands or through waste piles of spent material has the potential to impact surface water or shallow aquifers with leached hydrocarbons and salts.

5.3.1.2 Geologic Resources

A variety of other geologic resources are present in the STSAs. Tar sands development could impact these resources, including contributing to the loss of resources.

Sand and gravel and crushed stone supplies are widespread throughout the study areas. Their use at project sites (for construction, fill, etc.) would not be expected to impact their availability.

Oil and gas occur at the P.R. Spring and Pariette STSAs, are likely at the Hill Creek and Raven Ridge STSAs, and are possible at other STSAs. Significant oil shale is present stratigraphically above the tar sands along the northern edge of the P.R. Spring, Hill Creek, Pariette, and Raven Ridge STSAs. Coal occurs at the Sunnyside STSA at a depth that would require underground mining. Coal is also possible at the Hill Creek, P.R. Spring, and Asphalt Ridge STSAs. Uranium may occur in localized areas at the Circle Cliffs, Tar Sand Triangle, White Canyon, and San Rafael STSAs. Localized copper deposits are present at the San Rafael STSA.

5.3.2 Mitigation Measures

Various mitigation measures may be taken to reduce the impact of tar sands activities on soil and geologic resources during construction, operations, and reclamation and could include the following. The subsequent effects on water quality may therefore be reduced (see Section 5.5).

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

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

- Mapping of highly erosive soils and soils with a high salt content should be performed in proposed project areas and on their connecting roads, so that site-specific information could be used to guide project planning. A proper road grading analysis should be performed to reduce the potential for problems such as erosion or cut slope failure (DOI and USDA 2007).

- The revegetation and restoration potential of soil, as was the case for many other soil factors described above, is site-specific and would be addressed in a project-level NEPA analysis. Mitigations involving soil erosion control, stabilization, and reseeding would limit the impact of soil erosion.

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

- Detailed geotechnical analyses would be required to address the stability of quarry walls and slopes; these analyses would include an assessment of slope cuts for the creation of roads or work areas.

- Site-specific soil mapping would be necessary in assessing the condition of any proposed project site. Geologic resources may vary at the STSAs, and current information on exploration would be required to understand the potential for conflict between tar sands development and other energy or mineral development. Geologic hazards are expected to be similar among the STSAs, with varying potential for landslides.

- Literature and field studies focused on the region surrounding STSAs should be undertaken to assess faulting and earthquake potential.

5.4 PALEONTOLOGICAL RESOURCES

5.4.1 Common Impacts

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

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

- Complete destruction of the resource and loss of valuable scientific information could result from the clearing, grading, and excavation of the project area; construction of facilities and associated infrastructure; and extraction of the tar sands resource, if paleontological resources are located within the development area.

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

- Increases in human access and related disturbance (e.g., looting and vandalism) of exposed paleontological resources would result from the establishment of corridors or facilities in otherwise intact and inaccessible areas. Increased human access (including OHV use) increases the probability of impact from a variety of stressors.

Paleontological resources are nonrenewable; once they are damaged or destroyed, they cannot be recovered. Therefore, if a paleontological resource (specimen, assemblage, or site) is damaged or destroyed during tar sands development, this scientific resource would become irretrievable. Data recovery and resource removal are ways in which at least some information can be salvaged should a paleontological site be developed, but certain contextual data are invariably lost. The discovery of otherwise unknown fossils would be beneficial to science and the public good, but only if sufficient data are recorded.

5.4.2 Mitigation Measures

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

A paleontological overview was completed for the study area (Murphey and Daitch 2007). The overview synthesized existing information and generated maps showing tar sands areas in Utah with the PFYC designation and paleontological sensitivity of formations that could be affected by tar sands development. This analysis did not identify geographical areas to be precluded from leasing. However, during the leasing phase, the overview will be used to aid developers and the BLM in determining areas of sensitivity and appropriate survey and mitigation needs.

Mitigation measures to reduce impacts on paleontological resources would be required based on the environmental analysis conducted prior to leasing and/or development and could include the following:

- Project developers should determine whether paleontological resources exist in a project area on the basis of the sedimentary context of the area and its potential to contain significant paleontological resources. A records search of published and unpublished literature may be required for past paleontological finds in the area. Paleontological researchers working locally in potentially affected geographic areas and strata may be consulted. A paleontologist may be required to observe during active excavation at project sites. Depending on the extent of paleontological information, the BLM may require a paleontological survey. If paleontological resources are present at the site, or if areas with a high fossil yield potential are identified, the development of a paleontological resources management plan may be required to define required mitigation measures (i.e., avoidance, removal, and monitoring) and the curation of any collected fossils.

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

- If fossils are discovered during construction, the BLM should be notified immediately. Work should be halted at the fossil site and continued elsewhere until a qualified paleontologist could visit the site and make site-specific recommendations for collection or (other) resource protection measures.

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

5.5 WATER RESOURCES

5.5.1 Common Impacts

Similar to oil shale development, tar sands development would impact water resources as a result of ground surface disturbance, water withdrawal and use, disposal of wastewater and potential contaminant sources, alteration of hydrologic flow systems for both surface water and groundwater, and the interaction between groundwater and surface water. These factors are interdependent and depend on the technologies used for tar sands development. In this section, the range of potential impacts of tar sands development on water resources is discussed. Because STSAs are located in areas where surface water resources are limited, water storage facilities and delivery systems are likely to be needed for water use at development sites. The construction or modification of storage facilities and new delivery systems may cause additional environmental impacts on water resources and additional competition among various water use sectors. The consequences could affect water quality and quantity in both groundwater and surface water on- and off-site.

Common impacts could include the following:

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

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

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

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

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

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

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

- Spent tar sands that might be sources of contamination for salts, metals, and hydrocarbons for both surface and groundwater;

- Degradation of groundwater quality resulting from injection of lower-quality water, from contributions of residual hydrocarbons or chemicals from retorted zones after recovery operations have ceased, and from spent tar sands;

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

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

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

5.5.1.1 Ground Surface Disturbance

Ground surface disturbance is unavoidable in tar sands development. The disturbance comes from mining, site development, material (including waste) handling, access road construction, supportive infrastructure construction (e.g., reservoir, pipelines for water and products, and transmission lines), reclamation activities, and onroad and offroad traffic. Specific actions may include the following:

- Clearing of vegetation and stripping of overburden;
- Stockpiling of topsoil and overburden;
- Drilling and blasting;
- Backfilling, grading, and contouring;
- Onroad and offroad traffic;
- Mining operations;
- Material handling of mined tar sands and disposal of tailings;
- Developing facilities to support mining operations, including pipelines, sewers and drainage facilities, water treatment plants, gas cleaning facilities, control facilities, offices, housing, warehouses, evaporation and cooling ponds, boiler houses, electric generation facilities, electricity substations, pump houses, and storage tanks for fuels, chemicals, and products;
- Drainage construction; and
- Land reclamation of access roads, mines, spent tar sands storage areas, and facility sites.

These activities can affect surface water flows and surface water and groundwater quality in various ways. Disturbed lands are generally susceptible to soil erosion and affect surface water quality with increased salt, metals, and sediment loads until the disturbed areas are reclaimed and stabilized. Silt and potential contaminants from tar sands may be transported into surface water bodies by runoff. Leaching of stockpiles and overburden piles can also enhance the transport of organics, salts, and trace metals into the water courses and into shallow groundwater. Fallout of dust from access roads, mines, and material handling may affect surface waters. Diverted surface runoff from the disturbed areas can also adversely impact nearby water bodies.

5.5.1.2 Water Use

The water use in tar sands development is closely related to the technologies used to extract the bitumen from the source rock and the conservation measures adopted in a site. Various water uses also depend on water quality. For example, the highest quality of fresh water is needed for human consumption. Poor-quality water, such as brackish groundwater, may be used for dust suppression or hydrotransport (transporting mined tar sands as a water slurry). A list of water uses for tar sands development follows:

- Consumptive use of surface water and/or groundwater for dust suppression (including the use of poor-quality water) in mines, access roads, stockpiles of source rock and spent tar sands, well drilling, equipment maintenance, and solid waste compaction;

- Consumptive use of surface water and/or groundwater in processes, boilers, coolers, and ancillary operations;

- Consumptive use of domestic water, including potable and nonpotable water;

- Optional consumptive use for hydrotransport;

- If in situ steam injection technology is used to extract bitumen, a large amount of good-quality water is needed to make steam; the steam mixed with bitumen and formation water can be recovered at a rate of 90 to 95% and recycled for further use; and

- If in situ combustion technology is used to extract bitumen, water from combustion and source rock formation could be collected; surplus water may be possible.

The potential impact of transferring agricultural water rights for tar sands development can be attributed to the potential change of delivery systems and return flows from agricultural lands. Tar sands project sites need not be in the same general locations as the irrigated lands where the original water applies, which implies that new delivery systems would be built or some existing systems would be modified. The use of old systems may be reduced or abandoned. The construction of the new systems would cause new ground disturbance. Sediment and dissolved solids from the disturbed area would be carried by surface runoff and transported to downgradient water bodies. If the new system is constructed with pipes rather than ditches or canals, water loss during the delivery through evaporation or percolation would be reduced. Because water rights are based on consumptive uses, water loss due to evaporation, percolation, and surface runoff during water delivery is not counted as part of the water rights. Using a pipe delivery system would reduce the amount of water diverted from a water body to meet the same water rights. The impacts on the water resource by using a pipe delivery system relative to those of an open channel include the following:

- Increased streamflow because of the reduction of the amount of water diverted to meet the same water rights,

- Improved water quality of the stream because of streamflow increase,

- Improved water quality because the returned flow from percolated water (which generally contains higher dissolved solids) during the delivery is reduced,

- Reduced groundwater recharge from infiltrated water because of the reduction of percolation, and

- Reduced evaporation from open ditches or canals.

As agricultural water rights are transferred, the acreage of agricultural lands is expected to decline. Irrigation is reduced as well as the base flow of the irrigated water to surface water bodies. The impacts on the water resources include the following:

- Improved water quality of the streams receiving the base flows from farms as leaching by base flows is reduced,

- Reduced groundwater recharges from the percolation of base flows, and

- Reduced yield of groundwater wells that relied on base flow recharge.

Additional impacts would be caused by the use or recycling of wastewater at project sites; such impacts are described in Section 4.5.1.

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

Withdrawal of water from local streams can inadvertently affect water temperature. With reduced flow, water depths in depleted streams would decrease and be more susceptible to warming due to solar radiation during the summer. In contrast, cooling of shallower stream water is more rapid in cold weather.

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

Groundwater may be extracted from aquifers for use as a resource or for dewatering to control groundwater inflow into a mine. Mine dewatering would be necessary where saturated conditions, including perched aquifers, are present. Dewatering would lower the potentiometric surfaces and/or water table of the aquifers that are intercepted by the surface mine. Because some deeper groundwater is the source for springs and seeps in the region, the lowering of the potentiometric surface could have an effect similar to withdrawals from shallow, surficial aquifers—reducing or eliminating flow of the connected springs and seeps. Existing groundwater supply wells within the cones of depression also would have reduced yields or could be dewatered. Permanent changes to the groundwater flow regime due to mining and drilling could affect water rights to specific aquifers. The growth of a cone of depression may be time-delayed and affect water rights in the future.

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

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

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

Regardless of the location or technology for potential tar sands operations, the water availability may be exacerbated by the effects of climate change. The U.S. Bureau of Reclamation (BOR 2007) investigated climate change related to the Colorado River Basin. In its report, the Bureau reviewed various climate change models and the associated predictions. Its findings include generally decreased runoff in the basin due to higher temperatures and constant or slightly decreased precipitation. Although the confidence level regarding higher temperatures is fairly high, a lower confidence is associated with precipitation changes due at least in part to the difficulty in addressing such changes in mountainous terrain. BOR (2011) also analyzed the possible hydrologic changes from more than 100 climate change projections. Findings for the Colorado River Basin included an increasing trend in temperature, decreasing trends in April 1 snow water equivalent and in spring-summer runoff, and a slight decrease in precipitation in the overall basin to the year 2099. BOR also noted a lack of calibration in the models and a need to refine them.

A climate change summary produced by the USGCRP (2009) provides some details on the tar sands region. In the northeast portion of Utah, the projected spring precipitation in 2080 to 2099 is predicted to range from a 0 to 5% increase under a low emissions scenario, to a 5 to 10% decrease under a high emissions scenario. The study notes that water is already becoming limited in the region and that recent and projected conditions include rising temperatures and reduced river flows.

While there is uncertainty about the potential future effect of climate change on water availability, it is an important factor for consideration, as water rights and water usage may be influenced by an overall decrease in water availability in the region.

5.5.1.3 Discharge, Waste Handling, and Contaminant Sources

The discharge of mine water (from dewatering operations), wastewater (after treatment), cooling water (for cooling equipment such as crushers, bearings, pumps, and compressors), and diverted surface runoff from a tar sands site can adversely impact nearby water bodies. The impacts are attributed to potential contaminants in the water and potential change of streamflow. In addition, contaminants released by nonpoint sources associated with the project (through access roads, air emissions, and groundwater discharge) could further degrade the surface water quality.

The water and potential contaminants associated with surface mining include the following:

- Dewatering operations and possible underground reinjection or discharge to surface water;
- Discharge of the surface runoff from project sites;
- Spills of fuels, chemicals, and products;
- Discharge of treated sanitary and domestic wastewaters; and
- Discharge of effluents from the treatment of process waters, such as sour water, hydrocarbon storage tanks condensate, boiler condensate, boiler water blowdown, and pump and compressor cooling water blowdown.

The water and potential contaminants associated with leachate include the following:

- Stockpiled mined or spent tar sands, and other stored materials;
- Drilling wastes;

- Sludges recovered from water treatment, wastewater treatment, blowdown from boilers, and solvent extraction;

- Fly ash and boiler bottom ash; and

- Tailings ponds, backfilled mined areas, or backfilled valleys or gullies.

Management of mine water, wastewater, and surface runoff could involve various forms of reuse or disposal. Deep groundwater or mine water in the region generally has high dissolved solids content. This water, as well as treated or untreated wastewater, could be used to support facility operations, including dust suppression along access roads, at the project site, in the mine, or on stockpiles of source rocks or tailings.

Underground injection, as a means to dispose of low-quality water, especially brine water from a water treatment plant, could affect groundwater quality. The injection could take place at locations hydraulically downgradient of the mine. Injection would be governed by the state UIC program, except on tribal land, which is managed by the EPA. Tribes may complete a process to gain eligibility to self-enforce UIC. The permitted injection into deep, confined aquifers would be presumed to avoid water quality problems with potable aquifers and eventual discharge of the injectate into surface water or springs. The potential for induced seismicity would require evaluation if underground injection is used for the disposal of the produced water.

Surface discharge of treated or nontreated surface runoff, wastewater, or mine water to a stream from the project site could potentially change the streamflow as well as the stream's water quality, especially during the low-flow season. The water to be discharged may come from domestic wastewater, industrial wastewater, tailing pond drainage, overland flow, and treated water from a leachate collection system. If discharge to a surface water body is selected, the water generally requires treatment and an NPDES permit. The permit specifies the quality and flow of the discharged water, thus limiting the impact on surface water quality. The discharges from a plant generally would have poorer water quality than the natural water of the surface water body. The discharge would increase streamflow at outfalls.

At mining sites after reclamation, the spent tar sands piles and mine tailings could be potential sources of contamination with salts, metals, and hydrocarbons. Leachate containing these contaminants may enter nearby surface water bodies or shallow aquifers and continue to degrade the surface water quality well after the reclamation phase.

For surface mining with surface retort technologies, if the direct coking process is used to upgrade bitumen, then fly ash and boiler bottom ash would be produced as wastes. Leaching of the wastes might produce an additional potential source of contamination for surface water or groundwater. If hot water extraction or cold water extraction technology is used, the amounts of processed water and wastewater generated would be substantial. The impacts attributed to the disposal of wastewater are greater for hot water or cold water extraction technologies if the wastewater is not treated and reused.

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

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

If a solvent (e.g., heptane, cyclohexane, or ethanol) extraction technology is used to extract the bitumen from the source rock, the spent tar sands (tailings) are expected to contain residual solvents after most are recovered for recycling. The waste could be subjected to leaching processes when it is disposed of in open areas. The leachate could potentially enter into surface water bodies or into shallow groundwater and pollute the resource unless sufficient controls, including leachate collection and treatment, are implemented. Solvent spills or leaks are other potential sources of impacts on surface water or shallow groundwater.

In situ combustion could produce large volumes of water from the underground burning and thermal cracking of bitumen, estimated to be 1 to 2 bbl of water for each barrel of oil produced. The produced water from in situ combustion may contain increased levels of potential contaminants such as TDS, chloride, hydrocarbons, and heavy metals.

Residual organic compounds are expected to be present in a formation following in situ processing. In a laboratory study, Raphaelian et al. (1981) analyzed water samples obtained from two in situ tar sands experiments. Water from the combustion experiment was found to contain cyclic cyclohexonyl compounds, acetophenones of ketones, alcohols, quinolines, pyridines, phenyl piperidines, pyrazoles, phenols, carboxylic acids, and lactones. The sample from the steam injection experiment contained alkenes, cyclohexanes, cyclic ketones, toluenes, quinolines, acridines, pyrazoles, pyridines, phenyl piperidines, piperidines, and phenols. Steam from injection can also dissolve organics and metals from source rocks, potentially contaminating groundwater. All of these potential contaminants could migrate with the groundwater to reach wells or discharge locations (i.e., springs, seeps, or surface water). The quality of the surface water could consequently be impacted.

Several of the STSAs are drained in part by state-classified Category 1 streams. These include the Sunnyside, Argyle Creek, and Asphalt Ridge STSAs. According to the state, such streams are of “exceptional recreational or ecological significance or have been determined to be a State or National resource requiring protection, [and] shall be maintained at existing high quality through designation, by the Board after public hearing, as High Quality Waters -

Category 1. New point source discharges of waste water, treated or otherwise, are prohibited in such segments" (BLM 2007a). Point source or nonpoint-source releases from these STSAs to these Category 1 streams may therefore not be allowed.

Tar sands development eventually would result in population growth in local communities near project sites and on-site (see Section 5.12.1). With population growth, the loading in local wastewater treatment plants or on-site treatment plants would increase. The effluent from the plants is likely to be an additional source of nutrients, such as phosphorus and nitrogen-containing compounds, and other potential pollutants to nearby waters. Such impacts are closely related to where people would settle and the streamflow of the receiving water. A relatively large water quality impact is expected in areas where population growth is large and the receiving water is small.

5.5.1.4 Alteration of Hydrologic Flow Systems

Surface water usage would reduce the downstream flow and potentially cause deposition of stream sediment and change the morphology of the stream. If a reservoir is built for regulating the water supply, sediment would be trapped upstream of the dam. The flow pattern of the stream could change depending on the discharge of the reservoir. The degradation (erosion of the streambed) and deposition along the stream channel would respond to the streamflows. Losses due to evaporation and seepage in the reservoir would affect the amount of water available (Keefer and McQuivey 1979).

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

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

By extracting the bitumen, in situ processes could affect the permeability of the treated formation. The change in permeability for in situ–treated formations would be increased further by dissolving soluble minerals and hydrofracturing the rock formation. Subsidence may also occur. Changes to the site groundwater flow field could occur. This could continue after reclamation of the project site.

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

In the case of natural drainage channels that are rerouted or modified for the construction of roads or facilities, the surface runoff would be altered, affecting existing downstream flow. Erosion of streambeds may occur in this case and affect downstream water quality. Access roads are likely to be added or modified with tar sands development. The construction activities on access roads involve clearing vegetation, grading, and building drainages. These activities would increase salt loading of streams near the roads. Sediment load could also be increased by the fallout of airborne dust and surface runoff, although these could be reduced or minimized by BMPs. Whether the water for operations is derived from a surface water body with or without the use of a reservoir, the downstream flow would be reduced, which could cause deposition of steam sediment and change the morphology of the stream. If a reservoir is built for regulating water supply, sediment would be trapped upstream of the dam. The flow pattern of the stream could change depending on the discharge of the reservoir. The degradation (erosion of streambed) and deposition along the stream channel would adjust to the new streamflows. Losses due to evaporation and seepage in the reservoir would affect the amount of water available (Keefer and McQuivey 1979).

The improvement of the drainage tends to increase surface runoff drainage efficiency, and, thus, the erosion power of the runoff. The receiving stream downgradient would be impacted by additional loading of dissolved salt and sediments.

5.5.2 Water Budget for Individual Tar Sands Projects

5.5.2.1 Overall Water Budget

Table 5.5.2-1 summarizes the water consumption for tar sands development sites using different technologies, each with a 20,000-bbl/day capacity. The estimated water consumption does not include water use on access roads and other supportive facilities. In general, traditional surface mining operations consume large amounts of water for dust suppression at the mine site, access roads, source rock crushing locations, and source rock stockpiles. However, new hydrotransport technologies mix water with tar sands and transport the slurry through a pipeline to the processing facility. This process is able to reduce water consumption by reducing water use for dust suppression on access roads. Water used in hydrotransport becomes part of the process water and can later be recycled, resulting in great savings in water use. An oil sands company using surface mining and surface upgrading in Canada (Syncrude Canada, Ltd.) claims that its water consumption is 2.3 m^3 for each cubic meter of synthetic crude oil produced (Table 5.5.2-1). However, it is expected that the water use for tar sands development in Utah using the same technologies and water conservation could be higher because the deposits are oil-wet tar sands.

Less water consumption for extracting bitumen from tar sands is expected from the use of solvent extraction technology (mixing 10 to 15% of solvent with water and source rock) than

TABLE 5.5.2-1 Estimated Water Consumption for Tar Sands Development

Production (bbl/day)	Technology	Water for Mining (bbl/day)	Process Water (bbl/day)	Produced Wastewater from Formation (bbl/day)[a]	Potable Water (operation phase) (bbl/day)	Net Water Requirement (bbl/day)	Net Water Requirement (ac-ft/yr)
20,000	In situ steam injection	0	10,000[b]–80,000	0[a]	950[c]	11,000–81,000	520–3,810
20,000	In situ combustion	0	0	–40,000[d]		e	44
20,000	Surface mine with surface retort	0–25,000[f]	46,000[g]–90,000	0	0[h]	46,000–115,000[i]	2,160–5,410
20,000	Surface mine with solvent extraction	0–25,000[f]	21,800[j]	0	950	22,800–47,800[k]	1,070–2,250

[a] Water from source rock formation mixed with steam and bitumen is collected (E&P 2007) as produced water.

[b] The lower number is for SAGD (steam-assisted gravity drainage) technology, and the higher number is for CSS (cyclic steam stimulation) steam injection technology. Start-up water used for steam injection in the first phase in SAGD is 100,000 bbl/day; thereafter, 90% of steam/water is assumed to be recovered from steam and formation water (E&P 2007; Alberta Chamber of Resources 2004). Assumes 42 gal/bbl of water.

[c] A demand of 135 gal/person/day, a consumptive rate of 35%, and a population of 1,100 are assumed. The consumptive rate is based on the Colorado M&I consumptive rate (CWCB 2004).

[d] Water from source rock formation and from combustion, assumed to be 2 bbl for each bbl of oil produced. The water could be used beneficially, subject to water quality and possible treatment. About 100,000 bbl of start-up water is required to make steam for the first phase of bitumen extraction in the toe to heel air injection (THAI) technology. No process water is needed thereafter (*The Oil Drum* 2007). Upgrading may need additional water.

[e] For potable water.

[f] The lower number is for hydrotransport; mined tar sands are mixed with water/solvent to make slurry, which is then transported through a pipeline from the mine to the process plant. The water/solvent is counted as processed water use. The larger water use number is for mined tar sands transported by truck. Water is used for haul-road spraying (brackish water), irrigation, and dust containment (fresh water) (Daniels et al. 1981).

[g] The low number is from Syncrude Canada Ltd., which uses 2.3 bbl of water per barrel of crude oil produced, half of the industry average (Thompson 2006; Syncrude Canada, Ltd. 2006; Alberta-Canada 2007). Note that Canadian oil sands are water-wet tar sands, while the deposit in Utah is oil-wet sands (also see Appendix B). The number includes upgrading water use. Water demand is 14.2 bbl per barrel of crude oil produced; most of it is recycled.

[h] Potable water is included in the reporting process water.

[i] Water use for upgrading is included; final product is syncrude.

[j] For the solvent extraction process, about 109,000 bbl/day of water is required. If 80% of the water is recycled, consumption would be 21,800 bbl/day. Water use for upgrading is not included (Daniels et al. 1981).

[k] Water use for upgrading is not included.

from the use of hot water extraction technology. However, the efficiency of recovering the relatively expensive solvent and the potential contaminant from spent tar sands poses a challenge in the solvent extraction technology.

In situ combustion technology uses a portion of the tar sands as fuel to raise the temperature of source rock and mobilize bitumen. Because of the combustion, water is formed. The partially upgraded bitumen, gas, and water (including water originally in the source rock) are collected by vertical or horizontal wells. It is possible that the process water collected from the subsurface may exceed the water need in the tar sands plant. However, the captured water would need treatment before it could be reused.

In the toe to heel air injection (THAI) technology (one of the in situ combustion technologies; see Appendix B), steam injection is used in start-up to extract bitumen (leaving residual bitumen behind) before in situ combustion is conducted. Water is required to make up the steam. The majority of the steam is recaptured in production wells.

The in situ combustion variation known as wet combustion would require water. In this approach, water and air are both injected into the heated formation. Another technology option among in situ combustion techniques that require water is a combination of water flooding with combustion. The water needs associated with these technologies would need to be addressed at individual project sites.

Estimated domestic water needs are estimated for the workforce and family population required for a single 20,000-bbl/day tar sands facility. The construction workforce and families could number about 2,600 people, and the operations workforce and families would number about 1,100 people. Assuming an overall requirement of 135 gal/day/person, the fresh water need is 8,360 and 3,540 bbl/day, respectively (1 bbl of water = 42 gal). Using a consumptive rate of 0.35, the water consumption during the construction phase and operation phase would be about 2,900 and 1,240 bbl/day (140 and 58 ac-ft/yr), respectively.

5.5.2.2 Water Availability for Individual Tar Sands Projects in STSAs

To develop tar sands, there must be enough water available, both physically and legally. This section describes the availability of water for potential tar sands development. Legal availability is discussed in terms of the allocation of the Upper Colorado River water in Utah, based on the Upper Colorado River Basin Compact of 1948. The discussion of physical availability focuses on the water resources near the STSAs.

