BLM

United States Department of the Interior
Bureau of Land Management

Environmental Assessment for the Peabody Twentymile Coal, LLC Lease-by-Application COC78449

Little Snake Field Office
455 Emerson Street
Craig, Colorado 81625

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TABLE OF CONTENTS

LIST OF APPENDICES

CHAPTER 1 – INTRODUCTION

1.1 Identifying Information

CASEFILE/PROJECT NUMBER: COC78449

APPLICANT: Twentymile Coal, LLC

PROJECT NAME: Twentymile Coal, LLC LBA COC78449

1.2 Project Location and Legal Description

LEGAL DESCRIPTION: Sixth PM, T5N, R86W;
SEC 22: E½NE¼, NE¼SE¼, N½SE¼SE¼
SEC 23: N½, N½S½, N½SW¼SW¼

Proposed Project location contains approximately 640 acres in Routt County, Colorado.

1.3 Background/Introduction

The Bureau of Land Management (BLM) prepared this environmental assessment (EA) to analyze the environmental effects related to a coal Lease-by-Application (LBA). Peabody Energy's Twentymile Coal, LLC (TC) submitted the LBA to the BLM Little Snake Field Office (LSFO) seeking to obtain an additional 640 acres at the Foidel Creek Mine. TC currently operates the Foidel Creek Mine which is an underground longwall coal mine located about 20 miles southwest of Steamboat Springs in Routt County, Colorado (see Map 1, Appendix A). TC has been mining at the Foidel Creek Mine by underground methods since 1983. The Foidel Creek Mine consists of six federal coal leases, private coal leases, and state coal leases. In 2016, TC produced approximately 2.6 million tons of coal. In 2017, after production at the mine moved from federal coal to state coal, TC produced 3.8 million tons of state and private coal. The mine has approximately 29.8 million tons of recoverable clean coal (42.0 million tons recoverable raw coal including 3.1 million tons of federal coal) remaining under current leases. At current mining rates, TC expects that the Foidel Creek Mine would have a remaining productive life of approximately 9 years mining coal reserves in existing leases.

The proposed LBA is for the unleased federal coal in the Wolf Creek seam, a coal seam below the Wadge coal seam. It is estimated that the federal coal reserves included in the LBA would total approximately 4,679,000 recoverable tons of high volatile, group A, bituminous coal. Coal recovery from the preparation plant is approximately 80% or 3,743,200 tons of saleable coal. TC uses a coal preparation plant at the Foidel Creek Mine to remove rock, and other impurities from run-of-mine (ROM) coal through washing and separation processes to meet customer's specifications. Removal of rock and impurities reduces the potential for generation of ash when the coal is burned. The proposed LBA would not result in new or additional surface disturbance within the boundaries of the 640-acre lease block; therefore, as provided in 43 Code of Federal

Regulations (CFR) §3461.1, the proposal would be exempt from the unsuitability criteria analysis for mining on federal lands. When coal is a federal asset, the BLM is required by law to consider leasing federally-owned minerals for economic recovery. The Mineral Leasing Act (MLA) of 1920, as amended by the Federal Coal Leasing Amendments Act (FCLAA) of 1976, and the CFR Title 43 Part 3400, et seq., provide the legal foundation for the leasing and development of federal coal resources. The BLM is the federal agency delegated the authority to offer federal coal resources for leasing and to issue leases. The Mining and Minerals Policy Act of 1920 declares that it is the continuing policy of the federal government to foster and encourage the orderly and economic development of domestic mineral resources. The BLM must also comply with the Federal Land Policy and Management Act of 1976 (FLPMA) to plan for multiple uses of public lands and determine those lands suitable and available for coal leasing and development.

If the BLM decides to lease the federal coal described in the LBA submitted by TC, the BLM would determine the fair market value (FMV) of the coal and the successful bidder would submit a bonus bid payment for the FMV of the 4,679,000 tons of coal. After issuing the lease, the lessee must begin rental payments. After production begins, the lease would require the lessee to pay royalties on sales of the coal.

A decision to lease these lands conveys rights to the mineral resource; however, leasing does not authorize coal mining. Subsequent state permitting actions are necessary to allow mining.

As provided for under the Surface Mining Control and Reclamation Act (SMCRA), the United States Office of Surface Mining Reclamation and Enforcement (OSMRE) has worked with Colorado to develop Colorado’s regulatory program to permit coal mining with OSMRE in an oversight role. The Division of Reclamation, Mining and Safety (DRMS) manages its own coal regulatory program under SMCRA and the Colorado Surface Coal Mining Reclamation Act (34-33-101 et seq, Colorado Revised Statutes [CRS] 1973 as amended). Federal coal lease holders in Colorado must submit applications for revisions to existing DRMS permits for proposed expansions of existing mines that cover mining and reclamation on federal lands. The DRMS reviews the applications to ensure that they comply with the permitting requirements and that the coal mining operation would meet Colorado’s performance standards. OSMRE, BLM, and other federal agencies also review the applications to assure they comply with the coal lease, the MLA, the National Environmental Policy Act (NEPA) and other applicable federal laws and regulations. The DRMS has the authority and responsibility to make decisions to approve SMCRA mine permits and regulate coal mining under Regulations of the Colorado Mined Land Reclamation Board for Coal Mining (last revised 09/14/2005). DRMS submits the permit application package and its permit findings to OSMRE who determines whether a mining plan modification is necessary. If it is, OSMRE provides a recommendation whether to approve, approve with conditions, or deny the mining plan modification to the Assistant Secretary for Land and Minerals Management. The OSMRE and DRMS have agreed to be cooperating agencies in preparing this EA.

The entirety of the lands in the LBA is split estate. The LBA involves leasing 640 acres of underground federal coal reserves beneath private lands. The surface is owned entirely by Sage Creek Land and Reserves, LLC, a subsidiary of Peabody Energy, and is used as rangeland and pastureland. TC is a subsidiary of Peabody Energy. The LBA is located inside TC's Foidel Creek Mine permit boundary. TC holds the adjacent coal leases and no other coal lease holders exist in the surrounding area. The only adjacent coal mine is the Sage Creek Mine which is also permitted by Peabody Energy. The Sage Creek Mine is currently in temporary cessation status.

1.4 Cooperating Agencies

The BLM identified state agencies, local governments, tribal governments, and other federal agencies with jurisdiction or special expertise for potentially impacted environmental resources associated with the project. These agencies were extended the opportunity to become Cooperating Agencies for the development of the EA, and be involved in the development of alternatives and mitigation measures. The agencies requesting cooperating agency status include OSMRE and Colorado Department of Natural Resources (DNR).

1.5 Purpose and Need

The purpose of the federal action is to respond to TC's LBA for federal coal resources (COC78449), which comprises approximately 640 acres underlying private surface lands within the approved Foidel Creek Mine permit area in Routt County, Colorado. The need for the action is established by the BLM's responsibility under the MLA and FLPMA, which states that public lands shall be managed in a manner that recognizes the nation's need for domestic sources of minerals (43 United States Code [USC] 1701(a)(12)). Furthermore, FLPMA authorizes the BLM to manage the use, occupancy, and development of public lands through leases and permits (43 USC 1732).

Part of the outlined responsibility of the BLM (as described in the MLA) includes encouraging development of domestic reserves to meet future energy needs, reduced dependence on foreign sources of energy, and provide for dependable and affordable domestic energy while giving due consideration to the protection of other resource values. Issuing a coal lease would ensure federal coal resources that cannot be mined by any other operation are not bypassed and that maximum economic recovery is achieved.

Decision to be Made:
BLM: The BLM Colorado State Director is the Authorized Officer for the BLM and will decide whether or not to conduct a competitive sale for the coal lease under the MLA, and the federal regulations under 43 CFR 3400. The BLM LSFO Manager/Northwest District Manager is responsible for providing the State Director with briefings and recommendations. Specifically, the BLM will decide whether to:

- Adopt the No Action Alternative (no leasing);
- Lease the coal as applied for by the applicant; or
- Lease the coal as amended by the BLM.

OSMRE: The OSMRE is a cooperating agency in preparing this EA. Once the Regulatory Authority (DRMS) informs the OSMRE of a permit revision occurring for leased federal coal and/or federal surface, the OSMRE reviews the Permit Applicant Package to ensure it contains the necessary information to comply with the coal lease, the MLA, the NEPA and other applicable federal laws and their attendant regulations. Then, in consultation with the BLM, the OSMRE must determine if the action requires a Mine Plan Decision Document (MPDD). Federal Regulations at 30 CFR § 740.4(b) and 746.13 require that OSMRE provide an MLA MPDD recommendation for Secretarial approval.

If the lease is issued, OSMRE would determine if there is a need for a federal mining plan modification at the time the actual state permitting process is underway. If a federal mining plan modification is needed, the OSMRE would be responsible for preparing a MPDD recommending that the Deputy Assistant Secretary of the Interior, Land and Minerals Management approve, approve with conditions, or not approve the mining plan modification under 30 CFR 746.

DRMS: The DRMS is a cooperating agency in preparing this EA. In Colorado, the DRMS operates under an OSMRE-approved program with primary responsibility for administering coal mining operations in the state, as codified by the Colorado Surface Coal Mining Reclamation Act (CRS 34-33-101) and attendant regulations which are consistent with the overarching federal regulations (30 CFR 906). Any applications submitted to the State of Colorado to revise the state mining and reclamation permit, including applications to allow mining and its related surface disturbances including reclamation, would be reviewed by the DRMS.

1.6 Plan Conformance Review

The Proposed Action is subject to and has been reviewed for conformance with the following land use plan (43 CFR 1610.5, BLM 1617.3):

<u>Name of Plan</u>: Little Snake Record of Decision and Resource Management Plan (RMP) (BLM 2011) as amended by the Northwest Colorado Greater Sage-Grouse Approved RMP Amendment (BLM 2015a).

<u>Date Approved</u>: October 2011 and September 2015
<u>Results</u>: The Proposed Action is in conformance with the Land Use Plan (LUP) because it is specifically provided for in the following LUP goals, objectives, and management decisions as follows:

Allow for the availability of federal coal and oil shale estate for exploration and development.

Objectives for achieving these goals include:

- Identify and make available the federal coal and oil shale estate for exploration and development, consistent with appropriate suitability studies, to increase energy supplies.
- Facilitate reasonable, economical, and environmentally sound exploration and development of the federal coal and oil shale estate.
- Promote the use of Best Management Practices (BMPs), including implementation of sound reclamation standards.

Section/Page: RMP-36

Name of Plan: Northwest Colorado Greater Sage-Grouse Approved RMP Amendment (BLM 2015a).

Date Approved: September 15, 2015

Results: The Proposed Action is in conformance with the LUP because it is specifically provided for in the following LUP goals, objectives, and management decisions as follows:

Objective: Manage solid mineral programs to avoid, minimize, and compensate for adverse impacts to greater sage-grouse habitat to the extent practical under the law and BLM jurisdiction.

The Proposed Action is consistent with the underground mining exception criteria for new leases:

- Federal lands with coal deposits that would be mined by underground mining methods shall not be assessed as unsuitable where there would be no surface coal mining operations, as defined in 43 CFR, Part 3400.0-5(mm) of this title, on any lease, if issued.

Section/Page: 2-18 and 2-19

Other Related NEPA Documents:
This EA tiers to the 1980 Green River–Hams Fork Environmental Impact Statement which analyzed the leasing of coal tracts in Northwest Colorado and South Central Wyoming (BLM 1980). In 1995, the BLM analyzed the impacts that would result from the leasing and development of the original 2,600 acre COC54608 lease (BLM 1995). The 1995 EA assessed the impacts that would result from the leasing and subsequent development of the underground mineable coal.

Lease COC54608 was originally issued in February 1996 for 2,600 acres. Recovery of the Wadge coal seam within this 2,600 acre lease boundary occurred from June 1996 to September 2001. In August 2002, mining of the Wadge coal seam in COC54608 was completed; therefore, TC relinquished 2,280 acres of lease COC54608. TC retained 320 acres of lease COC54608 for access to their continued mining operations. TC's last longwall panel in the Wadge coal seam was completed June 15, 2016. In December 2016, BLM approved a lease modification to lease COC54608 (DOI-BLM-CO-2014-0044-EA) adding 310 acres of the unleased federal coal in the Wolf Creek seam under privately owned surface at the TC Foidel Creek Mine (BLM 2016).

1.7 Scoping, Public Involvement and Issues

Scoping was the primary mechanism used by the BLM to initially identify issues. Internal scoping was initiated when the project was presented to the BLM LSFO interdisciplinary team on June 27, 2017. Issues identified were the proposed lease's potential impacts to air quality and climate, soils, solid minerals, special status animal species, cultural resources, Native American concerns, solid and hazardous wastes, social and economic conditions, and hydrology.

External scoping was conducted by posting this project on the BLM's ePlanning NEPA website beginning on July 24, 2017. BLM issued a news release on July 24, 2017, which requested comments from the public through August 23, 2017. Comments were received from one state agency (Colorado Parks and Wildlife [CPW]), eight businesses, and four environmental groups. The businesses were generally supportive of the project. The environmental groups include Clean Energy Action, WildEarth Guardians, and Sierra Club and Center for Biological Diversity as a joint letter. Comments from environmental groups centered on air quality and climate. Comments were received from 27 individuals (9 generally supporting the project and 18 generally opposing the project). There were also several form comments – mostly from environmental groups sent by email opposing the project including Sierra Club (1,194 comments) and WildEarth Guardians (4,850 comments). Form comments supporting the project were received from mine employees (133 comments) and Mill Man Steel (4 comments). Comments received after the scoping comment period closed include form comments from WildEarth Guardians (1,492 comments), Sierra Club (68 comments), and Mill Man Steel (1 comment).

CHAPTER 2 – PROPOSED ACTION AND ALTERNATIVES

2.1 Alternatives Analyzed in Detail

2.1.1 Proposed Action

The Proposed Action is to hold a competitive lease sale for 640 acres of unleased federal coal. The Proposed Action is also for the BLM to issue a federal coal lease (COC78449) for the LBA tract (approximately 640 acres), which would be for underground development and production of federal coal reserves, in accordance with applicable laws and regulations, including terms and conditions for protecting non-mineral resources.

Application of the Unsuitability Criteria for Coal Mining described in 43 CFR 3461 does not apply because there is no anticipated surface disturbance within the lease boundary. The BLM has prepared a Geologic and Engineering Report and Maximum Economic Recovery Report (GER/MER). The BLM prepares the combined GER/MER to define the tract to be leased and the recoverable coal contained therein. It is used as a basis for the NEPA analysis and BLM's determination of the FMV of the coal resources in the tract. The FMV is the standard used to set the minimum allowable bid amount for the lease sale per the coal regulations at 43 CFR 3422.1.

Reasonably Foreseeable Mine Operations Plan. To analyze potential impacts, this EA assumes a Reasonably Foreseeable Mine Plan (RFMP) for this leasing decision (see Map 2, Appendix A). The LBA contains an estimated 4.68 million tons of federal coal reserves in the Wolf Creek seam. At current mining rates, mining coal reserves in the new lease tract would extend the mine's productive life by approximately 2 years. While other coal is present in the LBA tract, the BLM GER/MER does not consider the other seams as economically mineable given their thickness and possible damage due to subsidence from Wadge seam mining.

The tract is bounded on the north by currently leased state and fee coal and on the east by fee coal. It is assumed that access to the coal reserves in the LBA tract would most easily be achieved from the existing underground workings at the Foidel Creek Mine with existing surface facilities. The BLM assumes that the coal identified in the LBA—the Wolf Creek seam—would be recovered using the longwall method of underground coal mining. Mains and longwall panel gateroads would be developed using continuous miner units. A continuous miner unit would consist of a continuous miner, shuttle cars, roof bolter, belt feeder, and conveyor belts. A longwall system would be used to mine the coal in the longwall panels (see Figure 1, Appendix A). A longwall system includes a shearer, face conveyor, and shields. As the coal is sheared from the face, the face conveyor transports the coal to a crusher which dumps the crushed coal on a conveyor belt. Additional conveyor belts transport the coal to the surface.

LBA tracts are nominated for leasing by companies with an interest in acquiring a federal coal lease; however, the LBA process is, by law and regulation, an open, public, competitive, sealed-bid process. TC may or may not be the highest bidder when the lease sale is held, and therefore may not be the successful bidder.

For purposes of the analyses in this EA, it is assumed that the applicant (TC) would be the successful bidder if the 640 acres are leased. It is unlikely a third party would deem the coal resource in the LBA either substantial or valuable enough for them to initiate new surface and underground facilities and acquire the requisite permits. The economic investment required in order to mine the LBA independent of the current leases held by TC would be uneconomical. Mine Cost Services (May 2017) estimates the cost of the construction alone of a new underground mine range from $41.8 million to $170 million.

The only logical access is from the applicant's existing adjacent leases and underground mine with its associated coal handling and processing surface facilities. The coal does not outcrop on the LBA tract; therefore, no new portals could be located, and there may not be a reasonable shaft location.

No new or additional surface facilities would be needed for mining of the LBA. Existing surface facilities are discussed in the DRMS Permit (DRMS 1982a). There would be no surface mining associated with the LBA. All ventilation of the mine workings would be provided by existing fans. The existing belt conveyor would transport the coal to the existing Foidel Creek Mine surface facilities. The LBA would allow continued operations by providing a logical extension to the mine's current Wadge and Wolf Creek seam operation. TC used a longwall mining system to mine the Wadge seam, and is presently using a longwall system to mine the Wolf Creek seam. The same or a similar longwall system would be used to mine the Wolf Creek seam as included in the LBA. The longwall panels in the Wolf Creek seam would be mined in the same orientation as the Wadge coal seam (northeast-southwest). Portions of sub-main entries, gateroads, bleeders, and four longwall panels would fall within the proposed lease area. Pillars would be left in place in the gateroads and bleeders and full extraction of the coal would occur in the longwall blocks. Annual production from the mine (federal, private, and state leases) would continue to be approximately 3.4 million tons.

Controlled subsidence (i.e., the land surface lowered as a result of mining) would occur over the longwall panels. TC's maximum predicted subsidence above the longwall panels would be 70 to 76 inches for overburden thickness of 1,000 feet (see Section 3.3, Minerals). Subsidence monitoring above a previously mined longwall panel in the Wadge coal seam showed subsidence to be less than predicted (TC 2002). Mining of longwall panels has already occurred beneath Routt County Road 27, Union Pacific Railroad's Energy Spur, and the Archer-Hayden and Craig-Hayden-Steamboat Power Line. Subsidence from longwall mining has not interfered with the use of these structures.

It is assumed that the coal would be transported to market using the existing coal handling facilities, the existing spur rail line, and existing truck routes. TC sells approximately 66% of coal produced from the Foidel Creek Mine to a broker who then sells it to foreign and domestic power companies and industrial users, which fluctuates. Then TC sells the remaining 33% to the Hayden Generating Station.

The LBA represents about 2 years of coal reserves based on the current rate of mining at the Foidel Creek Mine. Mining in the Wolf Creek seam in the LBA would begin with underground longwall development starting in about 2022. Mining of the longwall panels would be from about 2026 to 2028. Some variations to these timeframes may occur based on permitting, unforeseen mining or geologic circumstances, coal contract variability, etc.

Reasonably Foreseeable Post-lease Surface Use. Current surface facilities are operation and maintenance facilities associated with the mine. These facilities include a railroad, rail loadout, truck loadout, overland conveyors, offices, maintenance shop, coal preparation plants, and mine portals. The BLM does not anticipate that leasing of the LBA tract would result in any other surface disturbance.

2.1.2 No Action Alternative

In accordance with NEPA and the Council on Environmental Quality (CEQ) regulations, which require that a No Action Alternative be presented in all environmental analyses in order to serve as a “baseline” or “benchmark” from which to compare all proposed “action” alternatives, this EA analyzes a No Action Alternative.

Under the No Action Alternative, the coal lease would not be issued. As a result, federal coal reserves (4.68 million tons) within the applied for tract would not be recovered and would be bypassed. Denying the LBA could reduce recoverable coal resources on adjoining leases by approximately 8 million tons (BLM 2017a) due to the configuration of the longwall panels and not being able to extend the panels as far as if the LBA were approved. It is unlikely the LBA coal reserves would be recovered at a future time because there would be no logical competitive interest based upon the patchwork of coal ownership. The LBA would allow a continuum of an existing mining block and would not represent an economic venture based on a stand-alone development of the property. The only logical access is from TC’s existing operation and adjacent leases.

2.2 Alternatives Considered but not Analyzed in Detail

If an alternative is considered during the environmental analysis process, but the agency decides not to analyze the alternative in detail, the agency must identify those alternatives and briefly explain why they were eliminated from detailed analysis (40 CFR 1502.14). An alternative may be eliminated from detailed analysis if:

- It is ineffective (does not respond to the Purpose and Need for the Proposed Action);
- It is technically or economically infeasible (considering whether implementation of the alternative is likely, given past and current practice and technology);
- It is inconsistent with the basic policy objectives for the management of the area (such as, not in conformance with the RMP);
- Its implementation is remote or speculative;
- It would cause unreasonable environmental harm;
- It is substantially similar in design to an alternative that is analyzed; and/or
- It would result in substantially similar impacts to an alternative that is analyzed.

Alternatives specific to this EA that were considered, but that will not be analyzed in detail, are discussed below.

2.2.1 Methane Capture

Methane (CH_4) is released both naturally and as a direct result of the physical process of coal extraction. Methane concentrations between 5 to 15% are explosive. Methane concentrations must be less than 1% to protect underground workers (30 CFR § 75.323). Underground coal mining techniques release methane contained within the coal seam into the air supply of the mine as the coal is mined, thus creating a potential safety hazard. Methane emissions also arise from the collapse of the overlying rock strata after a section of the coal seam has been mined and the artificial roof supports are removed as mining progresses. The debris resulting from the collapse is known as gob and also releases methane or ‘gob gas’ into the mine.

Coalbed methane or coal-mine methane (CMM) is a form of natural gas that can be extracted from coal beds under certain favorable conditions. In recent decades it has become an important source of energy in many countries. An alternative that was considered, but eliminated from detailed analysis is capturing the CMM from the mining of the additional 640 acres of the coal. This alternative was eliminated from analysis because low methane concentrations and other factors render it technically infeasible and implementation is remote or speculative. The obstacles include technical challenges, power prices, and pipeline capacity, quantity of gas, and quality constraints.

Methane released from both active mining and gob areas can be diluted and removed by ventilation systems designed to move large volumes of air through the mine. These systems are designed to maintain adequate airflow in working areas, consistent with applicable regulatory requirements, and effectively dilute methane within the mine to concentrations below the explosive range of 5 to 15%, with a target for methane concentrations under 1 percent. The ventilation systems move the air and contained dilute methane out of the working areas of the mine to portals or ventilation shafts exposed at the surface. The methane removed from working mines via this technique is known as Ventilation Air Methane (VAM). The VAM is released through the ventilation portals/shafts and released directly to the atmosphere. VAM has the lowest concentration levels of all forms of methane from coal seams because of the dilution effects of the large quantities of associated air; often displaying levels of 0.05 to 0.8%.

To pre-empt the release of gob gas from post-mining collapse, it is possible for vertical gob wells to be drilled directly into the coal seam’s surrounding strata before mining activities pass through that section. These pre-drilled wells can then remove the gob gas once the collapse takes place, thus avoiding the release of methane directly into the mine.

Under the RFMP, all of the methane from the 640-acre lease and from the mine can be vented through the mine ventilation system efficiently. TC does not use gob wells (gob vent boreholes) because the methane concentrations of the mine are low and can be vented through the existing mine ventilation system to keep concentrations within Mine Safety and Health Administration (MSHA) regulations. Additionally, a gob well would require surface disturbance, which could result in associated environmental impacts. There is no surface disturbance associated with the Proposed Action within the lease boundary.

Currently, there are more than 1,000 underground coal mines in the United States (U.S.). There are presently only 15 coal mine methane recovery and utilization projects at active underground coal mines. The Foidel Creek Mine is not a gassy mine and was not identified as a candidate for methane recovery in the U.S. Environmental Protection Agency's (EPA's) Coalbed Methane Outreach Program (CMOP) report (EPA 2018a). A 2012 study by Vessels Coal Gas, Inc. (VCG), in the Paonia to Somerset corridor evaluated the need for volumes on the order of 10,000,000 cubic feet per day of methane to justify the costs for gas treating and pipeline facilities that would be required to access commercial natural gas markets (VCG 2012). The volume of methane from TC's main fan averaged 191,000 cubic feet of methane per 24 hour period for the first 11 months of 2017. TC's secondary fan averaged 29,300 cubic feet of methane per 24 hour period for the first 11 months of 2017.

Practical constraints on commercial development of methane or natural gas in this area include the depth of the resource, the occurrence of the resource, resource quality and quantity, and limitations relative to effective resource development and production and the mine life. EPA's Identifying Opportunities for Methane Recovery at U.S. Coal Mines (EPA 2009) states: "Life expectancy refers to the number of years left in the mine's plan for mining coal; it can be an important factor in determining whether a mine is a good candidate for a methane recovery and use project." Prediction of mine life is difficult and speculative. Mining of the Wolf Creek seam in state and fee coal could extend the mine life an additional 9 years or more, but mine life is dependent on numerous factors, and can easily change. Mining of the 640-acre LBA is estimated to occur intermittently over approximately 5 to 6 years and would extend the life of the mine by approximately 2 years.

There is no gas transmission pipeline in the immediate area and a market for the gas would be required. Only high quality gas (greater than 95% methane) can be used for pipeline injection, if a pipeline existed. Technologies for VAM capture are still in the developmental stage and cost information is still limited.

Therefore, implementation of methane capture is not reasonably feasible, given site-specific conditions and constraints and past and current practice and technology.

2.2.2 Methane Flaring

The alternative to flare the methane created by mining an additional 640 acres of the Wolf Creek coal seam was also considered and eliminated from detailed analysis. BLM determined it to be technically infeasible and its implementation is remote and speculative.

The EPA is currently sponsoring research and outreach efforts to coal mine operators to encourage coalbed and coal mine methane capture or flaring. The methodology for flaring methane emissions from underground coal mines is emerging, but remains technologically speculative at this time. In 2014, 20 methane flaring projects were operating in seven countries. The only methane flaring project on an active mine in the U.S. is at an underground trona (soda ash) mine in Green River, Wyoming. The hazard that flaring could create relative to the potential for an underground ignition has not been clearly dismissed by current technology. MSHA does not have regulations that would govern this activity, but has expressed concerns relative to safety with respect to the potential for propagation of fire through methane drainage boreholes into underground mines. MSHA would not approve flaring without significant preliminary testing to assure the safety of the miners. There would also be an associated potential fire hazard where flammable brush, trees, or other vegetation exists in close proximity to the wellhead. The BLM does not have a policy governing flaring of gas from coal mining operations, so the issue of whether or not a gas lease would be required is unclear. These outstanding questions would have to be resolved if flaring is considered as an alternative to discharging methane into the atmosphere.

Under the RFMP, it is anticipated that all of the methane from the 640-acre LBA and from the mine can be vented through the mine ventilation system safely and efficiently, though unanticipated mining conditions may necessitate ventilation system modification. TC does not use methane drainage wells because the methane concentrations are low and can be vented through the existing mine ventilation system to keep concentrations within MSHA regulations. Additionally, methane drainage wells would require surface disturbance, which could cause environmental impacts.

Flaring of methane would result in the release of other air pollutants, including nitrogen oxides (NOx), carbon dioxide (CO_2), and carbon monoxide (CO); these pollutants are regulated by the EPA for National Ambient Air Quality Standards (NAAQS). Methane is not a regulated gas. Therefore, the implementation of methane flaring is unlikely, given past and current practice and technology.

2.2.3 Alternative Mining Levels

A scoping comment requested the BLM consider an alternative that limits the amount of coal tonnage and/or acreage to be mined to lower levels than are currently proposed. The comment states that such an alternative "will limit the extent to which the direct and indirect impacts of mining, hauling, and coal combustion will occur, as well as incentivize power plant owners to develop alternative non-coal-fired electricity generation." The comment is remote or speculative that reducing the tonnage and or acreage in the LBA would incentivize coal-fired power plant owners to develop alternative non-coal-fired electricity generation. The comment presumes that limiting the amount of coal would result in alternative non-coal electricity generation. Incentivizing alternative electricity generation is a political and policy determination. Given the complexities of the power generation market, presuming a reduction in the tonnage and/or acreage would be speculative. The comment is also ineffective, as it does not respond to the Purpose and Need for the Proposed Action.

The EA analyzes a reasonably foreseeable Proposed Action that includes a mine plan that complies with MLA as amended by FCLAA by evaluating longwall mining as the method that achieves the maximum economic recovery of the coal within the proposed leasing tract (FCLAA Sec. 3 (C)).

An alternative to limit the amount of coal tonnage and/or acreage to be mined is technically or economically infeasible considering whether implementation of the alternative is likely, given past and current practice and technology. The reasonably foreseeable mine plan has three longwall panels in the LBA. Eliminating a longwall panel would reduce the tonnage and acreage mined but would not be economically feasible. About half of the third longwall panel development would be completed by the development of the second longwall panel. By not continuing the development of the third longwall panel nor mining a third longwall panel makes a smaller acreage/smaller tonnage LBA economically infeasible. The cost of mining the second longwall panel would be economically infeasible without the recovery of the coal in the third longwall panel. The RFMP represents a logical sequence of mining, incorporating the company's existing non-federal leases and the LBA which optimizes coal mining operations and productivity to meet mine economic constraints. A reduction in the coal production tonnage and/or minable area would adversely impact mine sequencing, coal recovery, and mine economics, making the alternative mining level economically infeasible.

2.2.4 Use of Low or No Pollutant Emitting Equipment

This alternative would require the use of equipment that produces less or no emissions, such as natural gas-fired vehicles and electric machinery powered by solar panels or other renewable energy sources.

Public comments also suggested considering an alternative that required the reduced air emissions at the mine by changing or modifying mining-related equipment to equipment that would produce lower air emissions.

Underground coal mining equipment is very specialized and is regulated by MSHA. Natural gas-fired equipment is not permissible in underground coal mines; its use would be a violation of MSHA regulations. The only internal combustion engines (ICE) that are allowed in underground coal mines would be MSHA-approved diesel engines that comply with "Subpart T" of 30 CFR Part 75. The modification to alternative fuels and its implementation would be speculative.

In addition, the use of solar power to run large electrical equipment has not been tested and is not considered technologically feasible at this time. Construction of a solar array, transmission lines, and electrical substations to power the longwall, continuous miners, roof bolters and other electrically powered underground equipment for 640 acres of coal would not be economically or technologically feasible. Mining activities occur 24 hours per day, 7 days per week. Large amounts of surface disturbance would be required to construct a solar array. Transmission lines would have to be constructed, requiring additional surface disturbance. The BLM has not brought forward this alternative for full analysis because requiring natural gas and solar powered engine technology and retrofitting existing equipment is not economically or technically feasible for all equipment, and would likely have substantially similar effects to alternatives that are already analyzed.

2.2.5 Requiring More Rigorous Air Quality Mitigation Measures

This alternative would require more stringent mitigation to eliminate nitrogen dioxide (NO_2) emissions and would require compensatory reduction in emissions for any and all emissions that would continue and/or increase as a result of the proposed coal lease operations.

Some public comments suggested that the BLM consider an alternative that mitigates air quality impacts, specifically by imposing more stringent emission limits at power plants fueled by the Foidel Creek Mine and for any and all emissions that would continue and/or increase as a result of the proposed coal lease operations.

These proposals are not alternatives to the mining plan being considered. The effects of coal combustion are analyzed in the RFMP as well as in the No Action Alternative because they are considered to be indirect effects. CEQ regulations at 40 CFR 1508 (b) define "indirect effects" as those which are caused by the proposed action and are later in time or farther removed in distance, but are still reasonably foreseeable. These indirect effects would occur as a result of burning the coal that is mined. BLM has no authority to impose more stringent emission limits at generating stations and therefore its implementation would be highly remote and speculative.

2.2.6 Limit or Reduce Other Greenhouse Gas Emissions

This alternative would require the applicant to secure an increase in the efficiency of the power plants it fuels, either through contractual terms or other mechanisms to reduce the total CO_2 emission rate, require the use of low carbon fuels for the operation of any heavy machinery and/or require that the applicant use renewable energy to power the Foidel Creek Mine. These proposals are not alternatives to the mine plan or the LBA being considered. The effects of coal mining and coal combustion are analyzed in the RFMP as well as in the No Action Alternative because they are considered to be indirect effects. These indirect effects would occur as a result of mining and coal combustion. Neither BLM nor the applicant have the authority to impose limits at the generating station. There is no available renewable energy source that transmits electricity to the mine.

2.2.7 Require Offsite Mitigation or Compensation for the Impacts

This alternative would require the applicant to offset its CO_2 emissions from the mine and power plants it fuels with offsite mitigation by developing a comparable amount of renewable energy. This alternative was not considered further because:

- Its implementation is remote or speculative; and
- Development of a comparable amount of renewable energy would require construction of a renewable source of energy. Large amounts of surface disturbance would be required to construct a wind farm or solar array to generate a comparable amount of electricity. Transmission lines would have to be constructed, requiring additional surface disturbance. It is beyond BLM’s control and outside the scope of the project geographically and jurisdictionally.

CHAPTER 3 – AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

The CEQ Regulations state that NEPA documents "must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail" (40 CFR 1500.1(b)). While many issues may arise during scoping, not all of the issues raised warrant analysis in an EA. Issues will be analyzed if: 1) an analysis of the issue is necessary to make a reasoned choice between alternatives, or 2) if the issue is associated with a significant direct, indirect, or cumulative impact, or where analysis is necessary to determine the significance of the impacts. Table 1 (Appendix A) lists the resources considered and the determination as to whether they require analysis.

Past, Present, Reasonably Foreseeable Actions

NEPA requires federal agencies to consider the cumulative effects of proposals under their review. Cumulative effects are defined in the CEQ regulations 40 CFR §1508.7 as "…the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions regardless of what agency…or person undertakes such other actions." The CEQ states that the "cumulative effects analyses should be conducted on the scale of human communities, landscapes, watersheds, or airsheds" using the area that might be affected by the proposed action.

Past, present, and reasonably foreseeable actions include coal mining, reclamation, livestock grazing, sand and gravel operations, and right-of-ways for utilities. Past coal mining in the area includes the surface Energy Strip #1, the surface Yoast Mine, the surface Seneca I, Seneca II, and Seneca IIW mines, the surface Johnson, the surface Commander Strip #1 and #3, the surface Fish, the surface Linholm, the underground Mt. Harris Mine and the surface Edna Mine. Reclamation of the Seneca II, Seneca IIW, and Yoast Mines would continue. The Sage Creek Mine was idled in 2012. There are two permitted private sand and gravel operations in T6N, R85W and two permitted private sand and gravel operations in T6N, R86W. These sand and gravel operation permits total 300 acres.

Reasonably foreseeable future actions include: the continued mining at the Foidel Creek Mine for approximately 9 years. Sage Creek Mining was issued a DRMS permit in 2010 and was issued a 400-acre lease effective October 1, 2012. Mining began at Sage Creek in May of 2012 and was idled in September 2012 until market conditions improve. Reclamation of past surface mining would continue. Mining of sand and gravel would continue.

Reasonably foreseeable future activities that may affect river-related resources within the Yampa and White river watersheds include coal mining and combustion, oil and gas exploration and development, irrigation, urban development, recreational activities, livestock grazing, and activities associated with the Upper Colorado River Endangered Fish Recovery Program.

3.1 Air Quality and Climate

3.1.1 Affected Environment

The Foidel Creek Mine is located in the central portion of Routt County, Colorado, approximately 15 miles southeast of Hayden, Colorado. The project area is within the Central Mountains region for air quality planning (Colorado Department of Public Health and Environment [CDPHE] 2017). The Central Mountains Region includes 12 counties in the central area of Colorado, including Routt County, and the Continental Divide passes through much of the region. Air quality concerns in these regions are primarily from impacts related to particulate pollution from wood burning and road dust.

The project area is located in a semiarid (dry and cold), mid-continental climate regime. The area is typified by dry, sunny days, clear nights, and large daily temperature changes. The nearest long-term meteorological measurements were collected at Pyramid, Colorado (1910-2005), located 13 miles south of the project area at an elevation of 8,080 feet above mean sea level (amsl) (Western Regional Climate Center [WRCC] 2018).

In this region, historical records show the lower elevations receiving relatively higher precipitation amounts in summer, while the higher elevations receive relatively higher amounts of precipitation in winter. The annual average total precipitation at Pyramid is 21.15 inches, with annual totals ranging from 12.76 inches (1963) to 31.59 inches (1983). Precipitation increases in the winter months, with average monthly precipitation ranging from 1.44 inches (June) to 2.11 inches (March). An average of 182.1 inches of snow falls during the year (annual high 266.5 inches in 1974), with the majority of the snow distributed between November and April with January the peak month, averaging 31.2 inches.

The region has cool temperatures, with average temperature (in degrees Fahrenheit [˚F]) ranging between 7.9˚F and 33.4˚F in January to between 42.9˚F and 73.9˚F in July. Extreme temperatures have ranged from -31˚F (1924) to 89˚F (1911). The frost free period generally occurs from June to August.

The closest comprehensive wind measurements were collected at the Hayden, Yampa Valley airport located approximately 10 miles northwest of the project area. Although local wind patterns in mountainous areas are almost always controlled by local topography, the Hayden site located at 6,600 feet above mean sea level (amsl) can be used to describe typical wind patterns in the project area. At this site, the winds originate from the east to southeast over 39% of the time and the annual mean wind speed is 7.8 miles per hour (mph).

Air quality impacts from pollutant emissions are limited by regulations, standards, and implementation plans established under the Clean Air Act (CAA), as administered by the CDPHE Air Pollution Control Division (APCD) under authorization of the EPA. The APCD is the primary air quality regulatory agency responsible for determining potential impacts once detailed industrial development plans have been made, and those development plans are subject to applicable air quality laws, regulations, standards, control measures, and management practices. Unlike the conceptual “reasonable, but conservative” engineering designs used in NEPA analyses, any APCD air quality preconstruction permitting demonstrations required would be based on very site-specific, detailed engineering values, which would be assessed in the permit application review. Any proposed facility that meets the requirements set forth under division permit regulations is subject to the Colorado permitting and compliance processes.

Federal air quality regulations adopted and enforced by the CDPHE-APCD limit incremental emission increases to specific levels defined by the classification of air quality in an area. The Prevention of Significant Deterioration (PSD) program is designed to limit the incremental increase of specific air pollutant concentrations above a legally defined baseline level. Incremental increases in PSD Class I areas are strictly limited, while increases allowed in Class II areas are less strict. All areas of the country are assigned a classification that describes the degree of degradation to the existing air quality allowed to occur within the area under the PSD permitting rules. PSD Class I areas are areas of special national or regional natural, scenic, recreational, or historic value, and very little degradation in air quality is allowed by strictly limiting industrial growth. PSD Class II areas allow for reasonable industrial/economic expansion.

Under the PSD program, Class I areas are protected by Federal Land Managers through management of Air Quality Related Values (AQRVs), such as visibility, aquatic ecosystems, flora, fauna, and others. Areas throughout the region not designated as PSD Class I are classified as Class II. Federal Land Managers can designate specific Class II areas that they manage as “sensitive” Class II areas, based on their own criteria, and request that PSD Class I level air quality analyses be included for these areas.

Regulations and standards which limit permissible levels of air pollutant concentrations and air emissions and are relevant to the project air impact analysis include:

- NAAQS (40 CFR Part 50) and Colorado Ambient Air Quality Standards (CAAQS) (5 Code of Colorado Regulations [CCR]-1001-14);
- Hazardous Air Pollutants (HAPs);
- PSD (40 CFR Part 51.166);
- New Source Performance Standards (NSPS) (40 CFR Part 60);
- National Emission Standards for Hazardous Air Pollutants (NESHAPS) (40 CFR Part 63);
- Non-Road Engine Tier Standards (40 CFR Part 89); and
- Colorado Air Quality Control Commission Regulations (Regulations 1, 3, and 8).

Air pollutants monitored in the region include the criteria pollutants CO, NO_2, ozone (O_3), particulate matter less than 10 microns in effective diameter (PM_{10}), particulate matter less than 2.5 microns in effective diameter ($PM_{2.5}$), and sulfur dioxide (SO_2). Background concentrations of these pollutants define ambient air concentrations in the region and establish existing compliance with ambient air quality standards. The most representative monitored regional background concentrations available for criteria pollutants (CDPHE 2018a; EPA 2018b) are shown in Table 2 (Appendix A). As indicated in Table 2, all background concentrations are below the levels of the NAAQS and CAAQS.

AQRVs have been identified as a concern at several Federal Class I and sensitive Class II areas in the region. The project area is within 200 kilometers (km) of eight Class I areas and two sensitive Class II areas as shown on Map 3 (Appendix A). Class I areas within 200 km of the project area include the Eagles Nest, Flat Tops, Maroon Bells (Snowmass), Mount Zirkel, Rawah, Savage Run, and West Elk wilderness areas, and Rocky Mountain National Park. Federal Class II areas within 200 km of the project area that are considered sensitive areas include the Raggeds Wilderness Area and Dinosaur National Monument. Dinosaur National Monument is regulated as a Class I area for SO_2 by the CDPHE. A discussion of the applicable AQRV analysis thresholds is provided below. Evaluation of potential impacts to AQRVs would be performed during the New Source Review permitting process under the direction of the CDPHE-APCD in consultation with the Federal Land Managers.

As part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) program, continuous visibility-related optical background data have been collected in the Flat Tops Wilderness Area (Class I area closest to the project area). The average standard visual range (SVR) at the Flat Tops Wilderness is historically greater than 150 km and in the most recent reported years, the average SVR has increased to greater than 200 km (IMPROVE 2017).

A National Atmospheric Deposition Program's (NADP's) National Trends Network (NTN) station monitors wet atmospheric deposition and Clean Air Status and Trends Network (CASTNET) station monitors dry atmospheric deposition at the Gothic site, located south of the project area near Crested Butte. The total annual deposition (wet and dry) reported as nitrogen (N) and sulfur (S) deposition for years 2006 through 2015 are shown in Table 3 (Appendix A).

Climate change is a statistically-significant and long-term change in climate patterns. The terms climate change and "global warming" are often used interchangeably, although they are not the same thing. Climate change is any deviation from the average climate, whether warming or cooling, and can result from both natural and human (anthropogenic) sources. Natural contributors to climate change include fluctuations in solar radiation, volcanic eruptions, and plate tectonics. Global warming refers to the apparent warming of climate observed since the early 20th century and is primarily attributed to human activities such as fossil fuel combustion, industrial processes, and land use changes.

The natural greenhouse effect is critical to the discussion of climate change. The greenhouse effect refers to the process by which greenhouse gases (GHGs) in the atmosphere absorb heat energy radiated by Earth's surface and re-radiate some of that heat back toward Earth, causing temperatures in the lower atmosphere and on the surface of Earth to be higher than they would be without atmospheric GHGs. These GHGs trap heat that would otherwise be radiated into space, causing Earth's atmosphere to warm and making temperatures suitable for life on Earth. Without the natural greenhouse effect, the average surface temperature of Earth would be about 0˚F. Higher concentrations of GHGs amplify the heat-trapping effect resulting in higher surface temperatures. Water vapor is the most abundant GHG, followed by CO_2, CH_4, nitrous oxide (N_2O), and several trace gases. Water vapor, which occurs naturally in the atmosphere, is often excluded from the discussion of GHGs and climate change because its atmospheric concentration is largely dependent upon temperature rather than being emitted by specific sources. Other GHGs, such as CO_2 and CH_4, occur naturally in the atmosphere and are also emitted into the atmosphere by human activities.

All of the different greenhouse gases have various capacities to trap heat in the atmosphere, known as global warming potentials (GWPs). Several different time horizons can express GWPs to fully account for the gases' ability to absorb infrared radiation (heat) over their atmospheric lifetime. The BLM uses the 100-year time interval because most of the climate change impacts derived from climate models are expressed toward the end of the century. Carbon dioxide has a GWP of one, and so for the purposes of analysis a GHGs GWP is generally standardized to a carbon dioxide equivalent (CO_2e), or the equivalent amount of CO_2 mass the GHG would represent. Methane has a current GWP estimated to be between 28 (gas alone) and 36 (with climate feedbacks), and N_2O has a GWP of 298 (Intergovernmental Panel on Climate Change [IPCC] 2013).

Current understanding of the climate system comes from the cumulative results of observations, experimental research, theoretical studies, and model simulations. The IPCC Fifth Assessment Report (AR5) (IPCC 2013) uses terms to indicate the assessed likelihood of an outcome ranging from exceptionally unlikely (0 to 1% probability) to virtually certain (99 to 100% probability) and level of confidence ranging from very low to very high. The findings presented in AR5 indicate that warming of the climate system is unequivocal and many of the observed changes are unprecedented over decades to millennia. It is certain that Global Mean Surface Temperature has increased since the late 19th century and virtually certain (99 to 100% probability) that maximum and minimum temperatures over land have increased on a global scale since 1950. The globally averaged combined land and ocean surface temperature data show a warming of 1.5 °F. Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea-level rise, and in changes in some climate extremes. It is extremely likely (95 to 100% probability) that human influence has been the dominant cause of the observed warming since the mid-20th century (IPCC 2013).

The U.S. Global Change Research Program released the third U.S. National Climate Assessment (NCA) in May 2014. The Assessment documents climate change impacts that are currently occurring and those that are anticipated to occur throughout this century. It also provides region-specific impact assessments for key sectors such as energy, water, and human health.
The Assessment summarizes their conclusions in a number of Key Messages (NCA 2014a), several of which are excerpted here:

- Global climate is changing and this change is apparent across a wide range of observations. The global warming of the past 50 years is primarily due to human activities.
- Global climate is projected to continue to change over this century and beyond. The magnitude of climate change beyond the next few decades depends primarily on the amount of heat-trapping gases emitted globally, and how sensitive the Earth's climate is to those emissions.
- U.S. average temperature has increased by 1.3°F to 1.9°F since record keeping began in 1895; most of this increase has occurred since about 1970. The most recent decade was the nation's warmest on record. Temperatures in the United States are expected to continue to rise. Because human-induced warming is superimposed on a naturally varying climate, the temperature rise has not been, and will not be, uniform or smooth across the country or over time.
- Average U.S. precipitation has increased since 1900, but some areas have had increases greater than the national average, and some areas have had decreases. More winter and

spring precipitation is projected for the northern United States, and less for the Southwest, over this century.
- Global sea level has risen by about 8 inches since reliable record keeping began in 1880. It is projected to rise another 1 to 4 feet by 2100.
- The oceans are currently absorbing about a quarter of the carbon dioxide emitted to the atmosphere annually and are becoming more acidic as a result, leading to concerns about intensifying impacts on marine ecosystems.

The Assessment provided analysis of projected climate change by region, and the project is part of the Southwest region. The Key Messages for this region (NCA 2014b) are as follows:

- Snowpack and streamflow amounts are projected to decline in parts of the Southwest, decreasing surface water supply reliability for cities, agriculture, and ecosystems.
- The Southwest produces more than half of the nation’s high-value specialty crops, which are irrigation-dependent and particularly vulnerable to extremes of moisture, cold, and heat. Reduced yields from increasing temperatures and increasing competition for scarce water supplies will displace jobs in some rural communities.
- Increased warming, drought, and insect outbreaks, all caused by or linked to climate change, have increased wildfires and impacts to people and ecosystems in the Southwest. Fire models project more wildfire and increased risks to communities across extensive areas.
- Flooding and erosion in coastal areas are already occurring even at existing sea levels and damaging some California coastal areas during storms and extreme high tides. Sea level rise is projected to increase as Earth continues to warm, resulting in major damage as wind-driven waves ride upon higher seas and reach farther inland.
- Projected regional temperature increases, combined with the way cities amplify heat, will pose increased risks to public health in southwestern cities, which are home to more than 90 percent of the region’s population. Disruptions to urban electricity and water supplies will exacerbate these health problems.

All climate model projections indicate future warming in Colorado (BLM 2015b). The statewide average annual temperatures are projected to warm by +2.5 ºF to +5 ºF by 2050 relative to a 1971 to 2000 baseline under Representative Concentration Pathway (RCP) 4.5 (IPCC 2013). Summer temperatures are projected to warm slightly more than winter temperatures, where the maximums would be similar to the hottest summers that have occurred in the past 100 years. Precipitation projections are less clear. Nearly all of the models predict an increase in winter precipitation by 2050, although most projections of snowpack (April 1 snow-water equivalent measurements) show declines by mid-century due to projected warming. Late-summer flows are projected to decrease as the peak shifts earlier in the season, although the changes in the timing of runoff are more certain than changes in the amount of runoff. In general, the majority of published research indicates a tendency towards future decreases in annual streamflow for all of Colorado’s river basins. Increased warming, drought, and insect outbreaks, all caused by or linked to climate change, will continue to increase wildfire risks and impacts to people and ecosystems.

3.1.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: Detailed air quality impact analysis for this project is provided in Appendix C. The BLM has developed the Colorado Air Resource Protection Protocol, which is a strategy to address air resource concerns consistently across district and field offices (BLM 2013). This protocol is followed in this EA to evaluate potential impacts to air resources.

Under FLPMA and the CAA, the BLM cannot conduct or authorize any activity that does not conform to all applicable local, state, tribal, or federal air quality laws, statutes, regulations, standards, or implementation plans. As such, significant impacts to air quality from project-related activities would result if it is demonstrated that:

- NAAQS or CAAQS would be exceeded, or
- AQRVs would be impacted beyond acceptable levels.

Air pollutant emissions would occur as part of direct and indirect activities related to the Foidel Creek Mine operations. The primary pollutants emitted include PM_{10}, $PM_{2.5}$, NOx, CO, SO_2, volatile organic compounds (VOCs), and GHGs.

Direct Emissions

Stationary sources at the Foidel Creek Mine are regulated by CDPHE-APCD where applicable and are authorized by permit number 93RO1204, issued on November 25, 2014. While actual annual coal production at the mine would continue to be approximately 3.4 million tons under the RFMP, the air quality permit authorizes up to 11.2 million tons of coal to be produced and processed annually. The 11.2 million tons per year limit on coal production limits potential emissions from the site to below major source thresholds for certain criteria pollutants. The development of additional coal reserves within the proposed LBA area would not require an increase in annual permitted production rate nor require an increase in maximum permitted air pollutant emissions. The Foidel Creek Mine is currently classified as a synthetic minor source for all criteria pollutants and therefore is not subject to PSD. According to the mine's 2016 production data, the mine is operating below its permitted production limits at approximately 23% of approved capacity. Consequently, actual air emissions are also well below permitted levels.

Sources of direct emissions at the Foidel Creek Mine include the following:

- Point sources such as material handling, transfer, crushing, screening, and loading, propane vent shaft heaters, mine ventilation, and internal combustion engines;
- Fugitive sources such as stockpile wind erosion, travel on unpaved haul roads, and heavy equipment operation;
- Fuel storage tanks;
- Ventilation air methane (VAM); and
- Mobile sources such as diesel-fired underground mining equipment and surface vehicles and equipment.

Table 4 (Appendix A) summarizes emission rates for these direct emissions sources. Emissions from permitted point and fugitive sources are taken from CDPHE-APCD permit 93RO1204 and are based on the permitted production rate of 11.2 million tons per year (tpy). Fuel storage tank emissions are exempt from permitting; therefore emissions are based on exemption thresholds. VAM for the Foidel Creek Mine is given as reported in the 2016 Greenhouse Gas Reporting Program Data Summary (EPA 2017). Mobile source emissions calculations are based on annual diesel and gasoline use at the mine as discussed below.

Greenhouse gases and minor amounts of HAPs are also emitted from fuel combustion sources. CMM would also be emitted by the ventilation air handling system required by MSHA to reduce the combustion/explosion potential of the mines underground atmosphere (also known as VAM). The operator does not drill gob vent boreholes (GVB) for its longwall operations at the Foidel Creek Mine to vent methane due to the area's naturally low occurring presence of the gas in the coal formation, overburden, and surrounding strata. VAM is the only source of CMM emissions at the Foidel Creek Mine.

Methane is not a regulated VOC. However, recent analyses of CMM gas from other mines in Colorado, including the West Elk and Elk Creek mines in the North Fork Valley (Delta and Gunnison counties), indicate that regulated VOCs make up a minor component of the CMM constituents, and these gases would be released as result of CMM venting. CDPHE, as the regulatory authority for such emissions, sent a letter to coal mines throughout the state requesting that mines provide data that would allow them to determine the status of each mine with respect to the state's VOC permitting thresholds. The Foidel Creek Mine and other mines in Colorado have not yet provided that information to the CDPHE.

Hazardous Air Pollutant emissions from stationary sources are considered de minimis. For the purposes of disclosing impacts from the alternatives proposed, insufficient data and analysis exists (as stated above) to determine if any component of the ventilation air emissions would be considered a hazardous air pollutant. Any HAP emissions from VAM would most likely be a tiny fraction of the VOC component, and would not be significant enough to analyze. Of the sources identified above, only the fuel tanks, internal combustion engines, and miscellaneous heating equipment would generate HAP emissions. Because of the limited use or the exempt status (CDPHE Air Pollutant Emission Notice [APEN] and permitting) of the identified units, expected cumulative HAP emissions from these sources would be below the required reporting threshold value, and therefore will not be analyzed any further in this document.
Mobile sources at the facility include underground mining equipment, above-ground construction equipment, as well as light-duty gasoline trucks and light- and heavy-duty diesel trucks. The underground mining mobile sources are specialized, industry-specific equipment designed to function in the unique environment of an underground mine, while the aboveground sources would be typical heavy construction equipment used for material handling and stockpile management.

TC provided the annual fuel use (diesel and gasoline) for these sources, and the analysis assumes that all the diesel fuel is consumed in the heavy equipment, which would produce conservative emissions estimates based on their higher emissions rates, and all gasoline is consumed on the surface in light-duty trucks. To estimate emissions from both categories of mobile sources operating at the facility, EPA's MOVES Version 2014a was used to generate equipment- and year-specific emission factors for nonroad and on-road vehicles. These emission factors were combined with annual horsepower-hours (nonroad equipment) and vehicle miles travelled (on-road gasoline equipment) to calculate criteria pollutant and GHG emissions summarized in Table 4 (Appendix A). The emissions shown in Table 4 are existing emissions, not newly proposed emissions. There is no increase in annual emissions associated with the RFMP beyond those currently permitted and operating.

Indirect Emissions

Indirect air pollutant emissions related to Foidel Creek Mine operations include those from electricity use at the mine site, employee travel to and from the mine, and transport of coal to contract customers by locomotive. These activities produce pollutant emissions but are not directly attributed to, authorized, or permitted.

Electrical energy consumed at the site can reasonably be expected to produce emissions from the supplying source, unless that source is some form of renewable energy. It is possible to provide rough estimates of emissions resulting from mine electricity consumption if the annual energy consumption data is known. Reasonable emissions estimates can be made by making use of EPA's Emissions & Generation Resource Integrated Database (eGRID). The eGRID tool is a comprehensive inventory of environmental attributes of electric power systems and is based on available plant-specific data for all U.S. electricity generating plants that provide power to the electric grid and report data to the U.S. government, including the following agencies: EPA, the Energy Information Administration (EIA), and the Federal Energy Regulatory Commission (FERC). Emissions data collected by the EPA is integrated with generation data from the EIA to produce useful values like pounds of emissions per megawatt-hour (lb/MWh), which allows direct comparison of the environmental attributes of electricity generation by state, U.S. total, company, and by three different sets of electric grid boundaries. Table 5 (Appendix A) provides an estimate of indirect emissions for the mine's approximate annual electrical consumption data. For the practical purposes of this EA, the BLM considers Colorado to be neither a net energy exporter, or importer, and therefore all indirect emissions estimates from mine electricity consumption are based on Colorado source data.

In 2016, 270 personnel were employed at the Foidel Creek Mine. Employees live predominantly in the towns of Hayden, Steamboat Springs, Yampa, and Oak Creek and commute to work daily. Because the specific employee travel details are not known, one vehicle round-trip per person per day is assumed to and from the town of Hayden. Based on these assumptions, a maximum of 98.550 round-trips per year could occur, with employee commuter vehicles travelling up to 3,961,710 miles each year. Actual employee mileage may be lower because ride-sharing may occur and some employees may reside nearer to the mine.

Locomotive emissions from hauling the mined and processed coal are currently occurring in the project area and would continue under the RFMP for the life of the mine, which is anticipated to extend approximately 2 years beyond its currently anticipated 9 year productive life. It is estimated that 70% of all railroad traffic in the U.S. is dedicated to the transport of coal. Although this statistic may be appropriately applied to certain metropolitan statistical areas, it may not reflect actual rail traffic composition for Routt County. The conservative assumption was made that all rail emissions in Routt County are from coal hauling, and further, that all rail emissions in Routt County are attributed to the Foidel Creek Mine's operations (although the Colowyo Mine between Craig and Meeker, Colorado, is also likely responsible for some of the coal hauling rail traffic). It is highly likely that emissions from this source class have been decreasing, and would continue to do so in the future, due to the implementation of emissions standards for new and reconstructed locomotives. The EPA estimates that the average useful life for these engines is 750,000 miles or 10 years, whichever occurs first, meaning that on average an engine is replaced or reconstructed every 10 years and would have to comply with the most stringent emissions requirement applicable to the engine at that time.

Downstream Emissions

Downstream criteria pollutant, HAP, and GHG emissions would result from the combustion of coal mined. The number and location of coal customers of the Foidel Creek Mine vary annually. According to EPA figures contained in the U.S. GHG Inventory Report: 1990-2014 (EPA 2016), nearly 93% percent of all coal consumed in the U.S. during 2014 was used in the generation of electric power. Approximately 95% of the coal shipped from the Foidel Creek Mine is sold for electrical generation and approximately 5% is sold for industrial purposes. For the purposes of this emission calculation only GHG emissions are quantified and it is conservatively assumed that 100% of the coal from the Foidel Creek Mine would be shipped to a coal-fired power plant. It would be possible to provide an estimate of Criteria and HAP emissions associated with the burning of the mined coal at a specific facility; however, the types and location of the facilities the coal might be processed and consumed in is speculative and not foreseeable. The contractual agreements between the coal-fired power plant and the coal supply company are outside the scope of this analysis, and the BLM does not determine at which facilities the future mined coal would be consumed.

Aggregated U.S. coal-fired power plant GHG emission factors are given in 2016 eGrid data (EPA 2018c). The eGrid data was used to calculate the worst-case combustion emissions for these criteria pollutants based on the heat input the modification coal, i.e. 4,679,000 tons, at a heat content of 12,680 British thermal units (Btu) per pound. Emissions are calculated using the assumption that approximately 80% (3,743,200 tons) of the coal proposed in the LBA is saleable and is combusted downstream over a 2-year period. The GHG emissions shown are in units of million metric tons (MMT) per year (Table 6, Appendix A). In addition GHG emissions are reported as total CO_2e.

Direct Impacts

The region surrounding the project area is currently designated as attainment for all criteria pollutants. The attainment designation means that no violations of ambient air quality standards have been documented in the area. Air quality impacts are measured by determining whether the area would continue to be in attainment or not.

The Foidel Creek Mine is primarily a source of PM_{10} emissions. PM_{10} tends to be a localized pollutant where concentrations can vary considerably. While actual annual coal production at the mine (federal, private, and state leases) would continue to be approximately 3.4 million tons, the current State of Colorado air quality permit issued to the Foidel Creek Mine authorizes up to

11.2 million tons of coal to be produced and processed annually. A near-field dispersion modeling analysis was completed for the Sage Creek Mine in 2010 and approved by CDPHE-APCD. The modeling simulated multiple operating scenarios and included a cumulative impact assessment by including nearby facilities: the Foidel Creek Mine, Hayden Generating Station, Connell Pit, Routt County Landfill, Milner Landfill, and Mesa Gravel Pit. Stationary and fugitive sources of PM_{10} and $PM_{2.5}$ were modeled, because these are the primary pollutants of concern emitted from aggregate handling and mining operations. Carbon monoxide and SO_2 were also modeled.

There have been several changes to sources included in that dispersion modeling analysis since its completion in 2010. The Sage Creek Mine was idled in 2012. Also, the Hayden Power Plant installed selective catalytic reduction units (SCRs) in 2015 (Unit 1) and in 2016 (Unit 2), which reduced NO_X emissions by 90 percent.

Cumulative modeling in combination with regional background concentrations demonstrated compliance with PM_{10}, $PM_{2.5}$, CO, and SO_2 ambient air quality standards. There were receptors near the Hayden Generating Station at which the cumulative 24-hour PM_{10} impacts exceeded ambient standards; however, impacts from the Sage Creek Mine alone and the Foidel Creek Mine alone were each below the modeling significance level of 5.0 micrograms per cubic meter ($\mu g/m^3$) at those locations.

The BLM will not be providing any additional analysis for direct impacts to Class I areas (AQRVs) for the RFMP given that impacts to Class I areas are very unlikely because of their distances from the mine, and fugitive dust (the majority of the PM_{10} emissions) settles out quickly from entrained air.

With respect to potential ozone formation, the Foidel Creek Mine sources (including all of the diesel-fired mobile sources) and associated processing equipment are not significant sources of VOC emissions (see earlier discussion on CMM VOC data limitations), the photochemical reactivity potential of methane in the troposphere is considered negligible (40 CFR § 51.100 (s)), and therefore the mine operations are not expected to contribute significantly to any regional ozone formation from its VOC emissions. The mine does emit a nontrivial amount of NO_X (the majority from mobile sources) on an annual basis, however the amount is not regionally significant compared to county emissions (less than 1%). Given that the area is currently attaining the ozone standard, and the mine is not anticipating changes in operations that would affect its current emissions volumes, impacts to regional air quality are not expected to produce changes from the current levels (Table 2, Appendix A).

The BLM analyzed ozone culpability of all of the mines that produce federal minerals in Colorado cumulatively, via the Colorado Air Resources Management Modeling study (CARMMS). The CARMMS model, the analysis scenarios, and results are all described in the cumulative impacts section below. The CARMMS model was also used to assess other cumulative air quality and AQRV impacts from the mines producing federal minerals in Colorado.

Methane emissions associated with the Foidel Creek Mine are anticipated to be very low when compared to other Colorado underground coal mines. The geology of the surrounding strata and composition of the coal itself produce very little emissions during longwall panel mining. As previously stated, no GVB would be drilled in advance of the mining to adequately provide for the health and safety of the miners, because emissions of any methane liberated are being adequately managed via the main vent fans at the facility. Methane emissions estimates are provided in Table 4 (Appendix A). The data represents the values reported by the mine to EPA (2016 emissions) under the Greenhouse Gas Reporting Rule.

Indirect Impacts

As related to railway emissions, in June 2008, the EPA finalized a three part program that will dramatically reduce emissions from diesel locomotives of all types (line-haul, switch, and passenger rail) (EPA 2008). The rule will cut particulate matter (PM) emissions from these engines by as much as 90% and NO_X emissions by as much as 80% when fully implemented. The rule sets new emission standards for existing locomotives when they are remanufactured to take effect as soon as certified systems are available. The rule also sets Tier 3 emission standards for newly-built locomotives, provisions for clean switch locomotives, and idle reduction requirements for new and remanufactured locomotives. Finally, the rule establishes long-term, Tier 4, standards for newly-built engines based on the application of high-efficiency catalytic after treatment technology, beginning in 2015. Therefore, it is reasonable to conclude that rail emissions in Routt County going forward should continue to substantially decrease in the near future.

Impacts from Downstream Combustion

As described above downstream combustion emissions for GHG pollutants were calculated using the assumption that approximately 80% (3,743,200 tons) of the coal proposed in the LBA is saleable and is combusted (at a coal-fired power plant) downstream over a 2-year period. Comparisons of these emissions to U.S. and global scale GHG emissions are provided below in the discussion of cumulative effects.

It is expected that about one-third (1.6 MMT) of the coal from the RFMP would be combusted at the Hayden Generating Station. The combustion location for the additional two-thirds of coal is speculative at this time. Coal from the Foidel Creek Mine is shipped to several power plants across the nation, with several contracts only lasting 1 year and destination plants often changing from year to year. Ultimately, any near or far field impacts from criteria or mercury emissions associated with coal combustion sources will have already received analysis as part of the permitting process or rule implementation from their respective regulatory agencies (state or EPA). Atmospheric deposition of mercury resulting from downstream coal combustion is further discussed in Section 3.4.

The Hayden Generating Station has two combustion units, one which went online in 1965 and the second in 1976. Both units have several components designed to decrease air emissions, including: low NOx burners, fabric filter dust collectors (baghouses), and lime spray dryers (scrubbers). In addition, SCRs for the control of NO_x emissions were installed on both units. Although not specifically designed to reduce mercury emissions, the SCR units oxidize elemental mercury and allow better collection of mercury in the scrubbers and baghouses. The SCRs went into service in 2015 (Unit 1) and 2016 (Unit 2) and effect a 30% to 77% control of mercury. The units qualify as low emitting electric generating units (LEE) for mercury under the new EPA Mercury and Air Toxic Standards.

Ultimately, any near or far field impacts from criteria or mercury emissions associated with coal combustion sources will have already received analysis as part of the permitting process or rule implementation (Best Available Retrofit Technology [BART], Mercury and Air Toxic Standard, etc.) from their respective regulatory agencies (state or EPA). Coal-fired power plants are required to have an operating permit (Title V) for any criteria pollutant for which the facility has a potential to emit greater than 100 tpy. Based on this criterion, no plant in Colorado would be exempt from this requirement. The CDPHE as the regulatory authority for such matters would provide the analysis showing compliance with the NAAQS and provide for appropriate permit monitoring and emissions controls as necessary.

Regional Climate Change

Renewable and nonrenewable resource management actions have the potential to impact climate change due to GHG emissions and other anthropogenic effects. However, the assessment of GHG emissions and climate change is extremely complex because of the inherent interrelationships among its sources, causation, mechanisms of action, and impacts. Emitted GHGs become well-mixed throughout the atmosphere and contribute to the global atmospheric burden of GHGs. Given the global and complex nature of climate change, it is not possible to attribute a particular climate impact in any given region to GHG emissions from a particular source. The uncertainty in applying results from Global Climate Models to the regional or local scale (a process known as downscaling) limits the ability to quantify potential future impacts from GHGs emissions at this scale. When further information on the impacts of local emissions to climate change is known, such information would be incorporated into the BLM's planning and NEPA documents as appropriate.

An overview of GHGs and climate change was previously presented in Section 3.1.1, including a national assessment of climate change and climate model projections for the State of Colorado that qualitatively describe the physical effects of climate change. As noted below, climate change analysis for this EA is limited to accounting for GHG emissions that would contribute incrementally to climate change and the potential effects previously discussed.

Greenhouse Gas Emissions

Research on climate change impacts is an emerging and rapidly evolving area of science, but given the lack of adequate analysis methods it is not possible to identify specific local, regional, or global climate change impacts based on potential GHG emissions from any specific project's incremental contributions to the global GHG burden. Moreover, specific levels of significance have not yet been established by regulatory agencies. Therefore, climate change analysis for the purpose of this analysis is limited to accounting for GHG emission changes that would contribute incrementally to climate change.

Described below under "Climate Change – Greenhouse Gas Impacts" GHG emissions from the RFMP are quantitatively assessed and then compared to various scales (state, national, and world-wide) of GHG emissions from coal production. This establishes a frame of reference for the reader to analyze meaningfully the potential impacts of the local-scale project at the global-scale of climate change.

Predicting the degree of impact any single emitter of GHGs may have on the changes to biotic and abiotic systems that accompany climate change, is not possible at this time. Consequently, the controversy relates to the extent that GHG emissions resulting from continued coal development may contribute to global climate change, as well as the accompanying physical changes to natural systems that cannot be quantified or predicted. The degree to which any observable changes can, or would, be attributable to the Proposed Action cannot be predicted at this time.

Social Cost of Carbon

A protocol to estimate what is referenced as the "social cost of carbon" (SCC) associated with GHG emissions was developed by a federal Interagency Working Group (IWG), to assist agencies in addressing Executive Order (EO) 12866 (United States Government 2010), which requires federal agencies to assess the cost and the benefits of proposed regulations as part of their regulatory impact analyses. The SCC is an estimate of the economic damages associated with an increase in CO_2 emissions and is intended to be used as part of a cost-benefit analysis for proposed rules. As explained in the Executive Summary of the 2010 SCC Technical Support Document "the purpose of the [SCC] estimates…is to allow agencies to incorporate the social benefits of reducing CO_2 emissions into cost-benefit analyses of regulatory actions that have small, or 'marginal,' impacts on cumulative global emissions." While the SCC protocol was created to meet the requirements for regulatory impact analyses during rulemakings, there have been requests by public commenters or project applicants to expand the use of SCC estimates to project-level NEPA analyses.

The decision was made not to expand the use of the SCC protocol for this Peabody Twentymile Coal EA for a number of reasons. Most notably, this action is not a rulemaking for which the SCC protocol was originally developed. Second, on March 28, 2017, the President issued EO 13783 (82 Fed. Reg. 61 [March 31, 2017]), which among other actions, withdrew the Technical Support Documents upon which the protocol was based and disbanded the earlier IWG on Social Cost of Greenhouse Gases. The Order further directed agencies to ensure that estimates of the social cost of greenhouse gases used in regulatory analyses "are based on the best available science and economics" and are consistent with the guidance contained in Office of Management and Budget (OMB) Circular A-4, "including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates" (EO 13783, Section 5(c)). In compliance with OMB Circular A-4, interim protocols have been developed for use in the rulemaking context. However, the Circular does not apply to project decisions, so there is no EO requirement to apply the SCC protocol to project decisions.

Further, NEPA does not require a cost-benefit analysis (40 CFR §1502.23), although NEPA does require consideration of "effects" that include "economic" and "social" effects (40 CFR §1508.8(b)). Without a complete monetary cost-benefit analysis, which would include the social benefits of the proposed action to society as a whole and other potential positive benefits, inclusion solely of an SCC cost analysis would be unbalanced, potentially inaccurate, and not useful in facilitating an authorized officer's decision. Any increased economic activity, in terms of revenue, employment, labor income, total value added, and output, that is expected to occur with the proposed action is simply an economic impact, rather than an economic benefit, inasmuch as such impacts might be viewed by another person as negative or undesirable impacts due to potential increase in local population, competition for jobs, and concerns that changes in population would change the quality of the local community. Economic impact is distinct from "economic benefit" as defined in economic theory and methodology, and the socioeconomic impact analysis required under NEPA is distinct from cost-benefit analysis, which is not required.

The fact that climate impacts associated with GHG emissions were not quantified in terms of monetary costs does not mean that climate impacts were ignored. Climate change and potential climate impacts, in and of themselves, are often not well understood by the general public (Etkin and Ho 2007; National Research Council 2009). This is in part due to the challenges associated with communicating about climate change and climate impacts, stemming in part from the fact that most causes are invisible factors (such as greenhouse gases) and there is a long lag time and geographic scale between causes and effects (National Research Council 2010). Research indicates that for difficult environmental issues such as climate change, most people more readily understand if the issue is brought to a scale that is relatable to their everyday life (Dietz 2013); when the science and technical aspects are presented in an engaging way such as narratives about the potential implications of the climate impacts (Corner et al. 2015); use examples and make information relevant to the audience while also linking the local and global scales (National Research Council 2010). In order to more effectively convey the potential climate impacts, the BLM qualitatively discussed potential climate change trends at several scales including at the state, regional, national, and global scales and the project-specific greenhouse gas emissions are quantitatively assessed and compared to state, national, and global GHG emissions from coal production. This approach presents the data and information in a manner that follows many of the guidelines for effective climate change communication developed by the National Academy of Sciences (National Research Council 2010) by making the information more readily understood and relatable to the decision-maker and the general public.

As described above in Section 3.1.1, under the National Assessment of Climate Change section, anticipated climate trends for North America indicate increases in average temperature to continue as well as increased winter and spring precipitation projected for the northern United States and decreasing amounts for the Southwest. Additionally, climate trends for the Southwest region are discussed such as declines in snowpack and streamflow amounts. The BLM further explains that such climate changes may reduce water supply reliability for livestock and agriculture as well as cities. Furthermore, Colorado climate change projections are also discussed including that increased warming and drought linked to climate change would continue to increase wildfire risk and impacts to people and ecosystems. The BLM also specifically discusses that greenhouse gas emissions from mining coal associated with this leasing action would contribute to national and global emission levels. The climate trends and projections as discussed in the EA provide a narrative in scales that are more relevant to the decision-maker and the general public because it provides more detailed specifics on potential implications to their everyday life in Colorado. This does not discount the direct, indirect, and downstream quantified greenhouse gas emissions as identified in Tables 4 through 6 (Appendix A), but together the climate trends and projections and quantified greenhouse gas emissions provide a meaningful and engaging way to connect the reader to more relevant impacts that then allow them to make the connections to the state, regional, and global impacts. This approach effectively informs the decision-maker and the public of future climate effects at a variety of scales, whereas the SCC metric would only provide a monetary value at the global scale.

Finally, the SCC protocol does not measure the actual incremental impacts of a project on the environment and does not include all damages or benefits from carbon emissions. The SCC protocol estimates economic damages associated with an increase in CO_2 emissions – typically expressed as a 1 metric ton increase in a single year —and includes, but is not limited to, potential changes in net agricultural productivity, human health, and property damages from increased flood risk over hundreds of years. The estimate is developed by aggregating results "across models, over time, across regions and impact categories, and across 150,000 scenarios" (Rose et al. 2014). The dollar cost figure arrived at based on the SCC calculation represents the value of damages avoided if, ultimately, there is no increase in carbon emissions. But the dollar cost figure is generated in a range and provides little benefit in assisting the authorized officer's decision for project level analyses.

To summarize, this EA does not undertake an analysis of SCC because 1) it is not engaged in a rulemaking for which the protocol was originally developed; 2) the IWG, technical supporting documents, and associated guidance have been withdrawn; 3) NEPA does not require cost-benefit analysis; and 4) the full social benefits of coal-fired energy production have not been monetized, and quantifying only the costs of GHG emissions but not the benefits would yield information that is both potentially inaccurate and not useful.

<u>Cumulative Effects</u>: The site-specific impacts analyzed in this EA are based on the assumption that if the lease is issued, mining would proceed at the currently authorized production rate for an additional 2 years. If the lease is issued, it is assumed that the extraction of the coal resource would proceed in accordance with all current permit conditions. In addition, it is also assumed the mined coal would be sold to coal users in response to forecasts of demand for this coal. The coal would be sold to a broker and re-sold. Historically these users have been electric utilities in the U.S with approximately 33% going to the Hayden Generating Station. In 2017, approximately 20% of the coal was exported. In 2018, a much higher percentage of coal has been exported. This coal market is open and competitive, and users can buy from the most cost effective suppliers that meet their needs.

The cumulative impacts to air quality in the Foidel Creek Mine area would result primarily from emissions of PM, NO_X, and CO from the current and future mining of coal within the region. As previously stated, the long term plan for the Foidel Creek Mine is to gradually replace declines in production with those from the Sage Creek Mine such that mining intensity for the region should not increase above currently authorized and evaluated levels.

Regional Ozone and Cumulative Air Quality and AQRV Analyses

As part of the adaptive management strategy for managing air resources within the BLM planning areas, the BLM conducted a regional air modeling study to evaluate potential impacts on air quality from future mineral development in Colorado and northern New Mexico. The

CARMMS (BLM 2017b) assesses predicted impacts on air quality and AQRVs from projected increases in oil and gas development and from mining activities. The CARMMS includes potential impacts using projected oil and gas development out to year 2025 that reflect realistic estimations of development projections and technological improvements.

The CARMMS includes cumulative air quality and AQRV impact assessments from future year (year 2025) oil and gas development on BLM-administered (federal) lands and other (non-federal) lands within eight western Colorado BLM planning areas, four subareas of the Royal Gorge Field Office Planning Area, the Mancos Shale in the Tres Rios Field Office, and the Farmington New Mexico Field Office planning areas, as well as mining activities within the planning areas. The oil and gas emissions on Southern Ute Indian Tribe (SUIT) lands in Colorado were also included. In addition, CARMMS includes emissions from other regional sources including oil and gas emissions throughout the modeling domain, which encompasses all of Colorado, western Arizona, western Utah, and north-central New Mexico and extends into southern Wyoming, western Nebraska, western Kansas, western Oklahoma, and northwest Texas.

The CARMMS includes use of the Comprehensive Air-quality Model with extensions (CAMx) photochemical grid model (PGM) to estimate air quality and AQRV impacts for both a base case year (2011) and future year 2025. Emissions from all source types (anthropogenic and natural) are included in the CAMx modeling.

As part of CARMMS, future year 2025 emissions estimates were developed for three development scenarios for the Colorado and New Mexico planning areas. These include year 2025 high, medium, and low oil and gas development scenarios. Modeling results from CARMMS are applicable for use in estimating potential ozone formation from regional emissions and project emissions, and for determining the maximum contribution of project sources to regional ozone formation. The CARMMS results are also applicable for project cumulative air quality and AQRV analyses. Given the level of oil and gas development within the BLM LSFO planning area projected through year 2025 the CARMMS 2025 Low Oil and Gas Development Scenario is used to describe the potential ozone formation from TC project area sources and for summarizing the cumulative air quality and AQRV analyses.

Table 7 (Appendix A) presents a summary of the CARMMS Low Oil and Gas Scenario emissions on BLM-administered (federal) lands and from mining activities on federal lands. These include the emissions from mining in Colorado BLM planning areas and the emissions from oil and gas activities in Colorado BLM and Farmington New Mexico planning areas and SUIT lands in Colorado. The maximum emissions from project sources are as follows: 27.1 tpy NO_x, 1.7 tpy VOC, 10.8 tpy CO, 0.03 tpy SO_2, 151.3 tpy PM_{10} and 29.7 tpy $PM_{2.5}$, and these emissions are included as part of the mining emissions shown in Table 7.

The mining emissions shown in Table 7 (Appendix A) include maximum allowable emissions from the following existing and future (hypothetical) mines:

- Book Cliffs Area (Grand Junction Field Office)
- McClane (Grand Junction Field Office)

- Bowie (Uncompahgre Field Office)
- King II (Tres Rios Field Office)
- Foidel (Little Snake Field Office)
- Deserado (White River Field Office)
- Trapper (Little Snake Field Office)
- Colowyo (Little Snake Field Office)
- Sage Creek (Little Snake Field Office)
- West Elk (Uncompahgre Field Office)
- Elk Creek (Uncompahgre Field Office)

The CARMMS included estimates of future year regional ozone impacts using two analysis methods. One method uses the change in the PGM concentrations between the base year (DVB) (year 2011) and future year (DVF) (year 2025) simulations to scale observed ozone concentrations from monitoring sites to obtain projected future year ozone concentrations. This method utilized EPA's Modeled Attainment Test Software (MATS) (Abt Associates 2012) projection tool with the CAMx 2011 Base Year and 2025 Low Development Scenario ozone concentrations to estimate ozone impacts. The second method uses the absolute modeling results from the CAMx model to estimate ozone impacts.

The CARMMS MATS analysis indicates current base year (DVB) areas of ozone exceedances of the NAAQS (70 parts per billion [ppb]) in and around Denver, places in Utah, Arizona, New Mexico, and Texas, with a maximum DVB of 109.6 ppb next to the Arizona/New Mexico border that is found to be caused by natural wild fire emissions. The base year DVBs also indicate that areas in the LSFO planning area within and nearby the project area are below the NAAQS. For the 2025 Low Development Scenario, the area of 2025 ozone DVF exceedances is substantially reduced from the base year with a peak DVF of 108.8 ppb (resulting from wild fires) near the Arizona/New Mexico border. The 2025 DVF – 2011 DVB differences shows the largest ozone reductions in the Denver metropolitan area. In the vicinity of the project area and throughout the LSFO planning area, there are widespread ozone reductions in the 1.0 ppb to 4.0 ppb range.

The CAMx absolute modeling results indicated that for the 2011 Base Case, there are ozone exceedance areas in Colorado, eastern Utah, southern Wyoming, northeast Arizona, New Mexico, and Texas. The maximum ozone concentrations are estimated along the Arizona/New Mexico border and near Los Alamos, New Mexico (resulting from natural fires). The 2011 Base Case also indicates that there are areas nearby the project area and to the north in the central eastern portion of the LSFO planning area that exceed 70 ppb the ozone NAAQS. In the 2025 Low Development Scenario, the areas of ozone exceedances are reduced. The 2025 – 2011 ozone differences show decreases in almost all areas, with the reduction (9.2 ppb) near Denver. In areas within and nearby the project area there are ozone reductions in the 2 ppb to 4 ppb range.

The CARMMS report indicates that the maximum contribution to year 2025 regional ozone formation from the LSFO planning area federal land oil and gas sources is 0.1 ppb. Given that the LSFO planning area federal land oil and gas emissions include 632 tpy NO_x and 727 tpy VOCs and that the maximum future year emissions from project sources include 27.1 tpy NO_x and 1.7 tpy VOCs, the contribution to regional ozone formation from project sources would likely be negligible. The Foidel Creek Mine sources (including all of the diesel fired mobile sources) and associated processing equipment are not significant sources of VOC emissions (see earlier discussion on CMM VOC data limitations), the photochemical reactivity potential of methane in the troposphere is considered negligible (40 CFR § 51.100 (s)), and therefore operation of the mine is not expected to contribute significantly to any regional ozone formation from its VOC emissions.

The CARMMS 2025 modeling analysis presented a scenario which included future year 2025 projected federal and non-federal oil and gas emissions throughout the 4-km grid CARMMS domain plus mining on BLM-administered lands in Colorado. This scenario, which includes future year oil and gas emissions from the 13 Colorado BLM planning areas plus the Mancos Shale area in Northern New Mexico, and SUIT lands in Colorado, along with mining emissions from BLM lands in Colorado, is presented herein to describe cumulative impacts for the project. For the project cumulative analysis, these cumulative oil and gas, and mining emissions, are considered Reasonably Foreseeable Development (RFD) emissions.

The CARMMS included impact assessments at 26 PSD Class I and 58 sensitive Class II areas, and at 58 lakes throughout the CARMMS modeling domain. For the project cumulative assessment, the CARMMS impacts are presented for five PSD Class I areas that are within 100 km of the project area, which include the Eagles Nest, Flat Tops, Mount Zirkel and Rawah wilderness areas and Rocky Mountain National Park. There are no sensitive Class II areas within 100 km of the project area.

The modeled concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ at Class I areas resulting from cumulative RFD source emissions are well below the PSD Class I increments.

Cumulative visibility impacts due to RFD oil and gas emissions and mining emissions were examined following the procedures provided by the U.S. Fish and Wildlife Service (USFWS) and National Park Service (NPS) (2012). These procedures use EPA’s MATS to project base year observed visibility impairment (from IMPROVE monitoring sites) for the best 20 percent (B20 percent) and worst 20 percent (W20 percent) days to the future year using the 2011 Base Case and 2025 Low Development Scenario modeling results (which include contributions from all source categories (including anthropogenic and natural) with and without emissions from RFD sources.

From the 2011 Base Year to the 2025 Low Development Scenario future year, the W20 percent visibility metric is estimated to improve at each of the Class I areas. The biggest improvement is a reduction of 0.28 deciviews (dv) that occurs at Eagles Nest and Flat Tops wilderness areas which goes from 8.47 dv in 2011 to 8.19 dv in 2025. RFD emissions are estimated to contribute a maximum of 0.18 dv to the 2025 W20 percent days visibility at Rocky Mountain National Park.

The B20 percent visibility metric indicates improvement in all Class I areas. The largest B20 percent visibility improvement is a 0.25 dv reduction that occurs at the Eagles Nest and Flat Tops wilderness areas which goes from 0.51 dv in 2011 to 0.26 dv in 2025. The maximum contribution from RFD sources to 2025 B20 percent visibility metrics is 0.05 dv at the Mount Zirkel and Rawah wilderness areas.

Potential atmospheric deposition impacts within Class I and sensitive Class II areas were calculated for cumulative RFD sources. The maximum direct total (wet and dry) N and S depositions are predicted to be well below the cumulative analysis thresholds of 2.3 kilogram per hectare per year (kg/ha-yr) for nitrogen and 5 kg/ha-yr for sulfur at all Class I and sensitive Class II areas. The maximum total nitrogen deposition rate (0.117 kg/ha-yr) occurs at the Mount Zirkel Wilderness Area is approximately 5% of the cumulative analysis threshold. The maximum total sulfur deposition rate (0.004 kg/ha-yr) is approximately 0.1% of the cumulative analysis threshold and it also occurs at the Mount Zirkel Wilderness Area.

Climate Change – Greenhouse Gas Impacts

Continued coal mining operations would result in minor cumulative contributions to atmospheric GHGs. Coal produced under the Proposed Action would be available for consumer or commercial use. The combustion of coal for electricity generation would produce GHGs, which would be controlled through applicable GHG emission control regulations (emissions standards) or by applicable air permit requirements.

Other industrial operations in the area would also contribute to GHG emissions through the use of carbon fuels (natural gas, liquefied petroleum gas, and diesel), and through the use of electricity produced using carbon fuels. Other anthropogenic activities such as residential wood and open burning, as well as biogenic sources, also contribute GHGs to the atmosphere. These would be more dispersed, but also more sustained, than the emissions from this coal development, which has a finite lifespan.

While significance levels exist to determine PSD applicability and emissions control requirements for GHGs, policies regulating specific GHG concentration levels and their potential for significance with respect to regional or global impacts have not been established for GHGs.

In 2015 approximately 9.3% of U.S. emissions of methane resulted from underground coal mining activities (EPA 2017). Based upon the national and state inventories of GHG emissions (EPA 2017, CDPHE 2014), the total CMM emissions were 60.9 MMT for the U.S. in 2015 and were 7.54 MMT for Colorado in 2010 on a CO_2e basis. Estimated total CMM emissions from the RFMP are approximately 826,300 short tons (0.75 MMT) of CO_2e (at full authorized production) or 10% and 1.2% of the total calculated CO_2e emissions of CMM from Colorado and the U.S. Based on BLM’s analysis, total annual GHG emissions from the Proposed Action (direct and indirect for maximum production levels) are estimated to be 0.87 MMT on a CO_2e basis. This represents approximately 0.67% and 0.013% percent of the Colorado (130 MMT) and U.S. (6,587 MMT) GHG emissions (CDPHE 2014; EPA 2017).

As shown in Table 6 (Appendix A), the maximum annual downstream CO_2e emissions are estimated at 107.8 MMT per year. The emissions are calculated using the assumption that approximately 80% (3,743,200 tons) of the coal proposed in the LBA is saleable and is combusted downstream (at a coal-fired power plant) over a 2-year period. These maximum annual downstream CO_2e emissions would be comparable to 1.6% of total U.S. emissions (EPA 2017).

At a global scale, the U.S. and the world produced 6,344 MMT and 53,530 MMT, respectively, of CO_2e emissions in 2012 (The World Bank Group 2017). In other words, the U.S. produced 12% of the global GHG emissions, and the maximum direct, indirect and downstream CO_2e emissions from the RFMP (108.7 MMT) represents approximately 0.002% of global GHG emissions on an annual basis. In addition the maximum direct, indirect and downstream CO_2e emissions over the life of the project (LOP) (217.3 MMT), assuming a 2-year LOP, represent approximately 1.1E-08% of total global CO_2e emissions (1.94E+12 MMT) used for climate modeling to estimate climate change impacts in year 2050 (described above under "Colorado Climate Change") using the RCP 4.5 scenario.

3.1.3 Environmental Consequences of the No Action Alternative

Direct, Indirect, and Cumulative Effects: Under the No Action Alternative, the mine would continue to operate under the current mine plan within the production limits authorized under the CDPHE air permit (maximum production rate of 11.2 million tpy) until such time that all of the available coal reserves are exhausted. At the current rate of mining (3.8 million tpy), the coal reserves (including federal, state, and fee coal) would be exhausted in approximately 9 years. The levels of air emissions from the stationary and mobile sources at the mine would be roughly the same as those estimated and analyzed for the Proposed Action, but would end approximately 2 years earlier.