In Chapter 3, Table 3.4.1-3 provides the projected consumptive use of water in the years 2020 and 2050. Without counting the potential water use for tar sands development, the projected consumptive uses as percentages of the Utah allocated water are 79.4 and 85.9% for the 2 years. That implies about 281,000 and 193,000 ac-ft/yr are available for 2020 and 2050, respectively.

Water physically available may be limited in a dry environment such as that of the STSAs. Keefer and McQuivey (1979) analyzed surface water and groundwater resources associated with specific STSAs and related the water availability to the water requirements estimated for in situ steam injection, which uses the highest amount of water among various in situ technologies (Table 5.5.2-1). In the following subsections, the physical availability of water in various STSAs is provided. The availability can be compared with the estimated water consumption used in different tar sands technologies as shown in Table 5.5.2-1.

Although water may be legally and physically available, that does not imply that it is readily available for tar sands development. Hydrologic basins enriched with surplus water resources are not necessarily coincident with the STSAs. Storage infrastructures and delivery systems have to be built to capture water for various uses. In addition, water rights and water storage rights (for reservoirs) have to be transferred or purchased before the water can be used for development, because most water rights and storage rights have been claimed in the Upper Colorado River Basin. Finally, the water uses for the development have to meet different state and federal regulations. All in all, whether enough water is available for tar sands development depends on the results of intensive negotiations among various parties, including water right owners, state and federal agencies, municipal water providers, and the tar sands developers. As discussed in Section 5.5.1.2, climate change is a concern in terms of its possible effect on water availability (BOR 2011; USGRCP 2009) and could affect decisions related to STSAs both individually and collectively.

5.5.2.2.1 Asphalt Ridge. Keefer and McQuivey (1979) describe shallow groundwater in the Ashley Creek alluvial aquifer as the best source of water for pilot facilities in the vicinity of Asphalt Ridge and Whiterocks. This water is fresh to slightly saline. They also note that Ashley Creek, with a flow of 82,000 ac-ft/yr near Vernal, could supply a production facility with water, assuming appropriate treatment of its high-salinity water.

Bedrock aquifers northeast of Asphalt Ridge are also a possible source of water to support production. These aquifers are at depths of 4,000 to 6,000 ft and have fresh water. Other surface water sources in the vicinity include perennial streams with flow rates that, like that of Ashley Creek, vary in response to weather and location along the watercourse, as diversions may result in lower flow rates at downstream locations. These streams and flow rates are Dry Fork (15,000 to 26,000 ac-ft/yr), Mosby/Deep Creek (no data available), and Whiterocks River (71,000 to 88,000 ac-ft/yr) (UDWR 1999). Any water obtained from surface water or groundwater sources would not only have to be transported (by pipeline or truck) some distance to a particular project site but might also have to ascend a significant vertical elevation. Overall, it appears that water might be available to support the 20,000-bbl/day plant using in situ technologies, although water rights might need to be purchased, suitable water quality would have to be confirmed, and the economics of transporting the water to the project area would need to be assessed. A 20,000-bbl/day plant using surface mining and surface processing technologies would use more than 6% of the annual average of Ashley Creek, a significant amount when other water users may rely on the same water source.

5.5.2.2.2 P.R. Spring and Hill Creek. Willow Creek has an average flow of 13,000 ac-ft/yr, although its flow is intermittent. Other streams in the vicinity of the STSA include perennial stream Sweetwater Canyon, Bitter Creek, and Center Ford, and intermittent Evacuation Creek. No flow data are available for these creeks from the Utah Division of Water Resources (UDWR 1999). No reliable groundwater sources were noted for P.R. Spring by Keefer and McQuivey (1979). However, springs are quite common in the P.R. Spring STSA, especially east of Willow Creek.

Water resource support for any of the proposed project sites at P.R. Spring may require the purchase of water rights to the distant White River, a regional resource. Willow Creek, even if 10% of its water was dedicated to the tar sands operations, would not support a 20,000-bbl/day operation using surface mining and processing technologies. If in situ combustion technology is selected, it will consume about 3.5% of the annual average streamflow of Willow Creek. Whether water from the other, ungauged streams in the vicinity could be combined to support one or more tar sands operations is uncertain, because of unknown flow rates and availability of water rights. Reservoir construction may be necessary on one or more of the rivers and creeks selected for tar sands operations. Willow Creek is classified as Category 5A impaired waters (UDEQ 2006). Discharge of any low-quality water from a project site, such as untreated wastewater or surface runoff, may further adversely affect the water quality in the lower reaches.

For P.R. Spring, Keefer and McQuivey (1979) recommend a White River reservoir as the best water source, despite its distance from the STSA. This river has a flow on the order of 480,000 ac-ft/yr (Keefer and McQuivey 1979). Withdrawing water from Green River is another possible option.

5.5.2.2.3 Sunnyside. Minnie Maude Creek and Price River are two streams in the vicinity of the Sunnyside STSA. Keefer and McQuivey (1979) recommend constructing a reservoir on intermittent Minnie Maude Creek (estimated at 12,000 ac-ft/yr) or obtaining water from Price River (75,000 ac-ft/yr). However, Minnie Maude Creek falls far short of being able to support production at the proposed level, even with a reservoir. Minnie Maude Creek flows into the perennial Nine Mile Creek, which has a flow of 38,000 ac-ft/yr near its junction with the Green River (UDWR 1999) and 12,000 ac-ft/yr at an unspecified upstream point (Keefer and McQuivey 1979). Minnie Maude Creek was a designated TMDL impaired stream in 2006, and the water of the Price River may be of low quality (Keefer and McQuivey 1979). Both locations would require the transport of water over long distances and elevation increases to the STSA. Other creeks in the vicinity of the STSA include perennial creeks Dry Creek and Cottonwood Canyon. The UDWR (1999) does not provide flow data for these creeks. The intermittent headwaters of Range Creek are nearby, but flow is only 5,000 ac-ft/yr (UDWR 1999), and it is a state-classified Category 1 stream. The upper reaches of Nine Mile Creek, Dry Creek, and Cottonwood Creek drain the tar sands area and are classified as Category 5A impaired waters (UDEQ 2006). Groundwater in the area has high TDS.

Overall water resources in the Sunnyside vicinity are limited, as compared with the operational water consumption using surface mining and process technologies. The in situ combustion process uses much less water (about 4% of the average annual flow of Minnie

Maude Creek) for potable use. Development of the tar sands in this area would likely degrade the surface water further and diminish the flow of the streams and their tributaries.

5.5.2.2.4 Tar Sand Triangle. The Dirty Devil River flows in the vicinity of the STSA. Mean flow for the Dirty Devil is about 74,000 ac-ft/yr, although it is dry each summer for 1 to 2 months. Other creeks in the vicinity of the Tar Sand Triangle are the intermittent Horse Canyon and the perennial Big Water Canyon/Happy Canyon. No flow data are available on those (UDWR 2000). The STSA is situated in the eastern part of Lower Dirty Devil River groundwater basin. The Navajo Sandstone of Mesozoic age is a major aquifer in the basin (UDWR 2000). The extent and yield of the aquifer near the STSA are unclear. However, spring sites are found in the STSA area (UDWR 2000).

In situ combustion and steam injection technologies with conservation practices are likely capable of supporting a 20,000-bbl/day tar sands development site in the Tar Sand Triangle by using Dirty Devil River water. Other technologies could consume more than 5% of the Dirty Devil River mean flow. Other water sources may include the Colorado or Green Rivers.

5.5.2.2.5 Other STSAs. Other STSAs are expected to have water availability problems similar to those described above. The UDWR (1999, 2000) provides average annual flows for creeks and rivers in the STSA study areas. The available water rights to these flow systems have not been determined, and the given average flows are likely representative of downstream values rather than values in upland areas adjacent to (both areally and vertically) the STSAs.

For any reservoir project, Keefer and McQuivey (1979) note that losses due to evaporation and seepage would affect the amount of water available. In addition, the use of reservoirs would change the flow of natural water bodies downstream of the reservoir and modify the erosional and depositional features of the river channels. Sedimentation would be enhanced along the stream channels upstream of the reservoirs. Discharge of treated or nontreated wastewater to a stream from the project site could potentially change the streamflow as well as the stream's water quality, especially during the low-flow season. Water rights would be a key issue for any intended use of groundwater or surface water.

5.5.3 Mitigation Measures

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

- Highly erodible geologic material;

- Steep terrain prone to soil erosion;

- Groundwater discharge and recharge areas; and

- River/stream segments sensitive to human impacts (such as streamflow, water quality, and channel modification) that can affect ecosystems.

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

- Technologies that result in minimum footprint of disturbed areas;

- Technologies that have minimum total water consumption;

- Technologies that can use wastewater or brackish water in processing source rocks;

- Technologies that result in minimum disturbance between groundwater flow regimes to avoid cross flows between aquifers; and

- Technologies that have the highest recovery of tar sands, leaving spent material with the least amount of contaminants to be leached.

Other mitigation measures that the BLM might consider requiring, if warranted by the results of the lease-stage or plan of development–stage NEPA analyses, are related to engineering practices. They are as follows:

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

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

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

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

- Earth material would not be excavated from, and excavated material would not be stored in, any stream, swale, lake, or wetland.

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

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

- Topsoil removed during construction should be stockpiled and reapplied during reclamation. Stockpiled topsoil should be seeded with appropriate species to reduce erosion until the time soil is re-applied. Practices such as using jute netting, silt fences, and check dams should be applied near disturbed areas.

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

- Existing drainage systems should not be altered, especially in sensitive areas such as erodible soils or steep slopes. Culverts of adequate size should be in compliance with applicable state and federal requirements and take the flow regime into consideration for temporary and permanent roads. Potential soil erosion should be controlled at culvert outlets with appropriate structures. Catch basins, roadway ditches, and culverts should be cleaned and maintained regularly.

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

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

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

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

- An erosion and sedimentation control plan, as well as a stormwater pollution protection plan, should be prepared in accordance with federal and state regulations.

Adopting mitigation measures such as these does not mean that there would be no impacts on water resources. The exact nature and magnitude of the impacts would vary from project to project and would need to be examined in detail in future NEPA reviews of lease areas and project plans of development.

5.6 AIR QUALITY AND CLIMATE

5.6.1 Common Impacts

The potential for air quality impacts from commercial tar sands development, including ancillary facilities such as access roads, upgrading facilities, and pipelines, is directly related to the amount of land disturbance, drilling/mining operations, processing methods, and the quantity of oil and gas equivalent produced. Indirect effects, such as impacts resulting from secondary population growth, are also considered.

Impacts on air quality would occur in several ways, as described below.

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

- Long-term, regional impacts (primarily NO_x and CO, with lesser amounts of PM, VOC, and SO_2 emissions) would result from tar sands processing, upgrading, and transport (pipelines). Depending on location, meteorology, and topography, NO_x and SO_2 emissions could cause regional visibility impacts (through the formation of secondary aerosols) and contribute to regional nitrogen and sulfur deposition. In turn, atmospheric deposition could cause changes in sensitive (especially alpine) lake chemistry. In addition, depending on the amounts and locations of NO_x and VOC emissions, photochemical production of ozone (a very reactive oxidant) is possible, with potential impacts on human health and vegetation. Localized impacts due to emissions of HAPs (particularly benzene, toluene, ethylbenzene, xylene, and formaldehyde) and diesel PM could also present health risks to workers and nearby residents.

- During all phases of tar sands development, GHG emissions of CO_2 and lesser amounts of CH_4 and N_2O from combustion sources could contribute to climate change.

It is not possible to predict site-specific air quality impacts until actual tar sands projects are proposed and designed. Once such a proposal is presented, impacts on these resources would be further considered in project-specific NEPA evaluations and through consultations with the BLM prior to actual development. As additional NEPA analysis is done for leasing and site-specific development, it may be necessary as part of the air quality analysis to conduct air quality modeling. The types of modeling that may be performed, when warranted, include near-field modeling, far-field modeling, and photo-chemical grid modeling.

The tar sands deposits that are in the study area for this PEIS are found only in the state of Utah. There are two tar sands–rich areas: one is in the Uinta Basin near Vernal, Utah, and the other is near Canyonlands and Capitol Reef National Parks in east central Utah. Table 5.6.1-1 identifies those counties where direct and indirect air pollutant emissions could result from tar sands development.

Impacts on air quality would be limited by applicable local, state, tribal, and federal regulations, standards, and implementation plans established under the CAA and administered by the Utah Department of Environmental Quality-Division of Air Quality (UTDEQ-DAQ), with EPA and nearby state agency review. Air quality regulations require that proposed new or modified existing air pollutant emission sources undergo a permitting review before their construction can begin. Therefore, the state agencies have the primary authority and responsibility to review permit applications and to require emission permits, fees, and control

TABLE 5.6.1-1 Area and Population for Counties in Which Tar Sands Emissions Could Occur

State	County	Land Area (mi^2)	Population 2000	Population 2010
Utah	Carbon	1,478	20,425	21,403
	Duchesne	3,238	14,371	18,607
	Emery	4,452	10,962	10,976
	Garfield	5,174	4,735	5,172
	Grand	3,682	8,380	9,225
	San Juan	7,820	14,413	14,746
	Uintah	4,477	25,224	32,588
	Utah	1,998	368,540	516,564
	Wasatch	1,177	15,215	23,530
	Wayne	2,460	2,509	2,778
Regional	Total	35,956	484,774	655,589

Source: U.S. Census Bureau (2011).

devices prior to construction and/or operation. The U.S. Congress (through CAA Section 116) authorized local, state, and tribal air quality regulatory agencies to establish air pollution control requirements that are more (but not less) stringent than federal requirements.

All leases and approvals of plans of development will require lessees to comply with all applicable local, state, tribal, and federal air regulations within the leased area.

Before tar sands development could occur, additional project-specific NEPA analyses would be performed, subject to public and agency review and comment. The applicable air quality regulatory agencies (including the states and EPA) would also review site-specific preconstruction permit applications to examine potential air quality impacts. As part of these reviews, the air quality regulatory agencies could require additional air quality impact analyses or mitigation measures. Those reviews would take into consideration the specific project features being proposed (e.g., specific air pollutant emissions and control technologies) and the locations of project facilities (including terrain, meteorology, and spatial relationships to sensitive receptors). Project-specific NEPA assessments would predict site-specific impacts, and these detailed assessments (along with BLM consultations) would result in required actions by the applicant to avoid or mitigate significant impacts. Under no circumstances can the BLM conduct or authorize activities that would not comply with all applicable local, state, tribal, or federal air quality laws, regulations, standards, or implementation plans.

5.6.1.1 Climate Change

Analyzing the potential effects of an activity's potential contribution to climate change includes consideration of several factors: GHG emissions (including carbon dioxide, methane, and nitrous oxide) and concentrations, land use management practices, and surface albedo (a measure of how strongly a surface reflects light from light sources such as the sun). Decreased albedo (e.g., due to melting snow and ice) means that more light (and heat) is absorbed by the earth's surface.

For many activities with mature technologies, it is possible to make reasonable, quantitative predictions of the GHG emissions or the amount of carbon that would likely be sequestered from proposed activities.

For example, calculating GHG oil and gas production emissions is relatively straightforward, due to the long history of this type of activity. When adequate data are available to prepare an emissions inventory of a proposed project or activity, the BLM can account for and disclose factors that may contribute to global climate change. Once quantified, GHG emissions can be compared across appropriate sectors (where information is available), and then put into context for the public and the decision maker.

Even for such activities with known technologies, however, there is no scientifically accepted method to quantify the incremental climatic impacts of those activities, either to the global climate, or to the climate of any area or region.

Compounding that problem for the present analysis is the fact that there is no commercially proven technology for extracting liquid fuels from oil shale or tar sands. Thus, any quantitative prediction of the GHG emissions from commercial operations for oil shale or tar sands would be at best professional judgment based on technologies under research and development or deployed in non-commercial contexts, and at worst would be speculation.

The decisions to be made on the basis of this PEIS are land allocation decisions, which do not themselves result in emission of any GHGs. However, if and when oil shale and tar sands development activities are authorized, those activities are likely to result in the emissions of GHGs. As a programmatic analysis appropriate to support allocation decisions, this PEIS analyzes the potential environmental impacts of oil shale and tar sands activities in general. Further, since the particular technology and methodology with which the oil shale and/or tar sands will be extracted is currently in the R&D phase, specific information related to energy demands and equipment usage cannot be known at this time. Because adequate equipment and activity assumptions are unavailable at this time, preparing an emissions inventory for this PEIS is not a scientifically defensible effort. When project applications are submitted to the BLM and more specific information is known, including what types of mining technology (surface mining or underground mining) are planned for resource development, an appropriate air resource analysis would be conducted and could include a GHG emission inventory. Therefore, this section describes the potential GHG emissions of oil shale and tar sands development in a qualitative manner. Existing climatic conditions and an assessment of future potential climatic changes for the region are described in Section 3.5.

The following assumptions are central to this analysis:

- The assessment of climate-changing pollutant emissions and climate change is in its formative phase, so it is not yet possible to know with confidence the net impact on resources from GHG emissions.

- The lack of scientific tools to predict climate change due to localized changes in GHG emissions limits the ability to quantify potential future impacts for each alternative.

- Climate change is a global phenomenon in which larger changes in global GHG emissions are almost certain to have greater impacts on resources in the study area than are GHG emissions from commercial oil shale and tar sands industries in the study area.

- Future EPA regulatory actions to reduce GHG emissions are not considered in this analysis.

- In the future, should tools improve for predicting climate changes due to resource management actions, the BLM may be able to reevaluate decisions made as part of this planning process and to adjust management accordingly.

GHG emissions and changes in biological carbon sequestration would occur as a result of authorizing oil shale and tar sands activities. These emissions would occur during the construction, operation, and maintenance phases of potential future projects. Sources of emissions could include some of the following activities, depending on the types of extraction and processing technologies to be included in a potential future project:

- Construction of buildings and processing facilities;
- Construction of roads and other infrastructure (e.g., pipelines, electricity transmission, railroads);
- Electricity generation;
- Oil shale surface or underground mining;
- Tar sands surface or underground mining;
- Well drilling activities;
- In situ processes to recover bitumen from tar sands or oil shale kerogen pyrolysis products;
- Solid material crushing, sizing, and sorting;
- Retorting;
- On-site solid and liquid material conveyance, loading, and unloading;
- Stationary diesel- or gas-fired engines;
- Liquid product storage;
- Waste or overburden disposal;
- Vehicle exhaust associated with heavy equipment;
- Vehicle exhaust associated with construction, delivery, product transport, and commuting activities; and
- Site reclamation.

5.6.1.1.1 GHG Emissions Regulations and Trends. The EPA is in the early stages of regulating GHGs as air pollutants under the Clean Air Act (CAA). In its *Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act*, the EPA determined that GHGs are air pollutants subject to regulation under the CAA. The EPA regulates carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons, and perfluorocarbons. In addition, aggregate GHG emissions are regulated in terms of CO_2e emissions.

The first EPA regulation to limit emissions of GHGs imposed carbon dioxide emission standards on light-duty vehicles, including passenger cars and light trucks (40 CFR Part 98). As of August 2011, the EPA had not promulgated GHG emission limits for stationary sources, such as compressor stations. However, the EPA is gathering detailed GHG emission data from thousands of facilities throughout the United States and will use the data to develop an improved national GHG inventory and to inform future GHG emission control regulations. Beginning in 2010, many facilities across the United States estimated GHG emissions in accordance with the EPA's "Greenhouse Gas Mandatory Reporting Rule" and began reporting annual GHG emissions on March 31, 2011. Many oil and gas facilities will begin estimating GHG emissions in 2011 and will submit their first annual GHG emission reports on March 31, 2012, in accordance with Subpart W of 40 CFR Part 98. Under 40 CFR Part 98, underground coal mines that are subject to quarterly or more frequent sampling of ventilation systems by the Mine Safety and Health Administration (MSHA) are required to report their GHG emissions, such that the annual GHG report must cover stationary fuel combustion sources, miscellaneous use of carbonates, and all applicable source categories listed under 40 CFR Part 98 Subpart A. Control of GHGs is not required, however.

The EPA proposed oil and natural gas system emission control regulations on August 23, 2011 (76 FR 52738). These regulations are expected to decrease CH_4 emissions and increase CO_2 emissions. The net effect of the proposed emission controls is a 62 million metric ton decrease in CO_2e, which would represent approximately a 26% decrease in baseline CH_4 emissions from 2009 emission estimates for this industry sector (76 FR 52738).

5.6.1.1.2 Environmental Consequences. The EPA estimates that national GHG emissions in 2009 were 6,633,200,000 metric tons CO_2e in 2006 (EPA 2011). National GHG emissions in 2009 represented a 7.3% increase from estimated 1990 national GHG emissions (6,181,800,000 metric tons CO_2e). The EPA categorized the major economic sectors contributing to U.S. emissions of GHG compounds as follows:

- Electric power industry (33.1%),
- Transportation (27.3%),
- Industry (19.9%),
- Agriculture (7.4%),
- Commercial (6.2%),
- Residential (5.4%). and
- U.S. Territories (0.7%).

The three most commonly emitted GHGs likely from development and production of oil shale and tar sands sources are carbon dioxide, methane, and nitrous oxide. Other GHGs, including sulfur hexafluoride, hydrofluorocarbons, and perfluorocarbons, are not emitted by these activities or are emitted in trace quantities.

Changes in biological carbon sinks may result from surface disturbance activities associated with oil shale and tar sands development. There are numerous methodologies for calculating biological carbon sequestration and, depending on methodology, estimates of biologically stored or removed carbon can vary greatly. Because there is not yet a single generally accepted standard for estimating biological carbon sinks and removals and insufficient activity data are available, a discussion of potential biological carbon changes due to oil shale and tar sands activities is beyond the scope of this analysis.

Impacts from Air Quality Management. Air quality management actions require compliance with federal and state air quality regulations; therefore, future applicable GHG reduction requirements imposed by the EPA or state governments would apply to any future authorized activities and could potentially reduce GHG emissions and climate change impacts. In addition, many emission limits and standards that apply to criteria emissions have co-benefits of reducing carbon dioxide, methane, or nitrous oxide emissions. Therefore, any future emission restrictions on non-GHG pollutants may also effectively reduce GHG emissions.

For example, air quality management could include the following provisions that would decrease GHG emissions, compared to uncontrolled emissions:

- Capture and destruction or beneficial use of methane from mines;
- Carbon dioxide sequestration in geologic formations;
- Use of natural gas fuel rather than diesel fuel for stationary source engines;
- Emission capture and destruction of vapors from hydrocarbon storage tanks;
- Piping products to destinations rather than trucking products;
- Use of vehicles with low GHG emissions;
- Use of renewable energy for electricity generation; and
- Decreasing vehicle idling times.

When future air resource analyses are performed during the consideration of authorization of proposed activities, project-specific GHG emissions would be estimated and compared to relevant and available information, such as those emissions described in Table 5.6.1-2.

TABLE 5.6.1-2 Greenhouse Gas Emission Comparisons

Inventory Description	CO_2e Emissions (10^6 metric tons/yr)
State Inventories, Consumption-Based (2010)[a]	
Colorado	129.3 (+2.9)[b]
Utah	75.6 (–8.4)
Wyoming	60.3 (–30.4)
U.S. Inventories (2009)[c]	
Total U.S. greenhouse gases	6,633.2
U.S. natural gas systems[d]	253.4
U.S. coal mining[e]	76.5
U.S. landfills	117.5
U.S. fossil fuel combustion	5,209.0

[a] Sources: Bailie et al. (2007); Roe et al. (2007); Strait et al. (2007).

[b] The value in parentheses denotes emissions related to net imported/exported electricity, for which negative values represent exports. Thus, production-based emissions are about 50% higher than consumption-based emissions in Wyoming.

[c] Source: EPA (2011).

[d] Natural gas systems include natural gas production (e.g., wells), processing, transmission, and distribution.

[e] Including abandoned underground coal mines.

5.6.1.1.3 Cumulative Climate Change Impacts. GHG emissions generally increase with population growth, industrial activity, transportation use, energy production, and fossil fuel energy use. As discussed in Chapter 3, GHG emission increases contribute to climate change. Oil shale and tar sands activities’ emissions may or may not increase state, national, or global GHG emissions due to regulatory and market forces. Possible impacts that may be associated with oil shale and tar sands development are summarized below:

- Cumulative GHG emissions may increase if project GHG emissions add to global GHG emissions.

- Cumulative GHG emissions may not increase or may increase by a smaller quantity if some or all project emissions are offset due to decreased energy production from other sources (e.g., oil and gas production in other oil and gas basins with greater GHG emissions on a unit-production basis).

- GHG emissions from oil shale and tar sands may be offset, in part, by reduced transportation emissions from the site of production to the site of use. For example, transportation emissions from U.S. oil shale and tar sands production may be less than transportation emissions for oil that is transported from foreign countries.

Quantification of cumulative climate change impacts, such as changes in temperature, precipitation, and surface albedo is beyond the scope of this analysis. The maximum potential increase in cumulative GHG emissions from all potential oil shale and tar sands activities cannot be predicted with accuracy. Furthermore, such GHG emissions and changes to carbon sinks would be small relative to state, regional, and global GHG emission inventories. Consequently, global or regional scale modeling may be unlikely to yield meaningful predictions of climate change impacts in relation to GHG emissions attributable to oil shale and tar sands activities alone.

5.6.1.2 Impacts from Emissions Sources for Tar Sands Facilities

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

5.6.1.2.1 Construction. Mining and surface process technologies may include construction of a surface mine and mine bench, with primary crushing facilities, processing and upgrading facilities, spent material disposal areas, reservoirs for flood control, and a catchment dam below the disposal pile. For ICPs, considerable construction and preproduction development work includes extensive drilling and construction of upgrading/refining facilities.

Additional construction activities include access roads, power supply and distribution systems, pipelines, water storage and supply facilities, construction staging areas, hazardous materials handling facilities, housing, and auxiliary buildings.

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

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

5.6.1.2.3 Maintenance. In addition to maintenance at the primary operations facility, maintenance activities include access road maintenance and periodic visits to facilities and structures away from the main facilities. The primary emissions that could affect air quality would be fugitive dust and engine exhaust emissions.

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

5.6.1.2.5 Population Growth. Population growth and related emission increases associated with potential development would include those resulting from direct employment; employees of suppliers (e.g., equipment, materials, supplies, and services); consumers (e.g., additional retail stores); additional employees in federal, state, and local governments; and families.

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

5.6.2 Mitigation Measures

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

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

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

GHG emissions that may be related to climate change impacts may be reduced, regardless of their source (e.g., tar sands or conventionally-derived carbon-based energy sources) through the use of emission controls or by sequestering GHGs.

5.7 NOISE

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

The characteristics of the area around a noise source influence the impacts caused by that source. However, sources produce the same amount of noise independent of their location; in addition, to a first approximation, noise propagates identically everywhere. At the programmatic level, information that could help differentiate between noise impacts in different locations is unavailable, as are estimates of the noise levels associated with some of the technologies. The approach taken here assumes noise levels to be independent of location. Thus, differences in impacts due solely to restrictions in areas available for leasing are not considered.

When published estimates for facilities were unavailable, simple noise modeling was used to estimate noise impacts (Hanson et al. 2006). To predict an impact, the model requires that the noise level associated with the technology be assessed. Noise levels were not available for some technologies. In these cases, noise levels associated with similar technologies were used.

Noise Modeling Parameters

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

Published information was generally for a single-capacity facility. Noise impacts were extrapolated by using a conservative approach equivalent to the 3-dBA rule of thumb. [2] For

[2] A 3-dB change in sound level is considered barely noticeable on the basis of individuals' responses to changes in sound levels (NWCC 2002).

example, if noise levels were available for a reference facility producing 20,000 bbl/day, the noise impact of a 40,000-bbl/day facility was assumed to be 3 dBA higher, an assumption equivalent to locating two 20,000-bbl/day facilities at the same point.

As is generally the practice, this PEIS uses the EPA guideline of 55 dBA (L_{dn}), deemed adequate to protect human health and welfare, as a significance criterion for assessing noise impacts (EPA 1974). However, tar sands development would occur mostly in remote rural locations. In these areas, background (already existing) noise levels are low (40 dBA during the day and 30 dBA during the night are representative levels), and an increase in noise levels to 55 dBA would be noticeable and annoying to people (Harris 1991). This guideline may not be appropriate for people seeking solitude or a natural, wilderness experience. Depending on ambient conditions, the activities being pursued by the receptors, and the nature of the sound, wildlife and human activities can be affected at levels below 55 dBA, but quantitative guidelines are unavailable. In addition, the NPS has determined that L_{dn} and L_{eq} alone are not appropriate for determining impacts in National Parks and typically uses audibility metrics to characterize impacts on humans and wildlife. Site-specific impacts on resources administered by the NPS would be assessed by using audibility-based metrics and other appropriate data and methodologies. See Sections 5.8 and 5.9 for impacts on wildlife and human aesthetic experiences, respectively, that could result from increased levels of noise.

5.7.1 Common Impacts

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

5.7.1.1 Construction

Construction would include a variety of activities, including building of access roads, grading, drilling, pouring concrete, trenching, laying pipe, cleaning up, revegetating, and perhaps blasting. With the exception of blasting, construction equipment constitutes the largest noise source at construction sites. Table 5.7.1-1 presents noise levels for typical construction equipment. For a programmatic assessment of construction impacts, it can be assumed that the two noisiest pieces (derrick crane and truck) would operate simultaneously and in close proximity to each other (Hanson et al. 2006). Together these would produce a noise level of 91 dBA at a distance of 50 ft. Assuming a 10-hour workday, noise levels would exceed the EPA guideline of 55 dBA (L_{dn}) up to about 850 ft from the location where the equipment was operating. (Background levels are included in the calculation of L_{dn} but do not affect the noise levels much at the aforementioned distance.) Construction impacts could last up to 2 years and could recur during the operational phase if additional processing facilities needed to be constructed.

TABLE 5.7.1-1 Noise Levels at Various Distances from Typical Construction Equipment

	Noise Level $L_{eq(1\text{-}h)}$[a] at Distances (dBA)					
Construction Equipment	50 ft	250 ft	500 ft	1,000 ft	2,500 ft	5,000 ft
Bulldozer	85	67	59	51	40	32
Concrete mixer	85	67	59	51	40	32
Concrete pump	82	64	56	48	37	29
Crane, derrick	88	70	62	54	43	35
Crane, mobile	83	65	57	49	38	30
Front-end loader	85	67	59	51	40	32
Generator	81	63	55	47	36	28
Grader	85	67	59	51	40	32
Shovel	82	64	56	48	37	29
Truck	88	70	62	54	43	35

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

Source: Hanson et al. (2006).

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

5.7.1.2 Vehicular Traffic

Heavy-duty trucks produce most of the noise associated with vehicular traffic during construction.[3] Vehicular traffic includes hauling of materials, transport of equipment, delivery of water for fugitive dust control, and worker personal vehicles. Light-duty trucks, such as pickups and personal vehicles, produce less noise than heavy-duty trucks (10 passenger cars make about the same noise as a single heavy-duty truck on an L_{eq} basis). Except for short periods when workers are arriving at and leaving the construction site, heavy-truck traffic would dominate the vehicular traffic. Table 5.7.1-2 presents the noise impacts from heavy trucks estimated at various distances from a road for different hourly levels of truck traffic. For these estimates, a peak pass-by noise level from a heavy-duty truck operating at 35 mph was based on Menge et al. (1998) and a 10-hour working day. Except for locations very close to the road or with high traffic levels, noise levels would not exceed the EPA guideline level of 55 dBA L_{dn}.

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

TABLE 5.7.1-2 Noise Levels at Various Distances from Heavy Truck Traffic[a]

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

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

[b] Daytime and nighttime background noise levels of 40 and 30 dBA, respectively, are included.

Source: Menge et al. (1998).

5.7.1.3 Surface Mining with Surface Retort

No well drilling would be required for surface mining with surface retort (see Section 5.7.1.1 for general construction impacts). This assessment relies on data on noise from a mine supporting a 20,000-bbl/day surface retort and its associated surface mine (Appendix B). Noise from the retort is expected to be 73 to 88 dBA at 50 ft, while noise from the mine is expected to be about 61 dBA at 500 ft.[4] Both the retort and the mine would operate continuously. To be conservative, the higher noise level was used for the retort, and both sources were modeled at the same point. Table 5.7.1-3 presents the results. Given the distances at which the EPA guideline level might be exceeded, these results indicate that the potential noise impacts from surface mines and retorts should be evaluated thoroughly. If high noise impacts are projected, noise-reduction equipment such as mufflers, blowdown mutes, and pipe wrap and enclosures may be required (Daniels et al. 1981).

TABLE 5.7.1-3 Noise Levels from a Surface Mine with Surface Retort Site and a Surface Mine with Solvent Extraction Site

Plant Capacity (10^3 bbl/day)	Distance to L_{dn} of 55 dBA (ft)[a]
20	1,950

[a] Assuming 24 hours per day for continuous operation, the estimated noise level at a given distance is about 48.5 dBA L_{eq}.

[4] Considering the geometric spreading and ground effects only, this level is equivalent to a level of 88 dBA at a reference distance of 50 ft.

5.7.1.4 Surface Mining with Solvent Extraction

No well drilling would be required for this technology (see Section 5.7.1.1 for general construction impacts). The noise levels for operation of this technology described in Appendix B are identical to those for surface mining with surface retorting. Noise impacts would be identical to those noted in Section 5.7.1.3.

TABLE 5.7.1-4 Noise Levels from an In Situ Steam Injection Site

Plant Capacity (10^3 bbl/day)	Distance to L_{dn} of 55 dBA (ft)	
	Construction[a]	Operation[b]
20	440	2,750

[a] Assuming 10 hours per day for daytime construction, the estimated noise level at a given distance is about 58.7 dBA L_{eq}.

[b] Assuming 24 hours per day for continuous operation, the estimated noise level at a given distance is about 48.5 dBA L_{eq}.

5.7.1.5 In Situ Steam Injection

The BLM provides noise impact estimates for construction of a 30,000-bbl/day in situ steam injection tar sands processing facility (BLM 1984). At 250 ft, typical maximum construction noise was estimated to be 67 dBA. This estimate was revised to include the ground effects and to estimate L_{dn}, assuming 10 hours per day of construction time. The distance to where the L_{dn} noise level reached the EPA guideline level was modeled. Table 5.7.1-4 gives this distance for an in situ steam plant with a capacity of 20,000 bbl/day.

During operation, the BLM (1984) estimated a maximum noise level of 78 dBA at 250 ft. This estimate was also revised by assuming 24 hours per day of operational time; the results are presented in Table 5.7.1-4. The reference noise levels were estimated by using a simple aggregation technique and ignoring the spatial separation of the sources. This practice will generally lead to overestimates of noise levels. In view of the potential for overestimation of these noise estimates, the potential noise impacts of in situ steam injection plants should be evaluated thoroughly.

5.7.1.6 In Situ Combustion

On the basis of estimates in Daniels et al. (1981), a 20,000-bbl/day in situ combustion operation might have about 80 wells covering 160 acres operating at any time. The wells would be spaced about 330 ft apart. Daniels et al. (1981) did not specify the number of drilling rigs used during construction. For estimation purposes, it was assumed that 9 to 10 drilling rigs would be operating 10 hours per day. This situation was modeled as a square array of nine sources, each separated by 800 ft. This arrangement would allow all 81 wells to be drilled while about the same separation between rigs would be maintained as they moved to new locations. The results indicate that the 55 dBA L_{dn} noise level would be reached at just under 500 ft, with a corresponding noise level of almost 59 dBA L_{eq}. (For additional construction impacts see Section 5.7.1.1.)

To estimate noise levels during operations, a square array of 81 pumps (one for each well) was modeled, and operation of 24 hours per day was assumed. The noise level for each pump was taken as 82 dBA at 50 ft (BLM 2000). The results indicated that the EPA L_{dn} guideline level might be exceeded to about 3,600 ft, with a corresponding noise level of 48 dBA. Given the distances at which the EPA guideline level might be exceeded, these results indicate that the potential noise impacts of in situ combustion should be evaluated thoroughly. If high noise impacts are projected, noise-reduction equipment such as mufflers, blowdown mutes, and pipe wrap and enclosures may be required (Daniels et al. 1981).

As indicated in Appendix B, in situ combustion is the only technology for possible deployment in the Tar Sand Triangle STSA. Much of the leasable land in this STSA is located within 3,000 to 6,000 ft of special designated areas such as potential ACECs and WSAs (see Figure 3.1.1-9). In addition, some part of the leasable lands lies within the Glen Canyon NRA and abuts with other lands in the NRA that are zoned for natural use. In all these areas, the intrusion of noise into the natural environment may be a particular concern with regard to the development of in situ combustion projects.

5.7.1.7 Reclamation

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

5.7.1.8 Transmission Lines

General construction impacts are discussed in Section 5.7.1.1. During operation, the main sources of noise from the transmission line would be substation noise and corona discharge. Substation noise comes primarily from transformers and switchgear. A transformer produces a constant low-frequency hum. The average A-weighted sound level at about 490 ft for a transformer of about 500 MW is about 49 dBA (Wood 1992). The number and size of transformers are currently unknown, but a single transformer could exceed the EPA guideline at 500 ft. Transformer noise and mitigating measures must be addressed if substations are required along the transmission lines. Switchgear noise is generated when a breaker opens, producing an impulsive sound that is loud but of short duration. These sounds occur infrequently, and the industry trend is toward breakers that generate significantly less noise. The potential impacts of switchgear noise would be temporary, infrequent, and minor.

Transmission lines generate corona discharge, which produces a noise having a hissing or crackling character. During dry weather, transmission line noise is generally indistinguishable from background noise at the edge of typical ROWs. During rainfall, the level would be less than 47 dBA at 100 ft from the center of a 500-kV transmission line (Lee et al. 1996). This is the noise level typical of a library (MPCA 1999). Even if several transmission lines of this capacity were required, the overall corona noise would be lost even in rural background noise within several hundred feet.

5.7.1.9 Pipeline

General construction impacts are discussed in Section 5.7.1.1. Depending on the topography, a pipeline 95 mi long could require several pump stations. Pumps will generally be the noisiest equipment associated with a pump station. Contra Costa County (2003) gives a noise level of 94 dBA at 3 ft from a 400-hp pump but does not specify the throughput. Assuming that three pumps would be needed, the EPA guideline would be exceeded to a distance of about 240 ft from the pumps. Pumps are almost always located in structures for protection from the weather and for security. The enclosure would reduce noise levels. Because the pumps that would be needed to move the assumed output may be larger and noisier than those assumed here, noise impacts would need to be assessed during planning for the actual pump stations.

5.7.2 Mitigation Measures

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

5.7.2.1 Preconstruction Planning

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

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

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

5.7.2.2 Construction and Reclamation

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

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

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

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

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

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

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

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

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

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

5.7.2.3 Operation

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

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

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

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

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

- Facility design could include all feasible noise-reduction methods, including, but not limited to, mounting equipment on shock absorbers; mufflers or silencers on air intakes, exhausts, blowdowns, and vents; noise barriers; noise-reducing enclosures; noise-reducing doors and windows; sound-reducing pipe lagging; and low-noise ventilation systems.

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

5.8 ECOLOGICAL RESOURCES

5.8.1 Common Impacts

5.8.1.1 Aquatic Resources

Impacts on aquatic resources from the tar sands development projects and associated facilities could occur because of (1) direct disturbance of aquatic habitats within the footprint of construction or operation activities; (2) sedimentation in nearby aquatic habitats as a consequence of settled dust and soil erosion from operational areas; (3) changes in water quantity or water quality as a result of construction (e.g., grading that affects surface water runoff, water levels, or hydrologic connectivity) and operations (e.g., surface or groundwater withdrawals or increases in discharges of water into nearby aquatic habitats), or releases of chemical contaminants into nearby aquatic systems (e.g., accidental spills, controlled discharges, and the discharge of contaminated ground water into surface water); or (4) development of infrastructure such as roads and ROWs that increase public access to fishery resources. These impacts could occur to some degree during the construction period and throughout the operational life of the projects. In addition, some impacts could continue to occur beyond the operational life of the project. Potential impacts on aquatic resources from various impacting factors associated with tar sands development are discussed below and are summarized in Table 5.8.1-1. The potential magnitudes of the impacts that could result from tar sands development are presented separately for aquatic invertebrates and for fish. Potential impacts on federally listed, state-listed, and BLM-designated sensitive aquatic species are presented in Section 5.8.1.4, and potential impacts on other types of organisms that could occur in aquatic habitats (e.g., amphibians and waterfowl) are presented in Section 5.8.1.3.

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

Turbidity and sedimentation from erosion and settled dust are part of the natural cycle of physical processes in water bodies, and most populations of aquatic organisms have adapted to short-term changes in these parameters. However, if sediment loads are unusually high or last longer than they would under natural conditions, adverse impacts could occur (Waters 1995). Increased sediment loads could suffocate aquatic vegetation, invertebrates, and fish; decrease the rate of photosynthesis in plants and phytoplankton; decrease fish feeding efficiency; decrease the levels of invertebrate prey; reduce fish spawning success; and adversely affect the survival of incubating fish eggs, larvae, and fry (Waters 1995). The addition of fine sediment to aquatic

TABLE 5.8.1-1 Potential Impacts on Aquatic Resources Resulting from Commercial Tar Sands Development

	Potential Magnitude of Impacts According to Organism Group[a]	
Impact Category	Aquatic Invertebrates	Fish
Sedimentation from runoff	Large	Large
Water depletions	Large	Large
Changes in drainage patterns, discharge, and recharge rates	Small	Small
Disruption of groundwater flow patterns	Moderate	Moderate
Temperature increases in water bodies	Moderate	Moderate
Increases in salinity	Small	Small
Introduction of nutrients, inorganic, and organic contaminants	Small	Small
Oil and contaminant spills	Moderate	Large
Movement/dispersal blockage	Small	Small
Increased human access	Small	Small

[a] Potential impact magnitude (without mitigation) that might be expected from individual development projects is presented as none, small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of the local population (less than 10%), and does not result in a measurable change in carrying capacity or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of the local population, and result in a measurable but moderate change (less than 30%) in carrying capacity or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 30% of a local population, and result in a large measurable change in carrying capacity or population size in the affected area.

systems is considered a major factor in the degradation of stream fisheries (Waters 1995). Thus, although the organisms in many aquatic systems are capable of coping with smaller, short-term increases in sediment loads, exceeding (largely unmeasured) threshold levels or durations would be expected to have detrimental effects on the affected aquatic ecosystems.

The potential for soil erosion and sediment loading of nearby aquatic habitats is proportional to the amount of surface disturbance, the condition of disturbed areas at any given time, and the proximity to aquatic habitats. The presence of riparian vegetation buffers along waterways helps control sedimentation in waterways because it reduces erosion by binding soil, due to the presence of root systems, and by dissipating water energy of surface runoff during high flow events. Vegetation also helps to trap sediment contained in surface runoff.

Consequently, tar sands development activities that affect the presence or abundance of riparian vegetation would be expected to increase the potential for sediment to enter adjacent streams, ponds, and reservoirs. Because fine sediments may not quickly settle out of solution, impacts of sediment introduction to stream systems could extend downstream for considerable distances.

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

Changes in flow patterns of streams and depletion of surface water within tar sands development areas could affect the quality of associated aquatic habitats and the survival of populations of aquatic organisms within affected bodies of water. Most obviously, perhaps, complete dewatering of streams or stream segments would preclude the continued presence of aquatic communities within the affected areas. However, changes in flows and flow patterns could affect the nature of the aquatic communities that are supported, even if there is not complete dewatering. Reductions in flow levels can result in depth changes and reductions in water quality (e.g., water temperatures and dissolved oxygen levels) that some species of fish and invertebrates may be unable to tolerate. Reduced depths can also affect the susceptibility of some fish species to predation from avian and terrestrial predators. Depending on the magnitude of the water depletion in a particular waterway, aquatic habitat in all downstream portions of a watershed could be affected.

Aquatic organisms have specific temperature ranges within which survival is possible, and exceeding those temperatures, even for short periods, can result in mortality. In addition, aquatic organisms such as fish and macroinvertebrates use oxygen dissolved in the water to breathe, and if dissolved oxygen levels fall below the tolerances of those organisms they will be unable to survive unless there are areas with suitable conditions nearby that can serve as temporary refuge. The level of dissolved oxygen in water is highly dependent on temperature, and the amount of oxygen that can dissolve in a given volume of water (i.e., the saturation point) is inversely proportional to the temperature of water. Thus, with other chemical and physical conditions being equal, the warmer the water, the less dissolved oxygen it can hold. In the arid regions where the tar sands deposits described in this PEIS are found, surface water temperatures during hot summer months can approach lethal limits and the resulting depressed dissolved oxygen levels are often already near the lower limits for many of the aquatic species that are present, especially in some of the smaller streams. Consequently, increasing water temperatures even slightly may, in some cases, adversely affect survival of aquatic organisms such as fish and mussel species in the affected waterways.

Tar sands development activities could affect water temperatures through removal of surface vegetation, especially riparian vegetation, and by reducing streamflows or inputs of cooler groundwater into nearby waterways due to water depletions. Removing vegetation alters the amount of shading of the earth's surface and increases the temperature of overlying waters or surface water runoff. Fish typically avoid elevated temperatures by moving to areas of groundwater inflow, to deeper holes, or to shaded areas where water temperatures are lower. If temperatures exceed thermal tolerances for extended periods and no refuge is available, fish kills may result. The level of thermal impact associated with clearing of riparian vegetation would be expected to increase as the amount of affected shoreline increases. The potential for water depletions to affect surface water temperatures by depressing groundwater flows is not easily predicted, although as the proportion of groundwater discharge decreases, surface water temperatures during critical summer months would be expected to increase. Water depletions in the Colorado River Basin are of particular concern to native fish in the basin, including the four endangered Colorado River Basin fish species (humpback chub, razorback sucker, Colorado pikeminnow, and bonytail). As identified in Section 5.8.1.4, any water depletions from the upper Colorado River Basin are considered an adverse effect on endangered Colorado River fishes.

As identified in Section 5.5.1.1, surface disturbance in the tar sands areas could also negatively affect water quality by increasing the salinity of surface waters in downstream areas. Depending on the existing salinity levels and the types of aquatic organisms present in receiving waters, such increases could stress existing biota or alter species composition in affected areas. The potential for surface disturbance to increase salinity levels in surface waters would decrease as the distance between disturbed areas and waterways increases (Section 5.5.1.1). Once salts have entered waterways, they are not generally removed from solution. Consequently, salinity tends to increase with increasing downstream distance in a watershed, representing the accumulation of salt from many different sources. Section 5.5.3 identifies a number of potential mitigation measures that could be implemented to reduce the potential for negative effects on water quality from salinity due to tar sands development.

Nutrients (especially dissolved nitrogen and phosphorus) are required in small quantities for the growth and survival of aquatic plants. When the levels of nutrients become excessive, plant growth and decay are promoted. This, in turn, may favor the survival of certain weedy species over others and may result in severe reductions in water quality aspects such as oxygen levels. As discussed in Section 5.12, tar sands development could result in increases in human populations within the immediate area of specific developments and within the region as a whole. If these population increases resulted in increased nutrient loading of streams due to additional inputs from sewage treatment facilities, survival of some aquatic species could be affected and changes in biodiversity could result. Depending upon the magnitude of nutrient inputs, aquatic habitat in extended downstream portions of a watershed could be affected. The loss of native freshwater mussel species in some aquatic systems has been partially attributed to increases in nutrient levels (Natural Resources Conservation Service and Wildlife Habitat Council 2007). Because the water quality of effluents from such facilities is typically regulated under permits issued by state agencies, negative impacts on aquatic systems from increases in nutrient levels are expected to be small.

Contaminants could enter aquatic habitats as a result of recharge of contaminated ground water; leachate runoff from exposed tar sands deposits, including spent tar sands; controlled point source discharges; the accidental release of fuels, lubricants, or pesticides; or spills from pipelines used to transport petroleum products from the site. Contamination of surface waters by groundwater recharge could occur if the groundwater is contaminated by in situ processing. The produced water from in situ processing may contain elevated levels of contaminants such as TDS, chloride, hydrocarbons, and heavy metals.

Both raw and spent tar sands remaining on the surface could become a chronic source of contaminated runoff unless adequate containment measures are implemented or unless they are transported off-site for disposal. Tar sands development sites would be subject to stormwater management permits and the application of BMPs that would control the quality and quantity of runoff entering nearby aquatic habitats. Exposure to the leachate from tar sands and spent tar sands tailings has been shown to reduce the survival of some fish and aquatic invertebrate species if the concentrations are high enough (Siwik et al. 2000; Sik-Cheung et al. 2001; Colavecchia et al. 2004). Thus, spent tar sands returned to surface mine pits following processing could affect aquatic resources if they result in contaminants entering surface waters via surface runoff or groundwater. Spent tar sands remaining underground following in situ combustion or steam injection could similarly contaminate aquatic habitats if groundwater passes through these spent sands deposits and later enters surface waters. Because the resulting concentrations in aquatic habitats would depend largely on the dilution capability, and, therefore, the flow of the receiving waters, impacts would be more likely if runoff from spent tar sands deposits entered small perennial streams than if it entered larger streams.

Toxic materials (e.g., fuels, lubricants, and herbicides) could also be accidentally introduced into waterways during construction and maintenance activities or as a result of leaks from pipelines used to transport petroleum products from the project site to collection areas. The level of impacts from releases of toxic materials would depend on the type and volume of chemicals entering the waterway, the location of the release, the nature of the water body (e.g., size, volume, and flow rate), and the types and life stages of organisms present in the waterway. In general, lubricants and fuel would not be expected to enter waterways in detrimental quantities as long as (1) heavy machinery is not used in or near waterways, (2) fueling locations for construction and maintenance equipment are situated away from waterways, and (3) measures are taken to control spills that occur. Because tanker trucks are often used to transport petroleum products from collection sites, there is a potential for roadway accidents to release toxicants into adjacent waterways. Such releases could result in substantial mortality of fish and of the aquatic biota.

In areas where access roads, pipelines, or utility corridors cross streams, obstructions to fish movement could occur if culverts, low-water crossings, or buried pipelines are not properly installed, sized, or maintained. During periods of low water, vehicular traffic can result in rutting and accumulation of cobbles in some crossings that can interfere with fish movements. In streams with low flows, flow could become discontinuous if disturbance of the streambed during construction activities results in increased porosity or if the altered channel spreads across a wider area. Restrictions on fish movement would likely be most significant if they occurred in streams that support species that need to move to specific areas in order to reproduce.

In addition to the potential for the direct impacts identified above, indirect impacts on fisheries could occur as a result of increased public access to remote areas via newly constructed access roads and utility corridors. Fisheries could be impacted by increased fishing pressure, and other human activities (e.g., OHV use) could disturb riparian vegetation and soils, resulting in erosion, sedimentation, and potential impacts on water quality, as discussed above. Such impacts would be smaller in locations where existing access roads or utility corridors that already provide access to waterways would be utilized. Because all of the proposed projects would require similar levels of infrastructure that could result in increased public access, the level of impact would be similar regardless of the technology used. Overall, it is anticipated that impacts on fishery resources from increased access would be minor. Tar sands development also has the potential to affect fishing pressure in locations outside the immediately affected watershed if the development results in a loss of current fishing opportunities, either because developed locations become unavailable or because development results in decreases in catchable fish within adjacent or downstream areas. In such cases, displaced anglers could utilize nearby reservoirs or other streams or rivers, resulting in greater exploitation of fishery resources in those waterways. If water depletions associated with tar sands development affect water storage within reservoirs in nearby areas, fishing opportunities in those reservoirs could be affected.

5.8.1.2 Plant Communities and Habitats

Potential impacts on terrestrial, riparian, and wetland plant communities and habitats from activities associated with tar sands development would include direct impacts from habitat removal, as well as a wide variety of indirect impacts. Impacts would be incurred during initial site preparation and continue throughout the life of the project, extending over a period of several decades. Some impacts may also continue beyond the termination of asphalt or syncrude production. The potential magnitude of the impacts that could result from tar sands development is presented for different habitat types in Table 5.8.1-2.