Mitigation: None

3.2 Soils

3.2.1 Affected Environment

Soil survey information was obtained from the Natural Resources Conservation Service (NRCS) Soil Web Survey database for Routt County (NRCS 2017). Sixteen soil mapping units occur within the proposed LBA, predominantly made up of colluvium and/or alluvium derived from sandstone and shale. Soils found on hills and floodplains are generally deep, well-drained, loams, clay loams, and silty clay loams with high runoff potentials. Rock outcrops and shallow cobbly loams with high runoff and moderate wind erosion potential occur on mountain slopes. Most of the soils have a rating of moderate to poor suitability for native-surface road situations because of their low soil strength, rutting potential, slope, and erodibility. None of these soil types are considered "hydric" soils, although some areas of wetlands occur within these types. Lintim loam (map unit 50C) is considered a farmland of statewide importance. Five soils, mapping units 101, 103, 120, X8D, and X8F, have a restrictive layer of paralithic or lithic bedrock within 60 inches.

3.2.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: The LBA would not result in any direct or indirect effects to soil resources. Underground mining could result in soil cracking related to subsidence, which is discussed in Section 3.3, below. Surface soil cracks would be expected to fill naturally by sloughing of surrounding surface soils. Potential effects to soils caused by subsidence would be minor but would be expected to persist for the duration of mining operations.

Mining activities would require the presence and operation of vehicles and heavy equipment, which could result in accidental spills or leaks of petroleum products. Spills and leaks have the potential to impact surface soils; however, the risk of soil contamination would be mitigated by the use of BMPs such as routine maintenance. Any spills or releases would be immediately contained, recovered, and disposed of in accordance with the mine's waste management procedures.

Cumulative Effects: Cumulative effects to soils under the Proposed Action would be minor as described above for direct and indirect effects. Impacts to soils from activities such as coal mining, sand and gravel operations, grazing, and utility rights-of-ways would continue.

3.2.3 Environmental Consequences of the No Action Alternative

Direct, Indirect, and Cumulative Effects: Under the No Action Alternative, the mine's productive life would not be extended by 2 years. The potential for soil contamination from spills and soil impacts related to subsidence would continue at existing levels; however, this would not occur for an additional 2 years. Cumulative effects under the No Action Alternative would be similar to those under the Proposed Action. Impacts to soils from activities such as coal mining, sand and gravel operations, grazing, and utility rights-of-ways would continue.

Mitigation: None.

3.3 Minerals, Solid

3.3.1 Affected Environment

The project area lies within the Twentymile Park on the southeast tip of the Yampa Coal Field of the Green River Region. Twentymile Park is a structural and topographic basin. The Wolf Creek seam is in the 75 million year old Upper Cretaceous Mesaverde Group (see Figure 2, Appendix A). This sedimentary sequence was deposited in offshore, shallow, and near-marine environments at the western edge of an epeiric seaway. Although there are two other smaller coal seams in the LBA (the Fish Creek seam and the Lennox seam), the Wolf Creek seam is the only mineable seam in the proposed LBA. The Wolf Creek seam is below the previously mined workings of the Wadge seam. Approximately 500 acres of the Wadge seam was longwall mined by TC from 1998 to 1999 within the proposed LBA (BLM 1995).

The interburden between the two seams is 100 to170 feet. The overburden ranges from 1,250 to 1,500 feet. The Wolf Creek coal seam thickness ranges from 7.5 to 10 feet thick.

3.3.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: Leasing of the 640-acre LBA would cause no direct effects. As a result of mining, approximately 4.7 million recoverable tons, or approximately 330 acres of the Wolf Creek seam would be removed from the LBA area, permanently depleting the existing coal reserves. Approximately 100 million tons of coal has been mined at the Foidel Creek Mine. Currently, Foidel Creek is the only active coal mine in Routt County. There are approximately 9 more years of Wolf Creek seam mining left at the Foidel Creek Mine. The 2006 Colorado Geological Survey estimated the remaining coal reserves in the Green River Coal Region to be 23,263 million tons. Mining the 4.7 million tons would reduce the Green River Coal Region reserve by 0.02%. The Proposed Action constitutes approximately 0.10% of the 623,860 acres of the LSFO coal planning area.

Removal of the coal would result in controlled subsidence. Subsidence depends upon many factors, including mine plans, coal seam thickness, geologic strata, and depth of overburden. As a longwall face retreats, the immediate roof strata cave behind the face supports (shields). Caving continues until it is stopped by more competent overlying strata. The overlying strata bend and deform toward the center of the longwall, resulting in subsidence at the ground surface. The limit and magnitude of subsidence are affected by the type of strata. Strata would subside as a block and retain their internal structure. TC has compiled an extensive subsidence database from monitoring longwall panel extraction from the Wadge seam. Subsidence has already occurred within the LBA when the Wadge seam was mined. Subsidence under power lines, County Road 27, Foidel and Fish creeks, and the Union Pacific Railroad has occurred with no effect to the systems. Subsidence from mining the Wolf Creek seam is anticipated to be about 5% higher in magnitude than the initial mining in the Wadge seam (DRMS 1982b). Subsidence monitoring above a previously mined longwall panel in the Wadge Coal seam showed subsidence to be less than predicted. Ninety-five to 98% of subsidence resulting from longwall mining occurs during active mining. Long-term subsidence effects are not anticipated because subsidence occurs within a fairly short time.

The subsidence predictions from Exhibit 7K (DRMS 1982b) are:

- Maximum subsidence of 70 to 76 inches for the initial and subsequent longwall panels located at a depth of 1,000 feet; and
- Maximum subsidence of 63 inches for longwall panels located at a depth of 1,400 feet. Except for the removal of the coal bed, the overall nature of the solid mineral resources of the area would not change.

Cumulative Effects: Cumulative effects to solid minerals under the Proposed Action would be similar to those described above for direct and indirect effects. Impacts to soils from ongoing activities such as coal mining, sand and gravel operations, grazing, and utility rights-of-ways would continue.

3.3.3 Environmental Consequences of the No Action Alternative

Direct, Indirect, and Cumulative Effects: Under the No Action Alternative, the 4.68 million tons of recoverable coal would not be recovered. Mining would most likely continue at existing levels but would not occur for an additional 2 years. Cumulative effects would be similar to those described for the Proposed Action. Impacts to mineral resources from ongoing mining and sand and gravel operations would continue.

Mitigation: None.

3.4 Special Status Animal Species

3.4.1 Affected Environment

The area of the LBA does not provide habitat for any federally listed species. Several BLM sensitive species including greater sage-grouse, Columbian sharp-tailed grouse, golden eagle, and bald eagle may use habitat in the vicinity of the Foidel Creek Mine.

Federally listed species that could be indirectly affected downstream are listed in Table 8 (Appendix A). Species were identified by the USFWS (2018) in an official species list (Consultation Code: 06E24100-2018-SLI-0194).

A detailed description of habitat for listed species in Routt County in included in the Biological Assessment (Appendix D).

3.4.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: There would be no direct impacts to greater sage-grouse, Columbian sharp-tailed grouse, bald eagle, or golden eagle from the LBA. Because no new surface disturbance is expected from subsequent underground mining, there would also be no impacts to habitat utilized by BLM sensitive species.

There would be no direct impacts to any Endangered Species Act (ESA) listed or proposed species. No indirect impacts are expected to occur for Canada lynx or North American wolverine. Indirect impacts to Colorado River Fish, lineage greenback cutthroat trout, and yellow-billed cuckoo may occur from mercury and selenium released during coal combustion. These potential impacts are described below.

The BLM LSFO provided a Biological Assessment (BA) to the USFWS Western Colorado Ecological Services Field Office requesting formal Section 7 ESA consultation for the LBA on June 8, 2018; see Appendix D). The BA identified that potential release of mercury from the combustion of federal coal in the local airshed and subsequent deposition into designated critical habitat, "may affect, is likely to adversely affect" the four Colorado River fish species and their designated critical habitat. The BLM also determined that the Proposed Action "may affect, but is not likely to adversely affect" the yellow-billed cuckoo and the lineage greenback cutthroat trout or destroy or adversely modify proposed critical habitat for the yellow-billed cuckoo.

On September 5, 2018, the USFWS issued a Biological Opinion (BO) for the Proposed Action (TAILS 06E24100-2018-F-0271; see Appendix D). The USFWS determined that although the Proposed Action is likely to adversely affect the Colorado River endangered fish species, the Proposed Action is not likely to jeopardize the four endangered fish species. The USFWS also found that the Proposed Action is not likely to result in the destruction or adverse modification of critical habitat for the four Colorado River fish. Additionally, the USFWS concurred with BLM's determinations for the lineage greenback cutthroat trout and yellow-billed cuckoo and its proposed critical habitat.

Colorado River Fish Species

Mercury. Mercury is a naturally occurring element. It can be found in soils and the atmosphere, as well as water bodies. Atmospheric transport and deposition is an important mechanism for the global deposition of mercury (Electric Power Research Institute [EPRI] 2014), because it can be transported over large distances from its source regions and across continents. It is considered a global pollutant. Atmospheric mercury is primarily inorganic and is not biologically available. However, once mercury is deposited to the earth, it can be converted into a biologically available form, methylmercury (MeHg), through a process known as methylation. MeHg bioaccumulates in food chains, and particularly in aquatic food chains, meaning that organisms exposed to MeHg in their food can build up concentrations that are many times higher than the ambient concentrations in the environment.

Mercury is emitted by both natural and anthropogenic sources. Natural sources include volcanoes, geothermal sources, and exposed naturally mercury-enriched geological formations. These sources may also include re-emission of historically deposited mercury as a result of evasion from the surface back into the atmosphere, fires, meteorological conditions, as well as changes in land use and biomass burning. Anthropogenic sources of mercury include burning of fossil fuels, incinerators, mining activities, metal refining, and chemical production facilities. Anthropogenic sources currently account for 30% of the mercury being emitted into the environment. The global emissions inventory for 2010 estimated that 1,960 metric tons (4,319,840 pounds) of mercury was emitted into the atmosphere as a direct result of human activity (United Nations Environment Programme [UNEP] 2013), with an estimated 60.7 metric tons supplied by North America. East and Southeast Asia were by far the highest contributors, with 777 metric tons of mercury released (UNEP 2013).

Aquatic systems receive mercury by direct deposition from the atmosphere and from overland transport from within the watershed (EPA 1997). Once mercury is converted to MeHg, it can bioaccumulate in endangered fish and is a potent neurotoxin that affects their fitness and reproductive health (Crump and Trudeau 2009). Once mercury enters the body, it poses the highest threats of toxicity because it can be absorbed into living tissues and blood. Once in the blood it crosses into the brain and accumulates; there is no known way for mercury to be expelled from the brain (Gonzalez et al. 2005).

The effects of mercury on fish are numerous. Lusk (2010) describes the potential effects as:

1. Potent neurotoxin:
    a. Reduced ability to feed (emaciation and growth effects)
2. Endocrine disruptor
    a. Suppressed reproduction hormones in male and female fish
    b. Reduce gonad size and function, reduced gamete production
    c. Altered ovarian morphology, delayed oocyte development
    d. Reduced reproductive success
    e. Transfer of dietary mercury of the maternal adult during oogenesis and into the developing embryo
3. Inability to grow new brain cells or significantly reduce brain mercury.

To protect human health, the EPA developed a MeHg water quality criteria of 3.0 micrograms per gram (µg/g) wet weight (WW) in edible fish and shellfish. Beckvar et al. (2005) suggested a threshold-effect level of 0.2 micrograms per gram (µg/g) WW mercury in whole body fish as being generally protective of juvenile and adult fish. However, Yeardley et al. (1998) suggested that mercury concentrations greater than 0.1 µg/g WW may be harmful to predators eating contaminated fish.

Because Colorado pikeminnow are a long lived, top predator species, mercury would be most likely to impact this species. Osmundson and Lusk (2012) reported on the collection, locations, methods, chemical analyses, laboratory quality assurance and quality control, and interpretation of mercury in Colorado pikeminnow from Upper Colorado River Basins, including from the Yampa and White rivers during 2008-2009. The mercury in Colorado pikeminnow muscle tissues collected from the San Juan, Green, Upper Colorado, White, and Yampa rivers are summarized Table 9 (Appendix A).

The CDPHE Water Quality Control Division (WQCD) maintains a list of all waters in Colorado that exceed the total maximum daily loads for a variety of contaminants. The WQCD does not list the Yampa or White rivers as impaired for mercury levels. It should be noted; however, that impairment under this program relates to human effects and not necessarily to impacts to aquatic species. Water quality data for mercury collected from the Yampa River near Hayden (U.S. Geological Survey [USGS] Station 09244490) between 2016 and 2017 showed that the mercury concentrations ranged from 0.00052 to 0.00345 micrograms per liter (µg/L), with an average of 0.00183 µg/L (USGS 2018). There is currently not a fish consumption advisory for either the Yampa or White rivers. There are currently two fish consumption advisories within the LSFO for mercury. One of the advisories applies to Elkhead Reservoir, northeast of Craig, Colorado and one applies to Catamount Reservoir, east of Steamboat Springs, Colorado.

It is expected that about one-third (1,247,773 tons) of the saleable coal from the RFMP would be combusted at the Hayden Generating Station. The combustion location for the additional two-thirds of coal is speculative at this time. Coal from the Foidel Creek Mine is shipped to several power plants across the nation, with several contracts only lasting 1 year and destination plants often changing from year to year.

The Hayden Generating Station has two combustion units, one which went online in 1965 and the second in 1976. Both units have several components designed to decrease air emissions, including: low NOx burners, fabric filter dust collectors (baghouses), and lime spray dryers (scrubbers). In addition, SCRs for the control of NO_x emissions were installed on both units. Although not specifically designed to reduce mercury emissions, the SCR units oxidize elemental mercury and allow better collection of mercury in the scrubbers and baghouses. The SCRs went into service in 2015 (Unit 1) and 2016 (Unit 2) and effect a 30% to 77% control of mercury. The units qualify as LEE for mercury under the new EPA Mercury and Air Toxic Standards.

The 1,247,773 tons of federal coal from the LBA would supply the Hayden Generating Station for approximately 322 days (based on a 5 year average). With the newly implemented controls, the Hayden Generating Station emitted 8.31 lbs of mercury per year in 2016. Compared to the

2010 estimated total North America and global emissions of mercury, 60.7 and 1,960 metric tons (UNEP 2013), this would represent an insignificant amount of mercury (0.0062% and 0.00019%, respectively).

A mercury deposition network (MDN) monitoring site (Buffalo Pass–Summit Lake) is located east of Steamboat Springs, Colorado in the Routt National Forest. Since data has been collected at this site, annual mercury deposition (wet) has ranged from a low of 6.881 micrograms per square meter ($\mu g/m^2$) in 2012 to a high of 14.747 $\mu g/m^2$ in 2011 (Forest Service 2018). The most recent deposition measurement is 8.184 $\mu g/m^2$ in 2016.

No current data or modeling is available to indicate how much of the mercury emitted by the Hayden Generating Station alone is deposited annually within the local airshed. However, a recent modeling effort to assess local mercury deposition from the Craig Generating Station was completed (EPRI 2017). Results from this modeling showed that mercury depositions from non-local sources accounted for 98% of mercury deposited within the local watersheds. The Craig Station's contribution to annual mercury deposition was less than 0.1%, and the Hayden Generating Station and the Bonanza Power Plant and accounted for approximately 0.2% of total annual deposition within the Yampa and White River Basins. The study indicated that approximately 88% of the mercury deposition in these watersheds results from distant (non-U.S.) human and natural sources of atmospheric mercury.

Of the amount of mercury emitted from the federal coal, it is reasonable to assume that some portion would deposit directly or indirectly into the Yampa River or its tributaries. Some of this mercury would be converted into MeHg and thereby has the potential to affect the Colorado River fish. In addition to impacts to individual Colorado River fish, impacts would also potentially occur to those species' designated critical habitats in the region.

Mercury from the combustion of federal coal at the Hayden Generating Station that is deposited either directly or indirectly into the designated critical habitat for these species would have the potential to impact the critical habitat. This would occur primarily by increasing the amount of contaminates present in those areas. It is difficult to quantify the level of this impact from the Proposed Action to critical habitats given the lack of information on how much mercury would make its way to critical habitat and how much would be converted to MeHg.

Selenium. In addition to mercury, impacts to listed fish species from increases in selenium from the combustion of coal could occur. Selenium, a trace element, is a natural component of coal and soils in the area and can be released to the environment by the irrigation of selenium-rich soils and the burning of coal in power plants with subsequent emissions to air and deposition to land and surface water. Contributions from anthropogenic sources have increased with the increases of world population, energy demand, and expansion of irrigated agriculture. Selenium, abundant in western soils, enters surface waters through erosion, leaching, and runoff.

Selenium is a micro-nutrient, necessary for proper cellular function of structural proteins and cellular defenses against oxidative damage. While small amounts of selenium are essential for proper cellular functioning, excess amounts can be toxic. Excess dietary selenium causes elevated selenium concentrations to be deposited into developing eggs, particularly the yolk

(Buhl and Hamilton 2000). If concentrations in the egg are sufficiently high, developing proteins and enzymes become dysfunctional or result in oxidative stress, conditions that may lead to embryo mortality, deformed embryos, or embryos that may be at higher risk for mortality.

The reporting limit for selenium in water is generally 1 μg/L while the EPA (2012) has set the maximum contaminant level of 0.05 milligrams per liter (mg/L) [50 μg/L]) for drinking water. During sampling of the Yampa River between 1997 and 1998, levels between less than 1 and 4.8 μg/L were found near Craig, between less than 1 and 4.9 μg/L near Maybell, and less than 1 and 3.6 μg/L near Deerlodge Park (USGS 2001). The peak reported levels for these sites all occurred in March, possibly during the beginning of the snow runoff. Concentrations were less than 1 μg/L during May through October. However, it should be noted that selenium in water may be less important than dietary exposure when determining the potential for chronic effects to a species (USFWS 2014).

While the reportable limit of selenium in water is 1 μg/L, the safe level of selenium for protection of fish and wildlife in water is considered to be below 2 μg/L and chronically toxic levels are considered to be greater than 2.7 μg/L (USFWS 2014). Excess selenium in fish have been shown to have a wide range of adverse effects including mortality, reproductive impairment, effects on growth, and developmental and teratogenic effects including edema and finfold, craniofacial, and skeletal deformities.

Of the four Colorado River fish species, selenium would disproportionately affect the razorback sucker more than the other three species. As with all sucker species, the razorback sucker is a bottom feeder and more likely to ingest selenium that has precipitated to the river bottoms.

If combustion of coal from the LBA occurs at the Hayden Generating Station, selenium could be emitted and subsequently deposited. However, because it is not monitored as it is emitted, unlike mercury, there is no information as to how much is released. When selenium is present in flue gas, it tends to behave much like sulfur and is removed to some extent via the SO_2 air scrubbers in place (EPRI 2008). Because the amount of selenium in emissions from the Hayden Generating Station is not measured, impacts cannot be measured or detected in a manner that allows for meaningful evaluation. However, the LBA is small (1,247,733 tons total) when compared to the amount of coal that is combusted by three local power plants (~13.8 million tons combusted annually) and because the Hayden Generating Station is over 60 miles away from razorback critical habitat, the likelihood of selenium from this coal reaching designated critical habitat may be minimal.

Yellow-billed cuckoo

Mercury. Mercury is an environmental contaminant that can also have adverse effects on riparian wildlife (Scheuhammer et al. 2012; Wentz et al. 2014). For riparian birds such as cuckoos, mercury is accumulated via ingestion of aerial insects emerging from benthic life stages in aquatic environments containing mercury or from associated predatory spiders (Cristol et al. 2008; Edmonds et al. 2012; Evers et al. 2012; Buckland-Nicks et al. 2014; Gann et al. 2014). Dietary total mercury concentrations associated with adverse effects to birds are generally greater than 0.1 milligram per kilogram (mg/kg) WW (U.S. Department of the Interior [DOI] 1998). Once ingested, MeHg rapidly moves into the bird's central nervous system, resulting in behavioral and neuromotor disorders (Tan et al. 2009; Scheuhammer et al. 2012). The developing central nervous system in avian embryos is especially sensitive to this effect, and permanent brain lesions and spinal cord degeneration are common (DOI 1998; Bryan et al. 2003; Scheuhammer et al. 2007). Therefore, adverse effects are described for the eggs, embryos, nestlings and/or fledglings associated with elevated mercury burdens in the female parent and due to foraging.

Uptake of mercury by birds has been shown to generally impact fish eating birds more severely than insectivorous birds (Zolfaghari et al. 2009; Boening 2000). Additionally, Howie (2010) found that the lateral extent of elevated mercury levels in birds and invertebrate prey species varied from approximately 250 to 650 meters from an affected water body. After this distance, mercury levels in the blood and feathers could not be distinguished from background levels, indicating that only those individuals that forage adjacent to affected water bodies show signs of bioaccumulation of mercury.

No information is available on the levels of mercury in the Yampa River invertebrates within the analysis area. Any yellow-billed cuckoos present in the analysis area would be at risk for mercury contamination. The risk would be low considering that the primary food sources for the cuckoo are generally not aquatic.

Lineage greenback cutthroat trout

Mercury. Cutthroat trout of greenback lineage are known to reside in only one stream within the boundary of the LSFO. BLM does not manage any surface portions of the creek or surrounding area but does administer the subsurface federal mineral estate within portions of the watershed. The Routt National Forest manages most of the land within the Deadman Gulch watershed. The closest BLM land is approximately 5 miles south/west of Deadman Gulch. This population is outside of the 50 km buffer (31 mile radius) for local deposition of mercury from coal combustion at the Hayden Generating Station. Because mercury would be deposited outside the local airshed, mercury from the federal coal could conceivably reach the one greenback stream that occurs in Routt County. However, with the small amount of mercury expected to be emitted from this coal, this impact would be negligible. In addition, this population of trout lives in a cold water stream and its main food is insects, even further reducing potential impacts.

Cumulative Effects: Declines in the abundance or range of many special status species have been attributed to various human activities on federal, state, and private lands, such as human population expansion and associated infrastructure development; construction and operation of dams along major waterways; water retention, diversion, or dewatering of springs, wetlands, or streams; recreation, including off-road vehicle activity; expansion of agricultural or grazing activities, including alteration or clearing of native habitats for domestic animals or crops; and introductions of non-native plant, wildlife, or fish or other aquatic species, which can alter native habitats or out-compete or prey upon native species. Many of these activities are expected to continue on state and private lands within the range of the various federally protected wildlife, fish, and plant species, and could contribute to cumulative effects to the species within the action area. Species with small population sizes, endemic locations, or slow reproductive rates, or species that primarily occur on non-federal lands where landholders may not participate in recovery efforts, would be generally be highly susceptible to cumulative effects.

Impacts to river-related resources within the Yampa and White river watersheds resulting from ongoing activities such as coal mining and combustion, oil and gas exploration and development, irrigation, urban development, recreational activities, livestock grazing, and activities associated with the Upper Colorado River Endangered Fish Recovery Program would continue.

3.4.3 Environmental Consequences of the No Action Alternative

Direct, Indirect, and Cumulative Effects: Because the Foidel Creek Mine would continue to operate with or without the federal coal in this lease sale, impacts from the No Action Alternative would be similar to the Proposed Action; however, the impacts would not occur for an additional 2 years. Impacts would be similar to those described for the Proposed Action but would be less, because there would not be an additional 2 years of mining. Cumulative effects would also be similar; however, impacts from ongoing activities such as coal mining and combustion, oil and gas exploration and development, irrigation, urban development, recreational activities, livestock grazing, and activities associated with the Upper Colorado River Endangered Fish Recovery Program would continue.

Mitigation: None

3.5 Cultural Resources

The National Historic Preservation Act (NHPA) requires federal agencies to consider the direct and indirect effects of federal undertakings on cultural resources that are eligible for inclusion in the National Register of Historic Places (NRHP). Leasing of federal coal constitutes a federal undertaking. In Colorado, the requirements of the NHPA are implemented under the terms of the Protocol Agreement between the BLM and the State Historic Preservation Officer (SHPO).

3.5.1 Affected Environment

A review of cultural resource records maintained at LSFO and available from SHPO's online database (COMPASS) revealed that previous cultural resource surveys have been completed within or adjacent to the proposed lease. Beginning as early as 1975, a number of cultural resource inventories have been conducted and most were completed in advance of activities related to coal development. However, it is estimated that only a few percent of the LBA has been surveyed for cultural resources to contemporary BLM standards of a thorough, on-the-ground survey (i.e., Class III survey).

The cultural resource surveys have recorded a number of Native American sites determined eligible to the NRHP or in need of data to determine eligibility. Native American sites include campsites and lithic scatters. Recorded campsites within the lease include 5RT3275 (eligible) and 5RT31 (needs data). Site RT153 (needs data) is a campsite adjacent to the proposed lease that could potentially be indirectly affected by ground subsidence (see below). A lithic scatter recorded as 5RT154 (needs data) is also adjacent to the proposed lease and could potentially be indirectly affected by ground subsidence.

The surveys also recorded various Euro-American sites, however all were determined not eligible to the NRHP. Included are a habitation site, a trash scatter, and a railroad spur.

3.5.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: The proposed underground mining of a coal seam would not have direct effects on cultural resources. Regarding indirect effects, underground mining of the Wolf Creek seam within the lease would cause ground subsidence. Such subsidence has the potential to adversely affect sites. Previous ground subsidence in the area caused by underground coal mining demonstrates that the effect of subsidence on cultural resources can vary considerably. It is expected that open terrain blanketed with soil will generally subside uniformly, posing little to no effect to Native American and Euro-American sites. Ground subsidence has been shown to cause adverse effects to certain types of Native American sites located along sandstone cliffs, specifically rockshelters and rock art. Ground subsidence along cliffs can cause the face of the cliff to spall off and subsidence of cliffs with joints in the sandstone can cause catastrophic failure of segments of cliff bands, resulting in rockslides. For example, nearby subsidence of segments of a cliff in the vicinity of the proposed lease caused the destruction of a rockshelter with rock art (5RT345) and nearby rock art sites.

Engineering analysis of subsidence has demonstrated that underground coal mining lowers the elevation of the ground directly above the coal lease, as well as within a band around the lease affected by the "angle of draw." Therefore, the potential of subsidence to adversely affect sites adjacent to the lease was considered.

Review of aerial photography revealed that the lease lacks cliff-forming outcrops of sandstone. Some apparent outcrops of sandstone were noted along the steep slope of the Middle Creek valley within the lease. However, these appear to be minor outcrops that do not form cliffs. Therefore, the potential for subsidence within the lease to damage or destroy rock art or rockshelters that may be present within the lease is considered to be of low probability.

The above information suggests that subsidence within and adjacent to the proposed lease is expected to result in a uniform lowering of the ground surface. Therefore, the potential for the proposed leasing action to adversely affect eligible sites within and adjacent to the lease is considered to be very low.

Cumulative Effects: Coal mining within the lease is not expected to result in cumulative effects on cultural resources within the coal mining district.

3.5.3 Environmental Consequences of the No Action Alternative

Direct, Indirect, and Cumulative Effects: The No Action Alternative would have no direct effects on eligible cultural resources within the proposed lease. The alternative would have no indirect effects on eligible cultural resources within the proposed lease. The alternative would not add to cumulative effects of coal mining on cultural resources.

Mitigation: None

3.6 Native American Concerns

The NHPA requires federal agencies to consult with Native Americans regarding the effect of federal undertakings on sites that may be of cultural or religious importance to Indian people to ensure that tribal values are taken into account to the extent feasible. In historic times, the LSFO area was inhabited by the Utes and the Shoshone. Lacking a formal agreement outlining a consultation process, the BLM LSFO policy is to consult with relevant tribes when an undertaking is known to be in or near an area of concern to the historic tribes or when an undertaking involves types of sites that experience has shown are usually of concern to native peoples. Such sites include burials, rock art sites, wickiups, stone circle sites, possible vision quest sites, and possible eagle trap sites.

3.6.1 Affected Environment

Based on available information, areas or sites of Native American concern are not involved in the proposed federal undertaking. Areas known to be of concern to native peoples are not present at or near the undertaking. A rockshelter with rock art (5RT345) and neighboring recorded rock art sites are located a number of miles from the lease and would not be affected by proposed underground mining. Nor are sites of the kind that experience has shown to be of concern to Indian people located in or adjacent to the proposed lease.

3.6.2 Environmental Consequences of the Proposed Action

In consideration of the above, the Proposed Action would not affect areas or sites of cultural or religious concern to native people.

3.6.3 Environmental Consequences of the No Action Alternative

Direct, Indirect, and Cumulative Effects: The No Action Alternative would also have no effect on areas or sites of cultural or religious concern to native people.

3.7 Hazardous or Solid Wastes

3.7.1 Affected Environment

There are no known hazardous waste sites within the LBA area. If production occurs in the LBA area, petroleum products and solvents would be used as part of the general mining operations. Use of these products would comply with all applicable state and federal regulations, as described in this section.

Mining operations must comply with regulations promulgated under the Resource Conservation and Recovery Act, Federal Water Pollution Control Act (Clean Water Act), Safe Drinking Water Act, Toxic Substances Control Act, Mine Safety and Health Act, Department of Transportation, and the federal CAA. Mining operations must also comply with all state rules and regulations relating to hazardous material reporting, transportation, management, and disposal. Disposal requirements for waste rock/ore derived from coal mining operations are based on whether the waste material is determined to be acid-forming and/or toxic-forming. If the material is determined to be non-acid-forming or non-toxic-forming, there are generally no restrictions on disposal. The material may be stockpiled within the permit area or disposed of per the Disposal of Excess Spoil, Coal Mine Waste Bank, or Coal Mine Waste Regulations (2 CCR 407-2.2.04.09 – 407-2.2.04.11). Acid-forming and toxic-forming waste material must be disposed of in accordance with 2 CCR 407-2.4.05.8 (Acid-forming and Toxic-forming Spoil), 2 CCR 407-2.4.10.1 (Coal Mine Waste Banks General Requirements), and 2 CCR 407-2.4.14.3. Potential sources of hazardous or solid waste materials in the project area would include spilling, leaking, or dumping of hazardous substances, petroleum products, and/or solid waste associated with coal development or agricultural or livestock activities. If the LBA area goes into production, petroleum products and solvents would be used underground as part of general operations. Use of these products would comply with all applicable state and federal regulations.

3.7.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: The 640-acre LBA area would be limited to underground mining. Impacts to the environment resulting from the release of hazardous or solid waste are not expected. The potential for impacts resulting from substance release would depend upon the responsible use of chemicals, and the immediate containment and adequate clean-up in the event of unintentional releases. The potential for exposure to hazardous or solid wastes would be low. Limited volumes of underground development waste would be generated from roof falls. To the extent practical, this material would be disposed of underground in mined-out areas. Coal refuse material (non-specification coal) and incombustible waste rock would be transported to the surface by conveyor, segregated, and transported to Foidel Creek Mine's approved refuse disposal area for permanent placement. Based on sampling and analysis of the geologic materials associated with Wadge and Wolf Creek seams in the TC permit area of the Foidel Creek Mine, the associated strata above and below the coal seams have little or no potential to generate acid- or toxic-forming refuse materials.

Cumulative Effects: In the past, the area has been mined by surface and underground methods. Present mining activities include the Foidel Creek Mine and reclamation of the Seneca surface mines and the Hayden Gulch Loadout. Operations at the Sage Creek Mine, an underground coal mine have been idled since September of 2012. Under the RFMP, the 640-acre LBA would be mined using the same equipment that is currently operating at the Foidel Creek Mine. The amount of petroleum products and solvents related to mining would remain at the current levels. These materials would continue to be managed and controlled under current regulations and best management practices. Cumulative impacts would be kept within state and federal guidelines and would be minor.

3.7.3 Environmental Consequences of the No Action Alternative

Direct, Indirect, and Cumulative Effects: Under the No Action Alternative, the mine's productive life would not be extended by 2 years. The Foidel Creek Mine would continue to operate with or without the federal coal in this lease sale. Impacts from the No Action Alternative would be similar to the Proposed Action but would not occur for an additional 2 years. Current operations at the Foidel Creek Mine and other ongoing activities such as coal mining, sand and gravel operations, grazing, and utility rights-of-ways would continue.

Mitigation: None.

3.8 Social and Economic Conditions

Information in this section discusses the demographic and economic characteristics of the region that may be affected by the Proposed Action, and is summarized from the *Socioeconomic Report for the Peabody Twentymile Coal, LLC Lease-by-Application COC78449* (Appendix E). Unless stated otherwise, all monetary values reported in this section are in nominal, or current year, dollars.

3.8.1 Affected Environment

The Foidel Creek Mine is located western Routt County, approximately 7 miles from Oak Creek, which had an estimated 2016 population of 914. Hayden (population 1,883) and Steamboat Springs (population 12,698) are each approximately 15 miles from the Foidel Creek Mine, and Craig (population 8,823) is approximately 36 miles west of the mine in Moffat County (Colorado Department of Local Affairs [CDOLA] 2017). The affected environment for social and economic conditions includes Routt and Moffat counties, which are linked by mining industry ties and worker commuting patterns.

Population. Between 2000 and 2010, population growth in Routt County averaged 1.5% per year, and the county's population increased from 20,123 in 2000 to 23,439 in 2010. Population growth slowed to an annual average of 0.9% between 2010 and 2016, and Routt County had 24,679 residents in 2016. Between 2000 and 2010, annual growth in Moffat County averaged 0.5%, and the county's population increased from 13,182 in 2000 to 13,806 in 2010. Moffat County's population decreased at an average annual rate of -0.9% between 2010 and 2016, falling to 13,088 residents in 2016 (CDOLA 2017).

Employment. Employment in Routt County (including wage and salary employment and self-employed individuals) increased from 18,584 jobs in 2000 to 20,862 jobs in 2010 and 22,994 jobs in 2016. In Moffat County, employment increased from 7,251 jobs in 2000 to 7,600 jobs in 2010, and decreased to 7,206 jobs in 2016 (Bureau of Economic Analysis [BEA] 2017a).

In 2016, over half of the wage and salary employment in Routt County was in Accommodation and Food Services; Retail Trade; Arts, Entertainment and Recreation; Health Care and Social Assistance; and Construction. The mining sector accounted for 3% of Routt County's 2016 employment, having lost 119 jobs between 2010 and 2016. Mining sector wages are among the highest paid in Routt County. In 2016, mining wages in Routt County averaged $91,896, compared to the county's overall average wage rate of $43,249 (Colorado Department of Labor and Employment [CDLE] 2017).

Nearly 60% of Moffat County's wage and salary employment in 2016 was in Retail Trade, Health Care and Social Assistance; Public Administration; Mining; and Accommodations and Food Services. The mining sector lost 127 jobs between 2010 and 2016 and accounted for 10% of Moffat County's employment in 2016. In 2016 mining wages in Moffat County averaged $82,663, compared to an overall average wage rate of $46,039 in the county (CDLE 2017).

The Foidel Creek Mine had 322 employees in 2001. Employment at the mine increased through most of the decade and peaked at 539 workers in 2009. The mine had 283 employees in 2016 and 269 workers in 2017 (DRMS 2018).

Unemployment Rates. In 2000, the unemployment rate was 2.8% in Colorado, 2.5% in Routt County, and 3.6% in Moffat County. Reflecting the national economic recession and downturns in energy markets, unemployment rates peaked at 8.7% in Colorado, 9.3% in Routt County, and 9.9% in Moffat County in 2010; and fell to 3.3% in Colorado, 2.7% in Routt County, and 4.0%

in Moffat County in 2016. Recent declines in Routt and Moffat counties' unemployment rates have been due in part to contractions in the labor force. Labor force levels in 2016 were at their lowest since 2006 in Routt County and 2001 in Moffat County (Bureau of Labor Statistics [BLS] 2017).

Fiscal Conditions. Routt and Moffat county governments receive revenues from several sources, including property, sales, and other taxes; fees for licenses, permits and services; and intergovernmental transfers. Revenues to Routt County government increased from $45.7 million in 2012 to $53.2 million in 2017 (Routt County 2018), and revenues to Moffat County increased from $85.3 million in 2012 to $96.5 million in 2018 (Moffat County 2018).

<u>Property Tax.</u> Coal production contributes to county government revenues primarily through property taxes, which are based on assessed valuations and tax rates (mill levies). Between 2010 and 2016 natural resources (including coal) accounted for 4% of Routt County's total assessed valuation; commercial property accounted for 21%; vacant, industrial, agricultural, and state assessed (public utilities, pipelines, and railroads) properties accounted for 24%; and residential property accounted for 51 percent. During this time natural resources (including coal) comprised 10% of Moffat County's assessed value; oil and gas production comprised 20%; vacant, residential, commercial, industrial, and agricultural property comprised 25%; and state assessed property comprised 45 percent. Natural resources contribute less to Routt County's tax base than they do to Moffat County's because of high residential and commercial property values in Routt County. Between 2010 and 2016 the assessed values for natural resources averaged $46.7 million in Routt County and $45.8 million in Moffat County, while the assessed values for residential and commercial properties averaged $820.4 million in Routt County and $98.3 million in Moffat County (CDOLA 2018).

TC is the largest source of property taxes in Routt County (Yampa Valley Data Partners 2015). Between 2008 and 2017, TC paid annual property taxes on the Foidel Creek Mine that ranged from a high of $3.46 million in 2011 to a low of $1.48 million in 2017 (Hutchinson 2018). Appendix E discusses the distribution of TC's property tax payments across Routt County taxing jurisdictions, as well as the distribution of federal mineral royalties, other federal taxes, and state severance tax payments made on coal production at the Foidel Creek Mine.

<u>Federal Mineral Royalties.</u> Revenues associated with federal coal leases include bonus payments, which are paid at the time the lease is issued, annual rent payments of at least $3 an acre, and a royalty rate on the gross value of production of 12.5% for surface coal and 8% for underground coal. For all types of coal leases, the BLM is authorized to reduce the royalty for the purpose of encouraging the recovery of federal coal and, in the interest of conservation of federal coal and other resources, whenever it is necessary to promote development or when the lease cannot be successfully operated under its terms. In no case can the royalty on a producing federal lease be reduced to zero (43 CFR §§3473.3-2(e), 3485(c)(1) (2013)). The BLM may approve royalty rate reductions for new leases.

In 2016, TC paid approximately $4.1 million in federal royalties from the development of federally-owned coal at the Foidel Creek Mine. In 2017, production at the mine moved from federal coal to state coal (Nettleton 2018).

State Mineral Royalties. TC paid approximately $110 million in state royalties from the development of state-owned coal at the Foidel Creek Mine between 1996 and 2017 (Courtney 2018). Although royalty payments fluctuated year by year, state royalty revenues equaled roughly $5 million per year over this 22-year period. In September 2017, the Colorado State Board of Land Commissioners approved a 5 year royalty rate reduction from 8% to 5% payable on state-owned coal mined at the Foidel Creek Mine.

3.8.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects:

Population. If LBA COC78449 is approved and under the RFMP, the Foidel Creek Mine would continue operating at current mining levels and the mine's life would be extended by approximately 2 years. Employment at the mine would remain near current levels and there would be no impact on population levels or trends in Routt and Moffat counties.

Earnings and Employment. The economic impacts of LBA approval and subsequent mining would include not only direct spending and employment at the mine, but would also include spending by businesses in Routt and Moffat counties that supply goods and services to the Foidel Creek Mine (indirect impacts) as well as spending by households that earn income from the Foidel Creek Mine and from businesses that supply goods and services to the mine (induced impacts).

This study used the BEA's Regional Input-Output Modeling System (RIMS II) to estimate the total economic impacts LBA approval and subsequent mining would have in Routt and Moffat counties. RIMS II generates multipliers that are based on the BEA's 2007 Benchmark Input-Output (I-O) accounts for the national economy and the BEA's regional economic accounts, which adjust the national I-O accounts to show a region's industrial structure and trading patterns.

The current analysis applied RIMS II multipliers for Coal Mining in Routt and Moffat counties to the Foidel Creek Mine's estimated output (sales), earnings (wages and benefits), and employment (full- and part-time jobs). Projected output was estimated by multiplying the mine's 2017 production of approximately 3.84 million tons by the average spot price of $41.80/ton for coal from Colorado (Uinta Basin) between January 5 and March 16, 2018 (EIA 2018). Note that these estimates are no guarantee that these level of production or prices would occur in the future; actual production and prices would be dictated by several factors, including market conditions. Projected earnings were based on 2017 labor costs of approximately $40 million at the Foidel Creek Mine and projected employment was based on the mine's 2017 employment level of 269 workers. All expenditures and income estimated through RIMS II and reported below are expressed in constant 2016 dollars.

Table 10 (Appendix A) summarizes the estimated annual impacts of LBA approval and subsequent mining on output, earnings, and employment in Routt and Moffat counties. These impacts could be expected to occur during each year of mine operations in the new lease tract, which are expected to last approximately 2 years, and would end with mine closure. The RIMS II analysis suggests that the Foidel Creek Mine's estimated annual output of $153.5 million would generate approximately $77.7 million in sales at other businesses, and total sales of approximately $231.2 million in Routt and Moffat counties. Because some of these sales would be for intermediate goods, the economy, or gross domestic product, of Routt and Moffat counties could be expected to increase by about $124.1 million. The estimated annual earnings of approximately $38.2 million at the mine would be associated with approximately $32.8 million in earnings at other local businesses, and total earnings in Routt and Moffat counties would be approximately $71 million. Total employment associated with mining operations would include 269 jobs at the mine and 254 jobs at other local businesses, for a total of 523 jobs in Routt and Moffat counties (BEA 2017b).

Fiscal Conditions. If the LBA is approved, and under the RFMP, federal, state, and local taxes would be paid on coal produced in the LBA tract. Lease approval is expected to extend production at the Foidel Creek Mine by approximately 2 years. Assuming that mining would occur at current production and price levels, each year of mining under LBA approval would result in approximately $12.8 million in federal mineral royalty payments, $1.1 million in severance tax revenues, and $1.5 million in property tax revenues. Routt County would receive a portion of federal mineral royalties and severance tax revenues (see Appendix E). Federal mineral royalty payments would be lower if the BLM approved a royalty rate lower than 8% for the new lease.

<u>Cumulative Effects</u>: The Foidel Creek Mine has been operating since 1983 and is currently the only operating coal mine in Routt County. Mining the coal reserves in the LBA tract would extend the life of the mine approximately 2 years beyond its currently anticipated 9 year productive life. The cumulative socioeconomic effects of continued operations at the mine along with past, present, and reasonably foreseeable actions in Routt and Moffat counties related to coal mining would include constant levels of population, employment, earnings, and federal, state, and local revenues throughout the life of the Foidel Creek Mine. These effects would end when the mine is closed.

3.8.3 Environmental Consequences of the No Action Alternative

<u>Direct, Indirect, and Cumulative Effects</u>: Under the No Action Alternative, the primary impact would be that the estimated 4.68 million tons of coal reserves in the LBA tract would be bypassed. Mining the reserves in the current lease tract would continue until these reserves are depleted. TC expects that reserves in the current lease tract can be mined at current mining rates for approximately 9 years. Upon depletion of the reserves in the current lease tract, direct and indirect jobs and related earnings, local expenditures and sales, and royalty and tax payments associated with mine production would end. Federal, state, and local governments would not receive any of the revenues associated with mining the coal in the proposed LBA. Because the Foidel Creek Mine is the only operating coal mine in Routt County, cumulative effects associated with the No Action Alternative could include regional job losses and population out-migration, and would occur approximately 2 years earlier than they would with LBA approval. Cumulative effects would be similar to those described for the Proposed Action. Impacts resulting from ongoing mining, sand and gravel operations, grazing, and utility rights-of-ways would continue.

Mitigation: None

3.9 Hydrology, Ground

3.9.1 Affected Environment

The LBA is on the southwest flank of the structural Twentymile Park Basin. Mining activities would occur approximately 1,800 feet beneath the land surface of Twentymile Park Basin. The Twentymile Park Basin is an enclosed groundwater basin. The Basin is a synclinal structure with rock outcrops on the margins of the Twentymile Park Basin. Groundwater flow is controlled by lithology and geologic structure and overall movement is generally toward the north. Within the proposed LBA area, groundwater is known to be present in the Wadge seam, Wadge overburden, surficial alluvium along the major creek drainages, Twentymile Sandstone, Fish Creek Sandstone, and the Trout Creek Sandstone. Heads in the Trout Creek aquifer are above land surface in much of Twentymile Park (DRMS 2010). The Trout Creek and the Twentymile sandstones are regional aquifers separated from the Wolf Creek seam by low-permeability shale and interbedded shale/siltstone units. The Twentymile Sandstone is approximately 800 feet above the Wolf Creek seam and the Trout Creek Sandstone is approximately 250 feet below the Wolf Creek seam. Recharge for the sandstone aquifers occurs predominantly in outcrop areas in the southern and western margins of the Twentymile Park Basin, with flow along the structural dip of the lithologic units toward the basin axis, where it ultimately discharges to Fish and Trout creeks.