Direct impacts would include the destruction of habitat during initial land clearing on the lease site, as well as habitat losses resulting from the construction of ancillary facilities such as access roads, pipelines, transmission lines, and employer-provided housing. Land clearing on the site would be required for the construction of processing facilities, storage areas for soil and spent tar sands, and excavation areas. Land clearing would also occur incrementally throughout the life of the project, resulting in continued losses of habitat. Storage of woody vegetation cleared from project areas would impact additional areas of vegetation. Native vegetation communities present in project areas would be destroyed. Riparian habitats or wetlands may be affected by ROWs that cross streams or other water bodies. E.O. 11990, “Protection of Wetlands,” requires all federal agencies to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands (U.S. President 1977). Impacts on jurisdictional wetlands (those under the regulatory jurisdiction of the CWA, Section 404, and the USACE) on or near the project site or locations of ancillary facilities would be avoided or mitigated. Preconstruction surveys would identify wetland locations and boundaries, and the permitting process would be initiated with the USACE for unavoidable impacts.

TABLE 5.8.1-2 Potential Impacts on Plant Communities Resulting from Commercial Tar Sands Development

	Potential Magnitude of Impacts According to Habitat Type[a]	
Impact Category	Upland Plants	Wetland and Riparian Plants
Vegetation clearing	Large	Large
Habitat fragmentation	Moderate	Moderate
Dispersal blockage	Moderate	Moderate
Alteration of topography	Moderate	Large
Changes in drainage patterns	Moderate	Large
Erosion	Large	Large
Sedimentation from runoff	Large	Large
Oil and contaminant spills	Moderate	Large
Fugitive dust	Moderate	Moderate
Injury or mortality of individuals	Large	Large
Human collection	Moderate	Moderate
Increased human access	Moderate	Moderate
Fire	Large	Large
Spread of invasive plant species	Large	Large
Air pollution	Moderate	Moderate
Water depletions	Small	Large
Disruption of groundwater flow patterns	Small	Moderate
Temperature increases in water bodies	None	Moderate

[a] Potential impact magnitude (without mitigation) that might be expected from individual development projects is presented as none, small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of a plant community or local species population (less than 10%), and does not result in a measurable change in community characteristics or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of a plant community or local species population (10 to 30%), and result in a measurable but moderate (not destabilizing) change in community characteristics or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 30% of a plant community or local species population, and result in a large, measurable, and destabilizing change in community characteristics or population size in the affected area.

Reclamation of impacted areas would include reestablishment of vegetation on restored soils. Although revegetation of disturbed soils in many locations may successfully establish a productive vegetation cover, with biomass and species richness similar to those of local native communities, the resulting plant community may be quite different from native communities in species composition and the representation of particular vegetation types, such as shrubs (Newman and Redente 2001). Community composition of revegetated areas would likely be greatly influenced by the species that are initially seeded, particularly perennial grasses, and colonization by species from nearby native communities may be slow (Newman and Redente 2001; Paschke et al. 2005; Belnap and Herrick 2006). The establishment of mature native plant communities may require decades. Successful restoration of some vegetation types, such as shrubland communities, may be difficult and would require considerable periods of time, likely more than 20 years. Restoration of plant communities in STSAs with arid climates (generally averaging less than 9 in. of annual precipitation), such as shadscale-saltbush communities, may be very difficult (Monsen et al. 2004). Although vegetation within ROWs would become reestablished, ROW management programs may prevent the establishment of mature native communities. Areas along ROWs that would be impacted by ROW construction would be restored in the same manner as other disturbed project areas. The loss of intact native plant communities could result in increased habitat fragmentation, even with the reclamation of impacted areas.

Disturbed soils may provide an opportunity for the introduction and establishment of non-native invasive species. Seeds or other propagules of invasive species may be inadvertently brought to a project site from infested areas by heavy equipment or other vehicles used at the site. Invasive species may also colonize disturbed soils from established populations in nearby areas. The establishment of invasive species may greatly reduce the success of the establishment of native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. In addition, the planting of non-native species in reclaimed areas may result in the introduction of those species into nearby natural areas. The establishment of invasive species may alter fire regimes, including an increase in the frequency and intensity of wildfires, particularly following the establishment of annual grasses such as cheatgrass. Native species, particularly shrubs, that are not adapted to frequent or intense fires, may be adversely affected and their populations may be reduced.

Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. Impacts on surface water and groundwater systems, which subsequently affect terrestrial plant communities, wetlands, and riparian areas, are described in Section 5.5. Deposition of fugitive dust, including associated salts, generated during clearing and grading, construction, and use of access roads or resulting from wind erosion of exposed soils, could reduce photosynthesis and productivity in plants near project areas and could result in foliar damage. Plant community composition could be subsequently altered, resulting in habitat degradation. In addition, pollinator species could be affected by fugitive dust, potentially reducing pollinator populations in the vicinity of a tar sands project. Temporary, localized effects on plant populations and communities could occur if seed production in some plant species is reduced. Soil compaction could reduce the infiltration of precipitation or snowmelt and, along with reduced vegetation cover, result in increased runoff and subsequent erosion and sedimentation. Reduced infiltration and altered surface runoff and drainage characteristics could result in changes in soil moisture characteristics, reduced recharge of shallow groundwater systems, and changes in the hydrologic regimes of downgradient streams and associated wetlands and riparian areas. Soils on steep slopes, such as those that occur in many STSAs, could be particularly susceptible to increased erosion resulting from changes in stormwater flow patterns.

Erosion and reductions in soil moisture could alter affected terrestrial plant communities adjacent to project activities, resulting in reduced growth and reproduction. Altered hydrologic regimes, particularly reductions in the duration, frequency, or extent of inundation or soil saturation (potentially resulting from elimination of ephemeral or intermittent streams), could result in species or structural changes in wetland or riparian communities, changes in distribution, or reduction in community extent. Increased volumes or velocities of flows could affect wetland and riparian habitats, thereby removing fine soil components, organic materials, and shallow-rooted plants. Large-scale surface disturbance that reduces infiltration may increase flow fluctuations, reduce base flows, and increase flood flows, resulting in impacts on wetland and riparian community composition and extent. Sedimentation, and associated increases in dissolved salts, could degrade wetland and riparian plant communities. Effects may include reduced growth or mortality of plants, altered species composition, reduced biodiversity, or, in areas of heavy sediment accumulation, reduction in the extent of wetland or riparian communities. Disturbance-tolerant species may become dominant in communities affected by these changes in hydrology and water quality. Increased sedimentation, turbidity, salt loading, or other changes in water quality may provide conditions conducive to the establishment of invasive species.

Alterations of groundwater flow or quality in project areas, such as during tar sands extraction or in situ processing, may affect wetlands and riparian areas that directly receive groundwater discharge, such as at springs or seeps, or that are present in streams with flows maintained by groundwater. Wetland and riparian communities far downgradient from tar sands extraction or retorting activities may be affected by reduced flows or reduced water quality. Flow reductions in alluvial aquifers from tar sands extraction, water withdrawals, or pipeline installation may also result in reductions, or changes in community composition, in wetland or riparian communities associated with streams receiving alluvial aquifer discharge. Water withdrawals from surface water features, such as rivers and streams, may reduce flows and water quality downstream, which may in turn reduce the extent or distribution of wetlands and riparian areas along these water bodies or degrade these plant communities. The construction of reservoirs would also affect downstream wetlands and riparian areas by reducing flows and sediment transport and increasing salt loading. Wetlands and riparian areas within the area of the reservoir and dam would be lost.

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

Oil shale endemic species that occur in STSAs would be potentially subject to the direct and indirect impacts described above. Habitats occupied by these species could be degraded or lost, and individuals could be destroyed. Local populations could be reduced or lost as a result of tar sands development activities. Establishment and long-term survival of these species on reclaimed land may be difficult. The potential introduction and spread of noxious weed species from project areas into the habitat of oil shale endemics could threaten local populations. In addition, the increased accessibility resulting from new roads could result in increased impacts from human disturbance or collection. Because of the generally small, scattered populations of oil shale endemics, impacts could result in greater consequences for these species than for commonly occurring species. However, many oil shale endemics are federally listed, state-listed, or BLM-designated sensitive species, and are protected by applicable federal or state requirements and agency policies.

5.8.1.3 Wildlife (Including Wild Horses and Burros)

All tar sands leasing projects that would be constructed and operated have the potential to affect wildlife, including wild horses (*Equus caballus*) and burros (*E. asinus*), over a period of several decades. Reclamation, which would occur in parallel with or after extraction activities are completed, would reduce or eliminate ongoing impacts to the extent practicable by recreating habitats and ecological conditions that could be suitable to wildlife species. The effectiveness of any reclamation activities would depend on the specific actions taken; the best results, however, would occur where original site topography, hydrology, soils, and vegetation patterns could be reestablished. However, as discussed in Section 5.8.1.2, this reestablishment may not be possible in all situations.

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

Impacts on wildlife from tar sands projects could occur in a number of ways and are related to (1) habitat loss, alteration, or fragmentation; (2) disturbance and displacement; (3) mortality; and (4) increase in human access. These can result in changes in habitat use;

changes in behavior; collisions with structures or vehicles; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminants.

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

Wildlife impacts from the impacting factors discussed below are summarized in Table 5.8.1-3. The potential magnitude of the impacts that could result from tar sands development is presented for representative wildlife species types. Impacts are designated as small, moderate, or large. A small impact is one for which most impacts on the affected resource could be avoided with proper mitigation; and, if impacts occur, the affected resource will recover completely without mitigation once the impacting stressor is eliminated. A moderate impact is one for which impacts on the affected resource are unavoidable. The viability of the affected resource is not threatened, although some impacts may be irreversible; or the affected resource would not recover completely if proper mitigation is applied during the life of the project or proper remedial action is taken once the impacting stressor is eliminated. A large impact is one for which impacts on the affected resource are unavoidable. The viability of the affected resource may be threatened; and the affected resource would not fully recover even if proper mitigation is applied during the life of the project or remedial action is implemented once the impacting stressor is eliminated. No population-level effects are expected from small and moderate impacts, while population-level impacts are expected from major impacts.

5.8.1.3.1 Habitat Disturbance. The reduction, alteration, or fragmentation of habitat would result in a major impact on wildlife. Habitats within the construction footprint of the projects, utility ROWs, access roads, and other infrastructure would be destroyed or disturbed. The amount of habitat impacted would be a function of the degree of disturbance already present in the project site area. With certain exceptions, areas lacking vegetation (e.g., operational areas, access roads, and active portions of tar sands mining) provide minimal habitat. The construction activities associated with the projects would not only result in the direct reduction or alteration of wildlife habitat within the project footprint but could also affect the diversity and abundance of area wildlife through habitat fragmentation. Habitat fragmentation causes both a loss of habitat and habitat isolation.

A decline in wildlife use near roads or other facilities would be considered an indirect habitat loss. Avoidance of habitat associated with roads has been reported to be 2.5 to 3.5 times as great as the actual habitat loss associated with the road's footprint (Reed et al. 1996). Mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) may avoid areas up to 0.40 km (0.25 mi) from a project area (BLM 2006c). Similarly, bird nesting may be disrupted within 0.40 km (0.25 mi) of construction activities during the nesting and brooding periods (e.g., February 1 to August 25) (BLM 2006a). Road avoidance by wildlife could be greater in

TABLE 5.8.1-3 Potential Impacts on Wildlife Species Resulting from Commercial Tar Sands Development

	Potential Magnitude of Impacts According to Species Type[a]						
Impact Category	Amphibians and Reptiles	Shorebirds and Waterfowl	Landbirds	Raptors	Small Game and Nongame Mammals	Big Game Mammals	Wild Horses and Burros
Vegetation clearing	Large	Small	Large	Moderate	Large	Large	Large
Habitat fragmentation	Large	Small	Moderate	Moderate	Large	Large	Large
Blockage of movement and dispersal	Large	Small	Small	Small	Moderate	Moderate	Moderate
Alteration of topography and drainage patterns	Small	Small	Small	Small	Small	Small	Small
Water depletions	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Stream impoundment and changes in flow pattern	Large	Large	Large	Large	Large	Large	Large
Erosion and sedimentation	Small	Small	Small	Small	Small	Small	Small
Contaminant spills	Small	Small	Small	Small	Small	Small	Small
Fugitive dust	Small	Small	Small	Small	Small	Small	Small
Injury or mortality	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Collection	Small	Small	Small	Small	Small	Small	Small
Human disturbance/harassment	Small	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Increased predation rates	Small	Small	Small	Small	Small	Small	Small
Noise	Small	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Spread of invasive plant species	Small	Small	Moderate	Moderate	Moderate	Small	Small
Air pollution	Small	Small	Small	Small	Small	Small	Small
Fire	Small	Small	Moderate	Small	Small	Small	Small

[a] Potential impact magnitude is presented as small, moderate, or large. A small impact is one for which most impacts on the affected resource could be avoided with proper mitigation; and if impacts occur, the affected resource will recover completely without mitigation once the impacting stressor is eliminated. A moderate impact is one for which impacts on the affected resource are unavoidable. The viability of the affected resource is not threatened, although some impacts may be irreversible; or the affected resource would not recover completely if proper mitigation is applied during the life of the project or proper remedial action is taken once the impacting stressor is eliminated. A large impact is one for which impacts on the affected resource are unavoidable. The viability of the affected resource may be threatened; and the affected resource would not fully recover even if proper mitigation is applied during the life of the project or remedial action is implemented once the impacting stressor is eliminated. No population-level effects are expected from small and moderate impacts, while population-level impacts are expected from major impacts.

open landscapes compared with forested landscapes (Thomson et al. 2005). Mule deer use declined within 2.7 to 3.7 km (1.7 to 2.3 mi) of gas well pads, suggesting that indirect habitat loss can be larger than direct habitat loss (Sawyer et al. 2006). Density of sagebrush obligates, particularly Brewer's sparrow (*Spizella breweri*) and sage sparrow (*Amphispiza belli*), was reduced by 39 to 60% within a 100-m (328-ft) buffer around dirt roads with low traffic volumes. The declines may have been due to a combination of traffic, edge effects, habitat fragmentation, and increases in other passerine species along road corridors. Thus, declines may persist until roads are fully reclaimed (Ingelfinger and Anderson 2004). Those individual animals that make use of areas within or adjacent to project areas could be subjected to increased physiological stress. This combination of avoidance and stress reduces the capability of wildlife to use habitat effectively (WGFD 2010). As noise and human presence are reduced (e.g., as may occur following the switch from construction to operation), wildlife may increase their use of otherwise suitable habitats, although probably not at the same levels as before disturbance began (BLM 2006d).

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

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

Long-term displacement of elk, mule deer, pronghorn (*Antilocapra americana*), or other species from crucial habitat because of habitat disturbance would be considered significant (BLM 2004a). For example, activities around parturition areas have the potential to decrease the usability of these areas for calving and fawning. A tar sands development project located within a crucial winter area could directly reduce the amount of habitat available to the local population. This could force the individuals to use suboptimal habitat, which could lead to debilitating stress. Habitat loss and an associated decrease in the raptor prey base could increase the foraging area necessary to support an individual and/or decrease the number of foraging raptors an area could support (BLM 2006d). With decreasing availability of forbs and grasses, greater sage-grouse (*Centrocercus urophasianus*) broods could move longer distances and expend more energy to find forage. Increased movement, in addition to decreased vegetative cover, could expose chicks to greater risk of predation (see BLM 2006d). Section 5.8.1.4 provides more detailed information about how greater sage-grouse may be impacted by tar sands development, including information about possible measures to mitigate impacts.

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

Water needs for construction and operation could lead to localized to regional water depletions depending on local conditions, process methods, and number of leases developed. Water depletions can be expressed in a number of ways ranging from decreases in soil moisture, reduced flow of springs and seeps, loss of wetlands, and drawdowns of larger rivers and streams. A number of direct and indirect impacts on wildlife can result from water depletions. These include reduction and degradation of habitat; reduction in vegetative cover, forage, and drinking water; attraction to human habitations for alternative food sources; increased stress, disease, insect infestations, and predation; alterations in migrations and concentrations of wildlife; loss of diversity; reduced reproductive success and declining populations; increased competition with livestock; and increased potential for fires (IUCNNR 1998; UDWR 2006).

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

Migration corridors are vulnerable, particularly at pinch points where physiographic constrictions force herds through relatively narrow corridors (Berger 2004). Loss of habitat continuity along migration routes would severely restrict the seasonal movements necessary to maintain healthy big game populations (Sawyer and Lindsay 2001; Thomson et al. 2005). Any activity or landscape modification that prevents the use of migration corridor constrictions (migration bottlenecks or pinch points) could effectively reduce the use of habitats either above or below the constriction (BLM 2004b). As summarized by Strittholt et al. (2000), roads have been shown to impede the movements of invertebrates, reptiles, and small and large mammals. For large mammals, blockages of a route between foraging or bedding areas and watering areas could cause the animals to abandon a larger habitat area altogether (BLM 2004b). High snow embankments as a result of plowing can greatly influence the mobility of wildlife such as moose (*Alces alces*) (WGFD 2010). Barriers to movement that prevent snakes from accessing wintering dens or that isolate amphibian breeding pools from feeding areas could affect or even eliminate a population (BLM 2004b).

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

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

The creation of edge habitat along the boundary between two habitats can (1) increase predation and parasitism of vulnerable forest or sagebrush interior animals in the vicinity of edges; (2) have negative consequences for wildlife by modifying their distribution and dispersal patterns; or (3) be detrimental to species requiring large undisturbed areas, because increases in edge are generally associated with concomitant reductions in habitat size and possible isolation of habitat patches and corridors (habitat fragmentation). Species that could benefit from the proposed utility or access road ROWs include those that prefer or require some open areas, edge habitat, and/or shrubs and small trees. Access roads through forested areas have been found to be positively correlated with bat activity because these areas can provide productive foraging areas and/or travel corridors (Zimmerman and Glanz 2000).

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

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

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

5.8.1.3.2 Wildlife Disturbance. Activities associated with construction and operation of a tar sands project may cause wildlife disturbance, including interference with behavioral activities. The response of wildlife to disturbance is highly variable and species specific. Intraspecific responses can also be affected by the physiological or reproductive condition of individuals; the distance from disturbance; and the type, intensity, and duration of disturbance. Wildlife can respond to disturbance in various ways, including attraction, habituation, and avoidance (Knight and Cole 1991). All three behaviors are considered adverse. For example, wildlife may cease foraging, mating, or nesting, or vacate active nest sites in areas where construction is occurring; some species may permanently abandon the disturbed areas and adjacent habitats. In contrast, wildlife such as bears, foxes, and squirrels readily habituate and may even be attracted to human activities, primarily when a food source is accidentally or deliberately made available. Human food wastes and other attractants in developed areas can increase the population of foxes, gulls, common ravens, and bears, which in turn prey on waterfowl and other birds.

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

The average mean flush distance for several raptor species in winter was 118 m (387 ft) due to walk disturbance and 75 m (246 ft) due to vehicle disturbance (Holmes et al. 1993). Bighorn sheep have been reported to respond at a distance of 500 m (1,640 ft) from roads with more than one vehicle per day, while deer and elk response occurs at a distance of 1,000 m (3,280 ft) or more (Gaines et al. 2003). Snowmobile traffic was found to affect the behavior of moose located within 300 m (984 ft) of a trail, and displaced them to less favorable habitats (Colescott and Gillingham 1998).

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

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

- Inherent species-specific characteristics,

- Seasonally changing threshold of sensitivity as a result of reproductive and nutritional status,

- Type of habitat (e.g., longer disturbance distances in open habitats),

- Specific experience of the individual or group,

- Weather (e.g., adverse weather such as wind or fog may decrease the disturbance),

- Time of day (e.g., animals are generally more tolerant during dawn and dusk), and

- Social structure of the animals (e.g., groups are generally more tolerant than solitary individuals) (BLM 2004b).

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

5.8.1.3.3 Noise. Much of the research on wildlife-related noise effects has focused on birds. This research has shown that noise may affect territory selection, territorial defense, dispersal, foraging success, fledging success, and song learning (e.g., Reijnen and Foppen 1994; Foppen and Reijnen 1994; Larkin 1996). Several studies have examined the effects of continuous noise on bird populations, including the effects of traffic noise, coronal discharge along electric transmission lines, and gas compressors. Some studies (e.g., Reijnen and Foppen 1994, 1995; Foppen and Reijnen 1994; Reijnen et al. 1995, 1996, 1997) have shown reduced densities of a number of species in forest (26 of 43 species) and grassland (7 of 12 species) habitats adjacent to roads, with effects detectable from 66 to 11,581 ft from the roads. On the basis of these studies, Reijnen et al. (1996) identified a threshold effect sound level of 47 dBA for all species combined and 42 dBA for the most sensitive species; the observed reductions in population density were attributed to a reduction in habitat quality caused by elevated noise levels. This threshold sound level of 42 to 47 dBA (which is somewhat below the EPA-recommended limit for residential areas) is at or below the sound levels generated by truck traffic that would likely occur at distances of 250 ft or more from the construction area or access roads, or the levels generated by typical construction equipment at distances of 2,500 ft or more from the construction site.

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

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

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

Direct mortality from vehicle collisions would be expected to occur along new access roads, while increases in collisions would occur along existing roads because of increased traffic volumes (e.g., associated with increased numbers of construction and operational personnel). Collision with vehicles can be a source of wildlife mortality, especially in wildlife concentration areas or travel corridors. When major roads cut across migration corridors, the effects can be dangerous for animals and humans. Between Kemmerer and Cokeville, Wyoming, hundreds of mule deer are killed during spring and fall migrations when they attempt to cross U.S. Highway 30 (Feeney et al. 2004). In unusual cases, mass casualties of wildlife occur from vehicular collision incidents, particularly in winter when animals may congregate near snow-free roads. In Wyoming, there have been several vehicular incidents in which 7 to 21 pronghorn were killed or injured per incident, and there was also an incident in which 41 pronghorn were killed by a train (Maffly 2007).

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

No electrocution of raptors would be expected when they are perching on the transmission line structures because the spacing between the conductors and between a conductor and ground wire or other grounding structure would exceed the wing span of the largest raptors in the study area (i.e., bald and golden eagles [*Haliaeetus leucocephalus* and

Aquila chrysaetos]). However, although a rare event, electrocution can occur to flocks of small birds that cross a line or when several roosting birds take off simultaneously because of current arcing. This occurrence is most likely in humid weather conditions (Bevanger 1998; BirdLife International 2003). Arcing can also occur by the excrement jet of large birds roosting on the crossarms above the insulators (BirdLife International 2003).

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

Any species of bird capable of flight can collide with power lines. Birds that migrate at night, fly in flocks, and/or are large and heavy with limited maneuverability are at particular risk (BirdLife International 2003). The potential for bird collisions with a transmission line depends on variables such as habitat, relation of the line to migratory flyways and feeding flight patterns, migratory and resident bird species, and structural characteristics of the line (Beaulaurier et al. 1984). Near wetlands, waterfowl, wading birds, shorebirds, and passerines are most vulnerable to colliding with transmission lines; in habitats away from wetlands, raptors and passerines are most susceptible (Faanes 1987). The highest concern for bird collisions is where lines span flight paths, including river valleys, wetland areas, lakes, areas between waterfowl feeding and roosting areas, and narrow corridors (e.g., passes that connect two valleys). A disturbance that leads to a panic flight can increase the risk of collision with transmission lines (BirdLife International 2003).

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

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

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

Some mortality resulting from bird collisions with transmission lines is considered unavoidable. However, anticipated mortality levels are not expected to result in long-term loss of population viability in any individual species or lead to a trend toward listing as a rare or endangered species, because mortality levels are anticipated to be low and spread over the life of the transmission lines. A variety of mitigation measures, such as those outlined in *Avian Protection Plan (APP) Guidelines* (APLIC and USFWS 2005) and *Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances* (Romin and Muck 2002), would minimize impacts on birds.

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

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

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

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

Most herbicides used on BLM-administered lands pose little or no risk to wildlife or wild horses and burros unless they are exposed to accidental spills, direct spray, herbicide drift, or by consuming herbicide-treated vegetation. The licensed use of herbicides would not be expected to adversely affect local wildlife populations. Applications of these materials would be conducted following label directions and in accordance with applicable permits and licenses. Thus, any adverse toxicological threat from herbicides to wildlife is unlikely. The response of wildlife to herbicide use is attributable to habitat changes resulting from treatment rather than direct toxic effects of the applied herbicide on wildlife. However, accidental spills or releases of these materials could affect exposed wildlife. Effects could include death, organ damage, growth decrease, and decrease in reproductive output and condition of offspring (BLM 2005).

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

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

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

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

5.8.1.3.6 Erosion and Runoff. As described in Section 5.8.1.1, it is assumed that the potential for soil erosion and the resulting sediment loading of nearby aquatic or wetland habitats would be proportional to the amount of surface disturbance, the condition of disturbed lands at any given time, and the proximity to aquatic habitats. It is also assumed that areas being actively disturbed during mining or construction activities would have higher erosion potential than areas that are undergoing reclamation activities, and that areas being restored would become progressively less prone to erosion over time because of completion of site grading and the reestablishment of vegetated cover. Erosion and runoff from freshly cleared and graded sites could reduce water quality in aquatic and wetland habitats that are used by amphibians, thus potentially affecting their reproduction, growth, and survival. Any impacts on amphibian populations would be localized to the surface waters receiving site runoff. Although the potential for runoff would be temporary, pending completion of construction activities and stabilization of disturbed areas with vegetative cover, erosion could result in significant impacts on local amphibian populations if an entire recruitment class is eliminated (e.g., complete recruitment failure for a given year because of siltation of eggs or mortality of aquatic larvae). Implementation of measures to control erosion and runoff into aquatic and wetland habitats would reduce the potential for impacts from increased turbidity and sedimentation. Assuming that reclamation activities are successful, restored areas should eventually become similar to natural areas in terms of erosion potential.

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

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

5.8.1.3.9 Fires. Increased human activity can increase the potential for fires. In general, the short-term and long-term effects of fire on wildlife are related to fire impacts on vegetation, which, in turn affect habitat quality and quantity, including the availability of forage shelter (Hedlund and Rickard 1981; Groves and Steenhof 1988; Knick and Dyer 1996; Schooley et al. 1996; Watts and Knick 1996; Sharpe and Van Horne 1998; Lyon et al. 2000b; USDA 2008a–c).

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

In the absence of long-term vegetation changes, rodents in grasslands usually show a decrease in density after a fire; they often recover, however, to achieve densities similar to or greater than preburn levels (Beck and Vogel 1972; Lyon et al. 2000b; USDA 2008d). Long-term changes in vegetation from a fire (such as loss of sagebrush or the invasion or increase of non-native annual grasses) may affect food availability and quality and habitat availability for wildlife; the changes could also increase the risk from predation for some species (Hedlund and Rickard 1981; Groves and Steenhof 1988; Schooley et al. 1996; Watts and Knick 1996; Knick and Dyer 1997; Lyon et al. 2000b; USDA 2008b,c).