The groundwater in the Twentymile Park Basin exists primarily under confined conditions within the bedrock units and under unconfined conditions within the alluvial deposits below the major surface drainages of the area and under previously disturbed areas of adjacent former surface mines. Below the surficial alluvial deposits and above the Twentymile Sandstone aquifer lies approximately 600 feet of low permeability Lewis Shale.

Alluvial groundwater exists in alluvial materials along the major surface drainages in the LBA. The alluvial deposits are generally less than 20 feet thick, and have limited extent along Foidel and Middle creeks in the LBA. Alluvial groundwater levels fluctuate with seasonal fluctuations in streamflow.

The one well within the LBA area is owned by TC, Permit number 66799-F. It is permitted for industrial use and provides for pumped transfer of water from an underground sump in an area of sealed Wadge seam mine workings to the surface. These uses include, but are not limited to, water for the coal wash plant, dust control for coal handling facilities and coal transfer conveyors. The water may also be treated at the surface and returned back underground for use in underground dust control and in underground mining equipment applications.

Existing and probable impacts from all mining operations in the Foidel Creek Mine are detailed in *The Cumulative Hydrologic Impact Assessment Yampa River Basin* (DRMS 2010. Drilling operations show 150 feet of shale, claystone, siltstone, and lenticular sandstone known as the interburden between the Wadge and Wolf Creek seams. These drilling operations into the Wolf Creek reserve showed little to no groundwater in the interburden or in the Wolf Creek seam. No drilling fluid losses or artesian flow were encountered during drilling. No significant groundwater flows have been encountered while mining in the Wolf Creek seam or in the interburden between the Wadge seam and the Wolf Creek seam. The interburden between the

Wadge seam and Wolf Creek seam is of very low permeability. Consequently, mine water inflows into the Wolf Creek seam are expected to be minimal. The Wadge seam above the Wolf Creek Reserve is mined out and filled with gob. Over time, slow water infiltration and recharge will result in some water in the Wadge seam gob, but vertical movement would be limited by the low permeability of the overlying and underlying units. There is currently an accumulation of water in the overlying sealed Wadge seam workings; this water will be transferred to sealed Wadge seam mine workings in the Western Mining District. The Western Mining District is to the west of the LBA area.

3.9.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: Dewatering of the Wolf Creek seam during mining would cause a localized decrease in the piezometric head in the Wadge Overburden. Any localized reduction in piezometric surfaces and/or changes in water quality and chemistry should not adversely affect water users because there are no wells that intercept the Wolf Creek reserve. Piezometric head is defined as "the level at which the hydrostatic water pressure in an aquifer will stand if it is free to seek equilibrium with the atmosphere." The Twentymile Sandstone is separated from the Wadge Overburden by a thick layer of low-permeability shale; however, where dewatering occurs near faults, piezometric head in the Twentymile Sandstone may be impacted. Previous dewatering for mining operations has caused decreases in water levels in some monitoring wells completed in the Twentymile Sandstone (TC 2017). Similarly, heads in the Trout Creek Sandstone may decrease as a result of mining operations, similar to previously recorded decreases in heads in monitoring wells, which were likely caused by mining operations (TC 2017). Heads in the Fish Creek Sandstone may be impacted by subsidence, and may decrease, similar to previously recorded decreases in heads at one of the monitoring wells in the Fish Creek Sandstone (TC 2017). No impacts would occur in the alluvial groundwater from dewatering. Any fluctuation in alluvial groundwater would be caused by changes to streamflow.

No significant increased degradation of groundwater quality is anticipated as a result of the proposed leasing activity. No water quality effects in the Twentymile Sandstone or the Trout Creek Sandstone would be anticipated during mining operations. The Twentymile Sandstone and Trout Creek Sandstone would not be affected because the thick, low permeability shales limit vertical water transmission between bedrock units. Following completion of mining in an area, the mined-out area would be sealed and allowed to flood. Oxidation effects associated with contact between the groundwater and exposed coal and overburden may result in changes in groundwater quality and chemistry including increases in total dissolved solids (TDS) and metals. These effects would be buffered by dilution by continued inflows and contact mixing with undisturbed groundwater sources. These increased TDS concentrations would be limited to the overburden unit.

Cumulative Effects: The TC Foidel Creek Mine has been in operation since 1983. Since that time groundwater quality has been monitored by monitoring wells which are part of an existing groundwater monitoring system. There are monitoring wells in the Twentymile Sandstone, the Trout Creek Sandstone, the Fish Creek Sandstone, and alluvial deposits. The groundwater monitoring system is used to document and assess any mining-related impacts to groundwater. Monitoring has shown that mining has had limited effects on the Twentymile Sandstone aquifer or Trout Creek Sandstone. Water quality data from the mine inflow into the Wadge seam workings does not indicate any significant connection to either the overlying Twentymile

Sandstone or the underlying Trout Creek Sandstone; however, some wells in the Twentymile Sandstone and Trout Creek Sandstone have shown decrease in head. Periodic evaluation of the existing monitoring system would be conducted to adequately monitor impacts resulting from mining coal under the RFMP.

Upon completion of mining of the Wolf Creek seam, mined-out areas would be sealed and allowed to flood, with gradual reestablishment of a stable piezometric surface within the water-bearing units and the mined-out units. TC conducts continual hydrologic monitoring and submits annual hydrology reports to DRMS. Impacts to groundwater quality from ongoing activities such as coal mining, sand and gravel operations, grazing, and utility rights-of-ways would continue.

3.9.3 Environmental Consequences of the No Action Alternative

Direct, Indirect, and Cumulative Effects: Under the No Action Alternative, the mine's productive life would not be extended by 2 years. The Foidel Creek Mine would continue to operate with or without the federal coal in this lease sale. Direct and indirect impacts to groundwater quality under the No Action Alternative would be similar to those described above for the Proposed Action; however, impacts would not occur for an additional 2 years. Cumulative effects would be similar to those described for the Proposed Action. Impacts to groundwater quality from ongoing mining and sand and gravel operations would continue.

Mitigation: None

3.10 Hydrology, Surface

3.10.1 Affected Environment

Middle Creek and Foidel Creek flow through the area of the LBA. Fish Creek is to the north of the LBA. Foidel Creek is a perennial tributary of Middle Creek, and Middle Creek and Fish Creek are perennial tributaries to Trout Creek; Trout Creek is a perennial tributary to the Yampa River. Runoff from the area affected by the Proposed Action would flow to Middle Creek and Foidel Creek, with a small portion of the LBA draining towards Fish Creek. The water quality of Foidel Creek, Middle Creek, and Fish Creek must support Aquatic Life Warm 1, Recreation E, and Agricultural beneficial uses. The water quality of Trout Creek must support Aquatic Life Cold 1, Recreation E, Water Supply, and Agricultural beneficial uses. Foidel Creek, Middle Creek, Fish Creek, and Trout Creek meet standards, and are not listed as impaired under CDPHE Section 303(d); however, all three creeks and their tributaries are on the Colorado Monitoring and Evaluation list for sediment (CDPHE 2018b). Water Quality Standards for Middle Creek and Foidel Creek have temporary modifications for selenium and iron. Water quality standard for chronic iron concentrations in Middle Creek from March through June is 2,090 µg/L, while it is 1,000 µg/L for Foidel and Fish creeks all year and Middle Creek for July through February. Iron standards are derived from current observed conditions in Middle and Foidel creeks. Selenium standards are also set to current conditions for Foidel and Middle Creek (CDPHE 2017). The Yampa River, around the confluence with Trout Creek is considered impaired for arsenic for water supply use and temperature for aquatic life use (CDPHE 2018b). Two reservoirs, Elkhead Reservoir, northeast of Craig, Colorado and Lake Catamount, south of Steamboat Springs, Colorado, are considered impaired under CDPHE Section 303(d) for mercury.

Longwall mining in the vicinity has occurred since approximately 1988 and runoff water from the subsided areas as well as some mine inflow water, has flowed or been released into Fish Creek or Foidel Creek after treatment in accordance with all state and federal regulations. Surface flows from disturbed and reclaimed areas are intercepted and treated in sedimentation ponds prior to discharge to meet the EPA's National Pollutant Discharge Elimination System (NPDES) standards. The State of Colorado CDPHE-WQCD administers the NPDES for the EPA and the Colorado Discharge Permit System (CDPS) issues discharge permits. TC's hydrologic monitoring program is subject to ongoing review under CDPHE's WQCD required Discharge Monitoring Reports. TC has five CDPS permits; each permit has 1 to 6 outfalls or monitoring sites.

Water discharge from the mine inflow water is also managed under TC's CDPS permit. Mine inflow water collects in underground sump rooms and is then pumped to the surface where it passes through the water treatment facility. This water is then either discharged to Fish Creek or returned underground for use in mining activities. Mine water can also be channeled and treated through surface settling ponds prior to discharging into Foidel Creek, or it can be returned for use underground. The discharge sites are rarely used because the Foidel Creek Mine makes use of and recycles much of the mine inflow water in various mining activities, especially dust suppression. If necessary, discharges are treated to meet CDPS permit effluent limits. In 2016, discharge into Fish Creek occurred from May through early July.

Average water quality discharge from the outfalls in 2017 was slightly alkaline, with average pH of 8.4, and conductivity of 4,670 micromhos per centimeter (µmho/cm). Total dissolved solids concentration averaged 4,126 mg/L. Total recoverable iron ranged from below detection limit to 0.98 mg/L, with the exception of a high values of 460 mg/L. Water quality samples taken from monitoring points in Fish and Foidel creeks show average arsenic concentrations of 0.7 µg/L and average selenium concentrations of 1.1 µg/L. Mercury was below detection limit for all samples (EPA 2018d). Mercury and selenium are of concern because of their detrimental effects to the Colorado federally listed fish species. The selenium standard for Fish and Foidel creeks is temporarily modified to current conditions, but the unmodified acute and chronic standards are 18.4 µg/L and 4.6 µg/L, respectively. None of the 2017 samples exceeded either value (EPA 2018d).

Water quality data collected from the Yampa River below Craig (USGS Station 09247600) between 1975 and January 2018 showed that selenium concentrations ranged from below detection limit to 17.0 µg/L. Quarterly measurements of selenium since 2005 show average selenium concentrations of 0.58 µg/L (USGS 2018). Quarterly selenium measurements were also conducted on the Yampa River near Hayden (USGS Station 09244490) from 2010 through 2017, and show selenium concentrations ranging from 0.08 to 2.7 µg/L, averaging 0.38 µg/L (USGS 2018). Water quality data for mercury collected from the same station between 2016 and 2017 showed that the mercury concentrations ranged from 0.00052 to 0.00345 µg/L, with an average of 0.00183 µg/L (USGS 2018). The State of Colorado chronic aquatic life water quality standard for mercury is 0.01 µg/L for all streams in the vicinity of the LBA (CDPHE 2017).

3.10.2 Environmental Consequences of the Proposed Action

<u>Direct and Indirect Effects</u>: Mining of the LBA would cause subsidence over the longwall panel (see Section 3.3.2, above). Subsidence would occur progressively during and shortly after

longwall mining. During mining of the Wadge seam, the maximum observed subsidence of Middle Creek was 4.5 feet (TC 2002). Subsidence could alter the flow paths of Foidel Creek and Middle Creek and change the size of the area contributing runoff to each creek. However, the change in runoff area would be small compared to the total runoff area of both creeks. Effects from subsidence of the ground surface likely would cause localized gradient changes in stream channels, with higher gradients at the upstream end of the subsidence area, and lower gradients at the downstream end of the subsidence area. The lower gradient would likely cause pooling in the stream, and could create additional ponds. Prior to full extraction under the creek, stream channel profile and cross-section surveys would be completed to provide a baseline for planning and evaluation of subsidence effects, and to support preparation of an assessment of Probable Hydrologic Consequences.

Subsidence-related impacts would be of limited magnitude and would occur progressively during and shortly after longwall mining. Subsidence of the Foidel Creek and Middle Creek valleys could result in potential seasonal flooding of low-lying areas and an increase in groundwater levels relative to the subsided surface along the margins of drainage channels. These subsidence effects have the potential to result in increased riparian vegetation and habitat along the margins of the affected drainages. The flooded area would be dictated by the surface flows in Foidel Creek and Middle Creek. More of the valley floor could be flooded during the spring runoff. If there is discharge due to mine dewatering, higher flows could be maintained during years of low stream flow. Because there would not be very much mine water inflow while mining the Wolf Creek seam, it is anticipated that little water would be discharged and therefore minimally affect the water quality or quantity.

Short term effects from localized gradient changes and stream profile changes could result in increased erosion and sediment transport. While the stream establishes a new stream bed or flow path, areas previously not part of the stream channel may become inundated, increasing erosion. Ninety-five to 98% of subsidence from longwall mining occurs during active mining. Long-term subsidence effects are not expected with longwall mining because such effects occur in a fairly short time.

Based on subsidence monitoring from previous mining in the overlying Wadge seam, the increase of the stream gradient should not result in any significant changes to the stream profile. Similar changes were documented in the Northern and Eastern Mining Districts without resulting in additional erosion. Temporary formation of broad, trough-shaped swales and ponding would be expected to occur over the longwall panels. The ponding would reduce the velocity of the stream due to the temporary gradient increase resulting in deposition of the suspended sediment. The stream would gradually adjust to a dynamic equilibrium once subsidence has stopped. Additional sediments could be generated in the short term from overland flow across soil surfaces; however, localized deposition is expected to occur within the stream channel, except during high runoff events. Slightly higher levels of TDS and Total Suspended Solids could result from sediment transport in the short term.

Surface cracking or fissuring formed from subsidence has occurred in areas where the Twentymile Sandstone either outcrops or is located relatively close to the surface. This condition does not occur in the LBA area. The thick marine shale covering the Twentymile Sandstone would decrease the potential for surface cracking or fissuring. The potential for surface water loss due to increased infiltration is extremely low due to the low permeability of the marine shale.

Mine water discharge into surface streams as a consequence of future mining could impact the quality of water in the receiving streams. Mine effluent would be regulated, and any discharge to receiving streams would have to meet permitted effluent requirements. Concentrations of TDS, iron, and manganese could increase. Most mine inflow water encountered during mining is currently being recycled for use in mining. This practice would continue if mining of the LBA occurs.

Combustion of the coal from the LBA would result in emissions that contain mercury and selenium. It is expected that about one-third of the saleable coal from the LBA would be combusted at the Hayden Generating Station. The combustion location for the additional two-thirds of coal is speculative at this time. Impacts from mercury emissions associated with coal combustion sources will have already received analysis as part of the permitting process or rule implementation by their respective regulatory agencies (state or EPA). Atmospheric deposition of mercury resulting from downstream coal combustion is further discussed in Section 3.4. The Yampa River, Trout Creek, Middle Creek, and Fish Creek are not on the CDPHE Section 303(d) List of Impaired Waters and Monitoring Evaluation List for mercury or selenium, but two reservoirs (Elkhead Reservoir and Lake Catamount) are considered impaired for mercury.

Cumulative Effects: Approval of the LBA would increase the life of mine by approximately 2 years. All mining impacts, including impacts from discharge would be extended for approximately 2 years. Additional subsidence would be added to existing and planned mine subsidence. An increase in erosion and deposition would continue until Foidel Creek and Middle Creek adjust to the changes that could be caused by subsidence. The discharge of mine inflow water to surface water drainage from the sediment ponds could affect water quality. The quality of surface water could possibly be affected by water handling and treatment methods under the planned operations of the mine. The effects of leaching in exposed spoil and waste rock piles, detention of water in sedimentation ponds, and pumping water out of pits and underground mine workings have the potential to increase TDS concentrations and change surface water quality. Impacts to surface water quality from ongoing activities such as coal mining, sand and gravel operations, grazing, and utility rights-of-ways would continue.

3.10.3 Environmental Consequences of the No Action Alternative

Direct, and Indirect, and Cumulative Effects: Under the No Action Alternative, the mine's productive life would not be extended by 2 years. The Foidel Creek Mine would continue to operate with or without the federal coal in this lease sale. Direct and indirect impacts to surface water quality under the No Action Alternative would be similar to those described above for the Proposed Action; however, impacts would not occur for an additional 2 years. Cumulative effects would be similar to those described for the Proposed Action. Impacts to surface water quality from ongoing mining and sand and gravel operations would continue.

Mitigation: None.

CHAPTER 4 – COORDINATION AND CONSULTATION

TRIBES, INDIVIDUALS, ORGANIZATIONS, OR AGENCIES CONSULTED

The NHPA requires federal agencies to consult with Native Americans regarding the effect of federal undertakings on sites that may be of cultural or religious importance to Indian people to ensure that tribal values are taken into account to the extent feasible. In historic times, the Little Snake field area was inhabited by the Utes and the Shoshone. Lacking a formal agreement outlining a consultation process, the BLM LSFO policy is to consult with relevant tribes when an undertaking is known to be in or near an area of concern to the historic tribes or when an undertaking involves types of sites that experience has shown are usually of concern to native peoples. Such sites include burials, rock art sites, wickiups, stone circle sites, possible vision quest sites, and possible eagle trap sites.

Because leasing of federal coal constitutes a federal undertaking, the possible effect of ground subsidence on areas or sites of Native American concern was considered. The project is not located within an area known to be of concern to the tribes, nor are any sites of the kind that are usually of concern to native peoples known in the area. From the above information, it is concluded that the proposed federal undertaking would not affect sites or areas of concern to Native Americans. Therefore Native American consultation was not initiated.

Under Section 7 of the ESA, federal agencies must consult with the USFWS when any action the agency carries out, funds, or authorizes may affect a listed endangered or threatened species. The LSFO initiated consultation by requesting a species list from the local USFWS office for federally listed, federally proposed, or current federal candidate species that may be present in the planning area. The LSFO subsequently prepared and submitted a BA to the USFWS on June 8, 2018 (Appendix D), that determined the Proposed Action “may affect, is not likely to adversely affect” the yellow-billed cuckoo and the lineage greenback cutthroat trout. In addition, the Proposed Action is not likely to destroy or adversely modify proposed critical habitat for the yellow billed cuckoo. The BLM LSFO also made a “may affect, likely to adversely affect” determination for the four Colorado River fish species and their critical habitats as a result of potential release of mercury from the combustion of federal coal in the local airshed and subsequent deposition into designated critical habitat.

On September 5, 2018, the USFWS issued a BO for the Proposed Action (TAILS 06E24100-2018-F-0271; Appendix D). The USFWS determined that although the Proposed Action is likely to adversely affect the Colorado River endangered fish species, the Proposed Action is not likely to jeopardize the four endangered fish species. The USFWS also found that the Proposed Action is not likely to result in the destruction or adverse modification of critical habitat for the four Colorado River fish. Additionally, the USFWS concurred with BLM’s determinations for the lineage greenback cutthroat trout and yellow-billed cuckoo and its proposed critical habitat.

Section 7(d) of the ESA prohibits federal agencies and applicants from making any irreversible or irretrievable commitment of resources which could foreclose the formulation and implementation of reasonable and prudent alternatives that could avoid jeopardy to listed species or destruction or adverse modification of critical habitat. Because a no jeopardy decision was provided from the USFWS (see Appendix D), and the project would not destroy or adversely modify critical habitat, no reasonable or prudent alternatives would be needed or developed for this action.

Appendix A

Figures, Maps, Tables

FIGURES

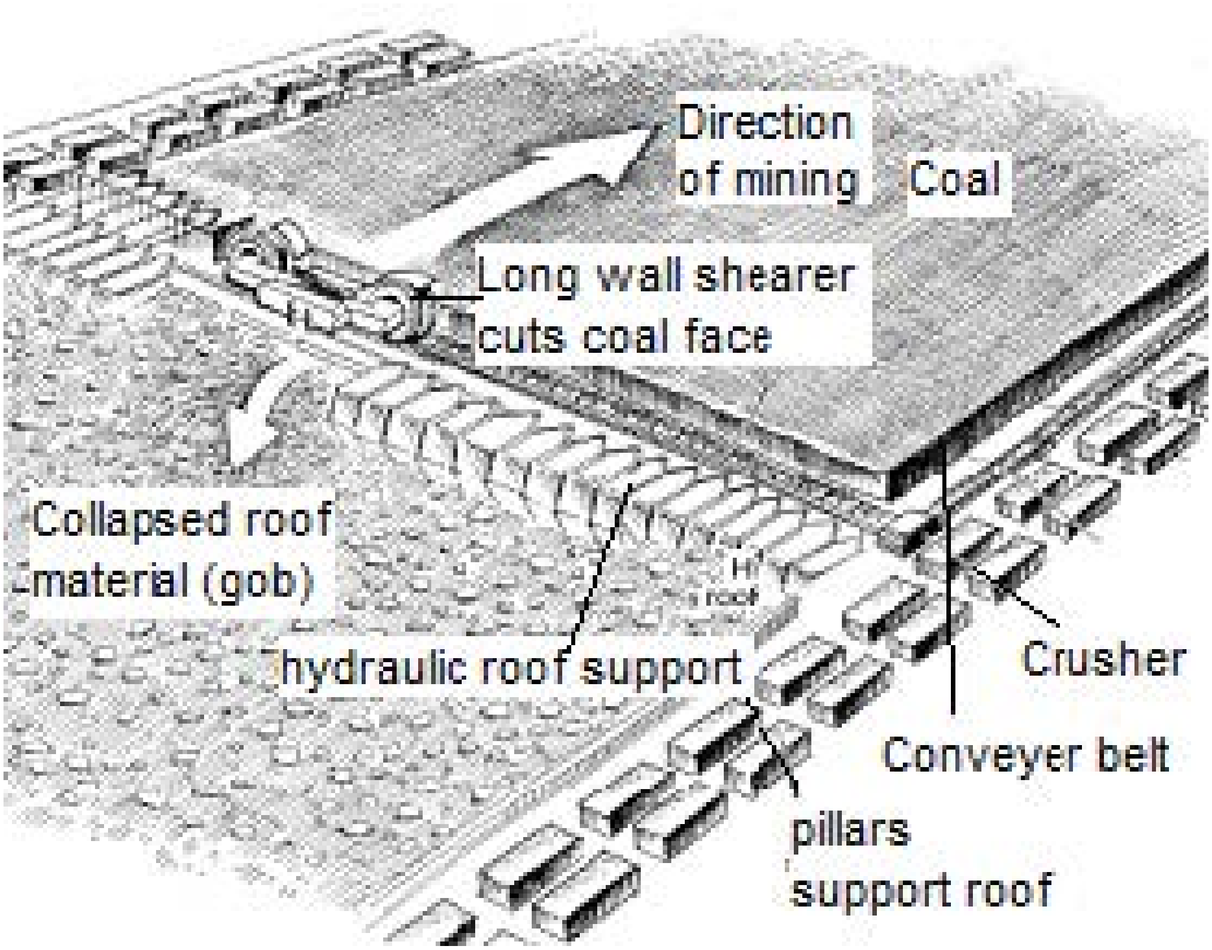


Figure 1.
Schematic of Longwall Mining

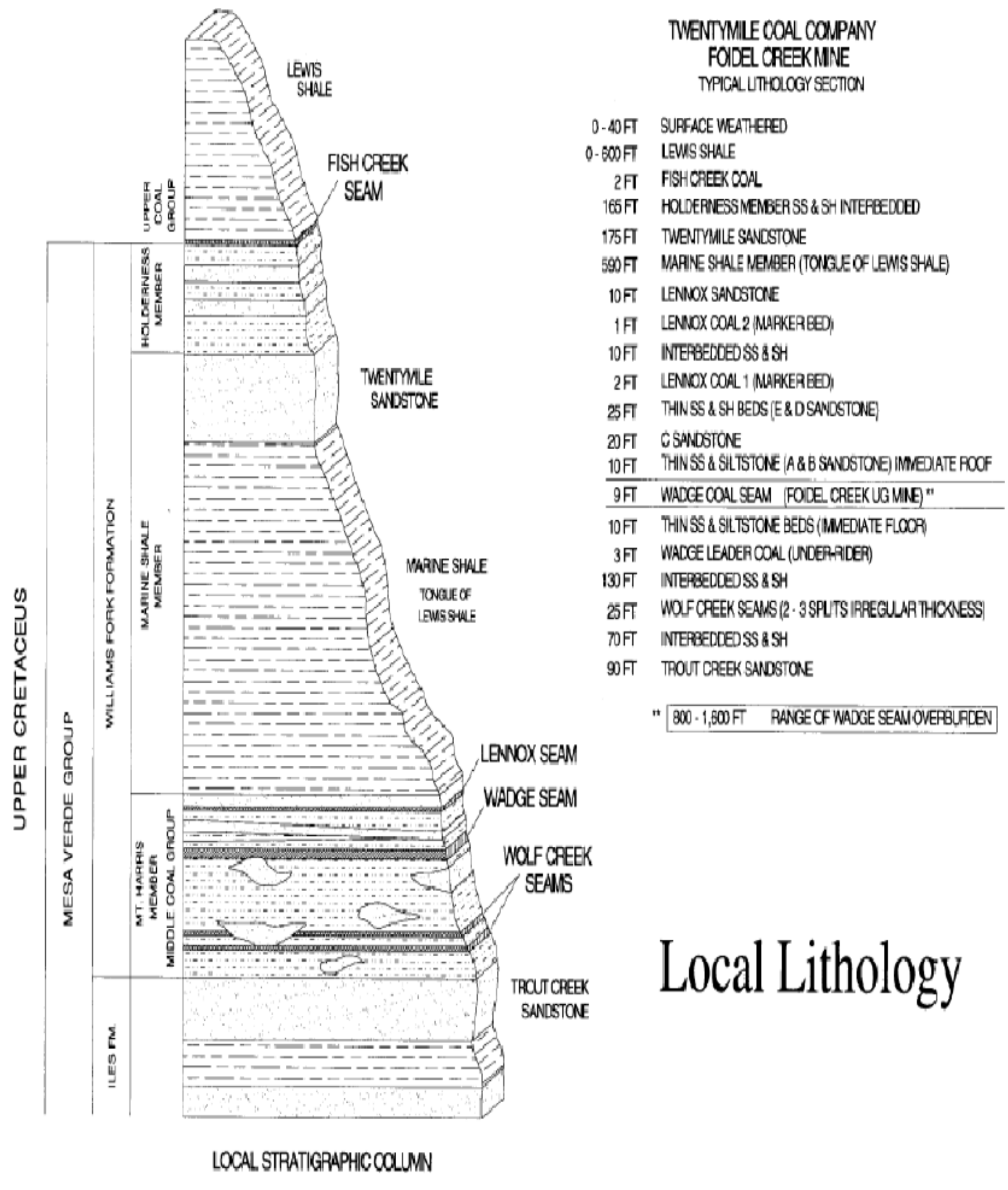
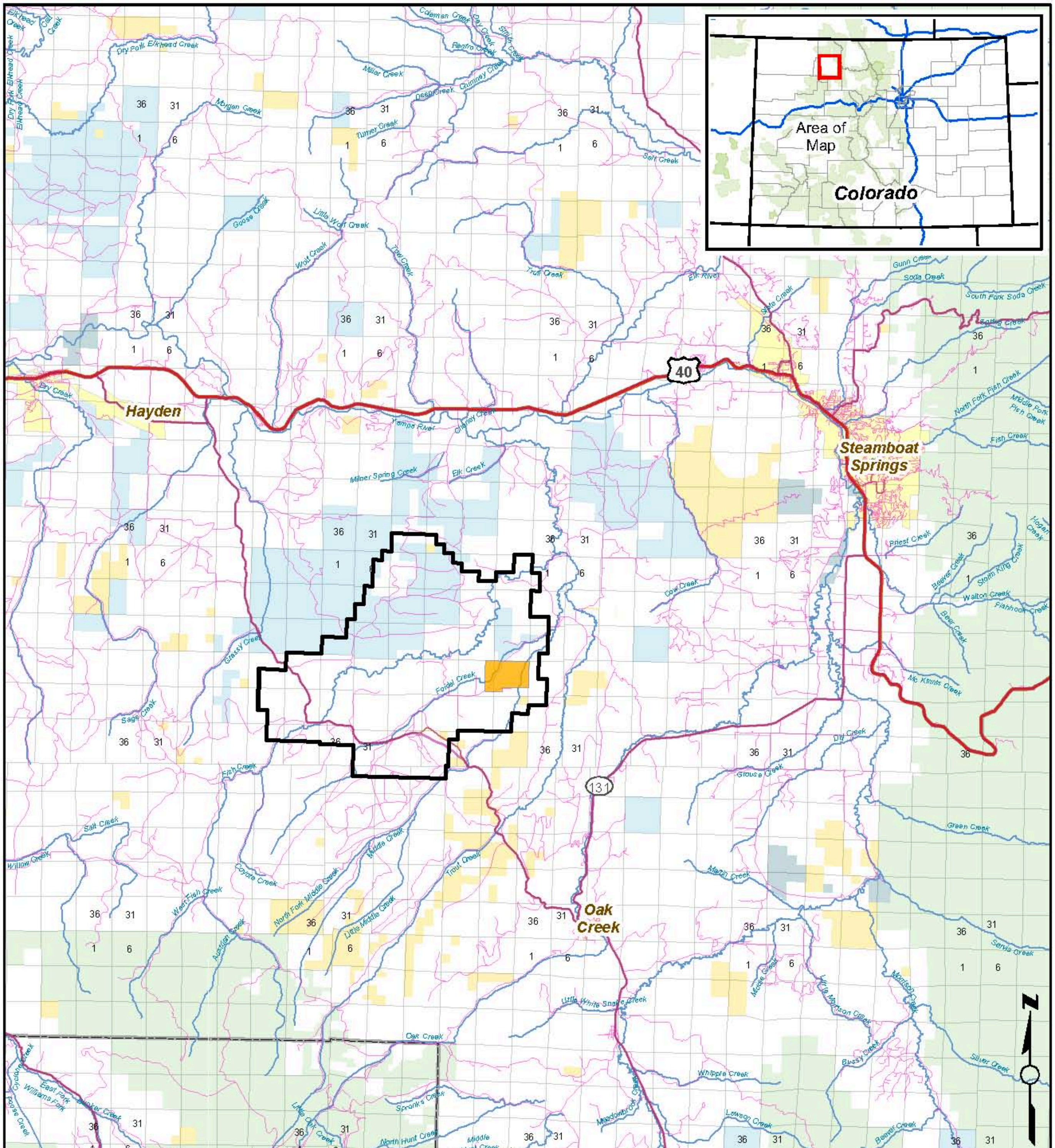


Figure 2.
Local Lithology

MAPS



Legend

DRMS Permit Boundary

LBA COC78449

0 2.5 5

Scale: 1 inch = 2.5 Miles

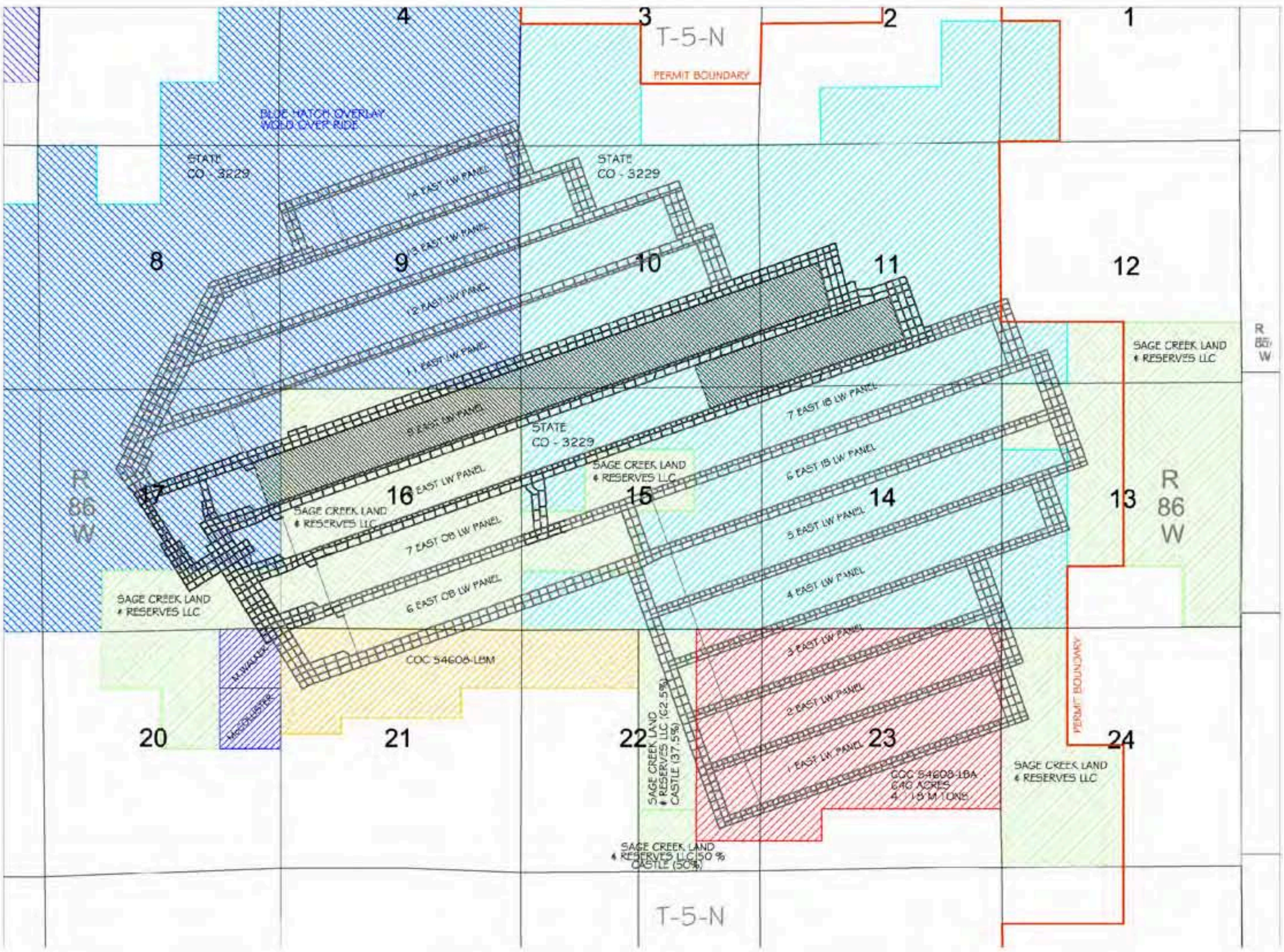
Twentymile Coal LBA COC78449

General Location

Routt County, Colorado

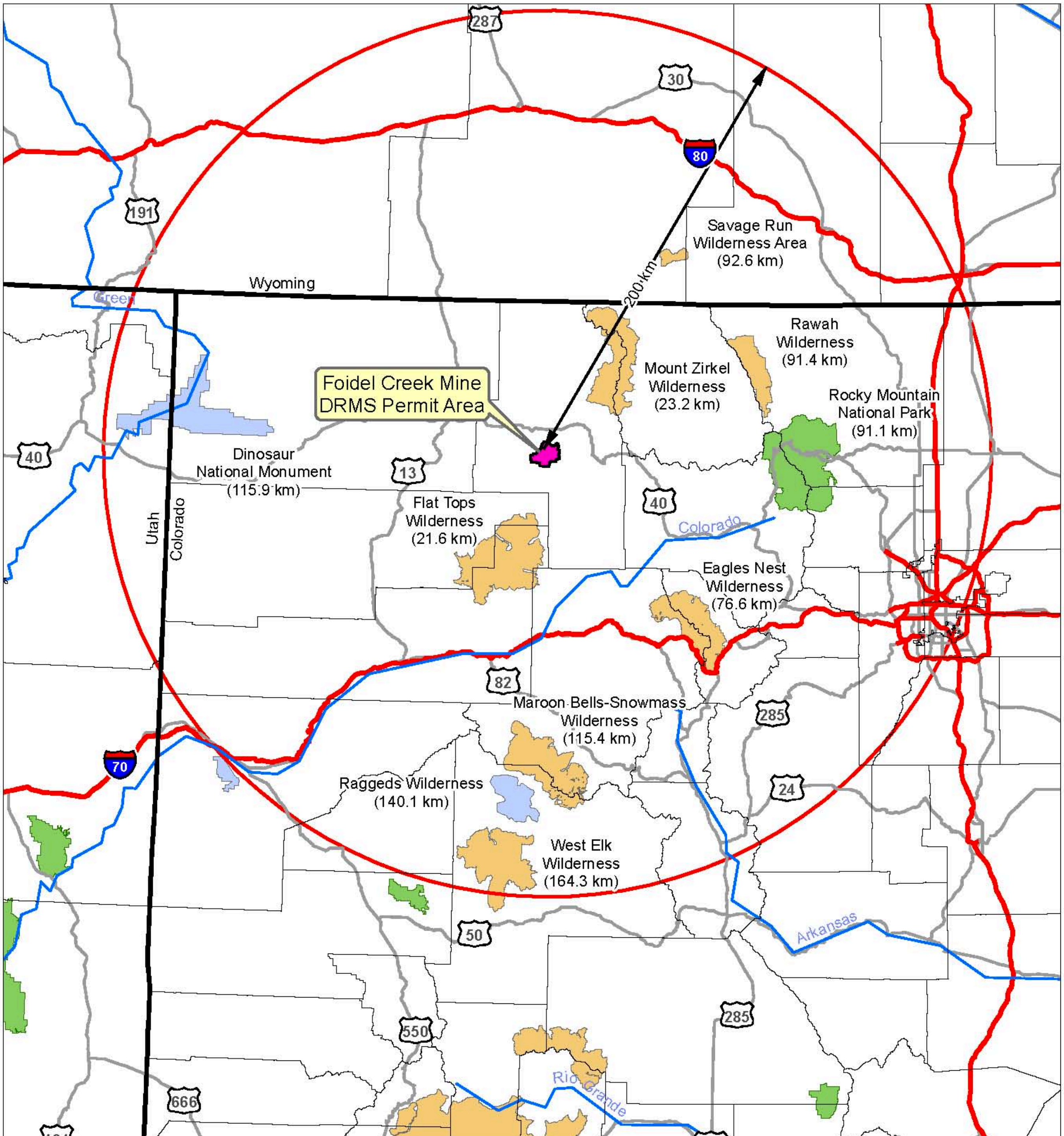
No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregation use with other data. All boundaries are an approximate representation.

Map 1



Twentymile Coal LBA COC78449
Wolf Creek Projections 8-31-2018
Map 2

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregation use with other data. All boundaries are an approximate representation.



Class I National Parks

Class I Wilderness Areas

Sensitive Class II Areas

0 25 50

Scale: 1 inch = 25 Miles

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregation use with other data. All boundaries are an approximate representation.

Twentymile Coal LBA COC78449

Air Quality PSD Class I and Sensitive Class II Areas in Relation to the Project Area

Map 3

TABLES

Table 1.
Resources and Determination of Need for Analysis

Determination [1]	Resource	Rationale for Determination
Physical Resources		
PI	Air Quality	See Chapter 3 and Appendix C
NI	Floodplains	The Proposed Action does not alter the surface hydrology such that flood hazards are increased. If the stream channel grades are increased, the functionality of the floodplains could be altered.
PI	Hydrology, Ground	See Chapter 3
PI	Hydrology, Surface	See Chapter 3
NP	Minerals, Fluid	There are no fluid mineral authorizations within the Proposed Action.
PI	Minerals, Solid	See Chapter 3
PI	Soils	See Chapter 3
PI	Water Quality, Ground	See Hydrology, Ground
PI	Water Quality, Surface	See Hydrology, Surface
Biological Resources		
NI	Invasive, Non-native Species	All activity as part of the LBA would occur underground – no activity that disturbs or modifies invasive, non-native species is proposed. Surface ownership above the coal lease is private.
NI	Migratory Birds	Underground coal mining would not impact use of the surface by migratory birds. Any subsidence that occurs would not be enough to modify habitat.
PI	Special Status Animal Species	See Section 3.3 and Appendix D
NP	Special Status Plant Species	There are no federally listed threatened, endangered, or BLM sensitive plant species populations identified within the vicinity of the project area.
NI	Upland Vegetation	No impacts are anticipated; there would be no new surface disturbance associated with the Proposed Action.
NI	Wetlands and Riparian Zones	There would be no mining impact and no subsidence below streams.
NI	Wildlife, Aquatic	Underground coal mining would not impact use of the surface by wildlife. Any subsidence that occurs would not be enough to modify habitat.
NI	Wildlife, Terrestrial	Underground coal mining would not impact use of the surface by wildlife. Any subsidence that occurs would not be enough to modify habitat.
NI	Wild Horses	The Sand Wash Herd Management Area is not near the project area.

Heritage Resources and the Human Environment		
PI	Cultural Resource	See Chapter 3
PI	Native American Concerns	See Chapter 3
NP	Environmental Justice	Routt and Moffat counties and the Oak Creek Census County Division have no minority or low-income populations that are 50% or more of the total population or exceed 120% of the relevant statewide population. Therefore, it was concluded that there are no environmental justice populations in the Foidel Creek Mine's region of influence (see Appendix E).
PI	Hazardous or Solid Wastes	See Chapter 3
NP	Lands with Wilderness Characteristics	Subject to WO-IM-2011-154 and in accordance with BLM policy, the project area does not have any parcels that meet the minimum size requirements for inventory finding of the presence of lands with wilderness characteristics. Size requirements are based on whether parcels are within roadless areas greater than 5,000 acres or are directly adjacent to designated wilderness or Wilderness Study Areas.
PI	Paleontological Resources	See Chapter 3
PI	Social and Economic Conditions	See Chapter 3
NI	Visual Resources	The surface area is managed as Class III, where the level of change to the characteristic landscape should be moderate and where management activities may attract attention but should not dominate the view of the casual observer. Because the project is underground, the coal lease would not impact the visual resources on the surface.
Resource Uses		
NP	Access and Transportation	The proposed project would occur on private lands where there is no public access.
NP	Fire Management	No BLM surface is involved; therefore, BLM fire management would not be impacted.
NP	Forest Management	This resource is not present in the project area.
NI	Livestock Operations	There would be no impact to surface livestock activities based on the nature of the Proposed Action and the limited amount of public lands being grazed within the lease area.
NP	Prime and Unique Farmlands	There are no Prime and Unique Farmlands in the project area.
NP	Realty Authorizations,	There are no rights-of-ways in the project area.

Determination [1]	Resource	Rationale for Determination
	Land Tenure	There are no land tenure adjustments currently proposed in the area.
NP	Recreation	The project area is located on private lands where there is no public access for recreational activities.
Special Designations		
NP	Areas of Critical Environmental Concern	The Irish Canyon Area of Critical Environmental Concern is not in the vicinity of the project area; therefore, would not be affected by the Proposed Action.
NP	Wilderness Study Areas	There are no Wilderness Study Areas in the vicinity of the project area; therefore, would not be affected by the Proposed Action.
NP	Wild and Scenic Rivers	There are no eligible rivers in the vicinity of the project area; therefore, would not be affected by the Proposed Action.

[1] NP=Not present in the area impacted by the Proposed Action or Alternatives. NI=Present, but not affected to a degree that detailed analysis is required. PI=Present with potential for impact analyzed in detail in the EA.

Table 2.
Background Ambient Air Quality Concentrations

Pollutant	*Averaging Period*	*Measured Background Concentration ($\mu g/m^3$)*	*NAAQS/CAAQS ($\mu g/m^3$)*
CO[1]	1-hour	1,145	40,000
	8-hour	1,145	10,000
NO_2[1]	1-hour	13	188
	Annual	1.9	100
PM_{10}[2]	24-hour	23	150
$PM_{2.5}$[1]	24-hour	14	35
	Annual	3	12
O_3[3]	8-hour	116	137
SO_2[1]	1-hour	2.6	196
	3-hour	2.6	1,300/700

[1] Williams Willow Creek, 2012 (CDPHE 2018a).
[2] Colowyo West 1997-1998 (CDPHE 2018a).
[3] Craig, 2016 (EPA 2018b).

Table 3.
Gothic Site N and S Deposition Values (kg/ha-yr), 2006 to 2015

Year of Monitoring	*Nitrogen Deposition*			*Sulfur Deposition*		
	Wet	*Dry*	*Total*	*Wet*	*Dry*	*Total*
2006	1.41	1.33	2.74	0.69	0.28	0.97
2007	1.25	1.46	2.71	0.52	0.31	0.83
2008	1.09	1.36	2.46	0.63	0.32	0.95
2009	1.41	1.28	2.69	0.81	0.28	1.09
2010	1.45	1.20	2.65	0.73	0.25	0.97
2011	1.31	1.32	2.63	0.62	0.26	0.88
2012	1.28	1.22	2.50	0.48	0.22	0.70
2013	2.14	1.25	3.39	0.84	0.24	1.08
2014	1.75	1.15	2.90	0.64	0.21	0.85
2015	1.95	1.12	3.07	0.72	0.18	0.90
Source: EPA 2018c.						

Table 4.
Direct Criteria and GHG Emissions from Stationary and Mobile Sources (tpy)

Sources/Types	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*CO*	*NO_X*	*SO_2*	*CO_2*	*CH_4*	*N_2O*
Point Sources (93RO1204)	40.96	18.57	NA	NA	4.9	NA	NA	NA	NA
Fugitives (93RO1204)	108.95	9.76	NA	NA	NA	NA	NA	NA	NA
Fuel Storage Tanks	NA	NA	3.99[a]	NA	NA	NA	NA	NA	NA
Emergency Generator	0.01	0.01	0.01	0.14	0.13	0.00	19.43	0.00	NA
Methane Sources (VAM)[b]	NA	NA	NA	NA	NA	NA	NA	22,952	NA
Underground & Surface Mining Equipment	1.35	1.31	1.68	9.70	21.99	0.027	4,588.34	0.091	0.0049
Pick-ups	0.0024	0.0021	0.0339	0.96	0.11	0.0008	115.84	0.0013	0.0006
Total Direct Emissions	**151.27**	**29.65**	**1.72**	**10.80**	**27.13**	**0.03**	**4,723.61**	**22,952.09**	**0.01**

[a] *Emissions based on APEN exemption (XA) threshold in attainment area (< 2.0 tpy) x 2 tanks.*
[b] *VAM reported by Twentymile Mine in the 2016 Greenhouse Gas Reporting Program Data Summary.*

Table 5.
Indirect Criteria and GHG Emissions (tpy)

Source	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*CO*	*NO_X*	*SO_2*	*Hg*	*CO_2*[1]	*CH_4*	*N_2O*
Electricity Consumption	ND[2]	ND	ND	ND	160.00	131.00	0.001	0.124	1.52	1.86
Commuter Traffic[3]	0.036	0.031	0.50	14.20	1.68	0.01	ND	0.0017	0.020	0.0095
Rail Hauling[4]	7.98	7.35	11.87	34.22	231.30	2.42	ND	ND	ND	ND
Total Indirect Emissions	**8.02**	**7.38**	**12.37**	**48.42**	**392.98**	**133.43**	**0.001**	**0.13**	**1.54**	**1.87**

[1] CO_2 Emissions reported in million tons per year
[2] ND = No Data
[3] Emissions based on MOVES Version 2014a 2018 emission factors for on-road Light-Duty Gasoline Trucks .
[4] Emissions from 2011 EPA NEI Mobile – Locomotives Data for Routt County, CO. Assumes all emissions from Foidel Creek coal hauling.

Table 6.
Downstream GHG Emissions (MMT per year)

CO_2	*CH_4*	*N_2O*	*CO_2e*
107.05	0.009	0.001	107.78

Table 7.
Emissions (tpy) from the Colorado BLM Planning Areas, SUIT Land and Mancos Shale for CARMMS 2025 Low Oil and Gas Development Scenario

Scenario	*NO_x*	*VOC*	*SO_2*	*PM_{10}*	*$PM_{2.5}$*
New Federal Oil & Gas	6,649	9,758	160	1,993	478
New Non-Federal Oil & Gas	17,718	31,186	67	15,515	2,344
Existing Oil & Gas on Federal Lands	56,767	136,746	281	19,683	5,134
New Mining Activities on Federal Lands	3,244	32	18	3,888	943
Total	**84,378**	**177,722**	**526**	**41,079**	**8,899**

Table 8.
List of Threatened and Endangered Species (Routt County Colorado)

Common Name	***Scientific Name***	***Federal Status***
Bonytail chub	*Gila elegans*	Endangered
Colorado pikeminnow	*Ptychocheilus lucius*	Endangered
Humpback chub	*Gila cypha*	Endangered
Razorback sucker	*Xyrauchen texanus*	Endangered
Canada lynx	*Lynx Canadensis*	Threatened
Yellow-billed cuckoo	*Coccyzus americanus*	Threatened
Greenback cutthroat trout	*Oncorhynchus clarki stomias*	Threatened
North American Wolverine	*Gulo gulo luscus*	Proposed Threatened

Table 9.
Average and Range of Mercury (Hg mg/kg WW) in Colorado Pikeminnow
Muscle Tissues from Upper Colorado River Basins 2008-2009 (Osmundson and Lusk 2012)

River Basin	***Average Hg in Muscle Tissue (min-max)***
San Juan River (> 400 mm TL)	0.37 (0.31 - 0.43)
Green River	0.77 (0.68 - 0.87)
Upper Colorado River	0.60 (0.31 – 1.04)
White River	0.95 (0.43 – 1.83)
Yampa River	0.49 (0.44 – 0.53)

Table 10.
Twentymile Coal LBA Approval
Estimated Annual Economic Impacts in Routt and Moffat Counties[1]

Impact Measure	***Direct Impacts***	***Indirect Impacts[2]***	***Total Impacts***
Output	$152,522,111[3]	$77,712,893	$231,235,003
Earnings	$38,230,245[4]	$32,801,551	$71,031,796
Employment	269[5]	254	523

[1] Source: RIMS II multipliers for Routt and Moffat counties (BEA 2017b). Dollar amounts are expressed in 2016 dollars.
[2] Includes indirect and induced effects.
[3] Based on estimated production of 3.5 million tons of coal and the EIA average January 5 to March 16, 2018 spot price of $41.80 for Colorado coal.
[4] Based on labor expenditures of approximately $40 million at the Foidel Creek Mine in 2017 (Brady 2018).
[5] Based on 2017 employment at the Foidel Creek Mine; includes full- and part-time jobs.

Appendix B

Land Health Standards

Public Land Health Standards

In January 1997, Colorado BLM approved the Standards for Public Land Health. The five standards cover upland soils, riparian systems, plant and animal communities, threatened and endangered species, and water quality. Standards describe conditions needed to sustain public land health and relate to all uses of the public lands. Environmental analyses of proposed projects on BLM land must address whether the Proposed Action or alternatives being analyzed would result in impacts that would maintain, improve, or deteriorate land health conditions identified in the applicable Land Health Assessment (LHA). Because there is no BLM surface within the project area, none of the Standards apply.

Appendix C

Air Quality Impact Analysis

Air Quality Impact Analysis

for the

Peabody Twentymile Coal, LLC
Lease-by-Application COC78449

1

Prepared by:

Carter Lake Consulting

September 2018

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CONTENTS

FIGURES

MAPS

TABLES

ABBREVIATIONS AND ACRONYMS

ºF	degrees Fahrenheit
μg/m^3	micrograms per cubic meter
acf	actual cubic feet
amsl	above mean sea level
APCD	Air Pollution Control Division
APEN	Air Pollutant Emission Notice
AQRVs	air quality related values
AR5	IPCC Fifth Assessment Report
B20 percent	best 20 percent
BART	Best Available Retrofit Technology
BLM	Bureau of Land Management
Btu	British thermal units
CAA	Clean Air Act
CAAQS	Colorado Ambient Air Quality Standards
CAMx	Comprehensive Air-quality Model with extensions
CARMMS	Colorado Air Resource Management Modeling Study
CASTNET	Clean Air Status and Trends Network
CCR	Code of Colorado Regulations
CDPHE	Colorado Department of Public Health and Environment

CFR	Code of Federal Regulations
CH_4	methane
CI	compression ignition
CMM	coal mine methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
DATs	deposition analysis thresholds
dv	deciview
DVB	base year
DVF	future year
EA	Environmental Assessment
eGRID	Emissions and Generation Resource Integrated Database
EIA	Energy Information Administration
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FLAG	Federal Land Managers Air Quality Related Values Work Group
GHGs	greenhouse gases
GVB	gob vent boreholes
GWP	Global Warming Potential
HAPs	hazardous air pollutants
HNO_3	nitric acid
ICE	internal combustion engine
IEM	Iowa Environmental Mesonet
IMPROVE	Interagency Monitoring of Protected Visual Environments
IPCC	Intergovernmental Panel on Climate Change
kg/ha-yr	kilogram per hectare per year
km	kilometer
LBA	Lease-by-Application
lb/MWh	pounds per megawatt-hour
LEE	low emitting electric generating units
LOP	Life-of-Project
LSFO	Little Snake Field Office
m^3	cubic meters
MATS	Modeled Attainment Test Software
MMT	million metric tons
mph	miles per hour
MSHA	Mine Safety and Health Administration
N	nitrogen
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NASA	National Aeronautics and Space Administration
NCA	National Climate Assessment
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NH_3	ammonia
NH_4	ammonium
NO_2	nitrogen dioxide
NO_3	nitrate
NO_x	nitrogen oxides

NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NSPS	New Source Performance Standards
NTN	National Trends Network
O_3	ozone
PGM	photochemical grid model
ppb	parts per billion
ppm	parts per million
PM	particulate matter
$PM_{2.5}$	particulate matter less than 2.5 microns in effective diameter
PM_{10}	particulate matter less than 10 microns in effective diameter
PSD	Prevention of Significant Deterioration
RCP	Representative Concentration Pathway
RFD	Reasonably Foreseeable Development
RFMP	Reasonably Foreseeable Mine Plan
RICE	Reciprocating Internal Combustion Engines
S	sulfur
SCC	Source Classification Code
SCRs	selective catalytic reduction units
SI	spark ignition
SO_2	sulfur dioxide
SO_4	sulfate
SUIT	Southern Ute Indian Tribe
SVR	Standard Visual Range
tpy	tons per year
USFWS	U.S. Fish and Wildlife Service
VAM	ventilation air methane
VOC	volatile organic compound
W20 percent	worst 20 percent
WRCC	Western Regional Climate Center

1. AFFECTED ENVIRONMENT

Regional air quality is influenced by a combination of factors including climate, meteorology, the magnitude and spatial distribution of local and regional air pollution sources, and the chemical properties of emitted pollutants. Within the lower atmosphere, regional and local scale air masses interact with regional topography to influence atmospheric dispersion and transport of pollutants. The following sections summarize the climatic conditions and existing air quality within the project area and surrounding region.

1.1 REGIONAL AIR QUALITY

The Foidel Creek Mine is located in the central portion of Routt County, Colorado (Township 5 North, Range 86 West, and Township 5 North, Range 87 West), approximately 15 miles southeast of Hayden, Colorado, and south of State Highway 40 between the towns of Steamboat Springs to the east and Craig to the west. The project is within the Central Mountains region for air quality planning (Colorado Department of Public Health and Environment [CDPHE] 2017). The Central Mountains Region includes 12 counties in the central area of Colorado, including Routt County, and the Continental Divide passes through much of the region. Air quality concerns in these regions are primarily from impacts related to particulate pollution from wood burning and road dust.

1.2 REGIONAL CLIMATE

The project area is located in a semiarid (dry and cold), mid-continental climate regime. The area is typified by dry, sunny days, clear nights and large daily temperature changes. The nearest long-term meteorological measurements were collected at Pyramid, Colorado (1910-2005), located 13 miles south of the project area at an elevation of 8,080 feet above mean sea level (amsl) (Western Regional Climate Center [WRCC] 2018).

In this region, historical records show the lower elevations receiving relatively higher precipitation amounts in summer, while the higher elevations receive relatively higher amounts of precipitation in winter. The annual average total precipitation at Pyramid is 21.15 inches, with annual totals ranging from 12.76 inches (1963) to 31.59 inches (1983). Precipitation increases in the winter months, with average monthly precipitation ranging from 1.44 inches (June) to 2.11 inches (March). An average of 182.1 inches of snow falls during the year (annual high 266.5 inches in 1974), with the majority of the snow distributed between November and April with January the peak month, averaging 31.2 inches.

The region has cool temperatures, with average temperature (in degrees Fahrenheit [˚F]) ranging between 7.9˚F and 33.4˚F in January to between 42.9˚F and 73.9˚F in July. Extreme temperatures have ranged from -31˚F (1924) to 89˚F (1911). The frost free period generally occurs from June to August. Table 1 shows the mean monthly temperature ranges and total precipitation amounts.

The closest comprehensive wind measurements were collected at the Hayden, Yampa Valley airport located approximately 10 miles northwest of the project area. Although local wind patterns in mountainous areas are almost always controlled by local topography, the Hayden site located at 6,600 feet amsl can be used to describe typical wind patterns in the project area. A wind rose for the site, for years 2013 through 2017, is presented in Figure 1. Tables 2 and 3 provide the wind direction distribution and wind speed distribution in a tabular format. From this information, it is evident that winds originate from the east to southeast over 39% of the time. The annual mean wind speed at the Hayden site is 7.8 miles per hour (mph).

Table 1. Monthly Temperature Ranges - and Total Precipitation Amounts[1]

Month	*Average Temperature Range (˚F)*	*Total Precipitation (inches)*
January	7.9-33.4	1.77
February	9.7-34.2	1.78
March	13.9-39.7	2.11
April	21.0-46.7	2.07
May	31.4-58.7	1.61
June	36.6-67.9	1.44
July	42.9-73.9	1.61
August	41.3-72.3	1.70
September	34.6-65.6	1.68
October	25.6-54.3	1.73
November	16.2-41.3	1.77
December	9.0-33.3	1.89
MEAN ANNUAL	**24.2–51.8**	**21.15**

[1] *Source: WRCC 2018.*

Table 2. Wind Direction Frequency Distribution - Hayden, Colorado, 2013 to 2017[1]

Wind Direction	*Frequency (percent)*
Calm	13.1
N	1.9
NNE	1.3
NE	1.7
ENE	3.2
E	16.5
ESE	16.3
SE	6.3
SSE	3.8
S	3.1
SSW	2.8
SW	3.9
WSW	4.5
W	10.4
WNW	5.5
NW	3.5
NNW	2.2

[1] *Source: Iowa Environmental Mesonet (IEM) 2018.*

Table 3. Wind Speed Distribution - Hayden, Colorado, 2013 to 2017[1]

Wind Speed (mph)	*Frequency (percent)*
< 2.0 (Calm)	13.1
2 – 4	9.1
4 – 8	28.7
8 – 13	36.5
13 – 19	9.7
19 – 25	2.3
Greater than 25	0.6

[1] Source: IEM 2018.

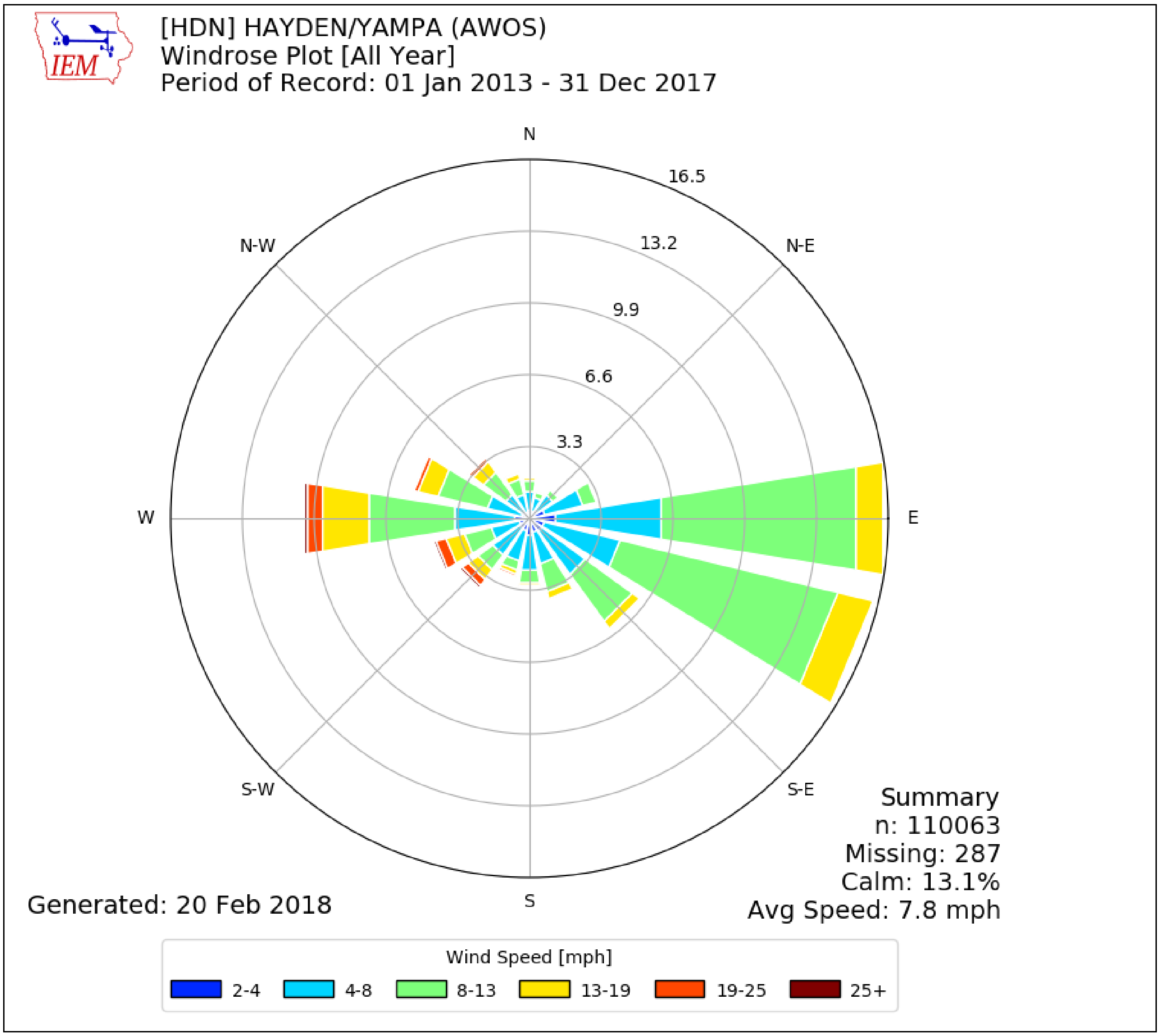


Figure 1.
Hayden, Colorado Meteorological Data Wind Rose, 2013-2017

1.3 OVERVIEW OF REGULATORY ENVIRONMENT

The CDPHE-Air Pollution Control Division (APCD) is the primary air quality regulatory agency responsible for estimating impacts once detailed industrial development plans have been made. Those development plans are subject to applicable air quality laws, regulations, standards, control measures, and management practices. Unlike the conceptual 'reasonable, but conservative' engineering designs used in National Environmental Policy Act (NEPA) analyses, any CDPHE-APCD air quality preconstruction permitting demonstrations required would be based on very site-specific, detailed engineering values, which would be assessed in the permit application review. Any proposed facility which meets the requirements set forth under Colorado Air Quality Control Commission Regulation 3 is subject to the CDPHE-APCD permitting and compliance processes.

Federal air quality regulations adopted and enforced by CDPHE-APCD limit incremental emission increases to specific levels defined by the classification of air quality in an area. The Prevention of Significant Deterioration (PSD) Program is designed to limit the incremental increase of specific air pollutant concentrations above a legally defined baseline level. Incremental increases in PSD Class I areas are strictly limited, while increases allowed in Class II areas are less strict. Under the PSD program, Class I areas are protected by Federal Land Managers through management of air quality related values (AQRVs) such as visibility, aquatic ecosystems, flora, fauna, and others.

The 1977 Clean Air Act (CAA) amendments established visibility as an AQRV for Federal Land Managers to consider. The 1990 CAA amendments contain a goal of improving visibility within PSD Class I areas. The Regional Haze Rule, finalized in 1999, requires states, in coordination with federal agencies and other interested parties, to develop and implement air quality protection plans to reduce the pollution that causes visibility impairment.

Regulations and standards which limit permissible levels of air pollutant concentrations and air emissions and which are relevant to the project air impact analysis include:

- National Ambient Air Quality Standards (NAAQS) (40 Code of Federal Regulations [CFR] Part 50) and Colorado Ambient Air Quality Standards (CAAQS) (5 Code of Colorado Regulations [CCR]-1001-14);
- Hazardous Air Pollutants (HAPs);
- Prevention of Significant Deterioration (PSD) (40 CFR Part 51.166);
- New Source Performance Standards (NSPS) (40 CFR Part 60);
- National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR Part 63);
- Non-Road Engine Tier Standards (40 CFR Part 89); and
- Colorado Air Quality Control Commission Regulations (Regulations 1, 3, and 8).

Each of these regulations is further described in the following sections.

Ambient Air Quality Standards

The CAA requires the U.S. Environmental Protection Agency (EPA) to set NAAQS for pollutants considered to endanger public health and the environment. The EPA has developed NAAQS for seven criteria pollutants: nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter less than 10 microns in effective diameter (PM_{10}), particulate matter less than 2.5 microns in effective diameter ($PM_{2.5}$), ozone (O_3), and lead. There would not be any lead emissions from project sources and therefore, lead impacts are not discussed in this document. There are two types of NAAQS; primary standards that prescribe limits on ambient levels of these pollutants in order to protect public health, including the health of sensitive groups, and secondary standards that provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. States typically adopt the NAAQS but may also develop State-specific ambient air quality standards for certain pollutants. The NAAQS and the CAAQS are summarized in Table 4.

Table 4. Ambient Air Quality Standards

Pollutant	***Averaging Time***	***Primary/Secondary***	***NAAQS***	***CAAQS***
CO	1-hour[1]	Primary	**35 ppm** (40,000 µg/m^3)	*
	8-hour[1]	Primary	**9 ppm** (10,000 µg/m^3)*	*
NO_2	1-hour[2]	Primary	**100 ppb** (188 µg/m^3)	*
	Annual[3]	Primary and Secondary	**53 ppb** (100 µg/m^3)	*
Ozone	8-hour[4]	Primary and Secondary	**70 ppb** (137 µg/m^3)	*
PM_{10}	24-hour[2]	Primary and Secondary	**150 µg/m^3**	*
$PM_{2.5}$	24-hour[5]	Primary and Secondary	**35 µg/m^3**	*
	Annual[6]	Primary	**12 µg/m^3**	*
	Annual[6]	Secondary	**15 µg/m^3**	*
SO_2	1-hour[7]	Primary	**75 ppb** (196 µg/m^3)	*
	3-hour[1]	Secondary	**0.5 ppm** (1,300 µg/m^3)	*
	3-hour[1]	Primary and Secondary	**--**	**700 µg/m^3**

Source: 40 CFR Part 50.
[1] No more than one exceedance per year.
[2] An area is in compliance with the standard if the 98th percentile of daily maximum 1-hour NO_2 concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
[3] Annual arithmetic mean.
[4] An area is in compliance with the standard if the fourth-highest daily maximum 8-hour O_3 concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
[5] An area is in compliance with the standard if the highest 24-hour $PM_{2.5}$ concentration in a year, averaged over 3 years, is less than or equal to the level of the standard.
[6] Annual arithmetic mean, averaged over 3 years
[7] An area is in compliance with the standard if the 99th percentile of daily maximum 1-hour SO_2 concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
Bold indicates the units in which the standard is defined.

The ambient air quality standards are shown in units of parts per million (ppm), parts per billion (ppb), and micrograms per cubic meter ($\mu g/m^3$) for purposes of providing the standards as written in the corresponding regulation, and for comparison with ambient pollutant concentrations. Although specific air quality monitoring has not been conducted within the project area, all of Routt County is currently designated as "attainment" by the CDPHE for all criteria pollutants (CDPHE 2017).

Hazardous Air Pollutants

Toxic air pollutants, also known as HAPs, are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. The majority of HAPs originate from stationary sources (factories, refineries, power plants) and mobile sources (cars, trucks, buses), as well as indoor sources (building materials and cleaning solvents). No ambient air quality standards exist for HAPs, instead emissions of these pollutants are regulated by a variety of laws that target the specific source category and industrial sectors for stationary, mobile, and product use/formulations. The majority of HAPs emitted from the Foidel Creek Mine's operation are the result of the on-road and non-road vehicle use. The largest component of the HAPs emissions from these sources are typically various benzene compounds, and the majority of them are emitted from spark ignition (gasoline-fueled) combustion sources. This is simply due to the fact that benzene is present in larger percent volumes in the fuel (typically 1.0% vs. 0.05% for diesel fuel). The majority of the vehicle emissions (all the trucks for underground transportation, scoops, graders, etc.) and all the surface equipment (dozers, loader, graders) are from diesel-powered engines, and thus HAP emissions from these sources are de minimis or insignificant.

Prevention of Significant Deterioration

The PSD program is designed to limit the incremental increase of specific air pollutant concentrations above a legally defined baseline level. All areas of the country are assigned a classification that describes the degree of degradation to the existing air quality allowed to occur within the area under the PSD permitting rules. PSD Class I areas are areas of special national or regional natural, scenic, recreational, or historic value, and very little degradation in air quality is allowed by strictly limiting industrial growth. PSD Class II areas allow for reasonable industrial/economic expansion. Areas such as national parks, national wilderness areas, and national monuments are designated as PSD Class I areas, and air quality in these areas is protected by allowing only slight incremental increases in pollutant concentrations. In a PSD increment analysis, impacts from proposed emissions sources are compared with the allowable limits on increases in pollutant concentrations, which are called PSD increments. Prevention of Significant Deterioration increments are established for NO_2, PM_{10}, $PM_{2.5}$, and SO_2. These increments are shown in Table 5. The project area is classified as PSD Class II, where less stringent limits on increases in pollutant concentrations apply.

Comparisons of project impacts to the PSD Class I and II increments are for informational purposes only and are intended to evaluate a threshold of concern. They do not represent a regulatory PSD Increment Consumption Analysis, which would be completed as necessary during the New Source Review permitting process by the State of Colorado.

Table 5. PSD Class I and Class II Increments

Pollutant	*Averaging Time*	*PSD Class I Increment ($\mu g/m^3$)*	*PSD Class II Increment ($\mu g/m^3$)*
NO_2	Annual[1]	2.5	25
PM_{10}	24-hour[2] Annual[1]	8 4	30 17
$PM_{2.5}$	24-hour[2] Annual[1]	2 1	9 4
SO_2	3-hour[2] 24-hour[2] Annual[1]	25 5 2	512 91 20

Source: 40 CFR 52.21(c).
[1] *Annual arithmetic mean.*
[2] *No more than one exceedance per year.*

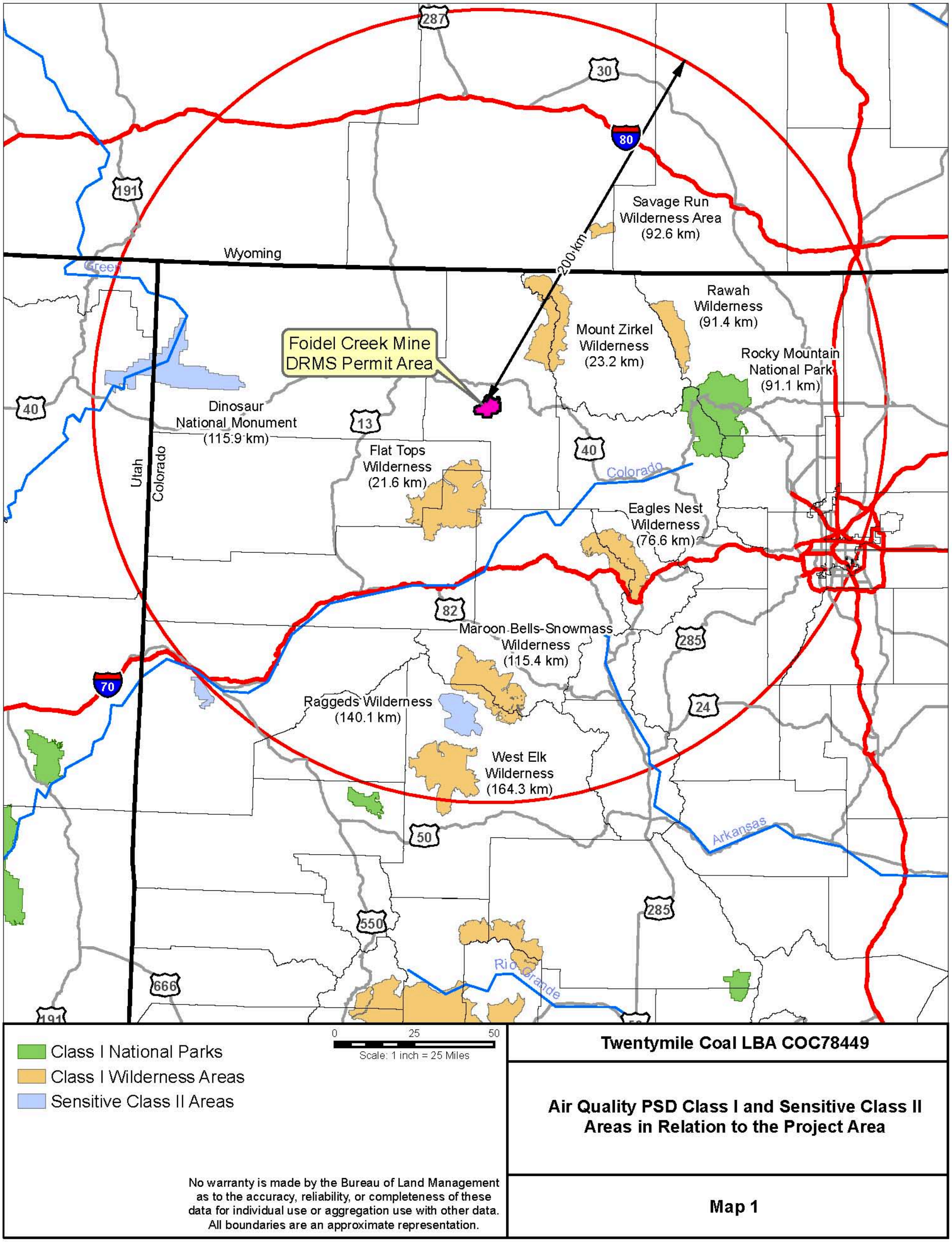
Air Quality Related Values

In addition to the PSD increments, Class I areas are protected by the Federal Land Managers through management of AQRVs, such as visibility, atmospheric deposition, aquatic ecosystems, flora, fauna, etc. Evaluation of potential impacts to AQRVs would be performed during the New Source Review permitting process under the direction of the CDPHE-APCD in consultation with the Federal Land Managers.

AQRVs have been identified as a concern at several federal Class I and sensitive Class II areas in the region. The project area is within 200 kilometers (km) of eight Class I areas and two sensitive Class II areas as shown on Map 1. Class I areas within 200 km of the project area include the Eagles Nest, Flat Tops, Maroon Bells – Snowmass, Mount Zirkel, Rawah, Savage Run, and West Elk wilderness areas, and Rocky Mountain National Park. Federal Class II areas within 200 km of the project area that are considered sensitive areas include the Raggeds Wilderness Area and Dinosaur National Monument. Dinosaur National Monument is regulated as a Class I area for SO_2 by the CDPHE. A discussion of the applicable AQRV analysis thresholds is provided below.

<u>Visibility</u>

Change in atmospheric light extinction relative to background conditions is used to measure regional haze. Analysis thresholds for atmospheric light extinction are set forth in the Federal Land Managers' Air Quality Related Values Work Group (FLAG) Report (FLAG 2010), with the results reported in percent change in light extinction and change in deciviews (dv). A 5 percent change in light extinction (approximately equal to a 0.5 change in dv) is the threshold recommended in FLAG (2010) and is considered to contribute to regional haze visibility impairment. A 10 percent change in light extinction (approximately equal to 1.0 dv) is considered to represent a noticeable change in visibility when compared to background conditions.


287
30
80
191
Savage Run
Wilderness Area
(92.6 km)
200 km
Wyoming
Green
Rawah
Wilderness
(91.4 km)
Mount Zirkel
Wilderness
(23.2 km)
Rocky Mountain
National Park
(91.1 km)
Foidel Creek Mine
DRMS Permit Area
Dinosaur
National Monument
(115.9 km)
40
13
40
Flat Tops
Wilderness
(21.6 km)
Colorado
Utah
Colorado
Eagles Nest
Wilderness
(76.6 km)
82
Maroon Bells-Snowmass
Wilderness
(115.4 km)
285
70
Raggeds Wilderness
(140.1 km)
24
West Elk
Wilderness
(164.3 km)
50
Arkansas
550
285
Rio Grande
666
191
Class I National Parks
Class I Wilderness Areas
Sensitive Class II Areas
0 25 50
Scale: 1 inch = 25 Miles
Twentymile Coal LBA COC78449
Air Quality PSD Class I and Sensitive Class II Areas in Relation to the Project Area
Map 1
No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregation use with other data. All boundaries are an approximate representation.

Atmospheric Deposition

The effects of atmospheric deposition of nitrogen (N) and sulfur (S) compounds on terrestrial and aquatic ecosystems are well documented and have been shown to cause leaching of nutrients from soils, acidification of surface waters, injury to high elevation vegetation, and changes in nutrient cycling and species composition.

FLAG (2010) recommends that applicable sources assess impacts of N and S deposition at Class I areas. This guidance recognizes the importance of establishing critical deposition loading values ("critical loads") for each specific Class I area as these critical loads are completely dependent on local atmospheric, aquatic, and terrestrial conditions and chemistry. Critical load thresholds are essentially a level of atmospheric pollutant deposition below which negative ecosystem effects are not likely to occur. FLAG (2010) does not include any critical load levels for specific Class I areas and refers to site-specific critical load information on Federal Land Manager websites for each area of concern. This guidance does, however, recommend the use of deposition analysis thresholds (DATs) developed by the National Park Service (NPS) and the U.S. Fish and Wildlife Service (USFWS). The DATs represent screening level values for N and S deposition from project-specific emission sources below which estimated impacts are considered negligible. The DATs established for both N and S in western Class I areas is 0.005 kilogram per hectare per year (kg/ha-yr).

In addition to the project-specific analysis, results from cumulative emission sources are compared to critical load thresholds established for the Rocky Mountain region to assess total deposition impacts. The NPS has provided recent information on N critical load values applicable for Wyoming and Colorado Class I and sensitive Class II areas (NPS 2014). For Colorado Class I and sensitive Class II areas (with the exception of Dinosaur National Monument) a critical load value of 2.3 kg/ha-yr is applicable for total N deposition, based on research conducted by Baron (2006) that estimated 1.5 kg/ha-yr as a critical loading value for wet N deposition for high-elevation lakes in Rocky Mountain National Park, Colorado. For Dinosaur National Monument, which is an arid region, a N deposition critical load value is based on research conducted by Pardo et al. (2011) which concluded that the cumulative critical load necessary to protect shrublands and lichen communities in Dinosaur National Monument is 3 (kg N/ha-yr).

For S deposition, current critical load values have not been established for the Rocky Mountain region. The critical load threshold published by Fox et al. (1989) for total sulfur of 5 kg/ha-yr, for the Bob Marshall Wilderness Area in Montana and Bridger Wilderness Area in Wyoming, is used as the critical load threshold for cumulative source impacts at Class I areas. This value is likely an overestimate of a current representative critical load value for the region.

New Source Performance Standards

Under Section 111 of the CAA, the EPA has promulgated technology-based emissions standards which apply to specific categories of stationary sources. These standards are referred to as NSPS (40 CFR Part 60). The NSPS potentially applicable to the Project include the following subparts of 40 CFR Part 60:

- Subpart A – General Provisions;
- Subpart Kb – Standards of Performance for Volatile Organic Storage Vessels;
- Subpart Y – Coal Preparation and Processing Plants;
- Subpart IIII – Standards of Performance for Stationary Compression Ignition Engines; and
- Subpart JJJJ – Standards of Performance for Stationary Spark-Ignition Internal Combustion Engines.

Subpart A – General Provisions

Provisions of Subpart A apply to the owner or operator of any stationary source which contains an affected facility. The provisions apply to facilities that commenced construction or modification after the date of publication of any proposed standard. Provisions of Subpart A apply to project sources that are affected by NSPS.

Subpart Kb – Volatile Organic Liquid Storage Vessels

Subpart Kb applies to storage vessels with a capacity greater than or equal to 75 cubic meters (m^3) that are used to store volatile organic liquids for which construction, reconstruction, or modification is commenced after July 23, 1984. This subpart is applicable to storage tanks for natural gas liquids.

Subpart Y – Coal Preparation and Processing Plants

Subpart Y applies to new coal preparation and processing plants. Coal preparation and processing plants break, crush, screen, clean and/or use heat to dry coal at coal mines, power plants, cement plants, coke manufacturing facilities, and industrial facilities. The subpart, revised on September 25, 2009, requires new coal preparation and processing plants to meet the limits set forth in the performance standard.

Subpart IIII – Standards of Performance for Stationary Compression Ignition Engines

Subpart IIII establishes emission standards and compliance schedules for the control of emissions from compression ignition (CI) internal combustion engines (ICE) (diesel engines). The rule requires new engines of various horsepower classes to meet emissions standards for nitrogen oxides (NOx), volatile organic compounds (VOCs), and particulate matter (PM). Owners and operators of stationary CI ICE that commenced construction after July 11, 2005 are subject to this rule.

Subpart JJJJ – Spark-Ignition Internal Combustion Engines

Subpart JJJJ establishes emission standards and compliance schedules for the control of emissions from spark ignition (SI) internal combustion engines. The rule requires new engines of various horsepower classes to meet increasingly stringent NOx and VOC emission standards over the phase-in period of the regulation. Owners and operators of stationary SI ICE that commenced construction, modification, or reconstruction after June 12, 2006 are subject to this rule; standards will depend on the engine horsepower and manufacture date.

National Emission Standards for Hazardous Air Pollutants

NESHAPs for stationary Reciprocating Internal Combustion Engines (RICE) contained in 40 CFR Part 63 limits emissions of toxic air pollutants from stationary RICE. The RICE NESHAP applies to stationary RICE. All sizes of emergency and non-emergency stationary engines are covered by the rule. Engines located at an area source of HAP are considered “existing” if the original owner/operator of the engine entered into a contract for the on-site installation of the engine before June 12, 2006. Existing CI engines needed to comply by May 3, 2013. Existing SI engines needed to comply by October 19, 2013. New engines must comply upon startup.

Non-Road Engine Tier Standards

The EPA sets emissions standards for non-road diesel engines for hydrocarbons, NO_x, CO, and PM.The emissions standards are implemented in tiers by year, with different standards and start years for various engine power ratings. The new standards do not apply to existing non-road equipment. Only equipment built after the start date for an engine category (1999-2006, depending on the category) is affected by the rule. Over the Life-of-Project (LOP), the fleet of non-road equipment will turn over and higher-emitting engines will be replaced with lower-emitting engines.

Colorado Air Quality Regulations

The project would be required to comply with all CDPHE-APCD regulations prior to commencing operation. Colorado Air Quality Control Commission Regulations applicable to emissions sources in the project area would include:

- Air Quality Standards, Designations and Emission Budgets (5 CCR 1001-14)
- Regulation 1 - Emission Control for Particulate Matter, Smoke, Carbon Monoxide and Sulfur Oxides (5 CCR 1001-3)
- Regulation 3 - Stationary Source Permitting and Air Pollutant Emission Notice Requirements (5 CCR 1001-5)
- Regulation 8 - Control of Hazardous Air Pollutants (5 CCR 1001-10)

1.4 GREENHOUSE GASES AND CLIMATE CHANGE

Climate change is a statistically-significant and long-term change in climate patterns. The terms climate change and “global warming” are often used interchangeably, although they are not the same thing. Climate change is any deviation from the average climate, whether warming or cooling, and can result from both natural and human (anthropogenic) sources. Natural contributors to climate change include fluctuations in solar radiation, volcanic eruptions, and plate tectonics. Global warming refers to the apparent warming of climate observed since the early 20th century and is primarily attributed to human activities, such as fossil fuel combustion, industrial processes, and land use changes.

The natural greenhouse effect is critical to the discussion of climate change. The greenhouse effect refers to the process by which greenhouse gases (GHGs) in the atmosphere absorb heat energy radiated by Earth’s surface and re-radiate some of that heat back toward Earth, causing temperatures in the lower atmosphere and on the surface of Earth to be higher than they would be without atmospheric GHGs. These GHGs trap heat that would otherwise be radiated into space, causing Earth’s atmosphere to warm and making temperatures suitable for life on Earth. Without the natural greenhouse effect, the average surface temperature of Earth would be about 0˚F. Higher concentrations of GHGs amplify the heat-trapping effect resulting in higher surface temperatures. Water vapor is the most abundant GHG, followed by carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and several trace gases. Water vapor, which occurs naturally in the atmosphere, is often excluded from the discussion of GHGs and climate change because its atmospheric concentration is largely dependent upon temperature rather than being emitted by specific sources. Certain GHGs, such as CO_2 and CH_4, occur naturally in the atmosphere and are also emitted into the atmosphere by human activities.

Atmospheric concentrations of naturally-emitted GHGs have varied for millennia and Earth’s climate has fluctuated accordingly. However, since the beginning of the industrial revolution around 1750, human activities have significantly increased GHG concentrations and introduced man-made compounds that act as GHGs in the atmosphere. The atmospheric concentrations of CO_2, CH_4, and N_2O have increased to levels unprecedented in at least the last 800,000 years. From pre-industrial times until today, the global average concentrations of CO_2, CH_4, and N_2O in the atmosphere have increased by around 40 percent, 150 percent, and 20 percent, respectively (Intergovernmental Panel on Climate Change [IPCC] 2013).

Human activities emit billions of tons of CO_2 every year. Carbon dioxide is primarily emitted from fossil fuel combustion, but has a variety of other industrial sources. Methane is emitted from oil and natural gas systems, landfills, mining, agricultural activities, and waste and other industrial processes. Nitrous oxide is emitted from anthropogenic activities in the agricultural, energy-related, waste, and industrial sectors. The manufacture of refrigerants and semiconductors, electrical transmission, and metal production emit a variety of trace GHGs, including hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. These trace gases have no natural sources and come entirely from human activities. Carbon dioxide, CH_4, N_2O, and the trace gases are considered well-mixed and long-lived GHGs.

All of the different GHGs have various capacities to trap heat in the atmosphere, known as global warming potentials (GWPs). Several different time horizons can express GWPs to fully account for the gases ability to absorb infrared radiation (heat) over their atmospheric lifetime. The Bureau of Land Management (BLM) uses the 100-year time interval because most of the climate change impacts derived from climate models are expressed toward the end of the century. Carbon dioxide has a GWP of one, and so for the purposes of analysis a GHGs GWP is generally standardized to a carbon dioxide equivalent (CO_2e), or the equivalent amount of CO_2 mass the GHG would represent. Methane has a current GWP estimated to be between 28 (gas alone) and 36 (with climate feedbacks), and N_2O has a GWP of 298 (IPCC 2013).

Several gases have no direct effect on climate change, but indirectly affect the absorption of radiation by impacting the formation or destruction of GHGs. These gases include CO, NO_X, and non-methane VOCs. Fossil fuel combustion and industrial processes account for the majority of emissions of these indirect GHGs. Unlike other GHGs, which have atmospheric lifetimes on the order of decades, these gases are short-lived in the atmosphere.

Atmospheric aerosols, or particulate matter (PM), also contribute to climate change. Aerosols directly affect climate by scattering and absorbing radiation (aerosol-radiation interactions) and indirectly affect climate by altering cloud properties (aerosol-cloud interactions). PM_{10} typically originates from natural sources and settles out of the atmosphere in hours or days. $PM_{2.5}$ often originates from human activities such as fossil fuel combustion. These so-called “fine” particles can exist in the atmosphere for several weeks and have local, short-term impacts on climate. Aerosols can also act as cloud condensation nuclei, the particles upon which cloud droplets form.

Light-colored particles, such as sulfate aerosols, reflect and scatter incoming solar radiation, having a mild cooling effect, while dark-colored particles (often referred to as “soot” or “black carbon”) absorb radiation and have a warming effect. There is also the potential for black carbon to deposit on snow and ice, altering the surface albedo (or reflectivity), and enhancing melting. There is high confidence that aerosol effects are partially offsetting the warming effects of GHGs, but the magnitude of their effects contributes the largest uncertainly to the understanding of climate change (IPCC 2013).