Raptor populations generally are unaffected by, or respond favorably to, burned habitat (Lyon et al. 2000b). In the short term, fires may benefit raptors by reducing cover and exposing prey; raptors may also benefit if prey species increase in response to post-fire increases in forage (Lyon et al. 2000b; USDA 2008d). Direct mortality of raptors from fire is rare (Lehman and Allendorf 1989), although fire-related mortality of burrowing owls has been documented (USDA 2008d). Most adult birds can be expected to escape fire, while fire during nesting (prior to fledging) may kill young birds, especially of ground-nesting species (USDA 2008d). Fires in wooded areas, such as pinyon-juniper woodlands, could decrease populations of raptors and other birds that nest in those habitats.

5.8.1.4 Threatened, Endangered, and Sensitive Species

The evaluation in this PEIS presents the potential for tar sands development impacts on federally and state-listed threatened and endangered species, BLM-designated sensitive species, or species that are proposed or candidates for listing. The discussion of impacts in this section presents the types of impacts that could occur if mitigation measures are not developed to protect listed and sensitive species. Project-specific NEPA assessments, ESA consultations, and coordination with state natural resource agencies would be conducted prior to leasing or development and would address project-specific impacts more thoroughly. These assessments and consultations would result in required actions to avoid or mitigate impacts on protected species.

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

Impacts on threatened, endangered, and sensitive species are similar to those described for impacts on aquatic resources, plant communities and habitats, and wildlife in Sections 5.8.1.1, 5.8.1.2, and 5.8.1.3, respectively, but the potential consequences may be greater. Because of their small population sizes, threatened, endangered, and sensitive species are far more vulnerable to impacts than more common and widespread species. Small population size makes these species more vulnerable than common species to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the specific characteristics of project development.

The potential magnitude of the impacts that could result from tar sands development is presented for different species types in Table 5.8.1-4. Unlike some projects where there are discrete construction and operation phases with different associated impacts, tar sands development projects include facility construction and extraction activities that would have similar types of impacts throughout the life of the project. Project construction and extraction activities would occur over a period of several decades. Land reclamation activities that would

TABLE 5.8.1-4 Potential Impacts of Commercial Tar Sands Development on Threatened, Endangered, and Sensitive Species

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

[a] Potential impact magnitude (without mitigation) that might be expected from individual development projects is presented as none, small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of the local population (less than 10%), and does not result in a measurable change in carrying capacity or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of the local population (10 to 30%), and result in a measurable but moderate (not destabilizing) change in carrying capacity or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 30% of a local population, and result in a large, measurable, and destabilizing change in carrying capacity or population size in the affected area.

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

occur after extraction activities are complete would serve to reduce or eliminate ongoing impacts by restoring habitats and ecological conditions that could be suitable for threatened, endangered, and sensitive species. The effectiveness of any reclamation activities would depend on the specific actions taken, but the best results would occur if site topography, hydrology, soils, and vegetation patterns were reestablished.

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

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

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

For all potential impacts, the use of mitigation measures, possibly including predisturbance surveys to locate protected plant and animal populations in the area, erosion-control practices, dust suppression techniques, establishment of buffer areas around protected populations, and reclamation of disturbed areas using native species upon project completion, would greatly reduce or eliminate the potential for effects on protected species. The specifics of these practices should be established in project-specific consultations with the appropriate federal and state agencies. ESA Section 7 consultations between the BLM and the USFWS would be required for all projects prior to leasing and before leased areas could be developed, if ESA-listed species were present and would be affected by the lease.

Those consultations would identify conservation measures, allowable levels of incidental take, and other requirements to protect listed species. Conservation measures for oil shale and tar sands development have been recommended by the USFWS to avoid and minimize impacts of commercial oil shale and tar sands development on federally listed threatened and endangered species (Appendix F).

Tables 5.8.1-5 and 5.8.1-6 identify the federally and state-listed threatened, endangered, and sensitive species that could be affected by commercial tar sands development. The two tables consider separately the impacts on state-listed threatened and endangered species and species of special concern, federal candidates for listing, and BLM-designated sensitive species (Table 5.8.1-5), and on federally listed threatened, endangered, and proposed species (Table 5.8.1-6). In both tables, a determination is made regarding the "potential for negative impact." Potential for impact was determined on the basis of conservative estimates of species distributions. It is possible that impacts on some species would not occur because suitable habitat may not be present in project areas or impacts on those habitats could be avoided.

Federally listed species in study area counties that are not expected to be affected by development include the autumn buttercup, Barneby ridge-cress, Navajo sedge, and Utah prairie dog (Table 5.8.1-6). These species are not likely to be affected because known population distributions are clearly outside of the potential lease areas.

Listed plant species (including species that are being proposed for listing) that could occur in project areas and that could be affected by project activities include the Barneby reed-mustard, clay reed-mustard, Jones cycladenia, last chance townsendia, Maguire daisy, San Rafael cactus, shrubby reed-mustard, Uinta Basin hookless cactus, Ute ladies'-tresses, Winkler cactus, and Wright fishhook cactus. In addition to these listed plant species, the Graham's beardtongue – a species proposed for listing under the ESA – could be affected by project activities. All but the Ute ladies'-tresses are upland species that could be affected by a variety of impacting factors, including vegetation clearing, habitat fragmentation, dispersal blockage, alteration of topography, changes in drainage patterns, erosion, sedimentation from runoff, oil and contaminant spills, fugitive dust, injury or mortality of individual plants, human collection, increased human access, spread of invasive plant species, and air pollution (Table 5.8.1-4).

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

Tar sands development in any of the STSAs could affect federally listed endangered Colorado River fishes (bonytail, Colorado pikeminnow, humpback chub, and razorback sucker) either directly, if projects are adjacent to occupied habitats, or indirectly, if project activities are located within occupied watersheds (e.g., Green River and White River). Direct and indirect effects could result from vegetation clearing, alteration of topography and drainage patterns, erosion, sedimentation from runoff, oil and contaminant spills, water depletions, stream impoundment and changes in streamflow, and disruption of groundwater flow patterns. Any activities within watersheds that affect water quality (e.g., land disturbance or water volume changes that affect sediment load, contaminant concentrations, TDS concentrations, and temperature of streams) or quantity (e.g., stream impoundments or withdrawals that affect base flow, peak flow magnitude, and seasonal flow pattern) could have effects in occupied areas far downstream. The Upper Colorado River Endangered Fishes Recovery Implementation Program considers any water depletions from the upper Colorado River Basin, which includes the watersheds of the Green River and White River, an adverse effect on endangered Colorado River

TABLE 5.8.1-5 Potential Effects of Commercial Tar Sands Development on BLM-Designated Sensitive Species, Federal Candidates for Listing, State-Listed Species, and State Species of Concern

Scientific Name	Common Name	Status[a]	Counties within Study Areas in Which Species May Occur	Potential for Effect[b]
Plants				
Amsonia jonesii	Jones blue star	BLM-S	UT-Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Aquilegia scopulorum var. *goodrichii*	Utah columbine	BLM-S	UT-Carbon, Duchesne, Emery, Grand, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Arabis vivariensis	Park rockcress	BLM-S	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Astragalus detritalis	Debris milkvetch	BLM-S	UT-Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Astragalus duchesnensis	Duchesne milkvetch	BLM-S	UT-Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Astragalus equisolensis	Horseshoe milkvetch	BLM-S	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Astragalus hamiltonii	Hamilton's milkvetch	BLM-S	UT-Uintah	Potential for negative impact. Possible occurrence in upland habitats of Utah study areas.
Astragalus musiniensis	Ferron milkvetch	BLM-S	UT-Emery, Garfield, Grand, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Astragalus naturitensis	Naturita milkvetch	BLM-S	UT-San Juan	Potential for negative impact. Suitable habitat may occur in the study area.
Astragalus piscator	Fisher Towers milkvetch	BLM-S	UT-Garfield, Grand, San Juan, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Astragalus rafaelensis	San Rafael milkvetch	BLM-S	UT-Emery, Grand	Potential for negative impact. Suitable habitat may occur in the study area.

TABLE 5.8.1-5 (Cont.)

Scientific Name	Common Name	Status[a]	Counties within Study Areas in Which Species May Occur	Potential for Effect[b]
Plants (Cont.)				
Cirsium ownbeyi	Ownbey's thistle	BLM-S; WY-SC	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Cleomella palmeriana var. *goodrichii*	Goodrich cleomella	BLM-S	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Cryptantha barnebyi	Barneby's cat's-eye	BLM-S	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Cryptantha caespitosa	Caespitose cat's-eye	BLM-S	UT-Carbon, Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Cryptantha grahamii	Graham's cat's-eye	BLM-S	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Cryptantha osterhoutii	Osterhout cat's eye	BLM-S	UT-Emery, Garfield, Grand, San Juan, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Cryptantha rollinsii	Rollins' cat's eye	BLM-S; WY-SC	UT-Duchesne, San Raphael, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Cymopterus duchesnensis	Uinta Basin spring-parsley	BLM-S	UT-Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Eriogonum contortum	Grand buckwheat	BLM-S	UT-Grand	Potential for negative impact. Suitable habitat may occur in the study area.
Eriogonum ephedroides	Ephedra buckwheat	BLM-S	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Frasera ackermanae	Ackerman frasera	BLM-S	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.

TABLE 5.8.1-5 (Cont.)

Scientific Name	Common Name	Status[a]	Counties within Study Areas in Which Species May Occur	Potential for Effect[b]
Plants (Cont.)				
Gentianella tortuosa	Utah gentian	BLM-S	UT-Duchesne, Emery, Garfield, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Gilia stenothyrsa	Narrow-stem gilia	BLM-S	UT-Carbon, Duchesne, Emery, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Habenaria zothecina	Alcove bog-orchid	BLM-S	UT-Emery, Garfield, San Juan, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Hymenoxys lapidicola	Rock hymenoxyz	BLM-S	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Lepidium huberi	Huber's pepperplant	BLM-S	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Listera borealis	Northern twayblade	BLM-S	UT Duchesne, San Juan	No impact. Suitable habitat is not likely to occur in the study area.
Lygodesmia doloresensis	Dolores River skeletonplant	BLM-S	UT-Grand	Potential for negative impact. Suitable habitat may occur in the study area.
Mentzelia goodrichii	Goodrich's blazingstar	BLM-S	UT-Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Mimulus eastwoodiae	Eastwood monkey-flower	BLM-S	UT-Garfield, Grand, San Juan	Potential for negative impact. Suitable habitat may occur in the study area.
Minuartia nuttallii	Nuttall sandwort	BLM-S	UT-Duchesne	Potential for negative impact. Suitable habitat may occur in the study area.
Parthenium ligulatum	Ligulate feverfew	BLM-S	UT-Wayne	Potential for negative impact. Suitable habitat may occur in the study area.

TABLE 5.8.1-5 (Cont.)

Scientific Name	Common Name	Status[a]	Counties within Study Areas in Which Species May Occur	Potential for Effect[b]
Plants (Cont.)				
Pediomelum aromaticum	Paradox breadroot	BLM-S	UT-Grand, San Juan	Potential for negative impact. Suitable habitat may occur in the study area.
Penstemon scariosus var. albifluvis	White River beardtongue	ESA-C	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Perityle specuicola	Alcove rock-daisy	BLM-S	UT-Grand, San Juan	Potential for negative impact. Suitable habitat may occur in the study area.
Phacelia argylensis	Argyle Canyon phacelia	BLM-S	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Thelesperma pubescens	Uinta greenthread	BLM-S; WY-SC	UT-Duchesne	Potential for negative impact. Suitable habitat may occur in the study area.
Townsendia strigosa	Strigose Easter-daisy	BLM-S	UT-Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Yucca sterilis	Spanish bayonet	BLM-S	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Invertebrates				
Speyeria nokomis nokomis	Great Basin silverspot butterfly	BLM-S	UT-Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Fish				
Catostomus discobolus	Bluehead sucker	BLM-S; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Catostomus latipinnis	Flannelmouth sucker	BLM-S; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Catostomus platyrhynchus	Mountain sucker	BLM-S; CO-SC	CO-Garfield Rio Blanco; UT-Carbon, Duchesne, Emery, Grand, Uintah; WY-Sweetwater, Uinta	Potential for negative impact. Suitable habitat may occur in the study area.

TABLE 5.8.1-5 (Cont.)

Scientific Name	Common Name	Status[a]	Counties within Study Areas in Which Species May Occur	Potential for Effect[b]
Fish (Cont.)				
Gila robusta	Roundtail chub	BLM-S; CO-SC; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in or near the study area.
Oncorhynchus clarkii pleuriticus	Colorado River cutthroat trout	BLM-S; CO-SC; WY-SC	UT-Duchesne, Garfield, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in or near the study area.
Amphibians				
Bufo boreas	Boreal toad	BLM-S; CO-E; UT-SC; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Hyla arenicolor	Canyon treefrog	BLM-S	UT-Garfield, Grand, Wayne, San Juan	Potential for negative impact. Suitable habitat may occur in the study area.
Rana luteiventris	Columbia spotted frog	BLM-S; WY-SC	UT-Utah, Wasatch	No impact. Suitable habitat for the species does not occur in the study area.
Rana pipiens	Northern leopard frog	BLM-S; CO-SC; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Spea intermontana	Great basin spadefoot	BLM-S; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Reptiles				
Elaphe guttata	Corn snake	BLM-S; UT-SC	UT-Grand, San Juan	Potential for negative impact. Suitable habitat may occur in the study area.
Liochlorophis vernalis	Smooth greensnake	BLM-S; UT-SC	UT-Carbon, Duchesne, Grand, San Juan, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Xantusia vigilis	Desert night lizard	BLM-S; UT-SC	UT-Garfield, San Juan	Potential for negative impact. Suitable habitat may occur in the study area.

TABLE 5.8.1-5 (Cont.)

Scientific Name	Common Name	Status[a]	Counties within Study Areas in Which Species May Occur	Potential for Effect[b]
Birds				
Accipiter gentilis	Northern goshawk	BLM-S; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Ammodramus savannarum	Grasshopper sparrow	UT-SC	UT-Duchesne, Uintah, Utah, Wasatch	No impact. Suitable habitat for the species does not occur in the study area.
Asio flammeus	Short-eared owl	BLM-S; UT-SC	UT-Carbon, Duchesne, Emery, Grand, Garfield, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Athene cunicularia	Burrowing owl	BLM-S; CO-T; UT-SC; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Buteo regalis	Ferruginous hawk	BLM-S; CO-SC; UT-SC; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Centrocercus minimus	Gunnison sage-grouse	ESA-C; UT-SC	UT-Grand, San Juan	Potential for negative impact. Suitable habitat may occur in the study area.
Centrocercus urophasianus	Greater sage-grouse	ESA-C; BLM-S; CO-SC; UT-SC; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Charadrius montanus	Mountain plover	BLM-S; CO-SC; UT-SC; WY-SC	UT-Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Coccyzus americanus occidentalis	Western yellow-billed cuckoo	ESA-C; BLM-S; WY-SC	UT-Duchesne, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Cypseloides niger	Black swift	BLM-S; CO-SC; UT-SC	UT-Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.

TABLE 5.8.1-5 (Cont.)

Scientific Name	Common Name	Status[a]	Counties within Study Areas in Which Species May Occur	Potential for Effect[b]
Birds (Cont.)				
Dolichonyx oryzivorus	Bobolink	BLM-S; UT-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Haliaeetus leucocephalus	Bald eagle	BLM-S; CO-T; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Melanerpes lewis	Lewis's woodpecker	BLM-S; UT-SC; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Numenius americanus	Long-billed curlew	BLM-S; CO-SC; UT-SC; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Pelecanus erythrorhynchos	American white pelican	BLM-S; UT-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Picoides tridactylus	Three-toed woodpecker	BLM-S; UT-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Mammals				
Brachylagus idahoensis	Pygmy rabbit	BLM-S; UT-SC; WY-SC	UT-Garfield, Wayne	No impact. Suitable habitat for the species does not occur in the study area.
Corynorhinus townsendii pallescens	Townsend's big-eared bat	BLM-S; CO-SC; UT-SC; WY-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Cynomys gunnisoni	Gunnison's prairie dog	ESA-C; BLM-S; UT-SC	UT-Grand, San Juan	No impact. Suitable habitat for the species does not occur in the study area.

TABLE 5.8.1-5 (Cont.)

Scientific Name	Common Name	Status[a]	Counties within Study Areas in Which Species May Occur	Potential for Effect[b]
Mammals (Cont.)				
Cynomys leucurus	White-tailed prairie dog	BLM-S; UT-SC; WY-SC	UT-Carbon, Duchesne, Emery, Grand, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Euderma maculatum	Spotted bat	BLM-S; UT-SC; WY-SC	UT-Duchesne, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Idionycteris phyllotis	Allen's big-eared bat	BLM-S; UT-SC	UT-Garfield, Grand, San Juan, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Lasiurus blossevillii	Western red bat	BLM-S; UT-SC	UT-Carbon, Emery, Grand, Garfield, San Juan, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Myotis thysanodes	Fringed myotis	BLM-S; UT-SC; WY-SC	UT-Duchesne, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Nyctinomops macrotis	Big free-tailed bat	BLM-S; UT-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Vulpes macrotis	Kit fox	BLM-S; CO-E; UT-SC	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.

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

[b] Potential impacts based on general habitat preference and presence of habitat in the study area. Specific habitat preferences are presented in Appendix E.

TABLE 5.8.1-6 Potential Effects of Commercial Tar Sands Development on Federally Listed Threatened, Endangered, and Proposed Species

Scientific Name	Common Name	Status[a]	Counties within Study Areas in Which Species May Occur	Potential for Effect[b]
Plants				
Carex specuicola	Navajo sedge	ESA-T	UT-San Juan	No impact. Suitable habitat does not occur in the study area. Known distribution is outside of the potential lease areas.
Cycladenia humilis var. *jonesii*	Jones cycladenia	ESA-T	UT-Emery, Garfield, Grand, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Erigeron maguirei	Maguire daisy	ESA-T	UT-Emery, Garfield, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Lepidium barnebyanum	Barneby ridge-cress	ESA-E	UT-Duchesne	No impact. Suitable habitat does not occur in the study area. Known distribution is outside of the potential lease areas.
Pediocactus despainii	San Rafael cactus	ESA-E	UT-Emery, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Pediocactus winkleri	Winkler cactus	ESA-T	UT-Emery, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Penstemon grahamii	Graham's beardtongue	ESA-PT; BLM-S	UT-Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Phacelia argillacea	Clay phacelia	ESA-E	UT-Utah, Wasatch	Potential for negative impact. Suitable habitat may occur in the study area.
Schoenocrambe argillacea	Clay reed-mustard	ESA-T	UT-Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Schoenocrambe barnebyi	Barneby reed-mustard	ESA-E	UT-Emery, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Schoenocrambe suffrutescens	Shrubby reed-mustard	ESA-E	UT-Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.

TABLE 5.8.1-6 (Cont.)

Scientific Name	Common Name	Status[a]	Counties within Study Areas in Which Species May Occur	Potential for Effect[b]
***Plants* (*Cont.*)**				
Sclerocactus brevispinus	Pariette cactus	ESA-T	UT-Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Sclerocactus glaucus	Colorado hookless cactus	ESA-T	UT-Carbon, Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Sclerocactus wrightiae	Wright fishhook cactus	ESA-E	UT-Emery, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Sclerocactus wetlandicus	Uinta Basin hookless cactus	ESA-T	UT-Carbon, Duchesne, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.
Spiranthes diluvialis	Ute ladies'-tresses	ESA-T	UT-Duchesne, Garfield, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Townsendia aprica	Last chance townsendia	ESA-T	UT-Emery, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Fish				
Gila cypha	Humpback chub	ESA-E; CO-T	UT-Carbon, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in or near the study area. Designated critical habitat occurs downstream within 10 mi (16 km) of the study area.
Gila elegans	Bonytail	ESA-E	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in or near the study area. Designated critical habitat occurs downstream within 10 mi (16 km) of the study area.
Ptychocheilus lucius	Colorado pikeminnow	ESA-E; CO-T	UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in or near the study area. Designated critical habitat occurs downstream within 10 mi (16 km) of the study area.

TABLE 5.8.1-6 (Cont.)

Scientific Name	Common Name	Status[a]	Counties within Study Areas in Which Species May Occur	Potential for Effect[b]
Fish (Cont.)				
Xyrauchen texanus	Razorback sucker	ESA-E; CO-E	UT-Carbon, Emery Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in or near the study area. Designated critical habitat occurs downstream within 10 mi (16 km) of the study area.
Birds				
Empidonax traillii extimus	Southwestern willow flycatcher	ESA-E	UT-Carbon, Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area.
Gymnogyps californianus	California condor	ESA-E	UT-Grand	Potential for negative impact. Suitable habitat may occur in the study area.
Strix occidentalis lucida	Mexican spotted owl	ESA-T	UT-Emery, Garfield, Grand, San Juan, Uintah, Wayne	Potential for negative impact. Suitable habitat may occur in the study area. Designated critical habitat may occur in the study area.
Mammals				
Cynomys parvidens	Utah prairie dog	ESA-T	UT-Garfield, Wayne	No impact. Suitable habitat does not occur in the study area. Known distribution is outside of the potential lease areas.
Lynx canadensis	Canada lynx	ESA-T; CO-E; WY-SC	UT-Emery, Uintah	No impact. Suitable habitat for the species does not occur in the study area.
Mustela nigripes	Black-footed ferret	ESA-XN; CO-E	UT-Carbon, Duchesne, Emery, Grand, San Juan, Uintah	Potential for negative impact. Suitable habitat may occur in the study area.

[a] Status categories: BLM-S = listed by the BLM as sensitive; CO-E = listed as endangered by the state of Colorado; CO-T = listed as threatened by the state of Colorado; ESA-E = listed as endangered under the ESA; ESA-PT = proposed for listing as a threatened species under the ESA; ESA-T = listed as threatened under the ESA; ESA-XN = experimental, nonessential population; WY-SC = species of special concern in the state of Wyoming.

[b] Potential impacts based on general habitat preference and presence of habitat in the study area. Specific habitat preferences are presented in Appendix E.

fishes that requires consultation and mitigation. Water depletions for individual projects could be quite large and represent a significant adverse impact on these riverine fish.

On the basis of proximity of populations and critical habitat to potential lease areas, the greatest potential for direct impacts on endangered fishes is related to development in Utah, where the Green River and White River flow through tar sands areas. If these areas are available for leasing, there is a relatively high probability that these species would be directly or indirectly affected by tar sands development.

Federally listed bird species that could be affected by commercial tar sands development include the California condor, Mexican spotted owl, and southwestern willow flycatcher. The California condor occurs in mountainous areas at low to moderate elevations, especially rocky and brushy areas near cliffs, while the Mexican spotted owl could occur year-round in steep forested canyons in Utah. The two species could be affected if these types of habitats are disturbed during tar sands development. Impacts on individual condors and owls could result from injury or mortality (e.g., collisions with transmission lines), human disturbance or harassment, increased human access to occupied areas, increases in predation rates, and noise from facilities.

The southwestern willow flycatcher is most commonly found in riparian areas, especially along large rivers (e.g., Green River). These riparian habitats could be affected directly by surface disturbance or indirectly by activities in their watersheds that resulted in alteration of topography, changes in drainage patterns, erosion, sedimentation from runoff, and oil and contaminant spills. In addition, impacts on riparian habitats that support these species could result if the habitats were crossed by project transmission lines or roads. Impacts on individual birds could result from injury or mortality (e.g., collisions with transmission lines), human disturbance or harassment, increased human access to occupied areas, increases in predation rates, and noise from facilities.

In addition to the listed bird species mentioned above, the federal candidate greater sage-grouse is a bird species that has the potential to be affected by commercial tar sands development. With loss of sagebrush and grassland habitats resulting from project developments, greater sage-grouse broods could move longer distances and expend more energy to find forage. Increased movement, in addition to decreased vegetative cover, could expose chicks to greater risk of predation (BLM 2006c). More detailed information about how greater sage-grouse may be impacted by tar sands development, including information about possible measures to mitigate impacts, is provided in a text box in Section 4.8.1.4.

Federally listed mammals that could be affected by tar sands development include the black-footed ferret and Canada lynx. The black-footed ferret occurs in grasslands and shrublands that support active prairie dog towns and may potentially occur near many of the tar sands project areas. The Canada lynx occurs in coniferous forests and potentially occurs near the Asphalt Ridge STSA. Impacts on these species could result from impacts on habitat (including vegetation clearing, habitat fragmentation, and movement/dispersal blockage) and individuals (injury or mortality [e.g., collisions with vehicles]), human disturbance or harassment, increased human access to occupied areas, increases in predation rates, and noise from facilities.

5.8.2 Mitigation Measures

Various mitigation measures would be required to reduce the impact of tar sands development on ecological resources during construction, operations, and reclamation. Existing guidance, recommendations, and requirements related to management practices are described in detail in the BLM Gold Book (DOI and USDA 2007), and BLM field office RMPs. The BLM has also developed a guidance document, *Hydraulic Considerations for Pipeline Crossing Stream Channels*, for construction of pipeline crossings of perennial, intermittent, and ephemeral stream channels. This guidance can be found at http://www.blm.gov/nstc/library/techno2.htm. BLM Manual 6840, *Special Status Species Management*, describes BLM policy to protect species identified by the BLM as sensitive (BLM 2008). In addition, the BLM has developed a set of conservation measures in consultation with the USFWS intended to minimize impacts of tar sands development on threatened and endangered species (see Appendix F).

In addition to the actions described in these guidance documents, the mitigation actions below could be used to reduce the potential for impacts on various ecological resources. Other mitigation measures may be identified by the BLM or USFWS prior to project development. Developing effective mitigation measures that avoid, reduce, or eliminate the impacts of tar sands development on ecological resources will represent a significant challenge because of the potentially large-scale, long operational time period, and reclamation difficulties that will be characteristic of many tar sands projects.

5.8.2.1 Aquatic Resources

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

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

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

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

- Decontaminate all equipment before arrival at the project site and before leaving the project site, for work occurring near water, to reduce the potential for the transport of aquatic invasive species. Decontamination may consist of draining all water from equipment and compartments, cleaning equipment of all mud, plants, debris, or animals, and then drying the equipment. Another potential decontamination method could be a high-pressure, hot water wash of all equipment and all compartments that may hold water.