Current understanding of the climate system comes from the cumulative results of observations, experimental research, theoretical studies, and model simulations. The IPCC Fifth Assessment Report (AR5) (IPCC 2013) uses terms to indicate the assessed likelihood of an outcome ranging from *exceptionally unlikely* (0 to 1 percent) to *virtually certain* (99 to 100 percent probability) and level of confidence ranging from *very low* to *very high*. The findings presented in the AR5 indicate that warming of the climate system is unequivocal and many of the observed changes are unprecedented over decades to millennia. It is *certain* that Global Mean Surface Temperature has increased since the late 19th century and *virtually certain* (99 to 100 percent probability) that maximum and minimum temperatures over land have increased on a global scale since 1950. The globally averaged combined land and ocean surface temperature data show a warming of 1.5°F. Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea-level rise, and in changes in some climate extremes. It is *extremely likely* (95 to 100 percent probability) that human influence has been the dominant cause of the observed warming since the mid-20th century (IPCC 2013). Findings from the AR5 and reported by other organizations, such as the National Aeronautics and Space Administration (NASA) Goddard Institute for Space Studies (National Oceanic and Atmospheric Administration [NOAA] 2013), also indicate that changes in the climate system are not uniform and regional differences are apparent.

National Assessment of Climate Change. The U.S. Global Change Research Program released the third U.S. National Climate Assessment in May 2014. The Assessment summarizes the current state of knowledge on climate change and its impacts throughout the U.S. It was written by climate scientists and draws from a large body of peer-reviewed scientific research, technical reports, and other publicly available sources. The Assessment documents climate change impacts that are currently occurring and those that are anticipated to occur throughout this century. It also provides region-specific impact assessments for key sectors, such as energy, water, and human health.

The Assessment summarizes their conclusions from a number of Key Messages (National Climate Assessment [NCA] 2014a), several of which are excerpted here:

> *Global climate is changing and this change is apparent across a wide range of observations. The global warming of the past 50 years is primarily due to human activities.*
>
> *Global climate is projected to continue to change over this century and beyond. The magnitude of climate change beyond the next few decades depends primarily on the amount of heat-trapping gases emitted globally, and how sensitive the Earth's climate is to those emissions.*
>
> *U.S. average temperature has increased by 1.3°F to 1.9°F since record keeping began in 1895; most of this increase has occurred since about 1970. The most recent decade was the nation's warmest on record. Temperatures in the U.S. are expected to continue to rise. Because human-induced warming is superimposed on a naturally varying climate, the temperature rise has not been, and will not be, uniform or smooth across the country or over time.*
>
> *Average U.S. precipitation has increased since 1900, but some areas have had increases greater than the national average, and some areas have had decreases. More winter and spring precipitation is projected for the northern U.S., and less for the Southwest, over this century.*
>
> *Global sea level has risen by about 8 inches since reliable record keeping began in 1880. It is projected to rise another 1 to 4 feet by 2100.*
>
> *The oceans are currently absorbing about a quarter of the carbon dioxide emitted to the atmosphere annually and are becoming more acidic as a result, leading to concerns about intensifying impacts on marine ecosystems.*

The Assessment provided analysis of projected climate change by region, and the project is part of the Southwest region. The Key Messages for this region (NCA 2014b) are as follows:

> *Snowpack and streamflow amounts are projected to decline in parts of the Southwest, decreasing surface water supply reliability for cities, agriculture, and ecosystems.*
>
> *The Southwest produces more than half of the nation's high-value specialty crops, which are irrigation-dependent and particularly vulnerable to extremes of moisture, cold, and heat. Reduced yields from increasing temperatures and increasing competition for scarce water supplies will displace jobs in some rural communities.*

Increased warming, drought, and insect outbreaks, all caused by or linked to climate change, have increased wildfires and impacts to people and ecosystems in the Southwest. Fire models project more wildfire and increased risks to communities across extensive areas.

Flooding and erosion in coastal areas are already occurring even at existing sea levels and damaging some California coastal areas during storms and extreme high tides. Sea level rise is projected to increase as Earth continues to warm, resulting in major damage as wind-driven waves ride upon higher seas and reach farther inland.

Projected regional temperature increases, combined with the way cities amplify heat, will pose increased threats and costs to public health in southwestern cities, which are home to more than 90 percent of the region's population. Disruptions to urban electricity and water supplies will exacerbate these health problems.

All climate model projections indicate future warming in Colorado (BLM 2015). The Statewide average annual temperatures are projected to warm by +2.5 ºF to +5 ºF by 2050 relative to a 1971 to 2000 baseline under Representative Concentration Pathway (RCP) 4.5. Summer temperatures are projected to warm slightly more than winter temperatures, where the maximums would be similar to the hottest summers that have occurred in the past 100 years. Precipitation projections are less clear. Nearly all of the models predict an increase in winter precipitation by 2050, although most projections of snowpack (April 1 snow-water equivalent measurements) show declines by mid-century due to projected warming. Late-summer flows are projected to decrease as the peak shifts earlier in the season, although the changes in the timing of runoff are more certain than changes in the amount of runoff. In general, the majority of published research indicates a tendency towards future decreases in annual streamflow for all of Colorado's river basins. Increased warming, drought, and insect outbreaks, all caused by or linked to climate change, will continue to increase wildfire risks and impacts to people and ecosystems.

Project Greenhouse Gases and Climate Change. Greenhouse Gases projected to be emitted by project sources are CO_2, CH_4, and N_2O. In 2007, the U.S. Supreme Court ruled in *Massachusetts v. EPA* that the EPA has the authority to regulate GHGs such as CH_4 and CO_2 as air pollutants under the CAA. The ruling did not, however, require the EPA to create any emission control standards or ambient air quality standards for GHGs. At present there are no ambient air quality standards for GHGs. However, there are applicable reporting requirements under the EPA's Greenhouse Gas Reporting Program (40 CFR Part 98). Underground coal mines are subject to the rule if emissions are above reporting thresholds, and would subsequently be required to report GHG emissions in accordance with the requirements of Subpart FF. Underground coal mines have to report if they liberate 36,500,000 actual cubic feet (acf) of CH_4 or more per year (equivalent to 100,000 acf of CH_4 or more per day) or if total stationary source emissions from other sources meet the general threshold of 25,000 tons.

Renewable and nonrenewable resource management actions have the potential to impact climate change due to GHG emissions and other anthropogenic effects. However, the assessment of GHG emissions and climate change is extremely complex because of the inherent interrelationships among its sources, causation, mechanisms of action, and impacts. Emitted GHGs become well-mixed throughout the atmosphere and contribute to the global atmospheric burden of GHGs. Given the global and complex nature of climate change, it is not possible to attribute a particular climate impact in any given region to GHG emissions from a particular source. The uncertainty in applying results from Global Climate Models to the regional or local scale (a process known as downscaling) limits the ability to quantify potential future localized physical impacts from GHGs emissions at this scale. When further information on the impacts of local emissions to climate change is known, such information would be incorporated into BLM planning and NEPA documents as appropriate.

1.5 MONITORED AIR POLLUTANT CONCENTRATIONS

Monitoring of air pollutant concentrations has been conducted in the region. These regional monitoring sites are part of several monitoring networks overseen by state and federal agencies, including: CDPHE (State of Colorado), Clean Air Status and Trends Network (CASTNET), Interagency Monitoring of Protected Visual Environments (IMPROVE), and the National Atmospheric Deposition Program's (NADP's) National Trends Network (NTN).

Air pollutants monitored in the region include the criteria pollutants CO, NO_2, O_3, PM_{10}, $PM_{2.5}$, and SO_2. Background concentrations of these pollutants define ambient air concentrations in the region and establish existing compliance with ambient air quality standards. The most representative monitored regional background concentrations available for criteria pollutants (CDPHE 2018; EPA 2018a) are shown in Table 6.

Table 6. Background Ambient Air Quality Concentrations

Pollutant	*Averaging Period*	*Measured Background Concentration ($\mu g/m^3$)*
CO[1]	1-hour	1,145
	8-hour	1,145
NO_2[1]	1-hour	13
	Annual	1.9
PM_{10}[2]	24-hour	23
$PM_{2.5}$[1]	24-hour	14
	Annual	3
Ozone[3]	8-hour	116
SO_2[1]	1-hour	2.6
	3-hour	2.6

[1] Williams Willow Creek, 2012 (CDPHE 2018).
[2] Colowyo West 1997-1998 (CDPHE 2018).
[3] Craig, 2016 (EPA 2018a).

1.6 MONITORED VISIBILITY

Visibility conditions can be measured as standard visual range (SVR). SVR is the farthest distance at which an observer can just see a black object viewed against the horizon sky; the larger the SVR, the cleaner the air. Continuous visibility-related optical background data have been collected in the Flat Tops Wilderness Area (Class I area closest to the project area), as part of the IMPROVE program. The average SVR at the Flat Tops Wilderness is historically greater than 150 km and in the most recent reported years, the average SVR has increased to greater than 200 km (IMPROVE 2017).

1.7 MONITORED ATMOSPHERIC DEPOSITION

Atmospheric deposition refers to the processes by which air pollutants are removed from the atmosphere and deposited on terrestrial and aquatic ecosystems, and it is reported as the mass of material deposited on an area per year in kg/ha-yr. Air pollutants are deposited by wet deposition (precipitation) and dry deposition (gravitational settling of pollutants). The chemical components of wet deposition include sulfate (SO_4), nitrate (NO_3), and ammonium (NH_4); the chemical components of dry deposition include SO_2, SO_4, NO_3, ammonia (NH_3), NH_4, and nitric acid (HNO_3).

The NADP's NTN station monitors wet atmospheric deposition and the CASTNET station monitors dry atmospheric deposition at the Gothic site, located southeast of the project area near Crested Butte. The total annual deposition (wet and dry) reported as N and S deposition for years 2006 through 2015 are shown in Table 7.

Table 7. Gothic Site N and S Deposition Values (kg/ha-yr), 2006 to 2015

Year of Monitoring	*Nitrogen Deposition*			*Sulfur Deposition*		
	Wet	*Dry*	*Total*	*Wet*	*Dry*	*Total*
2006	1.41	1.33	2.74	0.69	0.28	0.97
2007	1.25	1.46	2.71	0.52	0.31	0.83
2008	1.09	1.36	2.46	0.63	0.32	0.95
2009	1.41	1.28	2.69	0.81	0.28	1.09
2010	1.45	1.20	2.65	0.73	0.25	0.97
2011	1.31	1.32	2.63	0.62	0.26	0.88
2012	1.28	1.22	2.50	0.48	0.22	0.70
2013	2.14	1.25	3.39	0.84	0.24	1.08
2014	1.75	1.15	2.90	0.64	0.21	0.85
2015	1.95	1.12	3.07	0.72	0.18	0.90
Source: EPA 2018b.						

2. ENVIRONMENTAL CONSEQUENCES

2.1 PROJECT EMISSIONS

Direct Emissions

Stationary sources at the Foidel Creek Mine are regulated by CDPHE-APCD where applicable and are authorized by permit number 93RO1204, issued on November 25, 2014. While actual annual coal production at the mine would continue to be approximately 3.4 million tons under the Reasonably Foreseeable Mine Plan (RFMP), the air quality permit authorizes up to 11.2 million tons of coal to be produced and processed annually. The 11.2 million tons limit on coal production limits potential emissions from the site to below major source thresholds for certain criteria pollutants. The development of additional coal reserves within the proposed Lease-by-Application (LBA) area would not require an increase in annual permitted production rate nor require an increase in maximum permitted air pollutant emissions. The Foidel Creek Mine is currently classified as a synthetic minor source for all criteria pollutants and therefore is not subject to the PSD. According to the mine's 2016 production data, the mine is operating below its permitted production limits at approximately 23% of approved capacity. Consequently, actual air emissions are also well below permitted levels.

Sources of direct emissions at the Foidel Creek Mine include the following:

- Point sources such as material handling, transfer, crushing, screening, and loading, propane vent shaft heaters, mine ventilation, and internal combustion engines;
- Fugitive sources such as stockpile wind erosion, travel on unpaved haul roads, and heavy equipment operation;
- Fuel storage tanks;
- Ventilation air methane (VAM); and
- Mobile sources such as diesel-fired underground mining equipment and surface vehicles and equipment.

Table 8 summarizes emission rates for these direct emissions sources. Emissions from permitted point and fugitive sources are taken from CDPHE-APCD permit 93RO1204 and are based on the permitted production rate of 11.2 million tons per year (tpy). Fuel storage tank emissions are exempt from permitting; therefore emissions are based on exemption thresholds. VAM for the Foidel Creek Mine is given as reported in the 2016 Greenhouse Gas Reporting Program Data Summary (EPA 2017). Mobile source emissions calculations are based on annual diesel and gasoline use at the mine as discussed below.

Table 8. Direct Criteria and GHG Emissions from Stationary and Mobile Sources (tpy)

Sources/Types	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*CO*	*NO_X*	*SO_2*	*CO_2*	*CH_4*	*N_2O*
Point Sources (93RO1204)	40.96	18.57	NA	NA	4.9	NA	NA	NA	NA
Fugitives (93RO1204)	108.95	9.76	NA	NA	NA	NA	NA	NA	NA
Fuel Storage Tanks (XA)	NA	NA	3.99[a]	NA	NA	NA	NA	NA	NA
Emergency Generator	0.01	0.01	0.01	0.14	0.13	0.00	19.43	0.00	NA
Methane Sources (VAM)[b]	NA	NA	NA	NA	NA	NA	NA	22,952	NA
Underground & Surface Mining Equipment	1.35	1.31	1.68	9.70	21.99	0.027	4,588.34	0.091	0.0049
Pick-ups (LDGT)	0.0024	0.0021	0.0339	0.96	0.11	0.0008	115.84	0.0013	0.0006
Total Direct Emissions	**151.27**	**29.65**	**1.72**	**10.80**	**27.13**	**0.03**	**4,723.61**	**22,952.09**	**0.01**

a *Emissions based on APEN exemption (XA) threshold in attainment area (< 2.0 tpy) x 2 tanks.*
b *VAM reported by Twentymile Mine in the 2016 Greenhouse Gas Reporting Program Data Summary.*

Hazardous Air Pollutants and GHGs are also emitted from fuel combustion sources, albeit in de minimis amounts. Coal mine methane (CMM) would also be emitted by the ventilation air handling system required by Mine Safety and Health Administration (MSHA) to reduce the combustion/explosion potential of the mines underground atmosphere (also known as VAM). The operator does not drill gob vent boreholes (GVB) for its longwall operations at the Foidel Creek Mine to vent CH_4 due to the area's naturally low occurring presence of the gas in the coal formation, overburden, and surrounding strata. VAM is the only source of CMM emissions at the Foidel Creek Mine.

Methane is not a regulated VOC. However, recent analyses of CMM gas from other mines in Colorado, including the West Elk and Elk Creek mines in the North Fork Valley (Delta and Gunnison counties), indicate that regulated VOCs make up a minor component of the CMM constituents, and these gases would be released as result of CMM venting. CDPHE, as the regulatory authority for such emissions, sent a letter to coal mines throughout the state requesting that mines provide data that would allow them to determine the status of each mine with respect to the state's VOC permitting thresholds. The Foidel Creek Mine and other mines in Colorado have not yet provided that information to the CDPHE.

Hazardous Air Pollutant emissions from stationary sources are considered de minimis. For the purposes of disclosing impacts from the alternatives proposed, insufficient data and analysis exists (as stated above) to determine if any component of the ventilation air emissions would be considered a HAP. Any HAP emissions from VAM would most likely be a tiny fraction of the VOC component, and would not be significant enough to analyze. Of the sources identified above, only the fuel tanks, internal combustion engines, and miscellaneous heating equipment would generate HAP emissions. Because of the limited use or the exempt status (CDPHE Air Pollutant Emission Notice [APEN] and permitting) of the identified units, expected cumulative HAP emissions from these sources would be below the required reporting threshold values, and therefore will not be analyzed any further in this document.

Mobile sources at the facility include underground mining equipment, listed under source classification code (SCC) 2270009010, aboveground construction equipment identified under SCC 2270002000, as well as light-duty gasoline trucks and light- and heavy-duty diesel trucks. The underground mining mobile sources are specialized, industry specific equipment designed to function in the unique environment of an underground mine, while the aboveground sources would be typical heavy construction equipment used for material handling and stockpile management.

Peabody Energy provided the annual fuel use (diesel and gasoline) for these sources, and the analysis assumes that all the diesel fuel is consumed in the heavy equipment, which would produce conservative emissions estimates based on their higher emissions rates, and all gasoline is consumed on the surface in light-duty trucks. To estimate emissions from both categories of mobile sources operating at the facility, EPA's MOVES Version 2014a was used to generate equipment- and year-specific emission factors for nonroad and on-road vehicles. These emission factors were combined with annual horsepower-hours (nonroad equipment) and vehicle miles travelled (on-road gasoline equipment) to calculate criteria pollutant and GHG emissions summarized in Table 8. The emissions shown in Table 8 are existing emissions, not newly proposed emissions. There is no increase in annual emissions associated with the RFMP beyond those currently permitted and operating.

Indirect Emissions

Indirect air pollutant emissions related to Foidel Creek Mine operations include those from electricity use at the mine site, employee travel to and from the mine, and transport of coal to contract customers by locomotive. These activities produce pollutant emissions but are not directly attributed to, authorized, or permitted.

Electrical energy consumed at the site can reasonably be expected to produce emissions from the supplying source, unless that source is some form of renewable energy. It is possible to provide rough estimates of emissions resulting from mine electricity consumption if the annual energy consumption data is known. Reasonable emissions estimates can be made by making use of EPA's Emissions & Generation Resource Integrated Database (eGRID). The eGRID tool is a comprehensive inventory of environmental attributes of electric power systems and is based on available plant-specific data for all U.S. electricity generating plants that provide power to the electric grid and report data to the U.S. government, including the following agencies: EPA, the Energy Information Administration (EIA), and the Federal Energy

Regulatory Commission (FERC). Emissions data collected by the EPA is integrated with generation data from the EIA to produce useful values like pounds of emissions per megawatt-hour (lb/MWh), which allows direct comparison of the environmental attributes of electricity generation by state, U.S. total, company, and by three different sets of electric grid boundaries. Table 9 provides an estimate of indirect emissions for the mine's approximate annual electrical consumption data. For the practical purposes of this Environmental Assessment (EA), the BLM considers Colorado to be neither a net energy exporter, or importer, and therefore all indirect emissions estimates from mine electricity consumption are based on Colorado source data.

Table 9. Indirect Criteria and GHG Emissions (tpy)

Source	***PM_{10}***	***$PM_{2.5}$***	***VOC***	***CO***	***NO_X***	***SO_2***	***Hg***	***CO_2[1]***	***CH_4***	***N_2O***
Electricity Consumption	ND[2]	ND	ND	ND	160.00	131.00	0.001	0.124	1.52	1.86
Commuter Traffic[3]	0.036	0.031	0.50	14.20	1.68	0.01	ND	0.0017	0.020	0.0095
Rail Hauling[4]	7.98	7.35	11.87	34.22	231.30	2.42	ND	ND	ND	ND
Total Indirect Emissions	**8.02**	**7.38**	**12.37**	**48.42**	**392.98**	**133.43**	**0.001**	**0.13**	**1.54**	**1.87**

[1] CO_2 Emissions reported in million tons per year.
[2] ND = No Data.
[3] Emissions based on MOVES Version 2014a 2018 emission factors for on-road Light-Duty Gasoline Trucks.
[4] Emissions from 2011 EPA NEI Mobile – Locomotives Data for Routt County, CO. Assumes all emissions from Foidel Creek coal hauling.

In 2016, 270 personnel were employed at the Foidel Creek Mine. Employees live predominantly in the towns of Hayden, Steamboat Springs, Yampa, and Oak Creek and commute to work daily. Because the specific employee travel details are not known, one vehicle round-trip per person per day is assumed to and from the town of Hayden. Based on these assumptions, a maximum of 98,550 round-trips per year could occur, with employee commuter vehicles travelling up to 3,961,710 miles each year. Actual employee mileage may be lower because ride-sharing may occur and some employees may reside nearer to the mine.

Locomotive emissions from hauling the mined and processed coal are currently occurring in the project area and would continue under the RFMP for the life of the mine, which is anticipated to extend approximately 2 years beyond its currently anticipated 9 year productive life. It is estimated that 70% of all railroad traffic in the U.S. is dedicated to the transport of coal. Although this statistic may be appropriately applied to certain metropolitan statistical areas, it may not reflect actual rail traffic composition for Routt County. The conservative assumption was made that all rail emissions in Routt County are from coal hauling, and further, that all rail emissions in Routt County are attributed to the Foidel Creek Mine's operations (although the Colowyo Mine between Craig and Meeker, Colorado, is also likely responsible for some of the coal hauling rail traffic). It is highly likely that emissions from this source class have been decreasing, and would continue to do so in the future, due to the implementation of emissions standards for new and reconstructed locomotives. The EPA estimates that the average useful life for these engines is 750,000 miles or 10 years, whichever occurs first, meaning that on average an engine is replaced or reconstructed every 10 years and would have to comply with the most stringent emissions requirement applicable to the engine at that time.

Downstream Emissions

Downstream criteria pollutant, HAP, and GHG emissions would result from the combustion of coal mined. The number and location of coal customers of the Foidel Creek Mine vary annually. According to EPA figures contained in the U.S. GHG Inventory Report: 1990-2014 (EPA 2016), nearly 93% percent of all coal consumed in the U.S. during 2014 was used in the generation of electric power. Approximately 95% of the coal shipped from the Foidel Creek Mine is sold for electrical generation and approximately 5% is sold for industrial purposes. For the purposes of this emission calculation only GHG emissions are quantified and it is conservatively assumed that 100% of the coal from the Foidel Creek Mine would be shipped to a coal-fired power plant. It would be possible to provide an estimate of Criteria and HAP emissions associated with the burning of the mined coal at a specific facility; however, the types and location of the facilities the coal might be processed and consumed in is speculative and not foreseeable. The contractual agreements between the coal-fired power plant and the coal supply company are outside the scope of this analysis, and the BLM does not determine at which facilities the future mined coal would be consumed.

Aggregated U.S. coal-fired power plant GHG emission factors are given in 2016 eGrid data (EPA 2018c). The eGrid data was used to calculate the worst-case combustion emissions for these GHG pollutants based on the heat input the modification coal, i.e. 4,679,000 tons, at a heat content of 12,680 British thermal units (Btu) per pound. Emissions are calculated using the assumption that approximately 80% (3,743,200 tons) of the coal proposed in the LBA is saleable and is combusted downstream over a 2-year period. The GHG emissions shown are in units of million metric tons (MMT) per year (Table 10). In addition GHG emissions are reported as total (CO_2e).

Table 10. Downstream GHG Emissions (MMT per year)

CO_2	CH_4	N_2O	CO_2e
107.05	0.009	0.001	107.78

2.2 PROJECT IMPACTS

Direct Impacts

The region surrounding the project area is currently designated as attainment for all criteria pollutants. The attainment designation means that no violations of ambient air quality standards have been documented in the area. Air quality impacts are measured by determining whether the area would continue to be in attainment or not.

The Foidel Creek Mine is primarily a source of PM_{10} emissions. PM_{10} tends to be a localized pollutant where concentrations can vary considerably. While actual annual coal production at the mine (federal, private, and state leases) would continue to be approximately 3.4 million tons, the current State of Colorado air quality permit issued to the Foidel Creek Mine authorizes up to 11.2 million tons of coal to be produced and processed annually. A near-field dispersion modeling analysis was completed for the Sage Creek Mine in 2010 and approved by CDPHE-APCD. The modeling simulated multiple operating scenarios and included a cumulative impact assessment by including nearby facilities: the Foidel Creek Mine, Hayden Power Plant, Connell Pit, Routt County Landfill, Milner Landfill, and Mesa Gravel Pit. Stationary and fugitive sources of PM_{10} and $PM_{2.5}$ were modeled, because these are the primary pollutants of concern emitted from aggregate handling and mining operations. Carbon monoxide and SO_2 were also modeled.

There have been several changes to sources included in that dispersion modeling analysis since its completion in 2010. The Sage Creek Mine was idled in 2012. Also, the Hayden Power Plant installed selective catalytic reduction units (SCRs) in 2015 (Unit 1) and in 2016 (Unit 2), which reduced NO_X emissions by 90 percent.

Cumulative modeling in combination with regional background concentrations demonstrated compliance with PM_{10}, $PM_{2.5}$, CO, and SO_2 ambient air quality standards. There were receptors near the Hayden Power Plant at which the cumulative 24-hour PM_{10} impacts exceeded ambient standards; however, impacts from the Sage Creek Mine alone and the Foidel Creek Mine alone were each below the modeling significance level of 5.0 $\mu g/m^3$ at those locations.

With respect to potential ozone formation, the Foidel Creek Mine sources (including all of the diesel-fired mobile sources) and associated processing equipment are not significant sources of VOC emissions (see earlier discussion on CMM VOC data limitations), the photochemical reactivity potential of CH_4 in the troposphere is considered negligible (40 CFR § 51.100 (s)), and therefore the mine operations are not expected to contribute significantly to any regional ozone formation from its VOC emissions. The mine does emit a nontrivial amount of NO_X (the majority from mobile sources) on an annual basis, however the amount is not regionally significant compared to county emissions (less than 1%). Given that the area is currently attaining the ozone standard, and the mine is not anticipating changes in operations that would affect its current emissions volumes, impacts to regional air quality are not expected to produce changes from the current levels (Table 6).

The BLM analyzed ozone culpability of all of the mines that produce federal minerals in Colorado cumulatively, via the Colorado Air Resources Management Modeling study (CARMMS). The CARMMS model, the analysis scenarios, and results are all described in the cumulative impacts section below. The CARMMS model was also used to assess other cumulative air quality and AQRV impacts from the mines producing federal minerals in Colorado.

Methane emissions associated with the Foidel Creek Mine are anticipated to be very low when compared to other Colorado underground coal mines. The geology of the surrounding strata and composition of the coal itself produce very little emissions during longwall panel mining. As previously stated, no GVB would be drilled in advance of the mining to provide for the health and safety of the miners, because emissions of any methane liberated are being adequately managed via the main vent fans at the facility. Methane emissions estimates are provided in Table 8. The data represents the values reported by the mine to EPA (2016 emissions) under the Greenhouse Gas Reporting Rule.

Indirect Impacts

As related to railway emissions, in March 2008, the EPA finalized a three part program that will dramatically reduce emissions from diesel locomotives of all types - line-haul, switch, and passenger rail. The rule will cut PM emissions from these engines by as much as 90% and NO_X emissions by as much as 80% when fully implemented. The rule sets new emission standards for existing locomotives when they are remanufactured - to take effect as soon as certified systems are available. The rule also sets Tier 3 emission standards for newly-built locomotives, provisions for clean switch locomotives, and idle reduction requirements for new and remanufactured locomotives. Finally, the rule establishes long-term, Tier 4, standards for newly-built engines based on the application of high-efficiency catalytic after treatment technology, beginning in 2015. Therefore, it is reasonable to conclude that rail emissions in Routt County going forward should continue to substantially decrease in the near future.

Impacts from Downstream Consumption

As described above, downstream combustion emissions for GHG pollutants were calculated using the assumption that approximately 80% (3,743,200 tons) of the coal proposed in the LBA is saleable and is combusted (at a coal-fired power plant) downstream over a 2-year period. Comparisons of these emissions to U.S. and global scale GHG emissions are provided in Section 4.

It is expected that about one-third (1.6 MMT) of the coal from the RFMP would be combusted at the Hayden Generating Station. The combustion location for the additional two-thirds of coal is speculative at this time. Coal from the Foidel Creek Mine is shipped to several power plants across the nation, with several contracts only lasting 1 year and destination plants often changing from year to year. Ultimately, any near or far field impacts from criteria or mercury emissions associated with coal combustion sources will have already received analysis as part of the permitting process or rule implementation from their respective regulatory agencies (state or EPA).

The Hayden Generating Station has two combustion units, one which went online in 1965 and the second in 1976. Both units have several components designed to decrease air emissions, including: low NOx burners, fabric filter dust collectors (baghouses), and lime spray dryers (scrubbers). In addition, SCRs for the control of NO_x emissions were installed on both units. Although not specifically designed to reduce mercury emissions, the SCR units oxidize elemental mercury and allow better collection of mercury in the scrubbers and baghouses. The SCRs went into service in 2015 (Unit 1) and 2016 (Unit 2) and effect a 30% to 77% control of mercury. The units qualify as low emitting electric generating units (LEE) for mercury under the new EPA Mercury and Air Toxic Standards.

Ultimately, any near or far field impacts from criteria or mercury emissions associated with coal combustion sources will have already received analysis as part of the permitting process or rule implementation (Best Available Retrofit Technology [BART], Mercury and Air Toxic Standard, etc.) from their respective regulatory agencies (state or EPA). Coal-fired power plants are required to have an operating permit (Title V) for any criteria pollutant for which the facility has a potential to emit greater than 100 tpy. Based on this criterion, no plant in Colorado would be exempt from this requirement. The CDPHE as the regulatory authority for such matters would provide the analysis showing compliance with the NAAQS and provide for appropriate permit monitoring and emissions controls as necessary.

3. CUMULATIVE AIR QUALITY AND AQRV ANALYSES

As part of the adaptive management strategy for managing air resources within the BLM planning areas, the BLM conducted a regional air modeling study to evaluate potential impacts on air quality from future mineral development in Colorado and northern New Mexico. The CARMMS (BLM 2017) assesses predicted impacts on air quality and AQRVs from projected increases in oil and gas development. The CARMMS includes potential impacts using projections of oil and gas development out to year 2025 that reflect realistic estimations of development projections and technological improvements.

The CARMMS includes cumulative air quality and AQRV impact assessments from future year (year 2025) oil and gas development on BLM-administered (federal) lands and other (non-federal) lands within eight western Colorado BLM planning areas, four subareas of the Royal Gorge Field Office Planning Area, the Mancos Shale in the Tres Rios Field Office and the Farmington New Mexico Field Office planning areas, as well as mining within the planning areas. The oil and gas emissions on Southern Ute Indian Tribe (SUIT) lands in Colorado were also included. In addition, CARMMS includes emissions from other regional sources including oil and gas emissions throughout the modeling domain, which encompasses all of Colorado, western Arizona, western Utah, and north-central New Mexico and extends into southern Wyoming, western Nebraska, western Kansas, western Oklahoma, and northwest Texas.

The CARMMS includes use of the Comprehensive Air-quality Model with extensions (CAMx) photochemical grid model (PGM) to estimate air quality and AQRV impacts for both a base case year (2011) and future year 2025. Emissions from all source types (anthropogenic and natural) are included in the CAMx modeling.

As part of CARMMS, future year 2025 emissions estimates were developed for three development scenarios for the Colorado and New Mexico planning areas. These include year 2025 high, medium, and low oil and gas development scenarios. Modeling results from CARMMS are applicable for use in estimating potential ozone formation from regional emissions and project emissions, and for determining the maximum contribution of project sources to regional ozone formation. The CARMMS results are also applicable for project cumulative air quality and AQRV analyses. Given the level of oil and gas development within the BLM Little Snake Field Office (LSFO) planning area projected through year 2025 the CARMMS 2025 Low Oil and Gas Development Scenario is used to describe the potential ozone formation from Foidel Creek Mine project area sources and for summarizing the cumulative air quality and AQRV analyses.

The CARMMS analysis included the following BLM planning areas in Colorado and northern New Mexico:

- Roan Plateau portion of the Colorado River Valley Field Office
- Colorado River Valley Field Office outside of the Roan Plateau
- Grand Junction Field Office
- Kremmling Field Office
- Little Snake Field Office
- Royal Gorge Field Office (includes 4 separate areas)
- Tres Rios Field Office
- Mancos Shale (includes portions of Tres Rios CO and Farmington NM Field Offices)
- Uncompahgre Field Office
- White River Field Office

Table 11 presents a summary of the CARMMS Low Oil and Gas Scenario emissions on BLM-administered (federal) lands and from mining activities on federal lands. These include the emissions from mining in Colorado BLM planning areas and the emissions from oil and gas activities in Colorado BLM and Farmington New Mexico planning areas and SUIT lands in Colorado. The maximum emissions from project sources are as follows: 27.1 tpy NO_x, 1.7 tpy VOC, 10.8 tpy CO, 0.03 tpy SO_2, 151.3 tpy PM_{10} and 29.7 tpy $PM_{2.5}$, and these emissions are included as part of the mining emissions shown in Table 11.

Table 11. Emissions (tpy) from the Colorado BLM Planning Areas, SUIT Land and Mancos Shale for CARMMS 2025 Low Oil and Gas Development Scenario

Scenario	*NO_x*	*VOC*	*SO_2*	*PM_{10}*	*$PM_{2.5}$*
New Federal Oil & Gas	6,649	9,758	160	1,993	478
New Non-Federal Oil & Gas	17,718	31,186	67	15,515	2,344
Existing Oil & Gas on Federal Lands	56,767	136,746	281	19,683	5,134
New Mining Activities on Federal Lands	3,244	32	18	3,888	943
Total	**84,378**	**177,722**	**526**	**41,079**	**8,899**

The mining emissions shown above in Table 11 include maximum allowable emissions from the following existing and future (hypothetical) mines:

- Book Cliffs Area (Grand Junction Field Office)
- McClane (Grand Junction Field Office)
- Bowie (Uncompahgre Field Office)
- King II (Tres Rios Field Office)
- Foidel (Kremmling Field Office)
- Deserado (White River Field Office)
- Trapper (Little Snake Field Office)
- Colowyo (Little Snake Field Office)
- Sage Creek (Little Snake Field Office)
- West Elk (Uncompahgre Field Office)
- Elk Creek (Uncompahgre Field Office)

3.1 CUMULATIVE AND REGIONAL OZONE IMPACTS

The CARMMS included estimates of future year regional ozone impacts using two analysis methods. One method uses the change in the PGM concentrations between the base year (DVB) (year 2011) and future year (DVF) (year 2025) simulations to scale observed ozone concentrations from monitoring sites to obtain projected future year ozone concentrations. This method utilized EPA's Modeled Attainment Test Software (MATS) (Abt Associates 2012) projection tool with the CAMx 2011 Base Year and 2025 Low Development Scenario ozone concentrations to estimate ozone impacts. The second method uses the absolute modeling results from the CAMx model to estimate ozone impacts.

Figure 2 presents the CAMx predicted ozone concentrations using MATS. The current year base design values (DVBs) indicate areas of ozone exceedances of the NAAQS (70 ppb) in and around Denver, places in Utah, Arizona, New Mexico, and Texas, with a maximum DVB of 109.6 ppb next to the Arizona/New Mexico border that is found to be caused by natural wild fire emissions (Figure 2, top left). The base year DVBs also indicate that areas in the LSFO planning area within and nearby the project area are below the NAAQS. For the 2025 Low Development Scenario, the area of 2025 ozone DVF exceedances is substantially reduced from the base year with a peak DVF of 108.8 ppb (resulting from wild fires) near the Arizona/New Mexico border (Figure 3, top right). The 2025 DVF – 2011 DVB difference plot (Figure 2, bottom) shows the largest ozone reductions in the Denver metropolitan area. In the vicinity of the project area and throughout the LSFO planning area, there are widespread ozone reductions in the 1.0 ppb to 4.0 ppb range.

The CAMx absolute modeling results are presented in Figure 3. The ozone NAAQS is defined as the 3-year average of the 4th highest daily maximum 8-hour ozone concentrations. Because CARMMS only has one year of modeling results, the 2025 4th highest daily maximum 8-hour ozone concentrations are used for the NAAQS comparison metric. Figure 3 displays the 4th highest ozone concentrations for the 2011 Base Case and the 2025 Low Development Scenario and their differences.

For the 2011 Base Case, there are ozone exceedance areas in Colorado, eastern Utah, southern Wyoming, northeast Arizona, New Mexico, and Texas (Figure 3, top left). The maximum ozone concentrations are estimated along the Arizona/New Mexico border and near Los Alamos of New Mexico (resulting from natural fires). The 2011 Base Case also indicates that there are areas nearby the project area and to the north in the central eastern portion of the LSFO planning area that exceed 70 ppb the ozone NAAQS. In the 2025 Low Development Scenario, the areas of ozone exceedances are reduced (Figure 3, top right). The 2025 – 2011 ozone differences (Figure 3, bottom) show decreases in almost all areas, with the reduction (9.2 ppb) near Denver. In areas within and nearby the project area there are ozone reductions in the 2 ppb to 4 ppb range.

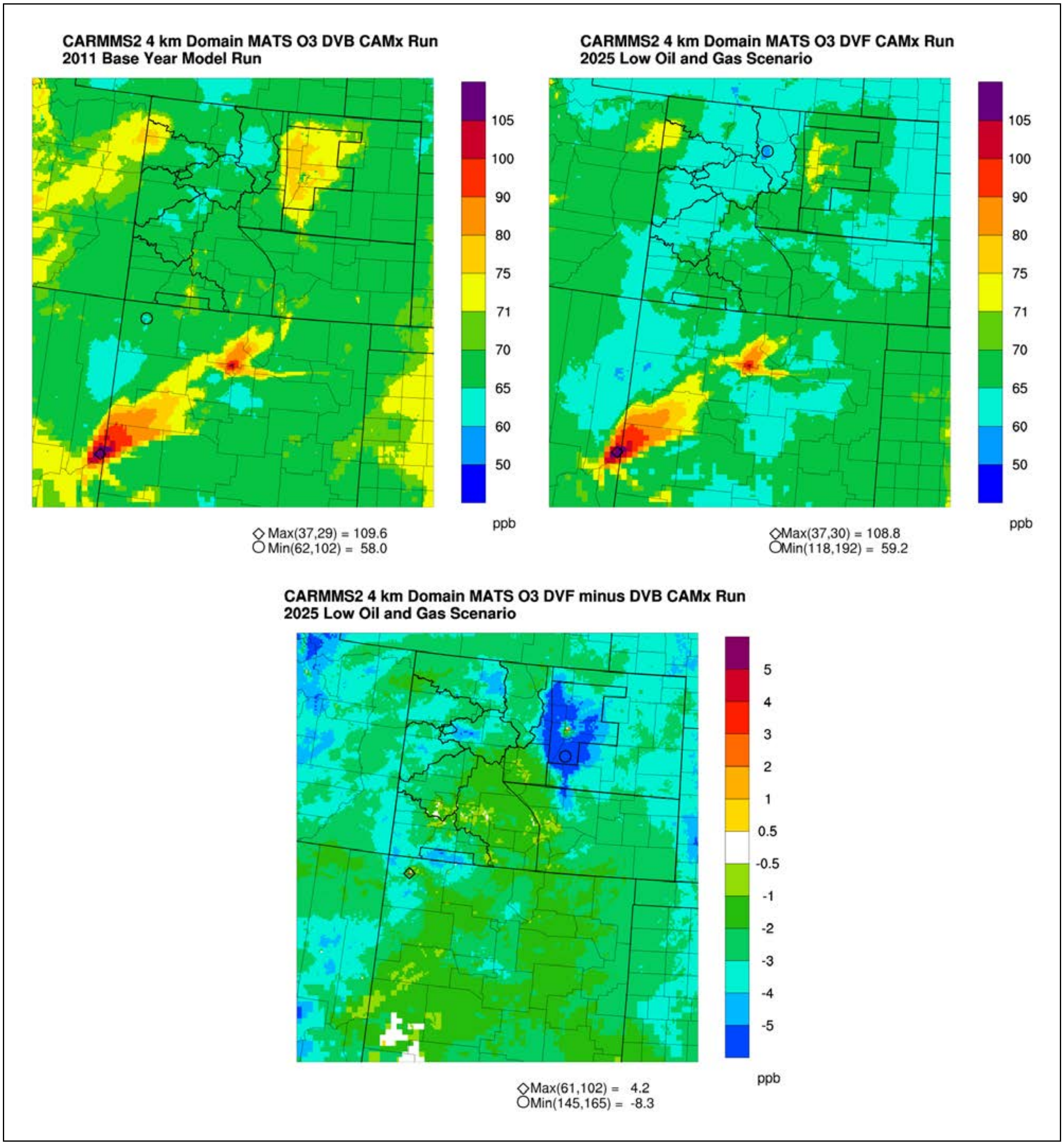


Figure 2.
2011 Ozone DVB (top left), 2025 Ozone DVF (top right), and 2025 DVF – 2011 Ozone DVB Differences Calculated Using MATS for the CARMMS 2025 Low Development Scenario

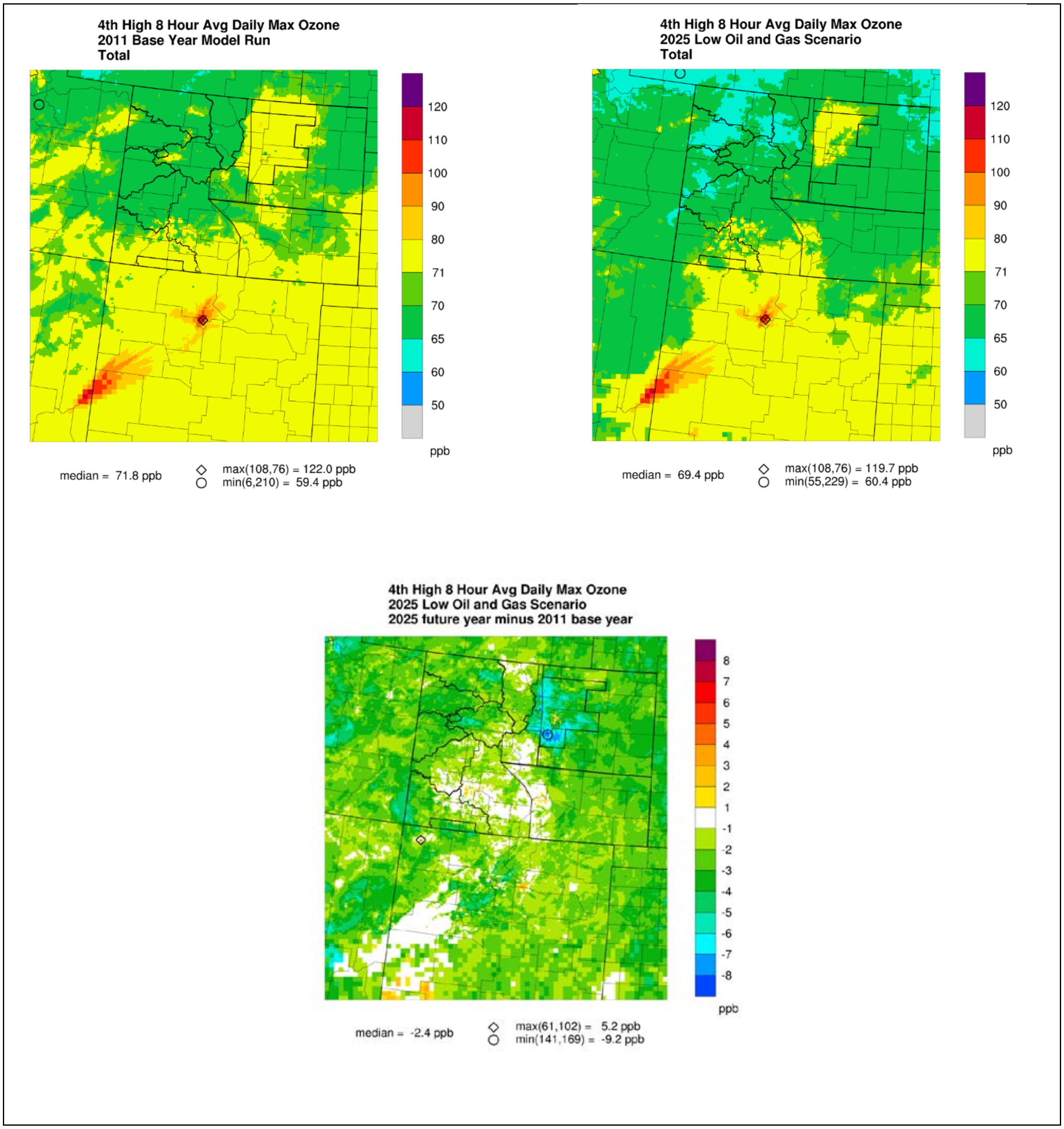


Figure 3.

Fourth Highest Daily Maximum 8-hour Ozone Concentrations for the 2011 Base Case (top left), CARMMS 2025 Low Development Scenario (top right), and 2025 Minus 2011 Differences (bottom)

The CARMMS report indicates that the maximum contribution to year 2025 regional ozone formation from the LSFO planning area federal land oil and gas sources is 0.1 ppb. Given that the LSFO planning area federal land oil and gas emissions include 632 tpy NO_x and 727 tpy VOCs and that the maximum future year emissions from project sources include 27.1 tpy NO_x and 1.7 tpy VOCs, the contribution to regional ozone formation from project sources would likely be negligible. The Foidel Creek Mine sources (including all of the diesel fired mobile sources) and associated processing equipment are not significant sources of VOC emissions (see earlier discussion on CMM VOC data limitations), the photochemical reactivity potential of methane in the troposphere is considered negligible (40 CFR § 51.100 (s)), and therefore operation of the mine is not expected to contribute significantly to any regional ozone formation from its VOC emissions.

3.2 CUMULATIVE AIR QUALITY AND AQRV IMPACTS AT CLASS I AND SENSITIVE CLASS II AREAS

The CARMMS 2025 modeling analysis presented a scenario which included future year 2025 projected federal and non-federal oil and gas emissions throughout the 4-km grid CARMMS domain plus mining on BLM-administered lands in Colorado. This scenario, which includes future year oil and gas emissions from the 13 Colorado BLM planning areas plus the Mancos Shale area in Northern New Mexico, and SUIT lands in Colorado, along with mining emissions from BLM lands in Colorado, is presented herein to describe cumulative impacts at PSD Class I and sensitive Class II areas for the project. For the project cumulative analysis, these cumulative oil and gas, and mining emissions, are considered reasonably foreseeable development (RFD) emissions.

The CARMMS included impact assessments at 26 PSD Class I and 58 sensitive Class II areas, and at 58 lakes throughout the CARMMS modeling domain. For the project cumulative assessment, the CARMMS impacts are presented for five PSD Class I areas that are within 100 km of the project area, which include the Eagles Nest, Flat Tops, Mount Zirkel and Rawah wilderness areas and Rocky Mountain National Park. There are no sensitive Class II areas within 100 km of the project area.

Air Quality Impacts

The modeled concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ at Class I areas resulting from cumulative RFD source emissions are provided in Table 12 for comparison to applicable PSD Class I increments. All values are well below the PSD Class I increments.

Table 12. Modeled Cumulative Pollutant Concentrations (CARMMS 2025 Low Development Scenario) at PSD Class I Areas (μg/m^3)

Location	*Pollutant*	*Averaging Time*	*Concentration*	*PSD Increment*
Eagles Nest Wilderness	NO_2	Annual	0.040	2.5
	SO_2	3-hour	0.011	25
		24-hour	0.006	5
		Annual	0.001	2
	PM_{10}	24-hour	0.077	8
		Annual	0.019	4
	$PM_{2.5}$	24-hour	0.050	2

Location	***Pollutant***	***Averaging Time***	***Concentration***	***PSD Increment***
		Annual	0.009	1
Flat Tops Wilderness	NO_2	Annual	0.101	2.5
	SO_2	3-hour	0.050	25
		24-hour	0.019	5
		Annual	0.004	2
	PM_{10}	24-hour	0.299	8
		Annual	0.047	4
	$PM_{2.5}$	24-hour	0.063	2
		Annual	0.015	1
Mount Zirkel Wilderness	NO_2	Annual	0.044	2.5
	SO_2	3-hour	0.015	25
		24-hour	0.007	5
		Annual	0.001	2
	PM_{10}	24-hour	0.102	8
		Annual	0.028	4
	$PM_{2.5}$	24-hour	0.071	2
		Annual	0.021	1
Rawah Wilderness	NO_2	Annual	0.033	2.5
	SO_2	3-hour	0.015	25
		24-hour	0.005	5
		Annual	0.001	2
	PM_{10}	24-hour	0.188	8
		Annual	0.032	4
	$PM_{2.5}$	24-hour	0.044	2
		Annual	0.009	1
Rocky Mountain National Park	NO_2	Annual	0.036	2.5
	SO_2	3-hour	0.016	25
		24-hour	0.004	5
		Annual	0.001	2
	PM_{10}	24-hour	0.511	8
		Annual	0.046	4
	$PM_{2.5}$	24-hour	0.158	2
		Annual	0.014	1

Air Quality Related Value Impacts

Visibility Impacts

Visibility impacts due to RFD oil and gas emissions and mining emissions were examined following the procedures provided by the USFWS and NPS (2012). These procedures use EPA's MATS to project base year observed visibility impairment (from IMPROVE monitoring sites) for the best 20 percent (B20 percent) and worst 20 percent (W20 percent) days to the future year using the 2011 Base Case and 2025 High Development Scenario modeling results (which include contributions from all source categories (including anthropogenic and natural) with and without emissions from RFD sources.

Tables 13 and 14 display the cumulative visibility results for the 2025 Low Development Scenario and RFD sources, for W20 percent and B20 percent days, respectively. These tables indicate the IMPROVE sites used for the base year observed visibility data for each of the Class I areas analyzed. The IMPROVE sites used include the White River National Forest (Maroon Bells-Snowmass Wilderness), Mount Zirkel Wilderness and Rocky Mountain National Park sites (WHRI1, MOZI1, and ROMO1). The data from the closest IMPROVE site was used for each Class I area.

As is indicated in Table 13, from the 2011 Base Year to the 2025 Low Development Scenario future year, the W20 percent visibility metric is estimated to improve at each of the Class I areas. The biggest improvement is a reduction of 0.28 dv that occurs at Eagles Nest and Flat Tops wilderness areas which goes from 8.47 dv in 2011 to 8.19 dv in 2025. RFD emissions are estimated to contribute a maximum of 0.18 dv to the 2025 W20 percent days visibility at Rocky Mountain National Park.

Cumulative visibility results at Class I areas for the B20 percent days are provided in Table 14. From 2011 to 2025, the B20 percent days visibility is estimated to improve in all Class I areas. The largest B20 percent visibility improvement is a 0.25 dv reduction that occurs at the Eagles Nest and Flat Tops wilderness areas which goes from 0.51 dv in 2011 to 0.26 dv in 2025. The maximum contribution from RFD sources to 2025 B20 percent visibility metrics is 0.05 dv at the Mount Zirkel and Rawah wilderness areas.

Table 13. Cumulative Visibility Results (Δdv) for Worst 20 percent Visibility Days at PSD Class I and Sensitive Class II Areas for the Base Year (2011) and 2025 Low Development Scenario, All Emissions and Contributions from RFD Sources

Location	*IMPROVE Site*	*2011 Base*	*2025 High*	*2025 High Improvement from 2011*	*Contribution from RFD*
Eagles Nest Wilderness	WHRI1	8.47	8.19	0.28	0.04
Flat Tops Wilderness	WHRI1	8.47	8.19	0.28	0.04
Mount Zirkel Wilderness	MOZI1	9.13	8.86	0.27	0.07
Rawah Wilderness	MOZI1	9.13	8.86	0.27	0.07
Rocky Mountain National Park	ROMO1	11.84	11.63	0.21	0.18

Table 14. Cumulative Visibility Results (Δdv) for Best 20 percent Visibility Days at PSD Class I and Sensitive Class II Areas for the Base Year (2011) and 2025 Low Development Scenario, All Emissions and Contributions from RFD Sources

Location	*IMPROVE Site*	*2011 Base*	*2025 High*	*2025 High Improvement from 2011*	*Contribution from RFD*
Eagles Nest Wilderness	WHRI1	0.51	0.26	0.25	0.03
Flat Tops Wilderness	WHRI1	0.51	0.26	0.25	0.03
Mount Zirkel Wilderness	MOZI1	0.89	0.76	0.13	0.05
Rawah Wilderness	MOZI1	0.89	0.76	0.13	0.05
Rocky Mountain National Park	ROMO1	1.61	1.43	0.18	0.03

Deposition Impacts

Potential atmospheric deposition impacts within Class I and sensitive Class II areas were calculated for cumulative RFD sources and are shown in Table 15. The maximum direct total (wet and dry) N and S depositions are predicted to be well below the cumulative analysis thresholds of 2.3 kg/ha-yr for N and 5 kg/ha-yr for S at all Class I and sensitive Class II areas. The maximum total nitrogen deposition rate (0.294 kg/ha-yr) occurs at the Maroon Bells – Snowmass Wilderness Area is approximately 13% of the cumulative analysis threshold. The maximum total S deposition rate (0.013 kg/ha-yr) is approximately 0.3% of the cumulative analysis threshold and it occurs at the Flat Tops Wilderness Area.

Table 15. Cumulative RFD Nitrogen and Sulfur Deposition Impacts (CARMMS 2025 Low Development Scenario) at PSD Class I and Sensitive Class II Areas

Location	*Maximum N Deposition (kg/ha-yr)*	*Maximum S Deposition (kg/ha-yr)*
Eagles Nest Wilderness	0.104	0.002
Flat Tops Wilderness	0.057	0.002
Mount Zirkel Wilderness	0.117	0.004
Rawah Wilderness	0.066	0.002
Rocky Mountain National Park	0.062	0.001

4. CLIMATE CHANGE – GREENHOUSE GAS IMPACTS

An overview of GHGs and climate change was previously presented in Section 1.4, including a national assessment of climate change and climate model projections for the State of Colorado that qualitatively describe the physical effects of climate change. As noted below, climate change analysis for this EA is limited to accounting for GHG emissions that would contribute incrementally to climate change and the potential effects previously discussed in Section 1.4. In the following, GHG emissions from the Proposed Action are quantitatively assessed and then compared to various scales (county, state, and national) of GHG emissions from coal production. This establishes a frame of reference for the reader to analyze meaningfully the potential impacts of the local-scale project at the global-scale of climate change.

Continued coal mining operations would result in minor cumulative contributions to atmospheric GHGs. Coal produced under the Proposed Action would be available for consumer or commercial use. The combustion of coal for electricity generation would produce GHGs, which would be controlled through applicable GHG emission control regulations (emissions standards) or by applicable air permit requirements.

Other industrial operations in the area would also contribute to GHG emissions through the use of carbon fuels (natural gas, liquefied petroleum gas, and diesel), and through the use of electricity produced using carbon fuels. Other anthropogenic activities such as residential wood and open burning, as well as biogenic sources, also contribute GHGs to the atmosphere. These would be more dispersed, but also more sustained, than the emissions from this coal development, which has a finite lifespan.

While significance levels exist to determine PSD applicability and emissions control requirements for GHGs, policies regulating specific GHG concentration levels and their potential for significance with respect to regional or global impacts have not been established for GHGs.

In 2015 approximately 9.3% of U.S. emissions of methane resulted from underground coal mining activities (EPA 2017b). Based upon the national and state inventories of GHG emissions (EPA 2017b, CDPHE 2014), the total CMM emissions in 2015 and 2005 were 60.9 MMT, and 7.54 MMT on a CO_2e basis for the U.S. and Colorado, respectively. Estimated total CMM emissions from the RFMP are approximately 826,300 short tons (0.75 MMT) of CO_2e (at full authorized production) or 10% and 1.2% of the total calculated CO_2e emissions of CMM from Colorado and the U.S. Based on BLM's analysis, total annual GHG emissions from the Proposed Action (direct and indirect for maximum production levels) are estimated to be 0.9 MMT on a CO_2e basis. This represents approximately 0.69% and 0.013% of the Colorado (130 MMT) and U.S. (6,587 MMT) GHG emissions (CDPHE 2014, EPA 2017).

As shown in Table 10, the maximum annual downstream CO_2e emissions are estimated at 107.8 MMT per year. The emissions are calculated using the assumption that approximately 80% (3,743,200 tons) of the coal proposed in the LBA is saleable and is combusted downstream (at a coal-fired power plant) over a 2-year period. These maximum annual downstream CO_2e emissions would be comparable to 1.6% of total U.S. emissions (EPA 2017). These downstream GHG emissions effects are included in the analysis described above along with a discussion on potential climate change impacts at the national and state levels.

At a global scale, the U.S. and the world produced 6,344 MMT and 53,530 MMT, respectively, of CO_2e emissions in 2012 (The World Bank Group 2017). In other words, the U.S. produced 12% of the global GHG emissions, and the maximum direct, indirect and downstream CO_2e emissions from the RFMP (108.7 MMT) represents approximately 0.002% of global GHG emissions on an annual basis. In addition, the maximum direct, indirect and downstream CO_2e emissions over the LOP (217.3 MMT), assuming a 2-year LOP, represent approximately 1.1E-08% of total global CO_2e emissions (1.94E+12 MMT) used for climate modeling to estimate climate change impacts in year 2050 (described above under "Colorado Climate Change") using the RCP 4.5 scenario.

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Appendix D

Biological Assessment for the
Peabody Twentymile Coal, LLC Lease-by-Application COC78449
And
Biological Opinion on
Coal Lease Modification COC54608, Foidel Coal Mine

BLM

United States Department of the Interior
Bureau of Land Management

Biological Assessment for the Peabody Twentymile Coal, LLC Lease-by-Application COC78449

Little Snake Field Office
455 Emerson Street
Craig, Colorado 81625

DOI-BLM-CO-N010-2017-0027-EA

June 2018

Table of Contents

List of Maps

List of Tables

List of Abbreviations and Acronyms

µg/g	micrograms per gram
µg/L	microgram per liter
BA	Biological Assessment
BiOp	Biological Opinion
BLM	Bureau of Land Management
˚C	degrees Celsius
CDPHE	Colorado Department of Public Health and Environment
CDPS	Colorado Discharge Permit System

CFR	Code of Federal Regulations
CPW	Colorado Parks and Wildlife
CRCT	Colorado River Cutthroat Trout
DOI	U.S. Department of the Interior
DPS	Distinct Population Segment
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
ESA	Endangered Species Act
LBA	Lease-by-Application
FR	Federal Register
GER/MER	Geologic and Engineering Report and Maximum Economic Recovery Report
km	kilometer
LBA	Lease-by-Application
LEE	low emitting electric generating units
m	meters
mm	millimeter
MATS	Mercury and Air Toxic Standards
MDN	mercury deposition network
MeHg	methylmercury
mg/kg	milligram per kilogram
mg/L	milligram per liter
mm	millimeter
NOx	nitrogen oxide
NPS	National Park Service
OSMRE	Office of Surface Mining, Reclamation and Enforcement
PCEs	primary constituent elements
PL	Public Law
RFMP	Reasonably Foreseeable Mine Plan
SCRs	selective catalytic reduction units
SO_2	sulfur dioxide
TC	Twentymile Coal, LLC
TL	total length
UNEP	United Nations Environment Program
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WQCD	Water Quality Control Division
WW	wet weight

1.0 INTRODUCTION

Threatened and endangered species are managed under the authority of the Endangered Species Act (ESA) of 1973 (Public Law [PL] 93-205, as amended). The ESA requires federal agencies to ensure that all actions which they authorize, fund, or carry out are not likely to jeopardize the continued existence of any endangered or threatened species, or result in the destruction or adverse modification of their critical habitat.

This Biological Assessment (BA) analyzes the effects of the Twentymile Coal, LLC (TC) Lease-By-Application (LBA) COC78449 on eight threatened, endangered or candidate species listed under the ESA. The LBA COC78449 is located near Hayden, Colorado in Routt County. The area of the LBA does not provide habitat for any federally listed species and none of the federally listed species would be directly impacted; however, the indirect impacts of reasonably foreseeable actions (mining operations and coal combustion) may impact federally listed species. Federally listed species that could be indirectly affected downstream are listed in Table 1. Species were identified by the U.S. Fish and Wildlife Service (USFWS 2018) in an official species list (Consultation Code: 06E24100-2018-SLI-0194).

Table 1. List of Threatened, Endangered, and Proposed Species

Common Name	***Scientific Name***	**Federal Status**
North American wolverine	*Gulo gulo luscus*	Proposed Threatened
Canada lynx	*Lynx Canadensis*	Threatened
Bonytail chub	*Gila elegans*	Endangered
Colorado pikeminnow	*Ptychocheilus Lucius*	Endangered
Humpback chub	*Gila cypha*	Endangered
Razorback sucker	*Xyrauchen texanus*	Endangered
Greenback cutthroat trout	*Oncorhynchus clarki stomias*	Threatened
Yellow-billed cuckoo	*Coccyzus americanus*	Threatened

2.0 CONSULTATION HISTORY

Consultation has not been completed for this LBA. No water depletions are expected from the LBA or subsequent mining operations.

The USFWS (2016) issued a Biological Opinion (BO) following formal consultation requested by the Bureau of Land Management (BLM) in their BA for COC54608 Lease Modification. The BA (BLM 2015a) was a revision of an earlier version BA (BLM 2015b) for the COC54608 Lease Modification. In the 2016 BO, the USFWS concurred with determinations of No Effect for black-footed ferret and Canada lynx and concurred with determinations of Not Likely to Adversely Affect for greenback cutthroat trout, western yellow-billed cuckoo, and proposed critical habitat for the western yellow-billed cuckoo. The USFWS determined that the proposed COC54608 Lease Modification would be Likely to Adversely Affect the four endangered Colorado River fish species, Colorado pikeminnow, razorback sucker, humpback chub, bonytail and the species' respective critical habitats.

3.0 PROPOSED ACTION

The Bureau of Land Management, Little Snake Field Office (LSFO) is preparing an environmental assessment to analyze the environmental effects of a coal LBA. Peabody Energy's Twentymile Coal, LLC (TC) has submitted a LBA to the BLM LSFO seeking to obtain an additional 640 acres at the Foidel Creek Mine. TC currently operates the Foidel Creek Mine, which is an underground longwall coal mine located about 20 miles southwest of Steamboat Springs in Routt County, Colorado . TC has been mining at the Foidel Creek Mine by underground methods since 1983. The Foidel Creek Mine is made up of six federal coal leases, private coal leases, and state coal leases. It produced approximately 2.6 million tons of coal in 2016, and produced 3.8 million tons of state and private coal in 2017.

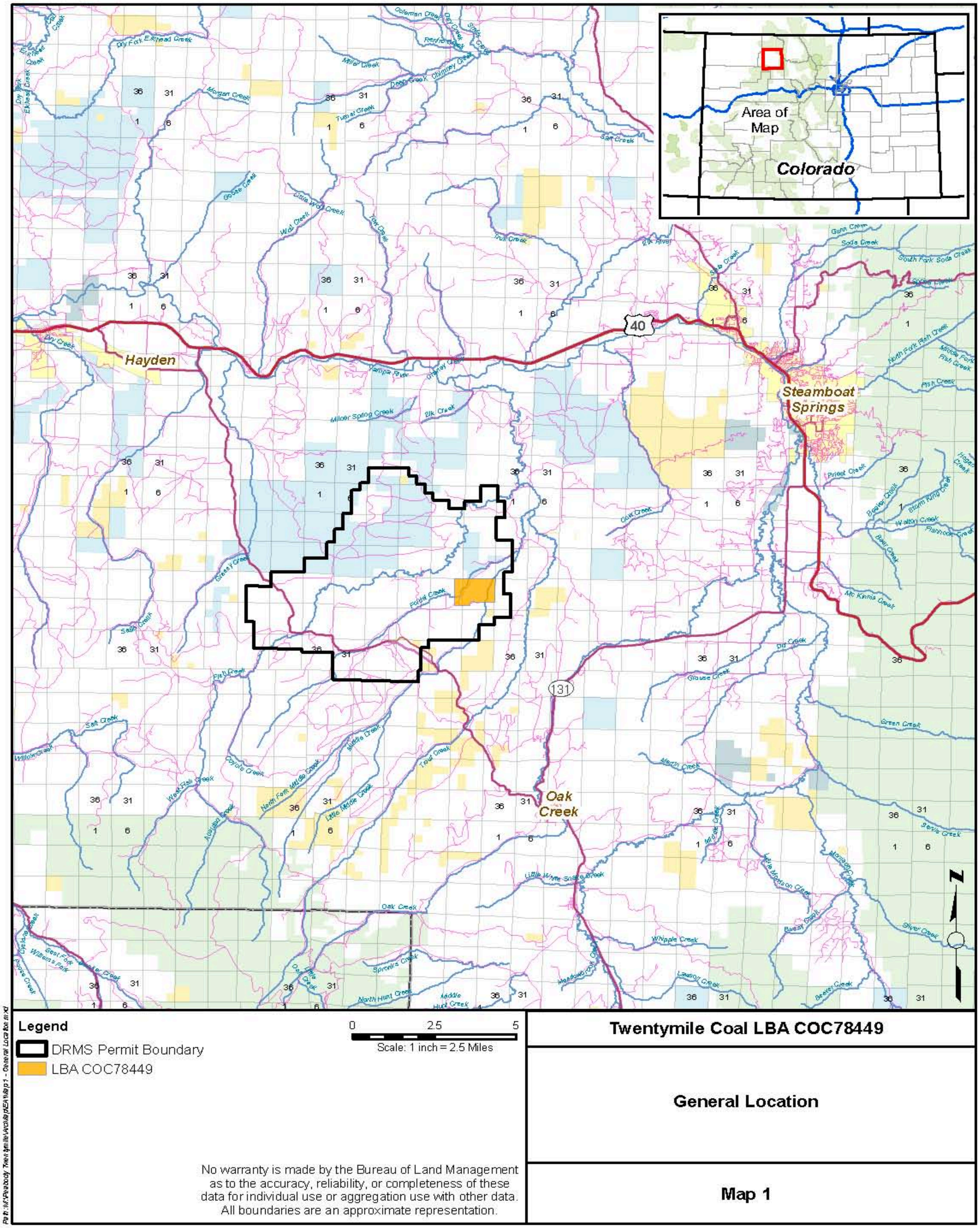
The proposed LBA is for the Wolf Creek Seam, a coal seam below the Wadge Coal Seam. It is estimated that the federal coal reserves included in the LBA would total approximately 4,679,000 recoverable tons of high volatile, group A, bituminous coal. Coal recovery from the preparation plant is approximately 80% or 3,743,200 tons of saleable coal.

Coal is a federal asset, and the BLM is required by law to consider leasing federally-owned minerals for economic recovery. The Mineral Leasing Act (MLA) of 1920, as amended by the Federal Coal Leasing Amendments Act (FCLAA) of 1976, and the Code of Federal Regulations (CFR) Title 43 Part 3400, et seq. provide the legal foundation for the leasing and development of federal coal resources. The BLM is the federal agency delegated the authority to offer federal coal resources for leasing and to issue leases. The Mining and Minerals Policy Act of 1970 declares that it is the continuing policy of the federal government to foster and encourage the orderly and economic development of domestic mineral resources. BLM complies with the Federal Land Policy and Management Act of 1976 (FLPMA) to plan for multiple uses of public lands and determine those lands suitable and available for coal leasing and development.

Reasonably Foreseeable Actions:

If the LBA is approved, development of the coal resources of the Wolf Creek Seam would be expected to occur in a similar manner as current operations and would use existing surface facilities. No new surface disturbance is expected to result from subsequent mining of the federal coal. Leasing conveys rights to the mineral resource; however, leasing does not authorize coal mining. Subsequent state permitting actions would be required to allow mining. These would be processed by the Colorado Division of Reclamation, Mining and Safety (DRMS). In some cases, additional consideration of some of these permitting actions by the U.S. Office of Surface Mining, Reclamation and Enforcement (OSMRE) could be required for possible approval of a new, or modification of an existing, federal mine plan. The Surface Mining Control and Reclamation Act of 1977 (SMCRA) provides the legal framework for the federal government to regulate coal mining by balancing the need for continued domestic coal production with protection of the environment, by protecting the health and safety of the public from the adverse effects of coal mining, and by ensuring the mined land is returned to beneficial use when mining is finished.

In addition to underground mining, combustion of federal coal is a reasonably foreseeable action. However, the BLM has no discretion or decisions regarding this action. This is an independent, but reasonably foreseeable future activity.



Twentymile Coal LBA COC78449

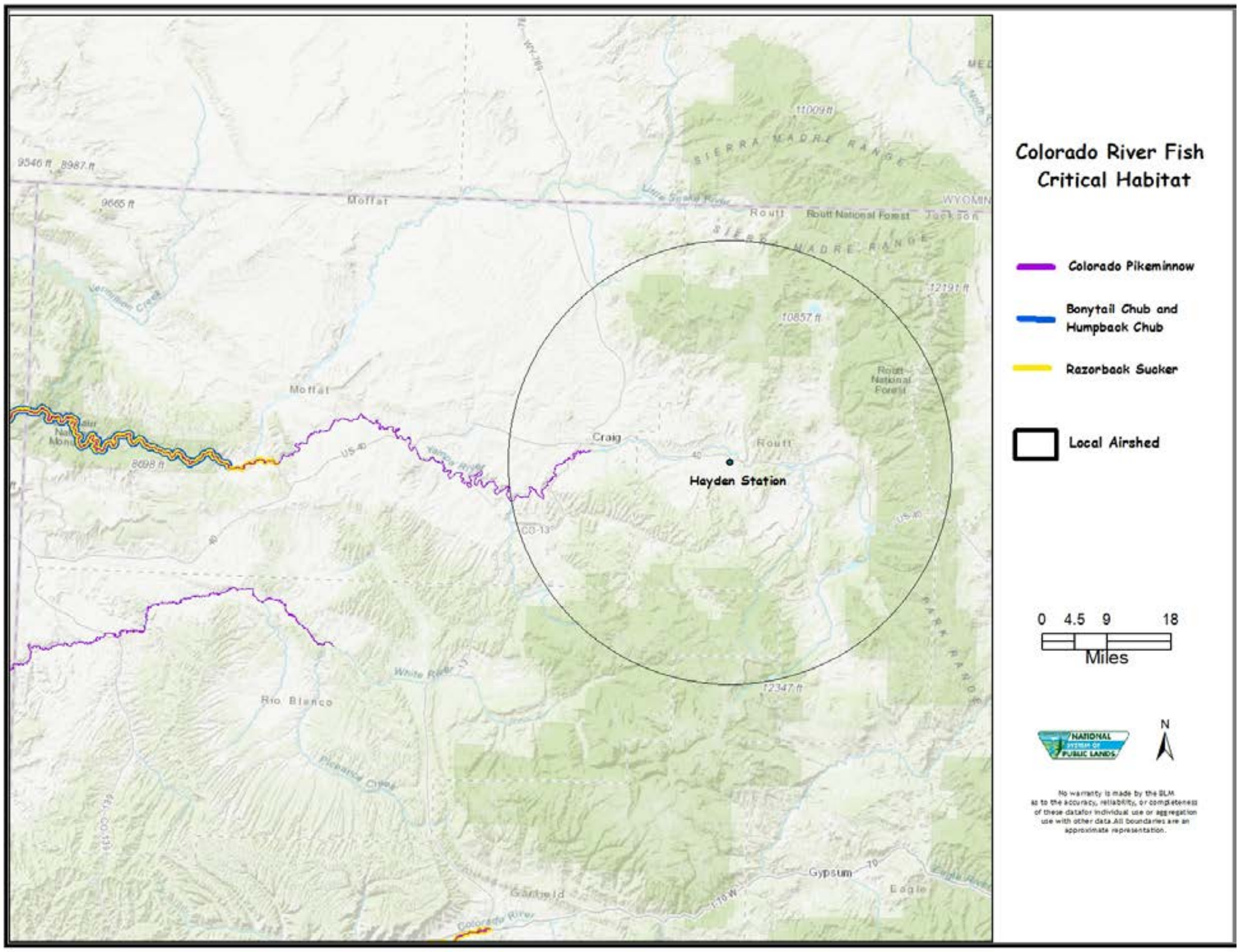
General Location

Map 1

Action Area:

The action area includes all areas that would be affected directly or indirectly by the proposed action and not just the immediate area involved in the action (50 CFR § 402.02). Effects of the action refer to direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. The action area includes direct and indirect modifications to the land, water, or air by the action covering 1) the Foidel Creek Mine, 2) the local deposition airshed which extents for 31 miles (50 kilometers [km]) from the Hayden Station, and 3) critical habitats designated for listed species within and downstream from the airshed.

Map 2. Colorado River Fish Critical Habitat and local airshed around the Hayden Station



4.0 THREATENED AND ENDANGERED SPECIES

Of the eight potential species noted in Table 1 above, two were eliminated from further evaluation because their range distributions are outside the action area, habitats necessary for their life requirements are not found within the action area, or no effects would occur with regard to the proposed actions. These species (North American wolverine and Canada lynx) are discussed briefly below. Detailed descriptions for the other six species follow.

North American Wolverine. In 2016, the U.S. District Court for the District of Montana vacated the USFWS' 2014 withdrawal of its proposed rule to list the Distinct Population Segment (DPS) of the North American wolverine as threatened under the ESA and the wolverine is currently considered a proposed threatened species. In Colorado, nearly all historical and recent reports of wolverines are from high elevation, alpine areas that occur as isolated islands of suitable habitat. Occasional reports of wolverine sightings were investigated, but wolverine were never officially documented after this (Fitzgerald et al. 1994). In the spring of 2009, a radio-collared male wolverine from Grand Teton National Park travelled south into Rocky Mountain National Park and was eventually killed in North Dakota. This was the first wolverine confirmed in Colorado in 90 years. Currently, no wolverine population is known to occur in the state and it is extremely unlikely that a wolverine would occur in the project area. In addition, no indirect impacts are expected from the Proposed Action. The Proposed Action would have "no effect" on North American wolverines and the species is not evaluated further.

Canada Lynx. Canada lynx historically occurred throughout much of the Southern Rockies. Habitats consist of coniferous forests and prey is primarily snowshoe hares. Habitat for this species within the LSFO primarily occurs adjacent to National Forest System (NFS) lands. The action area does not support coniferous forests and the closest mapped lynx habitat is over 10 miles away. No indirect impacts are expected from the Proposed Action. The Proposed Action would have "no effect" on Canada lynx and the species is not evaluated further.

4.1 Colorado Pikeminnow (*Ptychocheilus Lucius)*

Life History. The following information is from the Colorado Pikeminnow Recovery Goals (USFWS 2002a).

The Colorado pikeminnow is a long-distance migrator; adults move hundreds of km to and from spawning areas and require long sections of river with unimpeded passage. Adults require pools, deep runs, and eddy habitats maintained by high spring flows. These high spring flows maintain channel and habitat diversity, flush sediments from spawning areas, rejuvenate food production, form gravel and cobble deposits used for spawning, and rejuvenate backwater nursery habitats. Spawning occurs after spring runoff at water temperatures typically between 18 and 23 degrees Celsius (°C). After hatching and emerging from spawning substrate, larvae drift downstream to nursery backwaters that are restructured by high spring flows and maintained by relatively stable base flows. Flow recommendations have been developed that specifically consider flow-habitat relationships in habitats occupied by Colorado pikeminnow in the upper basin and were designed to enhance habitat complexity and to restore and maintain ecological processes.

Colorado pikeminnow live in warm-water reaches of the Colorado River mainstem and larger tributaries, and require uninterrupted stream passage for spawning migrations and dispersal of young. The species is adapted to a hydrologic cycle characterized by large spring peaks of snowmelt runoff and low, relatively stable base flows. High spring flows create and maintain in-channel habitats, and reconnect floodplain and riverine habitats, a phenomenon described as the spring flood-pulse (Junk et al. 1989; Johnson et al. 1995). Throughout most of the year, juvenile, subadult, and adult Colorado pikeminnow utilize relatively deep, low-velocity eddies, pools, and runs that occur in nearshore areas of main river channels (Tyus 1990 and 1991; Osmundson et al. 1995). In spring, however, Colorado pikeminnow adults utilize floodplain habitats, flooded tributary mouths, flooded side canyons, and eddies that are available only during high flows

(Tyus 1990 and 1991; Osmundson et al. 1995). Such environments may be particularly beneficial for Colorado pikeminnow because other riverine fishes gather in floodplain habitats to exploit food and temperature resources, and may serve as prey. Such low-velocity environments also may serve as resting areas for Colorado pikeminnow. River reaches of high habitat complexity appear to be preferred. Because of their mobility and environmental tolerances, adult Colorado pikeminnow are the most widely distributed life stage. During most of the year, distribution patterns of adults are stable (Tyus 1990 and 1991; Irving and Modde 2000), but distribution of adults changes in late spring and early summer, when most mature fish migrate to spawning areas (Tyus 1985, 1990 and 1991; Irving and Modde 2000). High spring flows provide an important cue to prepare adults for migration and also ensure that conditions at spawning areas are suitable for reproduction once adults arrive. Specifically, bankfull or much larger floods mobilize coarse sediment to build or reshape cobble bars, and they create side channels that Colorado pikeminnow sometimes use for spawning (Harvey et al. 1993).

Colorado pikeminnow spawning sites in the Green River subbasin have been well documented. The two principal locations are in Yampa Canyon on the lower Yampa River and in Gray Canyon on the lower Green River (Tyus 1990 and 1991). These reaches are 42 and 72 km long, respectively, but most spawning is believed to occur at one or two short segments within each of the two reaches. Another spawning area may occur in Desolation Canyon on the lower Green River (Irving and Modde 2000), but the location and importance of this area has not been verified. Although direct observation of Colorado pikeminnow spawning was not possible because of high turbidity, radio telemetry indicated spawning occurred over cobble-bottomed riffles (Tyus 1990). High spring flows and subsequent post-peak summer flows are important for construction and maintenance of spawning substrates (Harvey et al. 1993).

After hatching and emerging from the spawning substrate, Colorado pikeminnow larvae drift downstream to backwaters in sandy, alluvial regions, where they remain through most of their first year of life (Tyus and Haines 1991; Muth and Snyder 1995). Backwaters and the physical factors that create them are vital to successful recruitment of early life stages of Colorado pikeminnow; it is the early life stages of Colorado pikeminnow in backwaters that have received much research attention (e.g., Tyus and Haines 1991; Bestgen et al. 1997). It is important to note that these backwaters are formed after cessation of spring runoff within the active channel and are not floodplain features. Colorado pikeminnow larvae occupy these in-channel backwaters soon after hatching. They tend to occur in backwaters that are large, warm, deep (average, about 0.3 meters [m] in the Green River), and turbid (Tyus and Haines 1991). Recent research (Day et al. 1999a and 1999b; Trammell and Chart 1999a and 1999b) has confirmed these preferences and suggested that a particular type of backwater is preferred by Colorado pikeminnow larvae and juveniles. Such backwaters are created when a secondary channel is cut off at the upper end, but remains connected to the river at the downstream end. These chute channels are deep and may persist even when discharge levels change dramatically. An optimal river-reach environment for growth and survival of early life stages of Colorado pikeminnow has warm, relatively stable backwaters, warm river channels, and abundant food (Muth et al. 2000).

Young Colorado pikeminnow remain near nursery areas for the first 2 to 4 years of life, then move upstream to recruit to adult populations and establish home ranges (Osmundson et al. 1998). Adult Colorado pikeminnow remain in home ranges during fall, winter, and spring and may move considerable distances to and from spawning areas in summer. Individuals move to spawning areas shortly after runoff in early summer, and return to home ranges in August and September (Tyus 1990; Irving and Modde 2000).

Status and Distribution. The Colorado pikeminnow is currently listed as endangered under the ESA (16 United States Code [USC] 1531 et. seq.). It was first included on the List of Endangered Species issued by the USFWS on March 11, 1967 (32 Federal Register [FR] 4001) and was considered endangered under the provisions of the Endangered Species Conservation Act of 1969 (16 USC 668aa). It was included in the United States List of Endangered Native Fish and Wildlife issued on June 4, 1973 (38 FR No. 106) and received protection as endangered under Section 4(c)(3) of the ESA. The final rule for determination of critical habitat was published on March 21, 1994 (59 FR 13374). The latest version of the Colorado pikeminnow recovery plan was approved on August 1, 2002 (USFWS 2002a).

The Colorado pikeminnow is endemic to the Colorado River Basin, where it was once widespread and abundant in warm-water rivers and tributaries (Tyus 1991; Quartarone 1995). It was common in the lower basin in California and Arizona, where it was commercially harvested in the early 1900s (Minckley 1973). Numbers in the lower basin declined in the 1930s (Miller 1961), with few caught in the 1960s (Minckley 1973), and the last specimens reported in the mid-1970s (Moyle 1976; Minckley 1985).

The species was found from Rifle, Colorado, downstream in the mainstem upper Colorado River (Beckman 1963); from Delta, Colorado, downstream on the Gunnison River (Burdick 1995); and from Paradox Valley downstream on the Dolores River (Lynch et al. 1950). In the Green River, it was reported as far upstream as Green River, Wyoming (Baxter and Simon 1970); from Craig, Colorado, downstream on the Yampa River; from Rangely, Colorado, downstream and in the White, lower Price, and Duchesne rivers (Muth et al. 2000).

Colorado pikeminnow are presently restricted to the Upper Colorado River Basin and inhabit warm water reaches of the Colorado, Green, and San Juan rivers and associated tributaries. The Colorado pikeminnow recovery goals (USFWS 2002a) identify occupied habitat of wild Colorado pikeminnow as follows:

The Green River from Lodore Canyon to the confluence of the Colorado River, the Yampa River downstream of Craig, Colorado, the Little Snake River from its confluence with the Yampa River upstream into Wyoming, the White River downstream of Taylor Draw Dam and Kenney Reservoir, the lower 89 miles of the Price River, the lower Duchesne River, the Upper Colorado River from Palisade, Colorado, to Lake Powell, the lower 34 miles of the Gunnison River, the lower mile of the Dolores River and the San Juan River downstream from Shiprock, New Mexico to Lake Powell. Natural reproduction of Colorado pikeminnow is currently known from the Green, Yampa, upper Colorado, Gunnison, and San Juan rivers.

The current downlisting demographic criteria for Colorado pikeminnow (USFWS 2002a) in the Upper Colorado River Subbasin is a self-sustaining population of at least 700 adults maintained over a 5-year period, with a trend in adult point estimates that does not decline significantly. Secondarily, recruitment of age-6 (400 to 449 millimeters [mm] total length [TL]), naturally produced fish must equal or exceed mean adult annual mortality (estimated to be about 20%). The average of all adult estimates (1992 to 2010) is 644. The average of the five most recent annual adult population estimates is 658. Osmundson and White (2013) determined that recruitment rates were less than annual adult mortality in six years and exceeded adult mortality in the other six years when sampling occurred. The estimated net gain for the 12 years studied was 32 fish > 450 mm TL. Whereas the Colorado River population appears to meet the trend or ‘self-sustainability’ criterion, it has not met the abundance criteria of ‘at least 700 adults’ during the most recent five-year period (USFWS 2014).

Environmental Baseline. Critical habitat was designated in 1994 within the 100-year floodplain of the Colorado pikeminnow’s historical range in the following areas of the upper Colorado River (50 FR 13374). Critical habitat within the LSFO is as follows:

- Colorado, Moffat County. The Yampa River and its 100-year floodplain from state highway 394 bridge in T.6N., R.91W., Sec. 1 (6th Principal Meridian) to the confluence with the Green River in T.7N., R.103W., Sec. 28 (6th Principal Meridian).

The USFWS has identified primary constituent elements (PCEs) that are required to be present and are determined to be necessary for the survival and recovery of the species. All four Colorado River endangered species’ critical habitat contains the following PCEs (50 CFR 13378):

1. Water: This includes a quantity of water of sufficient quality (i.e. temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, etc.) that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage for each species.
2. Physical Habitat: This includes areas of the Colorado River system that are inhabited or potentially habitable by fish for use in spawning, nursery, feeding, and rearing, or corridors between these areas. In addition to river channels, these areas also include bottom lands, side channel, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which when inundated provide spawning, nursery, feeding and rearing habitats, or access to these habitats.
3. Biological Environment. Food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the species. Predation and competition, although considered normal components of this environment, are out of balance due to introduced nonnative fish species in many areas.

Pikeminnows found in the Yampa River are part of the Green River population. The Yampa River is considered occupied from the town of Craig, downstream to the confluence with the Green River. Two principal spawning sites have been identified in the Green River subbasin (Tyus 1990). One site is near Three Fords Canyon in Gray Canyon of the lower Green River and one site is in the Lower Yampa. Young produced in the lower Yampa River drift downstream and nurse primarily in alluvial backwaters upstream of Desolation and Gray canyons.

Despite a positive trend in the sub-basin population from 2006 to 2008, Bestgen et al. (2010) expressed concern that adult pikeminnow numbers in the Yampa River remained low from 2006 to 2008. They suspected that nonnative northern pike may have been suppressing numbers of pikeminnow (USFWS 2014). Preliminary results from the 2011 to 2013 analysis indicate adults and sub-adults are in decline throughout the entire Green River sub-basin. Preliminary results from 2011 and 2012 indicate that the Yampa River portion of the sub-basin population remains low and may be in further decline.

Threats. The primary threats to Colorado pikeminnow are stream flow regulation and habitat modification; competition with and predation by nonnative fishes; and pesticides and pollutants (USFWS 2002a). The existing habitat, altered by these threats, has been modified to the extent that it impairs essential behavior patterns, such as breeding, feeding and sheltering. These impairments are described in further detail below.

Stream flow regulation includes mainstem dams that cause the following adverse effects to Colorado pikeminnow and its habitat:

1. block migration corridors;
2. changes in flow patterns reduced peak flows and increased base flows;
3. release cold water, making temperature regimes less than optimal;
4. change river habitat into lake habitat; and
5. retain sediment that is important for forming and maintaining backwater habitats.

In the Upper Basin, 435 miles of Colorado pikeminnow habitat has been lost by reservoir inundation from Flaming Gorge Reservoir on the Green River, Lake Powell on the Colorado River, and Navajo Reservoir on the San Juan River. Cold water releases from these dams have eliminated suitable habitat for native fishes, including Colorado pikeminnow, from river reaches downstream for approximately 50 miles below Flaming Gorge Dam and Navajo Dam. In addition to mainstem dams, many dams and water diversion structures occur in and upstream from critical habitat that reduce flows and alter flow patterns, which adversely affect critical habitat. Diversion structures in critical habitat divert fish into canals and pipes where the fish are permanently lost to the river system. It is unknown how many endangered fish are lost in irrigation systems, but in some years, in some river reaches, a majority of the river flow is diverted into unscreened canals. The high spring flows which maintain habitat diversity, flush sediments from spawning habitat, increase invertebrate food production, form gravel and cobble deposits important for spawning, and maintain backwater nursery habitats have been reduced by flow regulation of dams and by water diversions (McAda 2003; Muth et al. 2000).

Predation and competition from nonnative fishes have been clearly implicated in the population reductions or elimination of native fishes in the Colorado River Basin (Propst and Bestgen 1991; Rinne 1991). Data collected by Osmundson and Kaeding (1991) indicated that during low water years nonnative minnows capable of preying on or competing with larval endangered fishes greatly increased in numbers.

Nonnative fishes compete with native fishes in several ways. The capacity of a particular area to support aquatic life is limited by physical habitat conditions. Increasing the number of species in an area usually results in a smaller population of most species. The size of each species population is controlled by the ability of each life stage to compete for space and food resources and to avoid predation. Some life stages of nonnative fishes appear to have a greater ability to compete for space and food, and to avoid predation in the existing altered habitat than do some life stages of native fishes. Tyus and Saunders (1996) cite numerous examples of both indirect and direct evidence of predation on Colorado pikeminnow eggs and larvae by nonnative species.

Threats from pesticides and pollutants include accidental spills of petroleum products and hazardous materials; discharge of pollutants from uranium mill tailings; and high selenium concentration in the water and food chain (USFWS 2002a). Accidental spills of hazardous material into critical habitat can cause immediate mortality when lethal toxicity levels are exceeded. Pollutants from uranium mill tailings cause high levels of ammonia that exceed water quality standards. High selenium levels may adversely affect reproduction and recruitment (Stephens and Waddell 1998; Osmundson et al. 2000).

The USFWS' status review of Colorado pikeminnow was completed in 2011. Although a good portion of the recovery factor criteria (USFWS 2002a) are being addressed, nonnative fish species continue to be problematic and researchers now speculate that mercury may pose a more significant threat to Colorado pikeminnow populations of the upper Colorado River Basin than previously recognized. Osmundson and Lusk (2012) have recently reported elevated mercury concentrations in Colorado pikeminnow muscle tissue; the highest concentrations were from the largest adults collected from the Green and Colorado river sub-basins. The San Juan River Recovery Implementation Program is conducting a population viability analysis for Colorado pikeminnow to determine how impaired reproduction (cause - heavy metal or selenium) would affect population dynamics and therefore, potentially influence adult demographic recovery criteria. Mercury is a global pollutant and remediation is obviously beyond the scope of the Recovery Program (USFWS 2014).