- Maintain historic flow regimes in these systems, or in systems that contribute to the support of native fisheries.

5.8.2.2 Plant Communities and Habitats

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

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

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

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

5.8.2.3 Wildlife (Including Wild Horses and Burros)

- Identify important, unique, or high-value wildlife habitats in the vicinity of the project and design the project to mitigate impacts on these habitats. For example, project facilities, access roads, and other ancillary facilities could be located in the least environmentally sensitive areas (i.e., away from riparian habitats, streams, wetlands, drainages, and crucial wildlife habitats). The lessee would consult with the BLM and state agencies to discuss important wildlife use areas in order to assist in the determination of facility design and location that would avoid or minimize impacts on wildlife species and their habitats to the fullest extent practicable. The lessee would, at a minimum, follow the *Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats* (WGFD 2010).

- Habitat enhancement or in-kind compensatory habitat are options available when developing a wildlife management plan for a project.

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

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

- Any surface water body created for a project may be utilized to the benefit of wildlife when practicable; however, netting and fencing may be required when water chemistry demonstrates a need to prevent use by wildlife.

- Mitigate wildlife mortality from vehicle collisions. To achieve this objective, important wildlife habitats could be mapped and activities within them avoided (if possible) or mitigated. Education programs could be implemented to ensure that employees are aware of wildlife impacts associated with vehicular use. These would include the need to obey state- and county-posted speed limits. Carpooling, busing, or other means to limit traffic (and vehicle collisions with wildlife) would be emphasized.

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

- Minimize habitat loss and fragmentation due to project development. For example, habitat fragmentation could be reduced by consolidating facilities (e.g., access roads and utilities would share common ROWs, where feasible), reducing access roads to the minimum number required, and, where possible, locating facilities in areas where habitat disturbance has already occurred. Transportation management planning can be used as an effective tool to minimize habitat fragmentation to meet this performance goal.

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

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

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

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

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

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

- Mitigate existing water sources used by wildlife or wild horses in the vicinity of the project if adversely impacted during project construction or operation.

- Protect or avoid important big game habitat (e.g., crucial winter habitat and birthing areas) to the extent practicable.

5.8.2.4 Threatened, Endangered, and Sensitive Species

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

- Protect federally listed and state-listed threatened and endangered species and BLM-designated sensitive species through siting and development decisions to avoid impacts. Conduct predisturbance surveys in all areas proposed for development following accepted protocols and in consultation with the USFWS and/or state agencies. If any federally listed species are found, and it is determined that the proposed development "may affect" the listed species or their critical habitat, the USFWS will be consulted as required by Section 7 of the ESA and an appropriate course of action developed to mitigate impacts and address any potential incidental take from the activity. If any state-listed or BLM-designated sensitive species are found, plans to mitigate impacts will be developed prior to construction consistent with guidance provided in BLM Manual 6840 (BLM 2008).

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

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

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

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

5.9 VISUAL RESOURCES

5.9.1 Common Impacts

While visual impacts associated with the construction, operation, and reclamation of tar sands projects considered in the PEIS differ in some important aspects on the basis of the tar sands extraction and processing technologies employed, there are many impacts that are common to the development approaches. Direct visual impacts associated with construction, operation, and reclamation of commercial tar sands development can be divided into generally temporary impacts associated with activities that occur during the construction and reclamation phases of the projects, and long-term impacts that result from construction and operation of the facilities themselves. Impacts are presented below by tar sands extraction and processing technology approach. In some cases, visual impacts would be very similar to those expected for commercial oil shale development (Section 4.9), and in the following discussion, the reader is referred to the PEIS sections discussing oil shale development impacts as appropriate.

As is the case for commercial oil shale production, regardless of the technologies employed for tar sands extraction and processing, commercial production of tar sands would entail industrial processes eventually requiring more than 5,000 acres of land disturbance and the presence and operation of major industrial facilities and equipment. These activities would introduce major visual changes to natural-appearing landscapes and create strong visual contrasts in line, form, color, and texture. Large visual impacts would be expected at night because of facility, vehicular, and activity lighting. While mitigation measures might lessen some visual impacts associated with these projects (Section 5.9.2), in large part the visual impacts associated with the commercial tar sands projects analyzed in the PEIS could not be effectively mitigated.

While some of the lesser elements of a tar sands project might be compatible with VRM Class III or Class II objectives (see Section 4.9), the siting of the major facility elements would be expected to be compatible with Class IV objectives only, as determined by visual contrast rating from nearby observation points with unobstructed views of the facility. VRM Class II or Class III areas near major facilities where open lines of sight existed between the Class II or Class III lands and the major facilities could in some cases also be subjected to strong visual contrasts, particularly if the distance was within the foreground-middleground range, but possibly farther in some cases.

5.9.1.1 Surface Mining with Surface Retorting

5.9.1.1.1 Construction and Reclamation. Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing surface mining and retorting would be very similar to those anticipated for commercial oil shale production utilizing surface mines and surface retorts. These impacts are described in Section 4.9.1.1.

It is assumed that there would be one connecting transmission line and ROW serving each site that could be up to 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide. It is assumed that there would be one pipeline and ROW serving each project site, up to 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (see Section 5.9.1.5 for a discussion of impacts associated with electric transmission line and pipeline construction).

5.9.1.1.2 Operation. Potential visual impacts associated with operation of commercial tar sands projects utilizing surface mining and retorting would be similar to those expected for commercial oil shale production utilizing surface mining and retorting (see Section 4.9.1.1). There would be some differences in the types of structures, buildings, and equipment used to extract and process the different materials; however, the general nature and extent of visual impacts would likely be similar. Rather than spent shale piles, tar sands projects would involve spent tar sands piles, which might be disposed of in pits and/or mounds. If stored in mounds, the form and line would likely be similar to spent shale piles, but the texture and color would likely be different, with spent tar sands being finer textured material and darker in color than spent shale. It is expected that up to 2,950 acres of land would be disturbed at a given time.

Figures 5.9.1-1 and 5.9.1-2 depict commercial surface mining activities for oil sands in Alberta, Canada. An oil sands processing facility is visible in the background in both figures. Figures 5.9.1-3 and 5.9.1-4 show closer views of an oil sands processing facility.

5.9.1.2 Surface Mining with Solvent Extraction

5.9.1.2.1 Construction and Reclamation. Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing surface mining and solvent extraction would be very similar to those anticipated for commercial oil shale production utilizing surface mines and surface retorts. These impacts are described in Section 4.9.1.1.

FIGURE 5.9.1-1 Large-Scale Commercial Oil Sands Surface Mining, North of Fort McMurray, Alberta, Canada (An oil sands processing plant is visible in the distant background.) (Image courtesy of Suncor Energy, Inc.)

It is assumed that there would be one connecting transmission line and ROW serving each site that could be up to 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide. It is assumed that there would be one pipeline and ROW serving each project site, up to 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (see Section 5.9.1.5 for a discussion of impacts associated with electric transmission line and pipeline construction).

FIGURE 5.9.1-2 Large-Scale Commercial Oil Sands Surface Mining Activity North of Fort McMurray, Alberta, Canada (The shovel bucket holds approximately 100 tons of oil sands ore. An oil sands processing plant is visible in the background.) (Image courtesy of Suncor Energy, Inc.)

5.9.1.2.2 Operation. Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing surface mining and solvent extraction would be similar to those expected for commercial oil shale production utilizing surface mining and retorting (see Section 4.9.1.1); however, there would be some differences in the types of structures, buildings, and equipment used to extract and process the different materials. Rather than retorts, buildings and structures for solvent extraction and related processes would be required. Spent tar sands, rather than spent oil shale, would be disposed of on the surface or in pits. It is expected that up to 2,950 acres of land would be disturbed at a given time. Figure 5.9.1-5 depicts an existing pilot-scale tar sands processing facility utilizing surface mining and solvent extraction on Asphalt Ridge near Vernal, Utah. The photo conveys a general sense of the appearance of the structures and layout for a tar sands processing facility. A

FIGURE 5.9.1-3 Portion of a Large-Scale Commercial Oil Sands Processing Plant near Fort McMurray, Alberta, Canada (Image courtesy of Suncor Energy, Inc.)

FIGURE 5.9.1-4 Close-up View of a Large-Scale Commercial Oil Sands Processing Plant near Fort McMurray, Alberta, Canada (Image courtesy of Suncor Energy, Inc.)

FIGURE 5.9.1-5 Photo Mosaic of Existing Pilot-Scale Tar Sands Processing Facility Utilizing Surface Mining and Solvent Extraction on Asphalt Ridge near Vernal, Utah

commercial-scale facility, however, such as that analyzed in the PEIS, would be many times larger.

5.9.1.3 In Situ Steam Injection

5.9.1.3.1 Construction and Reclamation. Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing in situ steam injection would be very similar to those anticipated for commercial oil shale production utilizing in situ methods. These impacts are described in Section 4.9.1.3.

It is assumed that there would be one connecting transmission line and ROW serving each site that could be up to 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide. It is assumed that there would be one pipeline and ROW serving each project site, up to 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (see Section 5.9.1.5 for a discussion of impacts associated with electric transmission line and pipeline construction).

5.9.1.3.2 Operation. Potential visual impacts associated with operation of commercial tar sands projects utilizing in situ steam injection would be similar to those expected for commercial oil shale production utilizing in situ methods (see Section 4.9.1.3); however, there would be some differences in the types of structures, buildings, and equipment used to extract and process the different materials. Rather than retorts, steam-assisted gravity drainage of tar sands would be used. This technology requires large pieces of equipment to create steam and to recover, treat, and recycle condensate (cooling towers, holding ponds, treatment tanks, etc.). Buildings and structures associated with power generation and the transport of heat and cooling fluids, as well as numerous wells, well pads, and associated structures and equipment, would be present. The overall visual impacts, however, would be lower than those for projects utilizing mining and aboveground processing of tar sands. It is expected that 80 to 200 acres of land would be disturbed at a given time. Development would proceed utilizing a "rolling footprint" approach.

Figure 5.9.1-6 shows an in situ steam injection facility for oil sands extraction in Alberta, Canada.

5.9.1.4 In Situ Combustion

5.9.1.4.1 Construction and Reclamation. Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing in situ combustion would be very similar to those anticipated for commercial oil shale production utilizing in situ methods (see Section 4.9.1.3). However, because there is no need for coolant and associated power generation and transport, there would be fewer aboveground structures, and, therefore, less construction and reclamation activity and associated visual impacts.

FIGURE 5.9.1-6 In Situ Steam-Assisted Gravity Drainage (SAGD) Facility near Fort McMurray, Alberta, Canada (SAGD technology uses underground wells to inject steam into the oil sands deposits and collect the bitumen released by the heat.) (Image courtesy of Suncor Energy, Inc.)

It is assumed that there would be one connecting transmission line and ROW serving each site that could be up to 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide. It is assumed that there would be one pipeline and ROW serving each project site, up to 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (see Section 5.9.1.5 for a discussion of impacts associated with electric transmission line and pipeline construction).

5.9.1.4.2 Operation. Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing in situ combustion would be similar to those expected for commercial oil shale production utilizing in situ methods (see Section 4.9.1.3); however, there would be some differences in the types of structures, buildings, and equipment used to extract and process the different materials. Rather than retorts, combustion of tar sands would require equipment to inject oxygen, but there would likely be fewer aboveground structures than would be required for in situ steam injection. While wells, well pads, and associated structures and equipment would be present, the overall visual impacts would likely be much lower than those for projects utilizing mining and aboveground processing of tar sands, and would likely be slightly lower than those for tar sands projects utilizing in situ steam injection. It is expected that 80 to 200 acres of land would be disturbed at a given time. Development would proceed utilizing a rolling footprint approach.

5.9.1.5 Other Associated Tar Sands Project Facilities

While many visual impacts expected from commercial tar sands development projects under consideration in the PEIS would be site- or technology-specific, the tar sands projects have some common elements that would be expected to create similar visual impacts regardless of location or the tar sands extraction or processing technologies employed. These elements include transmission lines and pipelines and employer-provided housing. The elements and related visual impacts are discussed here separately from impacts associated with specific tar sands extraction and processing technologies.

5.9.1.5.1 Electric Transmission Lines and Pipelines. Construction and operation of electric transmission lines and oil pipelines could be required for tar sands commercial development; the projected linear extent of the facilities, however, varies by project type and technology employed. Visual impacts associated with construction, operation, and reclamation of the electric transmission lines and pipeline facilities would be the same as those described for oil shale development projects discussed in Section 4.9.1.4. For a given tar sands project, up to 140 mi of transmission line and ROW might be required, and up to 95 mi of pipeline and ROW might be required.

5.9.1.5.2 Employer-Provided Housing. Employer-provided housing would be constructed for use by employees during the construction phase for tar sands projects. The locations of housing are unknown, but are not likely to be on public lands. Visual impacts associated with construction, operation, and reclamation of employer-provided housing are discussed in Section 4.9.1.4; however, for tar sands projects, an estimated 49 acres of land would be required for employer-provided housing during the construction phase for each project, and an estimated 13 acres of land would be required for employer-provided housing during the operations phase for each project.

5.9.2 Mitigation Measures

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

- Siting projects outside of the viewsheds of KOPs, or if this cannot be avoided, as far away as possible.

- Siting projects to take advantage of both topography and vegetation as screening devices to restrict views of projects from visually sensitive areas.

- Siting facilities away from and not adjacent to prominent landscape features (e.g., knobs and waterfalls).

- Avoiding placement of facilities on ridgelines, summits, or other locations such that they will be silhouetted against the sky from important viewing locations.

- Co-locating facilities to the extent possible, to utilize existing and shared ROWs, existing and shared access and maintenance roads, and other infrastructure, in order to reduce visual impacts associated with new construction.

- Siting linear facilities so that generally they do not bisect ridge tops or run down the center of valley bottoms.

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

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

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

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

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

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

- Minimizing the number of structures required.

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

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

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

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

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

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

- Preparing a lighting plan that documents how lighting will be designed and installed to minimize night-sky impacts during facility construction and operations phases. Lighting for facilities should not exceed the minimum number of lights and brightness required for safety and security, and should not cause excessive reflected glare. Low-pressure sodium light sources should be utilized where feasible to reduce light pollution. Full cut-off luminaires should be utilized to minimize uplighting. Lights should be directed downward or toward the area to be illuminated. Light fixtures should not spill light beyond the project boundary. Lights in high illumination areas not occupied on a continuous basis should have switches, timer switches, or motion detectors so that the lights operate only when the area is occupied. Where feasible, vehicle-mounted lights should be used for night maintenance activities. Wherever feasible, consistent with safety and security, lighting should be kept off when not in use.

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

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

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

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

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

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

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

- Avoiding downslope wasting of excess fill material.

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

- Leaving planting pockets on slopes where feasible.

- Providing benches in rock cuts to accent natural strata.

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

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

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

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

- Burying utility cables where feasible.

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

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

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

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

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

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

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

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

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

- Removing or burying gravel and other surface treatments.

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

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

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

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

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

5.10 CULTURAL RESOURCES

5.10.1 Common Impacts

Cultural resources, listed or eligible for listing on the NRHP, could be affected by future commercial tar sands leasing and development. The potential for impacts on cultural resources from commercial tar sands development, including ancillary facilities such as access roads, transmission lines, pipelines, and employer-provided housing, is directly related to the amount of land disturbance and the location of the project. Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces and from increased accessibility to possible site locations, are also considered. Leasing itself has the potential to impact cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development on cultural properties. However, compliance with Section 106 of the NHPA and with all other pertinent laws, regulations, and policies will likely result in the addition of stipulations to leases to avoid, minimize, or mitigate adverse impacts on historic properties present within a lease area or, when warranted, denial of the lease.

Several impacts on cultural resources could occur, as described below.

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

- *Site degradation and/or destruction* could result from the alteration of topography; alteration of hydrologic patterns; removal of soils; erosion of soils; runoff into and sedimentation of adjacent areas; and oil or other contaminant spills if sites are located near the project area. Such degradation could occur both within the project footprint and in areas downslope or downstream. While the erosion of soils could negatively impact sites downstream of the project area by potentially eroding materials and portions of sites, the accumulation of sediment could serve to protect some sites by increasing the amount of protective cover. Contaminants could affect the ability to conduct analyses of the material present at the site and thus the ability to interpret site components.

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

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

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

5.10.2 Mitigation Measures

For all potential impacts, the application of mitigation measures developed in consultation under Section 106 of the NHPA will avoid, reduce, or mitigate the potential for adverse impacts on significant cultural resources. Section 106 consultations between the BLM and the SHPOs, appropriate tribes, and other consulting parties would be required at the lease stage and at the plan of development stage. The use of BMPs, such as training and education programs, could reduce occurrences of human-related disturbances to nearby cultural sites. The specifics of these BMPs would be established during the leasing and project development stages in consultations between the applicant, the BLM, the SHPO, and tribes, as appropriate. The addition of stipulations to specific leases would ensure that resulting decisions from project-specific consultations are applied to the resources present in the lease areas.

An ethnohistory and cultural resources overview were completed for the study area (Bengston 2007 and O'Rourke et al. 2007, respectively). The overviews synthesized existing information on cultural resources that had been previously identified. In addition, tribal consultation was initiated to further identify significant cultural resources. This analysis did not identify geographical areas that would preclude moving areas forward for leasing. Prior to any lease issuance, or development project approval, the overviews and ongoing tribal consultation will be reviewed for any pertinent information to determine areas of sensitivity and appropriate survey and mitigation needs.

The BLM has initiated the Section 106 process pursuant to Subpart B of the Advisory Council on Historic Preservation (ACHP) regulations at 36 CFR Part 800, and is reviewing existing information regarding historic properties in the area of potential effects for this proposed amendment of land use plans. The BLM is engaging in consultation with the SHPOs, tribes, and other consulting parties. As appropriate to the level of analysis necessary for this PEIS, the BLM identified historic properties and evaluated potential impacts under Section 106 of the NHPA for this proposed undertaking, in part through consultation with the consulting parties. On the basis of this information, the BLM will make a determination about potential effects on historic properties at the programmatic level.

As discussed in Section 1.1.1, potential oil shale development would require a three-stage decisionmaking process including this proposed amendment of land use plans. Tar sands leasing may require additional consultation and information gathering (e.g., cultural resource inventories) prior to the lease sale. In addition, the lessee must submit a plan of development for any site-specific project that would require BLM approval. Additional site-specific NEPA analyses and Section 106 review will be conducted on these individual project plans of development. The BLM will complete comprehensive identification (e.g., field inventory), evaluation, protection, and mitigation following the pertinent laws, regulations, and policies. In addition, the BLM will continue to implement government-to-government consultation with tribes and with other consulting parties on a case-by-case basis for plans of development.

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

In some instances, additional special stipulations to the leases may be required for protection of specific cultural resources based on the Section 106 and other related reviews and consultations conducted during the leasing phase, in order to avoid, minimize, or mitigate adverse impacts on such resources.

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

5.11 INDIAN TRIBAL CONCERNS

Resources important to Native Americans could be affected by commercial tar sands leasing and development in and around the areas where development takes place.

5.11.1 Common Impacts

Native American concerns include traditional cultural properties, burial remains, sacred sites or landscapes, culturally important wild plants and animals, ecological balance and environmental protection, water quality and use, human health and safety, economic development and employment, and access to energy resources. Other Native American concerns could include the potential effect on Indian trust assets to the extent such assets are present. Native Americans may view these resources as interconnected, such that effects on one resource affect all. The potential for impacts on resources of significance to Native Americans from tar sands leasing and development, including ancillary facilities such as access roads and transmission lines, is directly related to the amount of land disturbance and the location of the project. Indirect effects—for example, impacts on water quality and use, the ecosystem in general, and the cultural landscape resulting from the erosion of disturbed land surfaces—are also possible.

Impacts on Native American resources could result in several ways, as described below:

- *Complete destruction of an important location or resource* could result from the clearing, grading, and excavation of the project area and from construction of facilities and associated infrastructure if archaeological sites, sacred sites, burials, traditional cultural properties, specific habitat for culturally important plants and wildlife species, or the like are located within the construction footprint of the project.

- *Degradation and/or destruction of an important resource* could result from the alteration of topography, alteration of hydrologic patterns, removal of soils, erosion of soils, runoff into and sedimentation of adjacent areas, and oil or other contaminant spills, if important sites or habitats are located in or near the project area. Such degradation could occur both within the lease parcel and in areas downslope or downstream. While the erosion of soils could negatively affect areas downstream of the project area by potentially eroding materials and portions of sites, the accumulation of sediment could serve to protect some archaeological sites by increasing the amount of protective cover.

- *Increases in human access* and subsequent disturbance (e.g., looting, vandalism, and trampling) of resources of significance to Native Americans could result from the establishment of roads or facilities in otherwise undisturbed and inaccessible areas. Increased human access (including OHV use) exposes plants, animals, archaeological sites, historic features, and other culturally significant natural features to greater probability of impact from a variety of stressors.

- *Visual degradation of settings* associated with significant cultural resources and sacred landscapes could result from the presence of a commercial tar sands development and associated land disturbances. This could affect important resources for which visual integrity is a component of the sites' significance to the tribes, such as sacred sites, landscapes, and trails.

- *Noise degradation of settings* associated with significant cultural resources and sacred landscapes could also result from the presence of tar sands extraction and processing facilities. This could affect the pristine nature and peacefulness of a culturally significant location.

The difference in surface disturbance is one technology-specific factor that could have a possible impact on resources of concern to Native Americans. However, because all potential impacts on tribally sensitive resources would be determined by site-specific conditions, differences in surface disturbance would not necessarily directly correspond to differences in impacts on these resources at the programmatic level. The magnitude or level of impact would depend on whether the specific location of a proposed tar sands facility contains significant resources, or degrades an important viewshed regardless of the overall size of the facility. Differences in water requirements of various technologies also could be a factor because water use, quality, and availability are important issues of Native American concern.

5.11.2 Mitigation Measures

Government-to-government consultation between the BLM and the directly and substantially affected tribes is required under E.O. 13175 (U.S. President 2000). In addition, Section 106 of the NHPA requires federal agencies to consult with Indian tribes for undertakings on tribal lands and for historic properties of significance to the tribes that may be affected by an undertaking (CFR 36 800.2 (c)(2)). BLM Manual H-8160-1 provides guidance for government-to-government consultations (BLM 1994). For impacts on resources of interest to Indian tribes and their members, such as traditional cultural properties, that constitute historic properties under the NHPA, the application of mitigation measures developed in consultation under Section 106 of the NHPA would avoid, reduce, or mitigate the potential for adverse effects. The use of management practices, such as training/education programs for workers and the public, could reduce occurrences of human-related disturbances to nearby resources of importance to tribes. The details of these management practices would be established in project-specific consultations among the applicant and the BLM, tribes, and SHPOs, as appropriate. The addition of special stipulations to specific leases would ensure that resulting decisions from project-specific consultations are applied to the resources present in the lease areas.

For those resources not considered historic properties under the NHPA, ongoing government-to-government consultation would help determine other issues of concern, including but not limited to access rights, disruption of cultural practices, impacts on visual resources important to the tribes, and impacts on subsistence resources. Ecological issues and potential mitigation measures are discussed in Section 5.8. Impacts on water use and quality and potential mitigation measures are discussed in Section 5.5. It should be noted that even when consultation and an extensive inventory or data collection occur, not all impacts on tribally sensitive resources can be fully mitigated.

Some specific mitigation measures are listed below (all mitigation measures listed in Section 5.10.2 for cultural resources would also apply to historic properties of concern to Indian tribes and their members):

- *The BLM will consult with Indian tribal governments* early in the planning process to identify issues and areas of concern for any proposed tar sands project. Such consultation is required by the NHPA and other authorities and is necessary to determine whether construction and operation of the project are likely to disturb tribally sensitive resources, impede access to culturally important locations, disrupt traditional cultural practices, affect movements of animals important to tribes, or visually affect culturally important landscapes. It may be possible to agree upon a mutually acceptable means of minimizing adverse effects on resources important to tribes.

- *Visual intrusion on sacred areas should be avoided to the extent practical* through the selection of location and extraction technology. When avoidance is not possible, timely and meaningful consultation with the affected tribe(s) should be conducted to formulate a mutually acceptable plan to mitigate or reduce the adverse effect.

- *Rock art (panels of petroglyphs and/or pictographs) should be avoided whenever possible*. These panels may be just one component of a larger sacred landscape, in which avoidance of all impacts may not be possible. Mitigation plans for eliminating or reducing (minimizing) potential impacts on rock art should be formulated in consultation with the appropriate tribal cultural authorities and the SHPO.

- *Tribal burial sites should be avoided. A contingency plan to follow when encountering* unanticipated burials and funerary goods during construction, maintenance, or operation of a tar sands facility should be developed in consultation with the appropriate tribal governments and cultural authorities well in advance of any ground-disturbing activities. The contingency plan should include consultation with the lineal descendants or tribal affiliates of the deceased. Human remains and objects of cultural patrimony should be protected and repatriated according to NAGPRA statutory procedures and regulations.

- *Springs and other water sources that are or may be sacred or culturally important should be avoided whenever possible*. If construction, maintenance, or operational activities must occur in proximity to springs or other water sources, appropriate measures, such as the use of geotextiles or silt fencing, should be taken to prevent silt from degrading water sources. The effectiveness of these mitigating barriers should be monitored. Measures for preventing water depletion impacts on spring flows should also be employed. Particular mitigations should be determined in consultation with the appropriate Indian tribe(s).

- *Culturally important plant and animal species should be avoided when possible*. Facilities should be designed to minimize impacts on game trails, migration routes, and nesting and breeding areas of tribally important species. Mitigation and monitoring procedures should be developed in consultation with the affected tribe(s). When it is not possible to avoid important plant resources, consultations should be undertaken with the affected tribe(s). If the species is available elsewhere on BLM-managed lands, guaranteeing access may be acceptable to the tribes. For rare or less common species, establishing (transplanting) an equal amount of the plant resource elsewhere on BLM-managed land accessible to the affected tribe may be acceptable.

Government-to-government consultation has been initiated to identify further significant resources. This phase of analysis is ongoing but has yet to identify geographical areas that would preclude allocating these lands as available for lease application. During the leasing phase, tribal consultation will be continued to help determine areas of tribal concern and appropriate means to avoid, minimize, or mitigate impacts on areas of tribal concern and may attach stipulations to any lease to ensure these measures. Tar sands leasing may require additional consultation and information gathering (e.g., cultural resource inventories or site visits by tribal cultural authorities) prior to the lease sale. The BLM will continue to implement government-to-government consultation with tribes and with other consulting parties on a case-by-case basis for plans of development.

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

5.12 SOCIOECONOMICS

The analysis of the socioeconomic impacts of tar sands development in Utah consists of two interdependent parts. The analysis of economic impacts estimates the impacts of tar sands facilities and associated housing on employment and personal income in an ROI in which tar sands resources are located. Because of the relative economic importance of tar sands developments in small rural economies and the consequent lack of local economic and community infrastructure, large-scale tar sands developments are likely to mean a large influx of temporary population. Because population increases are likely to be rapid, local communities may be unable to quickly absorb new residents, resulting in impacts on local finances and public service infrastructure. Social and psychological disruption may also occur, together with the undermining of established community social structures. Given these considerations, the analysis of social impacts assesses the potential impacts of tar sands developments on housing, local government, finances, and employment in the ROI in each of the three states. The analysis also assesses the potential for social disruption that may be associated with rapid population growth in small rural communities hosting large resource development projects.

The assessment of the socioeconomic impact of tar sands development was undertaken on the basis of a number of key assumptions relating to tar sands local procurement, worker in-migration, housing requirements and housing construction, and annual impacts. These assumptions are the same as those used in the analysis of the impact of oil shale development and are outlined in Section 4.11. Methods used in the analysis of the economic and social impacts of tar sands developments are briefly described in the introduction to Section 4.11. Details of this methodology are presented in Appendix G. Underlying employment numbers are also presented in Appendix G.

5.12.1 Common Impacts

5.12.1.1 Economic Impacts

Construction and operation of tar sands facilities and the associated temporary employer-provided housing and housing provided by local communities in Utah for tar sands workers and family members would have relatively large impacts on the economy of the ROI.

A single tar sands facility would produce 1,831 jobs in the ROI (1,187 direct jobs at tar sands facilities and 644 indirect jobs in the remainder of the local economy) during the peak construction year, and $91.3 million in income in the ROI (Table 5.12.1-1). During commercial production, 747 employees (482 direct and 265 indirect) would be required in the ROI, producing $36.8 million in income. Construction employment for a tar sands development facility would represent an increase of 4.1% over the projected ROI employment baseline.

Temporary housing built for tar sands workers and families would create 552 jobs (432 direct and 119 indirect in the remainder of the local economy) and $9.9 million in income in the ROI (Table 5.12.1-1).

It is assumed that no new power plants or coal mines would be needed to facilitate development of tar sands resources in Utah.

5.12.1.2 Social Impacts

Construction and operation of tar sands facilities would have a large impact on population in the Utah ROI. The influx of tar sands workers and family members into local communities would have a relatively large impact on the housing market. The new residential population associated with the construction and operation of tar sands facilities would also require the hiring of additional local public service employees (police officers, fire personnel, local government employees, and teachers) in each ROI. Increases in ROI public service employment would also require increases in local revenues and expenditures to provide the necessary additional local public service provision.

In the peak year of construction of tar sands developments, 1,000 new residents are expected in ROI communities (Table 5.12.1-2). With commercial operation of tar sands development, 671 workers and family members would move into the local communities in the ROI. Population in-migration associated with tar sands construction would represent an increase of 1.0% over the projected ROI population baseline. During the peak year of construction, 289 housing units, or 3.2% of the projected vacant housing stock in the ROI, would be required (Table 5.12.1-2).

Construction of tar sands developments would require 25 new local government employees, with 17 required during operations (Table 5.12.1-3). The additional local public service provision would require an increase in 1.0% in local expenditures during the peak construction year, and 0.7% during operations.

Higher local government expenditures would mean the potential for better quality local public services and infrastructure in some communities. In addition to providing employment and higher wages for some occupational groups, oil companies may also provide funds to upgrade portions of the road system in each ROI, and fund school scholarships and vocational training in some communities. Financing needed to support increases in local public expenditures that would be required to facilitate expansion in local public services, education, and local infrastructure impacted by tar sands and associated facilities might come from a

TABLE 5.12.1-1 ROI Economic Impacts of Tar Sands Development[a]

	Housing Construction		Tar Sands Development: Construction		Tar Sands Development: Operation	
	Employment	Income	Employment	Income	Employment	Income
Utah						
No specified technology						
Direct	432	7.3	1,187	78.3	482	31.8
Indirect	119	2.6	644	13.0	265	5.0
Total	552	9.9	1,831	91.3	747	36.8

[a] The direct employment data presented in this table are based on data provided in BLM (1984) and are extrapolated from data presented for construction and operation of a surface mine with a capacity of 190,000 bbl/day, and an in situ facility with a capacity of 175,000 bbl/day. Direct employment numbers and multiplier data from the IMPLAN model (Minnesota IMPLAN Group, Inc. 2007) were used to calculate total employment numbers; indirect employment numbers were then derived.

TABLE 5.12.1-2 ROI Demographic and Housing Impacts of Tar Sands Development

	Tar Sands Development In-Migration in Local Communities		Housing Demand in Local Communities	
	Construction	Operation	Number of Units	Vacant (%)
Utah				
No specified technology	1,000	671	289	3.2

TABLE 5.12.1-3 ROI Community Impacts of Tar Sands Development

	Government Employees		Change in Local Government Expenditures (%)	
	Construction	Operation	Construction	Operation
Utah				
No specified technology	25	17	1.0	0.7

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

With a relatively large in-migrant population expected in the Utah ROI during the construction and operation of tar sands facilities and the associated temporary housing, there is the potential for social disruption in communities in the ROI. The type and scope of impacts on social disruption are expected to be similar to those for oil shale development. Section 4.11.1.3 examines the experience of small rural communities in the Western states that would have rapid boomtown development associated with energy projects.

5.12.1.3 Agricultural Impacts

Since it is possible that tar sands technologies will require large quantities of water, water transfers from other industries may be required in each ROI. To facilitate new oil and gas development, historic water rights have often been purchased from agricultural landowners, primarily ranchers (see Section 3.10.2.2). Although the transfer of water rights to energy companies has not always meant that agricultural land is lost, the loss of water rights has often meant usually that irrigated agriculture is no longer possible and has led to the conversion of land to dryland farming and ranching activities. At higher levels of tar sands development, it is possible that water may be transferred into the ROI from other areas, which may limit the impact of reduced access by agriculture to water resources in some areas of the ROI. With restrictions on water use for irrigation, some agricultural land may consequently be sold and developed for second homes, condominiums, and other real estate types, which may create quality of life impacts in some farming communities (see Section 3.10.2.2.1). Water availability on agricultural land and land sales might also fragment wildlife habitat and affect the behavior of migratory big game species, such as elk and mule deer, which form an important basis for recreational activities in many parts of each ROI.

The impacts of substantial conversion of agricultural water rights could have large impacts on the economy of the ROI, the extent to which would depend on the amount of agricultural production lost, the extent of local employment in agriculture (see Section 3.10.2.1.2), the reliance of other industries in the ROI on agricultural production, the extent of local procurement of equipment and supplies by agriculture, and the local impact of spending of wages and salaries by farmers, ranchers, and farmworkers. In addition to income from agricultural activities, agricultural income comes from "agri-tourism," including hunting and fishing; hiking and other farm and ranch-related experiences may also be affected by losses of agricultural land or changes in agricultural land use. Tar sands and ancillary facility development may fragment or destroy wildlife habitat and affect the behavior of migratory big game species, such as elk and mule deer, which form an important basis for recreational activities in many parts of each ROI. Loss of revenues from recreation activities may also affect wildlife and habitat agency management practices. The impact of losses in employment and income from a reduction in agriculture in the economy of the ROI likely would be more than offset in some parts of each ROI by increases in revenues coming from tar sands development; however, the impact would likely change the character of community life in the ROI. Changes in economic activity such as these would also likely produce social impacts associated with the loss of traditional quality of life and the adoption of a more urban lifestyle.

5.12.1.4 Recreation Impacts

Estimating the impact of tar sands development on recreation is problematic, since it is not clear how activities in the ROI would affect recreational visitation (use values) and passive use values (the value of recreational resources for potential or future visits). While it is clear that some federal land in the ROI would no longer be accessible for recreation, the majority of popular wilderness locations would be precluded from tar sands development. It is also possible that tar sands developments and associated transmission lines and transportation infrastructure elsewhere in the ROI would be visible from popular recreation locations (see Section 5.9), thereby reducing visitation and consequently impacting the economy of the ROI.

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

In the Utah ROI, total (direct plus indirect) impacts of tar sands development on recreation would be the loss of 388 jobs and $3.2 million in income in the ROI as a whole as a result of a 10% reduction in recreation employment, and 776 jobs lost and $6.3 million in income lost with the 20% reduction (Table 5.12.1-4).

5.12.1.5 Property Value Impacts

There is concern that tar sands developments and their associated transmission lines and coal mines might affect property values in ROI communities located nearby. Property values might decline in some locations as a result of the deterioration in aesthetic quality, increases in

TABLE 5.12.1-4 Total ROI[a] Impacts of Reductions in Recreation Sector[b] Employment Resulting from Tar Sands Development (Actual Reduction is Unknown)

	10% Reduction		20% Reduction	
ROI	Employment	Income ($ million)	Employment	Income ($ million)
Utah	388	3.2	776	6.3

[a] The Utah ROI includes Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, and Wayne Counties.

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

noise, real or perceived health effects, congestion, or social disruption. In other locations, property values might increase because of access to employment opportunities associated with tar sands developments. The potential impacts of energy developments on property values are discussed in Section 4.11.1.6.

5.12.1.6 Transportation Impacts

Tar sands project development that could occur would lead to increases in traffic on any roads needed for access to project sites. In areas undergoing simultaneous oil and gas or other development at the same time, tar sands–related development would add to traffic volumes and maintenance needs. The amount of additional heavy vehicles associated with tar sands development is not large compared with the number of light vehicles transporting employees; however, such vehicles would add to the congestion and may require special consideration when designing or upgrading access roads and highways.

Providing adequate access roads to development sites may involve upgrading existing roads and road facilities or constructing completely new roads and facilities. Specifications for the access roads would be dictated by the expected volume and type of traffic. Significant increases in traffic loads would cause increased costs for maintenance and repair of roads and bridge structures.

Because some of the construction and processing equipment components are large, ROW clearances and minimum turning radii become critical parameters for road design. Typically, access roads would be a minimum of 10 ft (3 m) wide, but they may need to be as much as 30 ft (9 m) wide or more to accommodate continuous access needs. Depending on design requirements and local geology and soil characteristics, surface soils may need to be excavated, and road material may need to be imported to establish an adequate road base.

The majority of transportation-related environmental impacts would occur while creating access to development sites from existing public roads; existing public or private roadways may also need to be altered, however, to accommodate heavy and/or oversized transport vehicles or additional traffic volumes. It is reasonable to expect that special road transportation permits would be required for some vehicles. Excessive load weight may require fortification of existing bridges, and large loads may require the temporary removal of height or turning radius obstacles.

5.12.2 Mitigation Measures

Mitigation measures to reduce socioeconomic impacts will be required and could include the BLM working with state and local agencies to identify potential socioeconomic impacts and develop mitigations. In doing so, a suite of potential measures could be implemented, including but not limited to the following actions:

- Operators could be required to provide housing and basic services for all direct project hires and their families in order to minimize potential (1) social disruption associated with large numbers of in-migrants locating in small rural communities, (2) short-term adverse impacts on regional housing markets and overnight accommodation facilities, (3) adverse impacts on regional consumer products' availability and price, and (4) adverse impacts on public services provided by local communities in the surrounding region.

- Operators could work with state and local agencies to develop community monitoring programs that would be sufficient to identify and evaluate socioeconomic impacts resulting from commercial development. Monitoring programs should collect data reflecting economic, fiscal, and social impacts of the development at both the state and local level. Parameters to be evaluated could include impacts on local labor and housing markets, local consumer product prices and availability, local public services (police, fire, and public health), and educational services. Programs also could monitor indicators of social disruption (e.g., crime, alcoholism, drug use, and mental health) and the effectiveness of community welfare programs in addressing these problems.

It is possible that some community development programs, with participation from energy resource developers, and local, state, and federal governments, will be implemented proactively in each ROI to avoid, manage, or mitigate negative social, economic, and fiscal consequences of oil shale development, prior to development of oil shale.

Operators could work with state and local agencies to develop community outreach programs that would help communities adjust to changes triggered by commercial development. Such programs could include any of the following activities:

- Establishing vocational training programs for the local workforce to promote the development of skills required by the commercial development industries.

- Developing instructional materials for use in area schools to educate the local communities on the commercial development industries.

- Supporting community health screenings, especially those addressing potential health impacts related to commercial development activities.

- Providing financial support to local libraries for the development of information repositories on commercial development and processing, including materials on the hazards and benefits of commercial development. Electronic repositories established by the operators could also be of great value.

Additional impact mitigation strategies could be designed and implemented at the local and state level, notably market-based mitigation strategies to coordinate ecosystem management practices, and rotational schedules for direct workers once the location, timing, and magnitude of impacts of specific projects are known. The role of tax revenues in attempts to diversify local economies and reduce dependency on natural resource extraction industries, thereby reducing the susceptibility of local communities to the boom-and-bust economic cycle associated with energy development in rural areas, could also be considered. The BLM cannot direct that government funds be paid to state and local governments to mitigate impacts from oil shale development. The BLM can only show those impacts in NEPA documents and address how impacts were mitigated in the past by direction from Congress to use the bonus bids from the federal leases.

Mitigation measures that could be implemented to reduce transportation impacts include the following:

- Maintain and/or upgrade existing roads utilized for the proposed project, as necessary, to conditions equal to, or better than, those that existed prior to project-related use.

- Develop and maintain close working relationships with state and county highway departments during all phases of project construction and maintenance.

- Encourage employees and contractors to carpool to and from the site.

- Emphasize to contractors and employees the need to comply with all posted speed limits to prevent accidents as well as to minimize fugitive dust.

- Comply with county and state weight restrictions and limitations and overweight/size permitting requirements.

- Control dust along unsurfaced access roads and minimize the tracking of mud onto roads.

- Restore unsurfaced roads to conditions equal to or better than preconstruction levels after construction is completed.

- Develop measures to control unauthorized OHV use in cooperation with the BLM and interested landowners.

- Require all projects to develop transportation management plans; new road construction or road upgrades on BLM-administered public lands would be expected to follow minimum guidelines as provided in the BLM Gold Book (DOI and USDA 2007), including road maintenance requirements.

5.13 ENVIRONMENTAL JUSTICE

The construction and operation of tar sands developments and associated housing could impact environmental justice if any adverse health and environmental impacts resulting from either phase of development were significantly high and if these impacts disproportionately affected minority and low-income populations. If health and environmental impacts are not significant, there can be no disproportionate impacts on minority and low-income populations. If the impacts are significant, disproportionality is determined by comparing the proximity of high and adverse impacts with the location of low-income and minority populations. Details of the methodology for assessing environmental justice issues are presented in Appendix G. The following sections describe impacts on various resources located in the tar sands resource areas within the ROI that would be impacted by tar sands development. Local demographic and social disruption impacts, property value impacts, land use, air and water quality and use, and visual impacts are described. This discussion is followed by a determination of the extent to which impacts of tar sands development would have a disproportionate effect on low-income and minority groups on the basis of the location of low-income and minority populations.

5.13.1 Common Impacts

5.13.1.1 Impact-Producing Factors

Rapid population growth in small rural communities hosting large tar sands development projects may produce social and psychological disruption, together with the undermining of established community social structures. Various studies have suggested that social disruption may occur in small rural communities when annual population increases are between 5 and 15% (see Section 4.11.1.3).

Property value impacts on private land in the vicinity of tar sands development projects and associated transmission lines may affect minority and low-income populations. These impacts would depend on the range of alternate uses of specific land parcels by landowners, current property values, and the perceived value of costs (e.g., visual impacts, traffic congestion, noise and dust pollution, air quality impacts, and EMF effects) and benefits (e.g., infrastructure upgrades, employment opportunities, and local tax revenues) from proximity to tar sands–related facilities to potential purchasers of property owned by minority and low-income individuals in local communities.

Construction activities would produce fugitive dust emissions and engine exhaust emissions from heavy equipment and commuting and delivery vehicles on paved and/or unpaved roads, and wind erosion from soil disturbed by construction activities or from soil stockpiles. Emissions associated with these activities would consist primarily of particulate matter ($PM_{2.5}$ and PM_{10}), criteria pollutants, VOCs, CO_2, and certain HAPs released from heavy construction equipment and vehicle exhaust. Emissions during tar sands facility operations would consist of CO, NO_2, $PM_{2.5}$, PM_{10}, and SO_2. Construction of transmission lines and access roads required for the delivery of equipment and materials to project sites would produce fugitive dust impacts, the magnitude of which would depend, in part, on the terrain, road length, and the length of time they would be used for construction traffic.

Water consumption and quality impacts on land in the vicinity of tar sands development projects and associated transmission lines might affect minority and low-income populations, both in terms of water used for domestic consumption and water that may be used to support wildlife populations used for subsistence agriculture and for cultural and religious purposes. The impact on water resources during construction would consist primarily of increases in surface runoff and, consequently, in dissolved solids and in the volumetric flow of nearby streams near the project sites. The amount of water used during the operation of tar sands development projects is expected to be large at higher levels of facility production and could potentially impact minority and low-income populations if there were shortages of drinking water or water that might be used for agriculture.

Construction and operation of tar sands and supporting facilities, housing, and transmission lines would produce noise impacts, and the operation of transmission lines could lead to EMF effects.

Tar sands facilities and associated transmission towers may potentially alter the scenic quality in areas of traditional or cultural significance to minority and low-income populations, depending on the facility's size and location. Construction would introduce contrasts in form, line, color, and texture, as well as a relatively high degree of human activity into existing landscapes with generally low levels of human activity.

Land used for tar sands facilities might affect certain types of animals or vegetation that were of cultural or religious significance to certain population groups or that formed the basis for subsistence agriculture. Similarly, land that was used for facilities but that also has additional economic uses might affect access to resources by low-income and minority population groups.

5.13.1.2 General Population

Population in-migration would occur in each year of tar sands resource development. Workers would be required to move into the state for the construction and operation of tar sands facilities and to address the demand for goods and services resulting from the spending of tar sands and housing construction worker wages and salaries. It is projected that during the period in which a tar sands facility would be constructed in the ROI, population in the ROI would increase by 1.0%. In-migration associated with tar sands development would also require additional housing to be constructed in the ROI, with up to 3.2% of vacant housing units required during the peak year of construction.

Since tar sands development projects and the associated housing developments would lead to rapid population growth in many of the communities in each ROI, and given evidence presented in the literature (see Section 3.10.2.2), it is highly possible that some degree of social disruption would accompany these developments. In the absence of appropriate levels of local and regional planning, rapid demographic change may lead to the undermining of local community social structures by those among the local population and in-migrants with contrasting beliefs and value systems and, consequently, to a range of changes in social and community life, including increases in crime, alcoholism, and drug use. Partially offsetting some of these developments would be higher local government expenditures, with the potential for better quality local public services and infrastructure in some communities. In addition to providing employment and higher wages for some occupational groups, oil companies may also provide funds to upgrade portions of the road system in each ROI, and fund school scholarships and vocational training in some communities.

The precise nature of the impact of tar sands facility construction and operation on property values was not evaluated for this PEIS. The impact would depend on the range of alternate uses of specific land parcels by landowners, current property values, and the perceived value of costs (visual impacts, traffic congestion, noise and dust pollution, air quality impacts, and EMF effects) and benefits (infrastructure upgrades, employment opportunities, and local tax revenues) from proximity to tar sands–related facilities to potential purchasers of property owned by minority and low-income individuals in local communities.

Emissions associated with construction activities would consist primarily of particulate matter ($PM_{2.5}$ and PM_{10}), criteria pollutants, VOCs, CO_2, and certain HAPs released from heavy construction equipment and vehicle exhaust. Because all activities either conducted or approved by the BLM through use authorizations must comply with all applicable local, state, tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans, it is unlikely that future tar sands development would cause significant adverse air quality impacts.

Water from the Colorado River in Utah, combined with the estimated sustainable groundwater yield, would likely be sufficient to provide the amount of water needed for tar sands development, ancillary power and coal facilities, and associated population growth. It should be noted that prolonged drought conditions may occur and constrain water availability in Utah. Although discharges could have significant impacts on water quality if not properly controlled, water quality impacts of tar sands development are expected to be temporary and local, provided that mitigation measures are implemented, in part because of the dry climate where the sites are located. However, steep slopes in some areas may channel surface runoff and result in localized soil erosion.

Tar sands facilities might affect certain types of animals or vegetation that are of cultural or religious significance to certain population groups or form the basis for subsistence agriculture. Similarly, land that is used for these facilities that also has additional economic uses might affect access to resources by low-income and minority population groups.

Surface mine and surface retorting would involve the most surface disturbance and visible activity (including dust and emissions) and would be expected to generate the largest visual impacts relative to the other projects of similar size but using in situ processes. Visual impacts associated with reclamation also would likely be less than those for projects using surface mines because of the greatly reduced level of ground disturbance. Projects using in situ technologies would likely have the smallest level of visual impacts because of the absence of spent tar sands piles and other mining-related facilities and activities. These projects also would likely have the smallest reclamation impacts because of reduced surface disturbance and the absence of spent tar sands piles.

5.13.1.3 Environmental Justice Populations

The construction and operation of tar sands developments could impact environmental justice if the adverse health and environmental impacts resulting from either phase of development identified in the previous sections were significantly high and if these impacts disproportionately affected minority and low-income populations. Where impacts are significant, disproportionality is determined by comparing the proximity of high and adverse impacts with the location of low-income and minority populations.

A number of census block groups in the area potentially hosting tar sands development have low-income and minority populations in which the minority population exceeds 50% of the total population in each block group, and there are a number of block groups in which the minority share of total block group population exceeds the state average by more than 20 percentage points (see Section 3.11). Within 50 mi of the tar sands area, the minority population is located in the northeastern part of the state in the immediate vicinity of the tar sands resource area itself, in the southeastern portion of the Uintah and Ouray Indian Reservation, and in the north-central part of the state, to the east of Springville. The low-income population is centered in roughly the same area as the minority population, with five block groups in the southeastern portion of the Uintah and Ouray Indian Reservation, and one located in the vicinity of Price.

Given the location of environmental justice populations in each state, the construction and operation of tar sands facilities and employee housing required for the operation of tar sands development projects would produce impacts that may be experienced disproportionately by minority and low-income populations in a number of locations in each ROI. Of particular importance would be the social disruption impacts from large increases in population in small rural communities, the undermining of local community social structures, and the resulting deterioration in quality of life. The impacts of facility operations on air and water quality and on the demand for water in the region would also be important. Depending on their locations, impacts on low-income and minority populations may also occur with the development of transmission lines associated with power development and the supply of power to tar sands facilities in each state. Land use and visual impacts might be significant, depending on the location of land parcels impacted by tar sands projects and the associated housing facilities, their importance for subsistence, their cultural and religious significance, and alternate economic uses.

5.13.2 Mitigation Measures

Various procedures might be used to protect low-income and minority groups from high and adverse impacts of tar sands and associated facilities. Most important of these would be to develop and implement focused public information campaigns to provide technical and environmental health information directly to low-income and minority groups or to local agencies and representative groups. Included in these campaigns would be descriptions of existing air and groundwater monitoring programs; the nature, extent, and likelihood of existing and future airborne or groundwater releases from tar sands facilities; and the likely characteristics of environmental and health impacts. Key information would include the extent of any likely impact on air quality, drinking water supplies, and subsistence resources and the relevant preventative measures that could be taken.

Rapid population growth following the in-migration of construction and operation workers associated with tar sands and ancillary facilities into communities with low-income and minority populations could lead to the undermining of local community social structures where the in-migrants have beliefs and value systems that contrast with those of the local population. Consequently, a range of changes in social and community life, including increases in crime, alcoholism, and drug use, could result. In anticipation of these impacts, key information on the scale and time line of tar sands developments, and on the experience of other communities that have followed the same energy development path, together with information on planning activities that may be initiated to provide local infrastructure, public services, education, and housing, could be made available to low-income and minority populations.

5.14 HAZARDOUS MATERIALS AND WASTE MANAGEMENT

5.14.1 Common Impacts

Impacts related to hazardous materials and wastes are generally independent of location. Such impacts would be derivatives of the technologies employed for resource recovery and for the subsequent processing of recovered products rather than of the locations at which these activities occur.

Hazardous materials and wastes are unique to the technology combinations used for tar sands development. However, hazardous materials and waste impacts are common for some of the ancillary support activities that would be required for development of any tar sands facility regardless of the technology used. These include the impacts from development or expansions of support facilities such as employer-provided housing.

Hazardous materials impacts associated with construction or expansions of off-site support facilities would be minimal and limited only to the hazardous materials typically utilized in construction of such facilities. These would include the hazardous materials required to support construction equipment and vehicles (fuels, other vehicle and equipment fluids such as lubricating oils, hydraulic fluids, and glycol-based coolants) and miscellaneous hazardous materials typically associated with construction such as solvents, adhesives, and corrosion-control coatings. Construction-related wastes would include landscape wastes from clearing and grading of the construction sites and other wastes typically associated with construction, none of which are expected to be hazardous and all of which, except for landscape wastes, are expected to be disposed of in permitted sanitary landfills. Landscape wastes are expected to either be burned on-site or delivered to permitted off-site facilities for disposal or composting.

Once these support facilities become functional, different hazardous materials and waste impacts would result. It is expected that virtually no hazardous materials would be associated with employer-provided housing. However, wastes would include nonhazardous solid wastes and sanitary wastewaters. Solid wastes are expected to be containerized and hauled to permitted sanitary landfills or other appropriate waste disposal facilities. As conditions permit, sanitary wastewaters are expected to be treated on-site through such technologies as septic systems or active biological treatment; all such activities would be controlled by permits issued to state or local authorities. Depending on the location of the employer-provided housing and other circumstantial factors, it is also possible that sanitary wastewaters would be delivered by truck or sewer to existing or expanded municipal treatment works for treatment.

5.14.1.1 Surface Mining with Surface Retort

Hazardous materials associated with mining would primarily be used to support vehicles and equipment, most of which could not be easily transported to off-site maintenance and repair facilities. Hazardous materials would include fuels (primarily diesel fuel) and other engine and equipment fluids, such as lubricating oils, hydraulic fluids, glycol-based coolants, and battery electrolyte. Other miscellaneous hazardous materials used in the repair of mechanical equipment (cleaning solvents, welding gases, corrosion-control paints and coatings) would also likely be present in limited quantities. Explosives might also be used to support the mining activities; however, explosives are expected to be brought to the site on an as-needed basis rather than stored at the site. Limited amounts of herbicides would also be used on-site to manage vegetation in industrial areas for fire prevention and control. However, herbicides, like explosives, are not expected to be stored on-site but instead would be brought to the site on an as-needed basis.

Waste associated with surface mining operations also would be primarily associated with vehicle and equipment maintenance and would involve the spent hazardous materials described above. In addition, solid wastes (e.g., kitchen wastes, administrative wastes) and sanitary wastewater would result from the support of the workforce. Solid wastes would likely be containerized and hauled to an off-site permitted disposal facility. Sanitary wastes might be treated on-site by using septic systems or biological treatment as conditions dictate and operating permits allow, or alternatively, they might be delivered by truck or sewer to municipal treatment works. At the initial development of any given area, some landscape wastes could also result as the land surface was cleared and overburden removed. Landscape wastes would likely be burned on-site (under the authority of a state or local permit) or delivered to an off-site facility for disposal or composting. Stormwater runoff from stockpiled overburden could contain elevated amounts of suspended solids. Stormwater management is expected to be addressed by a sitewide SWPPP that is expected to be required by the site's stormwater management permit.

Other than the commercial fuel consumed as a source of heat, no hazardous materials would be required to support operation of the surface retort.[5] The inorganic phase remaining after bitumen removal is composed primarily of sand and silt. At some Canadian oil sands developments, the sand that is recovered is a type (crystalline form) that makes it valuable for use in formation fracturing as part of enhanced recovery techniques for conventional crude oil. There is no evidence to suggest that sands recovered from retorting of U.S. tar sands would have similar value. Consequently, for the purpose of this analysis, the sand and silt that remain after bitumen removal are considered to be a solid waste. The most likely management strategies for this material involve either its use in reclamation of the mine site (to establish original contours prior to replacement of stockpiled overburden) or disposal in an on-site facility operating under a permit issued by state or local authorities. Residual sand and silt from retorting are not expected to exhibit any hazardous characteristics (although some residual bitumen may remain adsorbed to sand grains); nevertheless, they represent the potential for contaminating surface water runoff with high concentrations of suspended particulates, organic contaminants, and perhaps some dissolved minerals present in the tar sands formation. Proper design of waste sand disposal cells, appropriate vegetative covers, and other controls established under a solid waste disposal permit and/or a sitewide SWPPP should adequately address and mitigate this potential. Free water present in the formation is expected to be released during the retorting step. However, it is not expected to contain significant amounts of contamination and is likely to be of sufficient quality for beneficial use on-site for fugitive dust control.

Subsequent upgrading of recovered bitumen would be only that necessary to produce an upgraded product that could be accepted at refineries for additional processing. Hydrogen would be introduced to the site to support this upgrading (provided by commercial supplier on an as-needed basis and not generated on-site by steam reforming of natural gas). Periodic maintenance and repair of upgrading systems would result in spent catalysts (some of which might require management as hazardous waste) and sludge from the cleaning of storage tanks and reaction vessels, all of which would require characterization before waste management strategies could be determined. However, regardless of their character, the wastes resulting from upgrading operations are likely to be containerized and delivered to properly permitted off-site treatment or disposal facilities.

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[5] For the purpose of this impact analysis, "retorting" means those actions conducted to separate the organic fraction, bitumen, from the inorganic materials contained in tar sands (primarily sand and silt). As it is used here, retorting implies only a separation of organic and inorganic fractions of tar sands and does not involve the chemical transformation of bitumen into other organic materials. As defined in Appendix B, a retort patterned after the Lurgi-Ruhrgas direct burn retort is considered to be representative of surface retorting.

5.14.1.2 Surface Mining with Solvent Extraction

Hazardous materials and waste impacts from surface mining discussed above would apply without change to this alternative. However, for the retorting step, a solvent in which the bitumen is soluble would be added as a means of bitumen separation rather than relying on heat, mechanical agitation, or phase separation to separate the bitumen from the inorganic fractions of tar sands. In this technique, additional hazardous materials would be introduced. A variety of solvents could be used. Those that have been used successfully for solvent extraction of oil sands in Canadian developments have included raw naphtha and raw gas oil (both condensate fractions from the distillation of conventional crude oil), hexane and cyclohexane (both chemicals produced in refineries or derived in petrochemical plants from secondary feedstocks), and ethanol. All of these materials have relatively high vapor pressures and low specific gravities, and all are extremely flammable.[6] When practiced correctly, solvent extraction will recover the majority of solvents for reuse, although some minor evaporative losses are expected. Some aromatic solvents (naphthenic derivatives) that could be used have moderately high water solubility. If used as extraction solvents, they can be expected to partition to some extent into the free formation water that would also be present during the extraction process. While this aqueous fraction is easily separated from the organic phase (the bitumen), it will likely need treatment to remove the polar organic contaminants before it can be released back to the environment or used for beneficial purposes on-site, such as fugitive dust control.

Obviously, the accidental release of any of the extraction solvents would represent a hazardous fire situation and a potential adverse impact on the environment. Prudent management procedures would prevent such accidental releases. For cost control, facilities are likely to be established for recovery and recycling of the extraction solvents. Alternatively, this mixture of extraction solvent and bitumen could also be sent directly to a refinery, eliminating on-site upgrading activities.[7]

Subsequent upgrading of recovered bitumen would be only that necessary to produce an upgraded product that could be accepted at refineries for additional processing. Hydrogen would be introduced to the site to support this upgrading (provided by commercial supplier on an as-needed basis and not generated on-site by steam reforming of natural gas). Periodic maintenance and repair of upgrading systems would result in spent catalysts (some of which might require management as hazardous waste) and sludge from the cleaning of storage tanks and reaction vessels, all of which would require characterization before waste management strategies could be determined. However, regardless of their character, the wastes resulting from upgrading operations are likely to be containerized and delivered to properly permitted off-site treatment or disposal facilities.

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[6] Many of the chemical constituents typically found in refinery fractionator condensates, such as raw naphtha and raw gas oil, have been identified as known or possible carcinogens. See the discussions of potential health impacts in Section 5.14.

[7] It is common practice among some Canadian oil sands developers to mix bitumen with diluents (many of which are the same materials that would be used as extraction solvents) to create a less viscous mixture (known in the industry as "dil-bit") that is delivered by conventional pipeline to refineries for processing, thereby eliminating mine site upgrading.

5.14.1.3 In Situ Steam Injection

For this technology, only bitumen is recovered from the formation, and spent sand is not generated. Steam is used to heat the bitumen, reducing its viscosity so that it can move through the formation and be recovered by a conventional production well. At the same time, steam condensates, as well as free formation water, are also recovered in the production well. Expected contaminants include suspended solids, dissolved minerals, and small amounts of polar organic constituents extracted from the bitumen. Typically, and especially in arid areas, these waters will be separated from the bitumen and recycled. Water sources for steam need to be of relatively high quality. Consequently, condensates require treatment to remove dissolved and suspended contaminants before being recycled. Such treatment is likely to produce sludge, which represents one of the primary wastes associated with this technology. Contaminants expected to be present in steam condensates include heavy metals and minerals dissolved from the formation, as well as small amounts of polar organic constituents extracted from the bitumen and partitioned into the aqueous phase. In addition to the primary steam cycle, secondary noncontact cooling systems may also be in operation. Water treatment chemicals are expected to be introduced into waters for primary steam loops as well as secondary cooling systems to control scale, corrosion, and bacteria, so blowdown water from both systems may also require treatment before release or beneficial use.

Bitumen recovered from steam injection is expected to undergo some upgrading on-site. To support such upgrading, hydrogen would be present on-site (delivered by a commercial vendor on an as-needed basis and not generated on-site through steam reforming of commercial natural gas). Periodic maintenance and repair of upgrading systems would result in spent catalysts (some of which might require management as hazardous waste) and sludge from the cleaning of storage tanks and reaction vessels, all of which would require characterization before waste management strategies could be determined. However, regardless of their character, the wastes resulting from upgrading operations are likely to be containerized and delivered to properly permitted off-site treatment or disposal facilities.

5.14.1.4 In Situ Combustion

Hazardous materials required to support in situ combustion would be limited to the conventional fuels (natural gas or propane) that would be introduced to initiate combustion. No solid wastes would result from in situ combustion. However, free formation water, as well as waters of combustion, would be recovered from the production wells used to extract the bitumen. This aqueous fraction is expected to contain some inorganic species (H_2S, NH_3), as well as organic species (e.g., carbonyl sulfide as well as polar organic constituents that formed from partial thermal destruction of bitumen and partitioned into the aqueous phase because of their moderate water solubility). Consequently, this wastewater would require some treatment on-site before being released to the environment or beneficially used on-site (e.g., for fugitive dust control).

The organic fraction recovered from in situ combustion (largely bitumen with lesser amounts of products of incomplete thermal destruction of bitumen) is expected to undergo some upgrading on-site. To support such upgrading, hydrogen would be present on-site (delivered by commercial vendor on an as-needed basis and not generated on-site through steam reforming of commercial natural gas). Periodic maintenance and repair of upgrading systems would result in spent catalysts (some of which might require management as hazardous waste) and sludge from the cleaning of storage tanks and reaction vessels, all of which would require characterization before waste management strategies could be determined. However, regardless of their character, the wastes resulting from upgrading operations are likely to be containerized and delivered to properly permitted off-site treatment or disposal facilities. Virtually all upgrading reactions occur at elevated temperatures and pressures. Therefore, additional fuels would likely be brought to the site to support upgrading heat and pressure requirements. Where steam would be generated to provide the needed heat, treatment of steam condensates to facilitate their recycling would result in sludge that would require characterization before disposal.

5.14.2 Mitigation Measures

Hazardous wastes will be present at a tar sands facility throughout construction, operation, and reclamation. During construction, hazardous wastes will be limited in both variety and volume, consisting mostly of wastes from the maintenance of construction equipment and the field applications of protective coatings. During operation, a greater variety of hazardous wastes can be expected with volumes generally proportional to the scale of the operation. Although facility owners/operators may elect to treat and even dispose of their hazardous wastes at the tar sands facility (with appropriate state-issued permits in place), it is reasonable to expect that most would adopt a strategy that minimizes the times and volumes of on-site storage of hazardous wastes, with expeditious transport to off-site, properly permitted TSDFs. Elementary neutralizations of strongly corrosive wastes, as well as preliminary treatment of wastes to stabilize them for storage and transport, might occur on-site but only to the extent that is minimally necessary.

Regulatory requirements to address hazardous materials and waste management already largely address the mitigation of impacts. To reinforce the regulatory requirements, additional mitigation measures and management plans could include the following:

- An individual, written management strategy for each hazardous waste anticipated;

- Written procedures for waste evaluations, containerization, on-site storage, and off-site disposal;

- Inspection procedures for hazardous material transportation vehicles and storage areas;

- Storage requirements for each hazardous material, including container type, required design elements and engineering controls for storage and handling areas (e.g., secondary containment for liquids, fire protection for areas where flammables are used), and chemical incompatibilities;

- Dedicated, restricted access areas for hazardous waste storage, including adequate separations of chemically incompatible wastes;

- Formal, routine inspections of hazardous waste storage and handling areas;

- In addition to HAZCOM training required for workers who handle hazardous materials, awareness training for all facility personnel, including an identification of explicit roles and responsibilities for each individual;

- Limitations on access to hazardous material storage and use areas to authorized personnel;

- A comprehensive inventory of all hazardous materials at the facility, including notations of incompatibilities;

- Formal, written standard operating procedures addressing "cradle-to-grave" management, including receipt, containerization, storage, use, emergency response, and management and disposal of spent materials for each hazardous material at the facility;

- "Just-in-time" purchasing strategies to limit the amounts of hazardous materials present at the facility to just those quantities immediately needed to continue operations;

- Preventive maintenance on all equipment and storage vessels containing hazardous materials;

- Aggressive pollution prevention programs to identify less hazardous alternatives and other waste minimization opportunities;

- Establishment of comprehensive in-house emergency response capabilities to ensure expeditious response to accidental releases; and

- Documentation of all accidental releases of hazardous materials and corrective actions taken; conduct of root cause analyses; determination of the adequacy of response actions (making changes to response capabilities as necessary); assessment of long- and short-term impacts on the environment and public health; initiation of necessary remedial actions; and identification of policy or procedural changes that will prevent reoccurrence.

5.15 HEALTH AND SAFETY

Potential health and safety impacts from recovering oil from tar sands deposits can be associated with the following activities: (1) surface mining of the tar sands (underground mining is not considered at this time for tar sands deposits because of possible collapse of the sand deposits); (2) obtaining and upgrading of the product (primarily syncrude oil and some asphalt) through surface retorting, solvent extraction, in situ steam injection, or in situ combustion; (3) transport of construction and raw materials to the facility and transport of product from the facility; and (4) exposure to water and air contamination associated with tar sands development. Hazards from tar sands development are similar to hazards from oil shale development and are summarized in Table 5.15-1.

For mining and upgrading activities, the primary health and safety impacts are to facility workers. These worker impacts include physical hazards from accidents (including heat stress or stroke, explosion, or injuries related to working around large, moving equipment); health risks from chemical exposures (usually inhalation or dermal) to hazardous substances present in tar sands, the products, other process chemicals, and wastes; and loss of hearing because of potentially high on-the-job noise levels. This section will mainly address worker physical hazards and worker chemical exposure risks. Noise risks are discussed in Section 5.7. Potential water and air contamination, which could lead to exposures for the general public, are discussed in Sections 5.5 and 5.6, respectively. Since, in general, water and air standards are set to be protective of public health, the discussion in those sections addresses potential impacts on the public.

TABLE 5.15-1 Potential Health Impacts Associated with Tar Sands Development[a]

Process or Product	Possible Hazard
Surface mining	Pneumoconiosis and/or increased cancer risk from inhalation of dust particles, tar sands particles, and/or diesel exhaust; physical hazards, including highwall collapse and explosions, heat stress, and noise.
Surface retorting, solvent extraction, and upgrading	Inhalation of or dermal contact with fumes or particles; noise; inhalation or dermal contact with contaminants in wastewater (e.g., hydrocarbons, phenols, trace elements, salts, suspended solids, oil, sulfides, ammonia, PAHs, and radionuclides).
In situ steam injection and in situ combustion	Physical hazards associated with well drilling, use of explosives, noise, and use of steam at high temperature and pressure; inhalation of or dermal contact with fumes or particles in product, recovered process water, or process chemicals.
Raw and spent tar sands storage	Exposure to contaminants in drinking water; concentrations of contaminants in edible aquatic organisms; inhalation of airborne particulates.
Products (syncrude, asphalt)	Potential cancers from dermal contact with or inhalation of volatile products.
Combustion products	Inhalation of HAPs from emissions of chemicals (e.g., criteria pollutants, trace elements, sulfur and nitrogen compounds, PAHs, and radionuclides).
All	Increased physical hazards and exposure risks from transportation of raw materials and products to and from the facility.

[a] Adapted from DOE (1988) and Brown (1979).

A potential safety impact on the local off-site population that must be considered is risk due to an increased volume of vehicular traffic. The presence of construction and product transport trucks on narrow, two-lane roads could create unique hazards for children waiting at the roadside for their school bus. Additional transportation hazards would include exposure to particulate dusts created by the large trucks, as well as the increased potential for accidents. Transport of bitumen and other by-products is expected to occur by tractor trailer or by pipeline. Traffic accidents involving truck movements or accidents involving the pipelines could also impact public safety.[8]

5.15.1 Common Impacts

5.15.1.1 Surface Mining

Tar sands mining is generally surface mining, because the instability of tar sands does not allow underground mining. The hazards associated with surface mining tar sands would be similar to those associated with surface mining other materials. These include the following (Bhatt and Mark 2000; Speight 1990; Daniels et al. 1981):

- Injuries from highwall-spoilbank failures;
- Hazards associated with storage, handling, and detonation of explosives;
- Inhalation of dust and particulates, possibly containing bitumen or VOCs; inhalation of exhaust fumes from mining equipment;
- Accidents and injuries from working in close proximity to large equipment (e.g., shovels, trucks, and loaders) and equipment with moving parts;
- Injury hazards from lifting, stooping, and shoveling; exposure to climate extremes and sun while working outside; and
- Elevated noise levels (discussed in Section 5.7).

Highwall failures are very dangerous, often resulting in fatalities when the falling material hits workers. MSHA statistics show that there were 428 accidents caused by highwall instability in active coal and nonmetal surface mines from 1988 to 1997; 28 fatalities were recorded (Bhatt and Mark 2000). About one-half of the injuries occurred when the workers were hit directly with the failed highwall material; the other injuries involved the material hitting

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8 Waste tar sands (tar sand tailings) would be generated in large quantities in any surface processing technology. However, it is expected that disposal of these tailings would occur on the leased site. Consequently, little if any tar sand tailings would be transported to disposal areas over public roadways. However, other chemical wastes associated with the operation may not be acceptable for on-site disposal and would, therefore, be transported by truck to permitted treatment or disposal facilities.

heavy or miscellaneous equipment. More than one-half of the accidents resulted in lost workdays.

Deaths and injuries from accidental ignition of explosives used to blast the formations and allow removal of the tar sands are a serious hazard in mining operations. Injuries and fatalities may also result from the high physical demands of surface mining. Large machinery could be used to remove the tar sands; a truck-and-shovel approach might also be used. This approach can be more efficient, but it also requires a larger number of employees to conduct the work. In Utah, where the water supplies are limited, making hydrotransport from the excavation site unattractive, it is most likely that excavated tar sands would either be trucked to the retorting or extraction facility or moved by conveyor. The degree of mechanization in the surface mining processes used would greatly influence the number of worker injuries. In general, more mechanization would be expected to result in a lower number of worker injuries, because fewer workers would be needed to conduct the mining (although the number of machinery-related injuries would increase).

Injury and fatality incidence from tar sands surface mining is likely to be lower than that from the mining industry as a whole, since the latter also includes the more hazardous underground mining accidents. However, as an indicator, the recent statistics for the mining industry as a whole are provided here. Statistics for work-related injuries and deaths show that mining is one of the most hazardous occupations, with approximately 28.3 deaths per 100,000 mine workers in the United States in 2004 (NSC 2006). Because of improved safety practices and the use of more advanced machinery, mining deaths have decreased since the 1970s. For example, the death rate in 1970 was 200 per 100,000 workers; the rate has decreased to about 30 deaths per 100,000 in recent years (DOL 2006). The number of work-related injuries for miners was 3.8 nonfatal injuries per 100 mine workers annually in 2004 (NSC 2006).

Inhalation of dusts generated during the mining process can cause disease. If these are tar sands dusts, they will likely contain PAHs, a carcinogenic component of the sands (further discussed in Section 5.14.1.2). Chronic inhalation of irritants such as mineral or metal particles causes pneumoconiosis or miner's lung, a condition characterized by nodular fibrotic lung tissue changes. Prolonged inhalation of silica dusts causes a form of pneumoconiosis termed silicosis, which is a severe fibrosis of the lungs that results in shortness of breath. Both conditions can be fatal. Although concentrations of these dusts are lower for surface mining in comparison with underground mining, additive exposures may nonetheless result in these diseases.

5.15.1.2 Surface Retorting and Solvent Extraction

The composition and toxicity of tar sands, produced oils, the residual char or coke, and process chemicals partially determine the potential hazards of processing the materials. Tar sands are deposits of consolidated or unconsolidated sediments that have pore spaces saturated with heavy, viscous petroleum known as bitumen. In contrast to heavy oils, the bitumen in tar sands is semisolid and cannot be pumped and collected at a well bore (Daniels et al. 1981).

Bitumen is composed of a mix of hydrocarbons with a high carbon-to-hydrogen ratio, and it may contain elevated concentrations of sulfur, nitrogen, oxygen, and heavy metals. Fumes from heated bitumens contain PAHs, many of which have been classified as probable human carcinogens in the EPA's Integrated Risk Information System (EPA 2006). According to the IARC, there is inadequate evidence to classify bitumens alone as human carcinogens (IARC 1985). Several studies have shown an increased risk of several types of cancer in workers exposed to bitumens. However, these workers were also exposed to other carcinogenic materials such as coal tars. The refined bitumens have not been classified for human carcinogenicity.

For animals, there is sufficient evidence for the carcinogenicity of extracts of steam- and air-refined bitumens, limited evidence for the carcinogenicity of undiluted steam-refined bitumen and cracking-residue bitumen (char), and inadequate evidence for the carcinogenicity of air-refined bitumens. The possible increased cancer risk from inhalation of or dermal exposure to crude and processed bitumens is a primary chemical health concern for tar sands workers.

In addition to the array of organic chemicals that would be produced during bitumen recovery and processing, additional chemicals, including caustic agents, would be present during the treatment of steam condensates and raw water to allow for the recycling of steam, which would most likely be necessary to control costs.

The potential for hazardous exposures differs among the various retorting and separation processes (i.e., hot and cold water processes and thermal processes). The cold water process has a lower potential for exposure to volatile compounds. Potential chemical exposure pathways for workers include inhalation (especially for processes that take place at elevated temperatures) and dermal contact. At all facilities, worker exposures would be monitored and limited to stay within OSHA standard levels, by using engineered controls as well as PPE if necessary.

Physical hazards to facility workers during retorting can be associated with equipment and systems. These include potential contact with hot pipes, fluids, and vapors; exposure to ruptured pipes and their contents; accidents from maintenance operations; and physical contact with chemical agents. Comprehensive facility safety plans and worker safety training can minimize these hazards.

Recovery of bitumen from mined tar sands through solvent extraction rather than through more conventional retorting presents many of the same hazards as discussed above for retorting, as well as additional hazards associated with exposure to the extraction solvent. Such solvents are typically naphthenic hydrocarbons (e.g., cyclohexane, raw naphtha) that pose both chemical and physical hazards. Many chemicals could be used successfully for solvent extraction. Since bitumen is soluble in a wide variety of organic solvents, the selection is based primarily on cost and availability rather than specific chemical or physical properties. Solvents could exhibit toxic properties through dermal, inhalation, or ingestion pathways (or through multiple pathways), as well as physical hazards such as volatility and flammability. Potential exposure pathways for workers include inhalation (especially for extractions that take place at elevated temperatures) and dermal contact.

5.15.1.3 In Situ Steam Injection and Combustion

The hazards for steam injection processes are similar to those for thermal retorting, although there is much less potential for exposure to the char or coke, since they will remain underground. Steam injection can occur without prior modification to the formation, or it may be preceded by explosive or hydraulic fracturing of the formation to enhance bitumen recovery. Hazards particularly associated with in situ steam injection processes include the following:

- Physical hazards associated with the high-pressure steam boilers and pumps and compressors used for injection;

- Hazards associated with the storage, handling, and detonation of explosives for modified in situ processes employing explosives to cause or enhance reservoir fracturing;

- Physical hazards associated with well drilling; and

- Exposures to hazardous substances in the recovered tar sands, in recovered process water, and in chemicals used to treat and recycle recovered water.

The hazards associated with explosives are the same as those discussed in Section 5.14.1.1 (surface mining). An additional hazard associated with in situ processes that is not applicable to mined tar sands is well drilling, in order to pump the mobilized bitumen to the surface. The phases of drilling wells include site preparation, drilling, well completion, servicing, and abandonment; each is associated with unique physical hazards (e.g., falling from heights, being struck by swinging equipment or falling tools, and burns from cutting and welding equipment or steam).

Health and safety procedures implemented at an in situ steam injection research facility (TS-1) near Vernal, Utah (Daniels et al. 1981) required that the workers (1) handle produced oil and recovered process water as toxic substances; (2) handle de-emulsifiers, water-treatment chemicals, oxygen scavengers, organic sequestering agents, and corrosion-control substances so as to prevent exposure; and (3) wear protective clothing and receive safety training.

Hazards associated with in situ combustion processes are similar to those associated with in situ steam injection processes; however, the hazards associated with high-temperature and high-pressure steam are eliminated and replaced with hazards associated with the storage and use of fuels used to initiate combustion and the hazards of potential exposures to combustion by-products (primarily CO as well as a wide variety of partial decomposition products of complex organic molecules). For most in situ combustion technologies, high-pressure sweeping gases may also be used to control the direction of the combustion front and to aid in product recovery. Sweeping gases such as CO_2 would introduce asphyxiant and toxic gas hazards.

5.15.2 Mitigation Measures

Regulatory requirements to address occupational health and safety issues already largely address the mitigation of impacts (e.g., OSHA standards under 29 CFR 1910 and 1926 [1910.109 is specific for explosives] and MSHA standards under 30 CFR Parts 1–99). In addition, electrical systems must be designed to meet applicable safety standards (e.g., NEC and IEC).

To reinforce the regulatory requirements, additional mitigation measures could include the following:

- Traffic safety should be addressed through installation of appropriate highway signage and warnings, which should be carried out to alert the populace of increased traffic and to alert vehicle operators to road hazards and pedestrian traffic, and construction of safe bus stops for children waiting for school buses; these stops should be located well away from the roadway.

- Highwall-spoilbank failure should be avoided through the use of benching, blasting patterns specifically designed for each mine site, adequate compacting of spoilbanks, and adequate miner training to allow for recognition and remediation of hazardous conditions (Bhatt and Mark 2000).

- Appropriate PPE should be used to minimize some safety and exposure hazards.

- The risks from accidental explosions risk can be lowered by implementing applicable occupational standards and following general safety measures (e.g., good housekeeping for explosives storage areas; requiring safety training for all workers using explosives).

- Safety assessments for tar sands facilities should be conducted to describe potential safety issues and the means that could be taken to mitigate them.

- A comprehensive facility health and safety program should be developed to protect workers during all phases of a tar sands project. The program should identify all applicable federal and state occupational safety standards, establish safe work practices for each task, establish fire safety evacuation procedures, and define safety performance standards.

- A comprehensive training program and hazards communications program should be developed for workers, including documentation of training and a mechanism for reporting serious accidents or injuries to appropriate agencies.

- Secure facility access control should be established and maintained for all tar sands project facilities. Site boundaries should be defined with physical barriers, and site access should be restricted to only qualified personnel.

- Hazards from well drilling may be mitigated through the use of measures recommended by OSHA (2007).

5.16 REFERENCES

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