4.2 Razorback Sucker (*Xyrauchen texanus*)

Life History. The following information is from the Razorback Sucker Recovery Goals (USFWS 2002b).

The razorback sucker evolved in warm-water reaches of larger rivers of the Colorado River Basin from Mexico to Wyoming. Habitats required by adults in rivers include deep runs, eddies, backwaters, and flooded off-channel environments in spring; runs and pools, often in shallow water associated with submerged sandbars in summer; and low-velocity runs, pools and eddies in winter. Spring migrations of adult razorback sucker were associated with spawning in historic accounts and a variety of local and long-distance movements and habitat-use patterns have been documented. Spawning in rivers occurs over bars of cobble, gravel and sand substrates during spring runoff at widely ranging flows and water temperatures (typically greater than 14^{o}C). Spawning also occurs in reservoirs over rocky shoals and shorelines. Young require nursery environments with quiet, warm, shallow water such as tributary mouths, backwaters, or inundated floodplain habitats in rivers, and coves or shorelines in reservoirs. Flow recommendations have been developed that specifically consider flow-habitat relationships in habitats occupied by razorback sucker in the Upper Basin and were designed to enhance habitat complexity and to restore and maintain ecological processes. The following is a description of observed uses in various parts of the Colorado River Basin.

Adult razorback sucker tend to occupy different habitats seasonally (Osmundson et al. 1995; Table A-1), and can do well in both lotic and lentic environments (Minckley et al. 1991). In rivers, they usually are captured in lower velocity currents, more rarely in turbulent canyon reaches (Tyus and Karp 1990; Bestgen 1990; Minckley et al. 1991). An exception may be in the San Juan River, where hatchery-reared, radio-tagged adults preferred swifter mid-channel currents during summer–autumn base-flow periods (Ryden 2000). In the Upper Basin, bottomlands, low-lying wetlands, and oxbow channels flooded and ephemerally connected to the main channel by high spring flows appear to be important habitats for all life stages of razorback sucker (Modde et al. 1996; Muth et al. 2000). These areas provide warm water temperatures, low-velocity flows and increased food availability (Modde 1997; Wydoski and Wick 1998).

Razorback sucker breed in spring, when flows in riverine environments are high. During that time of year, researchers in the Upper Basin have documented movement of adults into flooded bottomlands and gravel pits, backwaters and impounded tributary mouths near spawning sites (Modde and Wick 1997; Modde and Irving 1998; Osmundson et al. 1995). Temperature is an important aspect of habitat for razorback sucker. Thermal preference for adults is 22.9 to 24.8°C, based on electronic shuttle box studies; lower avoidance temperature is 8.0 to 14.7°C and upper avoidance temperature is 27.4 to 31.6°C (Bulkley and Pimentel 1983).

During the breeding season (mostly April to June), when river flows are high, adult razorback sucker congregate in flooded bottomlands and gravel pits, backwaters and impounded tributary mouths near spawning sites (Osmundson et al. 1995; Modde and Wick 1997; Modde and Irving 1998). Within the last 20 years, relatively large aggregations of razorback sucker have been observed in these types of environments, usually upstream of areas with broad floodplains (Modde et al. 1996; Muth 1995). Razorback sucker adults occupy such habitats both before and after spawning, presumably for feeding, resting, gonadal maturation, and other activities associated with their reproductive cycle (Modde and Wick 1997; Modde and Irving 1998). On the upper Colorado River, peak use of backwater and gravel pit habitats occurred in June (Osmundson et al. 1995). Ryden (2000) recorded somewhat similar behavior among introduced razorback sucker in the San Juan River, where radiotelemetered adults chose habitats warmer than the main channel from March to April; eddies during the ascending limb of the hydrograph in May; and low-velocity habitats along the river margin, including inundated vegetation, during the highest flows in June. The fish moved back into eddies on the descending limb of the hydrograph in July.

Spawning has not been observed directly in the Upper Basin, but aggregations of ripe razorback sucker indicate that spawning occurs in broad alluvial, flat-water regions over large gravel-cobble bars and coarse sand substrates at water temperatures of 6 to 19°C in velocities <1.0 meters/second and depths of <1.0 meter (Tyus and Karp 1990; Bestgen 1990; Snyder and Muth 1990). Studies suggest a linkage between egg survival and cleansing of substrates by high spring flows. Eggs deposited on substrates with moderate to high sediment have lower survival because of suffocation (Wick 1997). Young razorback sucker are thought to occupy shallow, warm, low-velocity habitats in littoral zones, backwaters and inundated floodplains and tributary mouths downstream of spawning bars. This inference is based on the few larval and young juveniles collected in the Upper Basin, observations of hatchery-reared fish and analogy with other native fish in the Colorado River system (Modde 1996 and 1997; Muth et al. 1998). Young-of-year appear to stay in these sheltered habitats for several weeks after hatching, then disperse to deeper water (Minckley et al. 1991). In lakeside rearing ponds in the Lower Basin, juvenile razorback sucker hide during the day in dense aquatic vegetation, under debris and in rock cavities (Valdez et al. 2012).

During non-reproductive times of the year (summer–winter), adult razorback sucker in lotic environments have been found in deeper eddies, slow runs, backwaters, and other types of pool habitats with silt or sand substrate, depths ranging from 0.6 to 3.4 m, and velocities ranging from 0.3 to 0.4 meters/second (Tyus and Karp 1990; Minckley et al. 1991; Osmundson et al. 1995).

Status and Population Distribution. The razorback sucker was listed as endangered under the ESA on October 23, 1991. The marked decline in populations of razorback sucker has been attributed to construction of dams and reservoirs, introduction of nonnative fishes, removal of large quantities of water from the Colorado River system, and degraded water quality (Minckley and Deacon 1991). The decline of razorback sucker populations was first reported following a period of dam construction throughout the Colorado River Basin. Dams have fragmented and inundated riverine habitat; released cold, clear waters; altered ecological processes; affected seasonal availability of habitat; and blocked fish passage. Stream flow regulation and habitat modification, primarily from dams, are listed as the two primary threats to the continued persistence of this species in the recovery goals (USFWS 2002b).

Historically, the razorback sucker occupied the mainstem Colorado River and many of its tributaries from northern Mexico through Arizona and Utah into Wyoming, Colorado, and New Mexico. In the late 19th and early 20th centuries, it was reported as being abundant in the Lower Colorado River Basin and common in parts of the Upper Colorado River Basin, with numbers apparently declining with distance upstream (Minckley et al. 1991).

Historic distribution of razorback sucker in the Upper Basin included the Colorado, Green, and San Juan River drainages (Minckley et al. 1991; Holden 1999; Muth et al. 2000). Evidence suggests that the species was common and possibly locally abundant in the lower, flat-water reaches of the Green and Colorado rivers and in the lower reaches of some tributaries (Minckley et al. 1991; Muth et al. 2000). This species was reported from the White, Duchesne, Little Snake, Yampa, and Gunnison rivers (Burdick 1995) and, although evidence is sparse and anecdotal, as far up the San Juan River drainage as the Animas River (Jordan 1891; Minckley et al. 1991).

Environmental Baseline. In the Upper Colorado River Basin, the razorback sucker has declined in distribution and abundance until it is now found in small numbers only in the middle Green River, between the confluences of the Duchesne and Yampa rivers, and in the lower reaches of those two tributaries (Tyus 1987; Bestgen 1990). According to Modde and Irving (1998), tag capture and telemetry data support the hypothesis that razorback sucker in the middle Green River constitute a single reproductive population. Known spawning sites are located in the lower Yampa River and in the Green River near Escalante Ranch between river km 492 and 501, but other, less-used sites are probable (Modde and Wick 1997; Modde and Irving 1998).

Abundance estimates of razorback suckers varied dramatically across years. Abundance was highest in the lower Green River, ranging from nearly 1,600 fish in 2006 to 5,153 in 2007, and then declining to 2,597 in 2008. Razorback sucker abundance was lowest in the Desolation-Gray Canyon reach of the Green River, ranging from nearly 474 fish in 2006 to 3,011 in 2007, and then declining to 836 in 2008. Abundance was intermediate in the middle Green River reach, ranging from nearly 600 fish in 2006 to 3,146 in 2007, and then declining to about 1,200 in 2008 (USFWS 2012). In 2011, researchers documented spawning by razorback sucker in the White River for the first time (USFWS 2014).

Critical habitat was designated in 1994 within the 100-year floodplain of the razorback sucker's historical range in the following area of the upper Colorado River (50 FR 13374). The PCEs are the same as those described for the Colorado pikeminnow. Critical habitat within the LSFO is as follows:

- Colorado, Moffat County. The Yampa River and its 100-year floodplain from the mouth of Cross Mountain Canyon in T.6N., R.98W., Sec. 23 (6th Principal Meridian) to the confluence with the Green River in T.7N., R.103W., Sec. 28 (6th Principal Meridian).

Threats. Distribution of the razorback sucker have been dramatically reduced because of water developments such as dams and water diversions. Dams have altered the timing, magnitude and duration of flows that characterize the variation in annual runoff in unaltered, large rivers; altered flows resulting from dam operation can also affect the abundance and distribution of spawning and rearing habitats preferred by the razorback sucker. Historical water depletions and any new water depletions are likely to negatively affect population and habitat conditions downstream, although assessing the effects on species viability may be difficult. In addition, the introduction of non-native trout to the historical habitats of the razorback sucker has almost eliminated their recruitment and survival (Minckley et al. 2003). Incidental catch by recreational anglers may pose a threat resulting from stress-caused direct and delayed mortality.

4.3 Bonytail Chub (*Gila elegans*)

Life History. The following information is from the Bonytail Recovery Goals (USFWS 2002c).

Little is known about the specific habitat requirements of bonytail because the species was extirpated from most of its historic range prior to extensive fishery surveys. The bonytail is considered adapted to mainstem rivers where it has been observed in pools and eddies. Similar to other closely related *Gila spp.*, bonytail in rivers probably spawn in spring over rocky substrates; spawning in reservoirs has been observed over rocky shoals and shorelines. It is hypothesized, based on available distribution data, that flooded bottomland habitats are important growth and conditioning areas for bonytail, particularly as nursery habitats for young. Flow recommendations have been developed that specifically consider flow-habitat relationships within historic habitat of bonytail in the Upper Basin, and were designed to enhance habitat complexity and to restore and maintain ecological processes. The following is a description of observed habitat uses in various parts of the Colorado River Basin.

It has been suggested that the large fins and streamlined body of the bonytail is an adaptation to torrential flows (Miller 1946; Beckman 1963). Of five specimens captured recently in the Upper Basin, four were captured in deep, swift, rocky canyon regions (i.e., Yampa Canyon, Black Rocks, Cataract Canyon, and Coal Creek Rapid), but the fifth was taken in a reservoir (Lake Powell). Also, all fish taken from the Lower Basin since 1974 were caught in reservoirs. Specimens encountered in reservoirs are believed to be inhabiting their former habitats now inundated by these impoundments. Vanicek (1967), who handled numerous bonytail, detected no difference in habitat selection from roundtail chub. These fish were generally found in pools and eddies in the absence of, although occasionally adjacent to, strong currents and at varying depths generally over silt and silt-boulder substrates. No quantitative data are available for the habitat of this species. It is hypothesized, based on historic and present distributions, that flooded bottomlands provide important nursery, growth, and conditioning habitats for bonytail. Adult bonytail captured in Cataract Canyon and Desolation/Gray canyons were sympatric with humpback chub in shoreline eddies among emergent boulders and cobble, and adjacent to swift current (Valdez 1990).

Natural reproduction of bonytail was last documented in the Green River in Dinosaur National Monument for the year classes 1959, 1960 and 1961 (Vanicek and Kramer 1969). Ripe spawning fish were captured from mid-June to early July at a water temperature of 18°C. Spawning by bonytail and roundtail chub was believed to be spatially separated because ripe adults of both species were never captured in the same net.

Little is known of the food habits of the bonytail. McDonald and Dotson (1960) reported that "Colorado chub" were largely omnivorous with a diet of terrestrial insects, plant matter and fish. Several chubs were observed feeding on floating masses of debris washed by heavy rainfall.

Status and Distribution. The bonytail is currently listed as endangered under the ESA, under a final rule published on April 23, 1980 (45 FR 27710). The final rule for determination of critical habitat was published on March 21, 1994 (59 FR 13374). The latest version of the recovery plan for this species was approved on August 1, 2002 (USFWS 2002c). Viable populations are extremely rare within the Green River drainage in Utah and are not known within the State of Colorado (USFWS 2002c).

Environmental Baseline. Surveys from 1964 to 1966 found large numbers of bonytail in the Green River in Dinosaur National Monument, downstream of the Yampa River confluence (Vanicek and Kramer 1969). Surveys from 1967 to 1973 found far fewer bonytail (Holden and Stalnaker 1975a). Few bonytail have been captured after this period and the last recorded capture in the Green River was in 1985 (USFWS 2002c). A stocking program is being implemented to reestablish populations in the Upper Colorado River Basin.

Critical habitat was designated in 1994 within the 100-year floodplain of the bonytail’s historical range in the following areas of the upper Colorado River (50 FR 13374). The PCEs are the same as those described for the Colorado pikeminnow. Critical habitat within the LSFO is as follows:

- Colorado, Moffat County. The Yampa River from the boundary of Dinosaur National Monument in T.6N., R.99W., Sec. 27 (6th Principal Meridian) to the confluence with the Green River in T.7N., R.103W., Sec. 28 (6th Principal Meridian).

- Utah, Uintah County; and Colorado, Moffat County. The Green River from the confluence with the Yampa River in T.7N., R.103W., Sec. 28 (6th Principal Meridian) to the southern boundary of Dinosaur National Monument in T.6N., R.24E., Sec. 30 (Salt Lake Meridian).

Threats. The primary threats to bonytail are stream flow regulation and habitat modification; competition with and predation by non-native fishes; hybridization with other native Gila species; and pesticides and pollutants (USFWS 2002c). The existing habitat, altered by these threats, has been modified to the extent that it impairs essential behavior patterns, such as breeding, feeding and sheltering. The threats to bonytail in relation to flow regulation and habitat modification, predation by non-native fishes, and pesticides and pollutants are essentially the same threats identified for the Colorado pikeminnow. Threats to bonytail in relation to hybridization are essentially the same threats identified for the humpback chub.

4.4 Humpback Chub (*Gila cypha*)

Life History. The following information is from the Humpback Chub Recovery Goals (USFWS 2002d).

The humpback chub evolved in seasonally warm and turbid water and is highly adapted to the unpredictable hydrologic conditions that occurred in the pristine Colorado River system. Adults require eddies and sheltered shoreline habitats maintained by high spring flows. These high spring flows maintain channel and habitat diversity, flush sediments from spawning areas, rejuvenate food production, and form gravel and cobble deposits used for spawning. Spawning occurs on the descending limb of the spring hydrograph at water temperatures typically between 16 and 22°C. Young require low-velocity shoreline habitats, including eddies and backwaters, that are more prevalent under base-flow conditions. Flow recommendations have been developed that specifically consider flow-habitat relationships in habitats occupied by humpback chub in the Upper Basin, and were designed to enhance habitat complexity and to restore and maintain ecological processes. The following is a description of observed habitat uses in various parts of the Colorado River Basin.

Humpback chub live and complete their entire life cycle in canyon-bound reaches of the Colorado River mainstem and larger tributaries. These reaches are characterized by deep water, swift currents and rocky substrates (Valdez et al. 1990). Subadults use shallow, sheltered shoreline habitats, whereas adults use primarily offshore habitats of greater depths (Childs et al. 1998; Chart and Lentsch 1999). In the Grand Canyon, nearly all fish smaller than 100 mm TL were captured near shore, whereas most fish larger than 100 mm TL were captured in offshore habitats (Valdez and Ryel 1995). Highest densities of subadults in the Colorado River in the Grand Canyon were from shorelines with vegetation, talus and debris fans (Converse et al. 1998).

As young humpback chub grow, they exhibit an ontogenic shift toward deeper and swifter offshore habitats. In Westwater Canyon during summer, fish smaller than 40 mm TL used low velocity areas, including backwaters and shorelines. Later in summer and fall, as fish attained sizes of 40 to 50 mm TL, their habitat use shifted toward higher-velocity, flowing-water habitats (Chart and Lentsch 1999). Karp and Tyus (1990) reported similar habitat use by larger humpback chub, noting that fish 88 to 228 mm TL in the Yampa and Green rivers used habitats consisting of rocky shoreline runs and small shoreline eddies. Average depths selected by larvae, young-of-year, juveniles, and adults in the Upper Basin were 0.4, 0.6, 0.7, and 3.1 meters, respectively (Valdez et al. 1990), and average velocities were 0.03, 0.06, 0.18, and 0.18 meter/second, respectively. Dominant substrates were silt and sand for Young-of-year, and boulders, sand and bedrock for juveniles and adults.

Little is known about spawning habitats of adult humpback chub during high spring-runoff flows. Habitats where ripe humpback chub have been collected are typically deep, swift and turbid. As a result, spawning in the wild has not been directly observed. Gorman and Stone (1999) reported that ripe male humpback chub in the LCR aggregated in areas of complex habitat structure (i.e., matrix of large boulders and travertine masses combined with chutes, runs and eddies, 0.5 to 2.0 m deep) and were associated with deposits of clean gravel. Valdez and Ryel (1995 and 1997) reported that during the spring, adult humpback chub in the Colorado River in the Grand Canyon primarily used large recirculating eddies, occupying areas of low velocity adjacent to high-velocity currents that deliver food items. They also reported that adults congregated at tributary mouths and flooded side canyons during high flows.

In the Upper Colorado River Basin during spring runoff, spawning adult humpback chub appear to utilize cobble bars and shoals adjacent to relatively low-velocity shoreline habitats that are typically described as shoreline eddies (Valdez et al. 1990; Valdez and Ryel 1995 and 1997). Tyus and Karp (1989) reported that humpback chub in the Yampa River occupy and spawn in or near shoreline eddy habitats. They also hypothesized that spring peak flows were important for reproductive success because availability of these habitats is greatest during spring runoff; loss or reduction of spring peak flows could potentially reduce availability of spawning habitat.

The humpback chub is an obligate warm-water species that requires relatively warm temperatures for spawning, egg incubation and survival of larvae. Highest hatching success is at 19 to 20°C, with an incubation time of 3 days, and highest larval survival is slightly warmer at 21 to 22°C. Humpback chub are broadcast spawners with a relatively low fecundity rate, compared to cyprinids of similar size (Carlander 1969). Male to female ratios for mainstem adults captured near the Lower Colorado River, based on external morphological examination of papillae and expression of gametes, ranged by sample from 41:59 to 53:47, for an overall average of 49:51 (Valdez and Ryel 1995). Observed male to female ratio of humpback chub in Westwater Canyon was 58:42 (Chart and Lentsch 1999).

Unlike larvae of other Colorado River fishes (e.g., Colorado pikeminnow and razorback sucker), larval humpback chub show no evidence of long-distance drift (Robinson et al. 1998). At hatching, larvae have nonfunctional mouths and small yolk sacs (Muth 1990). The larvae swim up about 3 days after hatching but tend to remain close to spawning sites. Robinson et al. (1998) found small numbers of larvae drifting in the Lower Colorado River from May through July, primarily at night.

The presence of juveniles in populations with complete size structure suggests successful reproduction in all or portions of the six populations; i.e., Black Rocks (Kaeding et al. 1990), Westwater Canyon (Chart and Lentsch 1999), the Lower Colorado River in the Grand Canyon (Douglas and Marsh 1996, Gorman and Stone 1999), Cataract Canyon (Valdez 1990), Desolation/Gray canyons (Chart and Lentsch 2000), and Yampa Canyon (Karp and Tyus 1990). Reproduction in the mainstem Colorado River in the Grand Canyon is precluded by cold-water temperatures, and the only documented evidence of reproduction (i.e., post-larvae) is in a thermal riverside spring located 72 km downstream of Glen Canyon Dam (Valdez and Masslich 1999). The large size structure of the humpback chub aggregation associated with this spring indicates little or no recruitment (Valdez and Ryel 1995).

Status and Distribution. The humpback chub is currently listed as endangered under the ESA. It was first included in the List of Endangered Species issued by the USFWS on March 11, 1967 (32 FR 4001) and was considered endangered under provisions of the Endangered Species Conservation Act of 1969 (16 USC 668aa). The humpback chub was included in the United

States List of Endangered Native Fish and Wildlife issued on June 4, 1973 (38 FR No. 106) and received protection as endangered under Section 4(c)(3) of the ESA. The final rule for determination of critical habitat was published on March 21, 1994 (59 FR 13374). The latest humpback chub recovery plan was approved on August 1, 2002 (USFWS 2002d).

Historic abundance of the humpback chub is unknown; historic distribution is surmised from various reports and collections that indicate the species presently occupies about 68% of its historic habitat of about 756 km of river. The species exists primarily in relatively inaccessible canyons of the Colorado River Basin and was rare in early collections (Tyus 1998).

Post-impoundment investigations (Vanicek et al. 1970) reported three humpback chub from the Green River downstream of Flaming Gorge Dam, and one each from Echo Park, Island Park and Swallow Canyon. Specimens were collected in Desolation Canyon on the Green River in 1967 (Holden and Stalnaker 1970), in Yampa Canyon in 1969 (Holden and Stalnaker 1975b), in Cross Mountain Canyon of the Yampa River in the 1970s (personal communication, C. Haynes), and an individual specimen was reported from the White River in Utah in the 1950s (Sigler and Miller 1963). Seven suspected humpback chub were captured in the Little Snake River, a tributary of the Yampa River, in 1988 (Wick et al. 1991). Surveys downstream of Flaming Gorge Dam, including Lodore Canyon, have not yielded humpback chub in that region of the Green River, despite warmer dam releases (Holden and Crist 1981; Bestgen and Crist 2000). Reproducing populations of humpback chub were first reported from Black Rocks, Colorado in 1977 (Kidd 1977), and from Westwater and Cataract canyons, Utah, in 1979 (Valdez et al. 1982; Valdez and Clemmer 1982).

Six humpback chub populations are currently identified: (1) Black Rocks, Colorado; (2) Westwater Canyon, Utah; (3) Lower Colorado River and Colorado rivers in the Grand Canyon, Arizona; (4) Yampa Canyon, Colorado; (5) Desolation/Gray canyons, Utah; and (6) Cataract Canyon, Utah (Valdez and Clemmer 1982; USFWS 1990). Each population consists of a discrete group of fish, geographically separated from the other populations, but with some exchange of individuals. River length occupied by each population varies from 3.7 km in Black Rocks to 73.6 km in Yampa Canyon.

Environmental Baseline. Five populations of humpback chub exist in the upper Colorado River Basin and one occurs in the lower Colorado River Basin in canyon-bound reaches of the river system (USFWS 2014). The Yampa River humpback chub population exists in the lower Yampa River Canyon and into the Green River through Split Mountain Canyon. This population is small, with an estimate of about 400 wild adults in 1998 to 2000. Sampling during 2003 to 2004 caught only 13 fish, too few to estimate population size. In 2007, humpback chub and roundtail chub hybrids were found in Yampa Canyon and it is not currently known if pure humpback chubs now exist in Yampa Canyon (USFWS 2014).

Critical habitat was designated in 1994 within the 100-year floodplain of the humpback chub's historical range in the following areas of the upper Colorado River (50 FR 13374). The primary constituent elements are the same as those described for the Colorado pikeminnow. Critical habitat within the LSFO is as follows:

- Colorado, Moffat County. The Yampa River from the boundary of Dinosaur National Monument in T.6N., R.99W., Sec. 27 (6th Principal Meridian) to the confluence with the Green River in T.7N., R.103W., Sec. 28 (6th Principal Meridian).

- Utah, Uintah County; and Colorado, Moffat County. The Green River from the confluence with the Yampa River in T.7N., R.103W., Sec. 28 (6th Principal Meridian) to the southern boundary of Dinosaur National Monument in T.6N., R.24E., Sec. 30 (Salt Lake Meridian).

Threats. The primary threats to the humpback chub are stream flow regulation and habitat modification; competition with and predation by non-native fishes; parasitism; hybridization with other native Gila species; and pesticides and pollutants (USFWS 2002d). The existing habitat, altered by these threats, has been modified to the extent that it impairs essential behavior patterns, such as breeding, feeding and sheltering. Threats to humpback chubs in relation to flow regulation and habitat modification, predation by non-native fishes and pesticides and pollutants are essentially the same threats identified for the Colorado pikeminnow.

The humpback chub population in the Grand Canyon is threatened by predation from non-native trout in the Colorado River below Glen Canyon Dam. This population also is threatened by the Asian tapeworm reported in humpback chubs in the Little Colorado River (USFWS 2002d). No Asian tapeworms have been reported in the Upper Basin populations.

Hybridization with the bonytail and the roundtail chub where they occur together is recognized as a threat to the humpback chub. A larger proportion of roundtail chubs have been found in Black Rocks and Westwater Canyon during low flow years (Kaeding et al. 1990; Chart and Lentsch 1999), which increase the chances for hybridization.

4.5 Lineage Greenback Cutthroat Trout (*Oncorhynchus clarki stomias*)

Species Description. True greenback cutthroat trout are unlikely to reside in the project area. Fish that are currently called Lineage greenback cutthroat trout do reside in Routt County and are being treated as greenback until such time as the genetics and management of these cutthroat trout are determined.

Lineage greenback cutthroat trout are a small salmonid fish (member of the salmon family) native to the headwaters of the South Platte River drainage. It is one of three subspecies of cutthroat that are currently recognized in Colorado. Adult greenbacks are greenish brown to olive colored on the back with silvery to yellow sides and a white belly (red during spawning). They have a crimson slash under the lower jaw and low numbers of large spots concentrated toward the caudal fin (USFWS 1998).

Life History. Greenbacks, like all cutthroat subspecies, inhabit cold water streams and lakes with adequate spawning habitat present in the spring of the year. Spawning generally occurs when water temperatures reach 5 to 8ºC. Greenbacks feed on a wide variety of organisms but their primary source of food is aquatic and terrestrial insects. Size and growth of greenbacks varies, based on elevation and population size. However, greenbacks typically do not reach a large size, with a maximum weight of 1 to 2 pounds (USFWS 1998).

Population Distribution and Genetics. Greenback distribution and numbers of fish declined rapidly beginning in the 1800s. By 1973, when the ESA was passed into law, greenbacks were believed to only exist in two small headwater streams (Como Creek and South Fork, Cache La Poudre River). The subspecies was listed under the ESA as endangered in 1973 and downlisted to threatened in 1978. Cooperative efforts between the Colorado Parks and Wildlife (CPW), Forest Service, BLM, USFWS and Rocky Mountain National Park have led to a large recovery effort for the greenback cutthroat trout. Today, it appears that only one true greenback population exists in Bear Creek near Colorado Springs, Colorado.

As of November 2012, 60 populations of Lineage greenback cutthroat trout have been identified in western Colorado (Rogers 2012a). One population occurs in Routt County in Deadman Gulch on the Routt National Forest.

As prized sport fish and one of only two salmonids native to Colorado, cutthroat trout have long held the interest of anglers and managers alike (Behnke 2002, Trotter 2008). Ever since greenback cutthroat trout (*Oncorhynchus clarkia stomias*) were listed as endangered under the ESA in 1974, there has been strong interest in developing methods to distinguish them from closely related subspecies with confidence. Prior to recent molecular testing, phenotypic traits associated with greenback cutthroat trout were larger spots, and higher scale counts above the lateral line and in the lateral series when compared to Colorado River cutthroat trout (*O. c. pleuriticus*; Behnke 1992). However, these two subspecies cannot be separated consistently on the basis of those characteristics (Behnke 1992 and 2002). As a result, geographic range had become the default approach for establishing subspecies designation. Early molecular work did not distinguish between these two subspecies (Behnke 2002), but in 2007 Metcalf et al. (2007) used mitochondrial and nuclear molecular markers to suggest that indeed there was a genetic basis for separating greenback from Colorado River cutthroat trout. The primary concern raised by that paper was five of the nine greenback cutthroat trout populations they examined actually displayed genetic fingerprints more similar to cutthroat trout of Trappers Lake origin than they did with many of the other greenback populations such as those found in Severy Creek. This was particularly troubling since mechanisms were in place to deliver Trappers Lake fish to the East Slope. From 1903 through 1938, at least 80 million pure Colorado River cutthroat trout were produced at Trappers Lake (Rogers 2012b). Millions more were produced on the south slope of Pikes Peak (Rogers and Kennedy 2008). Although the fate of many of those fish remains a mystery, it is clear that they were stocked in virtually every county east of the Divide that would support trout (Metcalf et al. 2012).

A finding of Metcalf et al. (2007) that attracted less attention was the discovery of a “greenback” cutthroat trout population west of the Continental Divide near Gunnison in West Antelope Creek. Intensive survey work since that time indicated that in fact the West Antelope Creek population is not unique, and that populations with similar genetic fingerprints are pervasive across Colorado’s western slope (Rogers 2010). That finding lead the Recovery Team to question whether the West Antelope Creek fish were really greenback cutthroat trout as suggested by Metcalf et al. (2007), or whether they simply represented diversity within Colorado River cutthroat trout (Rogers 2010). In an effort to avoid confusion, trout with this genetic fingerprint are hereafter referred to as Lineage GB, while cutthroat trout displaying the genetic signature commonly associated with those from Trappers Lake are referred to as Lineage CR.

The native distribution of different lineages of cutthroat trout in Colorado was clarified greatly with recent work published by a University of Colorado led research team that examined DNA from 150 year old museum specimens collected prior to large scale stocking activities (Metcalf et al. 2012). This work funded by the Greenback Cutthroat Trout Recovery Team, confirmed that indeed, Lineage GB is at least native to the Colorado, Gunnison Basin. Additional work suggests they were likely found in the Dolores Basin as well (Rogers 2010), with every other remaining major basin represented by its own distinct lineage. Since the subspecies were described using phenotypic characters (Cope 1871), and recent court cases have affirmed that visual characteristics should be central to the description of taxa (Kaeding 2003), the Recovery Team launched an additional research project with the Larval Fish Lab at Colorado State University to explore if distinct phenotypes can be predicted from these underlying genetic fingerprints.

While the taxonomy of these fish has yet to be resolved, the USFWS is urging federal agencies to treat Lineage GB cutthroat trout as if they are greenback cutthroat trout. If an action may affect a Lineage GB population, then initiation of Section 7 consultation is appropriate (USFWS 2009). The USFWS also believes that implementation of the Colorado River Cutthroat Trout (CRCT) Conservation Strategies (CRCT Coordination Team 2006) in place to conserve and protect Colorado River cutthroat trout populations will also adequately protect any that happen to display the Lineage GB genetic fingerprint. Agencies should therefore include these activities in their Biological Assessments as conservation measures for lineage GB populations (USFWS 2009).

Environmental Baseline. Cutthroat trout of greenback lineage are known to reside in only one stream within the boundary of the LSFO. BLM does not manage any surface portions of the creek or surrounding area but does administer the subsurface federal mineral estate within portions of the watershed. The Routt National Forest manages most of the land within the Deadman Gulch watershed. The closest BLM land is approximately 5 miles southwest of Deadman Gulch.

Threats. The primary threat to greenback cutthroat trout is the presence and stocking of non-native salmonids for sport fishing, resulting in predation and competitive exclusion, as well as potential for hybridization with other Oncorhynchus species or subspecies.

Other threats include:

- Climate change;
- Livestock grazing;
- Water diversions and reduced flows;
- Disease; and
- Toxicity

4.6 Yellow-billed Cuckoo

Species Description. Yellow-billed cuckoo (cuckoo) is a medium-sized bird about 12 inches (30 centimeters [cm]) in length and weighing about 2 ounces (57 grams [g]). Morphologically, cuckoos throughout the western continental United States and Mexico are generally larger, with significantly longer wings, longer tails, and longer and deeper bills compare to their eastern counterparts (Franzreb and Laymon 1993). The species has a slender, long-tailed profile, with a fairly stout and slightly down-curved bill, which is blue-black with yellow on the basal half of the lower mandible.

Plumage is grayish-brown above and white below, with rufous primary flight feathers. The tail feathers are boldly patterned with large white spots on a black background on the underside of the tail. The legs are short and bluish-gray, and adults have a narrow, yellow eye ring. Juveniles resemble adults, except the tail patterning is less distinct, and the lower bill may have little or no yellow. Males and females differ slightly. Males tend to have a slightly larger bill and the white in the tail tends to form oval spots, whereas in females the white spots tend to be connected and less distinct (USFWS 2011).

Life History. The breeding range of the entire yellow-billed cuckoo species formerly included most of North America from southeastern and western Canada (southern Ontario and Quebec and southwestern British Colombia) to the Greater Antilles and northern Mexico (American Ornithologists Union [AOU] 1998). Western populations of cuckoos breed in dense riparian woodlands, primarily of cottonwood, willow, and mesquite (*Prosopis spp.*), along riparian corridors in otherwise arid areas (Laymon and Halterman 1989, Hughes 1999). Dense undergrowth may be an important factor in selection of nest sites. Narrow bands of riparian woodland can contribute to the overall extent of suitable habitat. Adjacent habitat on terraces or in the upland (such as mesquite) can enhance the value of these narrow bands of riparian woodland.

In the Lower Colorado River this species occupies riparian areas that have higher canopies, denser cover in the upper layers of the canopy, and sparser shrub layers when compared to unoccupied sites. Although this species is generally associated with breeding and nesting in large wooded riparian areas dominated by cottonwood trees, they have been documented nesting in salt cedar between Albuquerque and Elephant Butte Reservoir and along the Pecos River in southeastern New Mexico.

Throughout the cuckoo's range, a large majority of nests are placed in willow trees, but alder (*Alnus spp.*), cottonwood, mesquite, walnut (*Juglans spp.*), box elder, sycamore, netleaf hackberry (*Celtis laevigata var. reticulata*), soapberry (*Sapindus saponaria*), and tamarisk are also used (Corman and Wise-Gervais 2005, Johnson et al. 2008.

Cuckoos reach their breeding range later than most other migratory breeders, often in June (Rosenberg et al. 1982). They construct an unkempt stick nest on a horizontal limb in a tree or large shrub. Nest height ranges from 4 feet to (rarely) 100 feet, but most are typically below 30 feet (Hughes 1999). The incubation period for cuckoo is 9 to 11 days, and young leave the nest at 7 to 9 days old. Nesting usually occurs between late June and late July, but can begin as early as late May and continue until late September (Hughes 1999).

The cuckoo primarily breeds in riparian habitat along low-gradient (surface slope less than 3 percent) rivers and streams, and in open riverine valleys that provide wide floodplain conditions (greater than 325 feet [100 m]). In the southwest, it can also breed in narrower reaches of riparian habitat. The moist conditions that support riparian plant communities that provide cuckoo habitat typically exist in lower elevation, broad floodplains, as well as where rivers and streams enter impoundments.

The optimal size of habitat patches for the species are generally greater than 200 acres (81 hectares) and have dense canopy closure and high foliage volume of willows and cottonwoods (Laymon and Halterman 1989) and thus provide adequate space for foraging and nesting. Tamarisk, a nonnative tree species, may be a component of the habitat, especially in Arizona and New Mexico. Sites with a monoculture of tamarisk are unsuitable habitat for the species. The association of breeding with large tracts of suitable riparian habitat is likely related to home range size. Individual home ranges during the breeding season average over 100 acres (40 hecctares), and home ranges up to 500 acres (202 hectares) have been recorded (McNeil et al. 2011; McNeil et al. 2012).

In addition to the dense nesting grove, western yellow-billed cuckoos need adequate foraging areas near the nest. Foraging areas can be less dense or patchy with lower levels of canopy cover and often have a high proportion of cottonwoods in the canopy. Optimal breeding habitat contains groves with dense canopy closure and well-foliaged branches for nest building with nearby foraging areas consisting of a mixture of cottonwoods, willows, or mesquite with a high volume of healthy foliage (USFWS 2013).

Cuckoos forage primarily by gleaning insects from vegetation, but they may also capture flying insects or small vertebrates such as tree frogs and lizards (Hughes 1999). They specialize on relatively large invertebrate prey, including caterpillars , katydids, cicadas , and grasshoppers (Laymon et al. 1997). Minor prey includes various other insects, wild berries, and bird eggs and young (Laymon et al. 1997, Hughes 1999). Prey species composition varies geographically. Their breeding season may be timed to coincide with outbreaks of insect species, particularly tent caterpillars (Hughes 1999, USFWS 2001) or cicadas (Johnson et al. 2007, Halterman 2009).

The species as a whole winters in woody vegetation bordering fresh water in the lowlands to 1,500 m (4,921 feet), including dense scrub, deciduous broadleaf forest, gallery forest, secondary forest, subhumid and scrub forest, and arid and semiarid forest edges (Hughes 1999). Wintering habitat of the cuckoo is poorly known.

Status and Distribution. Since 1980, statewide surveys from New Mexico, Arizona, and California indicate an overall estimated 52 percent decline with numbers too low to establish trends from Idaho, Montana, Utah, Nevada, and Colorado. Trend information is also lacking from west Texas and Mexico. Yellow-billed cuckoo has been extirpated as a breeding bird in Washington, Oregon, and British Columbia (USFWS 2011). Comparisons of historic and current information suggest that the western yellow-billed cuckoo’s range and population numbers have declined substantially across much of the western U.S. over the past 50 years.

Although the overall population size of this species remains large, western populations in many areas have decreased dramatically. Major declines among western populations in the 20th century are attributed to habitat loss and fragmentation. Although once considered a common nester in Arizona river bottoms, fewer than 50 pairs were estimated present in the state in the early 1990s. The greatest declines have been in California, from an estimated 15,000 pairs in the late 19th century to a few dozen pairs by the mid-1980s (New Mexico Avian Conservation Partners 2018).

The current breeding population is low, with estimates of approximately 350 to 495 pairs north of the Mexican border and another 330 to 530 pairs in Mexico for a total of 680 to 1,025 breeding pairs (USFWS 2013).

Environmental Baseline. On August 15, 2014 and again on November 12, 2014 the USFWS announced a proposal to designate critical habitat for the western distinct population segment of the yellow-billed cuckoo under the ESA of 1973. The comment period for the proposed critical habitat rule closed on January 12, 2015. There is one unit of proposed critical habitat located in northwest Colorado, within the LSFO:

- Unit 54: CO–1 Yampa River; Moffat and Routt Counties. Proposed critical habitat unit CO–1 is 6,938 acres (2,808 hectares) in extent and is a 20-mile (32-km)-long continuous segment of the Yampa River from near the Town of Craig in Moffat County to near the Town of Hayden in Routt County, Colorado. Approximately 5,739 acres (2,322 hectares), or 83 percent, of proposed unit CO–1 are privately owned, and 1,199 acres (485 hectares), or 17 percent, are located on Yampa River State Wildlife Area managed by the CPW. This high-elevation site is near the current northern limit of the current breeding range of the species.

Threats. Threats to yellow-billed cuckoos include loss or degradation of riparian habitat from water management (dams, flow control), urbanization, grazing, conversion to non-native species and agricultural conversion.

5.0 EFFECTS OF THE PROPOSED ACTION ON SPECIES EVALUATED

Leasing of federal coal under the LBA and mining the coal would have no direct effect to any listed species. Potential indirect impacts to T&E species from water discharge or runoff and combustion of federal coal are described below.

5.1 Colorado River Fish

Mercury. Mercury is a naturally occurring element. It can be found in soils and the atmosphere, as well as water bodies. Atmospheric transport and deposition is an important mechanism for the global deposition of mercury (Electric Power Research Institute [EPRI] 2014), because it can be transported over large distances from its source regions and across continents. It is considered a global pollutant. Atmospheric mercury is primarily inorganic and is not biologically available. However, once mercury is deposited to the earth, it can be converted into a biologically available form, methylmercury (MeHg), through a process known as methylation. Methylmercury bioaccumulates in food chains, and particularly in aquatic food chains, meaning that organisms exposed to MeHg in their food can build up concentrations that are many times higher than the ambient concentrations in the environment.

Mercury is emitted by both natural and anthropogenic sources. Natural sources include volcanoes, geothermal sources, and exposed naturally mercury-enriched geological formations. These sources may also include re-emission of historically deposited mercury as a result of evasion from the surface back into the atmosphere, fires, meteorological conditions, as well as changes in land use and biomass burning. Anthropogenic sources of mercury include burning of fossil fuels, incinerators, mining activities, metal refining, and chemical production facilities. Anthropogenic sources currently account for 30% of the mercury being emitted into the environment. The global emissions inventory for 2010 estimated that 1960 metric tons (4,319,840 pounds) of mercury was emitted into the atmosphere as a direct result of human activity (United Nations Environment Programme [UNEP] 2013), with an estimated 60.7 metric tons supplied by North America. East and Southeast Asia were by far the highest contributors, with 777 metric tons of mercury released (UNEP 2013).

Aquatic systems receive mercury by direct deposition from the atmosphere and from overland transport from within the watershed (U.S. Environmental Protection Agency [EPA] 1997). Once mercury is converted to methyl mercury, it can bioaccumulate in endangered fish and is a potent neurotoxin that affects their fitness and reproductive health (Crump and Trudeau 2009). Once mercury enters the body, it poses the highest threats of toxicity because it can be absorbed into living tissues and blood. Once in the blood it crosses into the brain and accumulates, there is no known way to be expelled from the brain (Gonzalez et al. 2005).

The accumulation of mercury from water occurs via the gill membranes as well as through ingestion (Beckvar et al. 1996; EPA 1997). Methylmercury is eventually transferred from the gills to muscle and other tissues where it is retained for long periods of time (Julshamn et al. 1982; Riisgård and Hansen 1990). Probably less than 10 percent of the mercury in fish tissue residues is obtained by direct (gill) uptake from water (Francesconi and Lenanton 1992; Spry and Wiener 1991). Mercury taken up with food initially accumulates in the tissues of the posterior intestine of fish (Boudou et al. 1991). Mercury ingested in food is transferred from the intestine to other organs including muscle tissues (Boudou et al. 1991). Mercury has been reported to constitute from 70 to 95 percent of the total mercury in skeletal muscle in fish (Huckabee et al. 1979; EPA 2001; Riisgård and Famme 1988; Greib et al. 1990; Spry and Wiener 1991). Methylmercury accounted for almost all of the mercury in muscle tissue in a wide variety of both freshwater and saltwater fish (Bloom 1992).

The effects of mercury on fish are numerous. Lusk (2010) describes the potential effects as:

1. Potent neurotoxin:

   a. Affects the central nervous systems (reacts with brain enzymes, then lesions)
   b. Affects the hypothalamus and pituitary, affects gonadotropin-secreting cells
   c. Altered behaviors: Reduced predator avoidance, reproduction timing failure
   d. Reduced ability to feed (emaciation and growth effects)

2. Endocrine disruptor:

   a. Suppressed reproduction hormones in male and female fish
   b. Reduce gonad size and function, reduced gamete production
   c. Altered ovarian morphology, delayed oocyte development
   d. Reduced reproductive success

e. Transfer of dietary mercury of the maternal adult during oogenesis and into the developing embryo

3. Inability to grow new brain cells or significantly reduce brain mercury

To protect human health, the EPA developed a MeHg water quality criteria of 3.0 micrograms per gram (µg/g) wet weight (WW) in edible fish and shellfish. Beckvar et al. (2005) suggested a threshold-effect level of 0.2 µg/g WW mercury in whole body fish as being generally protective of juvenile and adult fish. However, Yeardley et al. (1998) suggested that mercury concentrations greater than 0.1 µg/g WW may be harmful to predators eating contaminated fish.

Because Colorado pikeminnow are a long lived, top predator species, mercury would be most likely to impact this species. Osmundson and Lusk (2012) reported on the collection, locations, methods, chemical analyses, laboratory quality assurance and quality control, and interpretation of mercury in Colorado pikeminnow from Upper Colorado River Basins, including from the Yampa and White rivers during 2008-2009. The mercury in Colorado pikeminnow muscle tissues collected from the San Juan, Green, Upper Colorado, White, and Yampa Rivers are summarized in Table 2.

Table 2. Average and Range of Mercury (HG mg/kg WW) in Colorado Pikeminnow Muscle Tissues from Upper Colorado River Basins 2008-2009 (Osmundson and Lusk 2012)

River Basin	Average Hg in Muscle Tissue (min-max)
San Juan River (> 400 mm TL)	0.37 (0.31-0.43)
Green River	0.77 (0.68-0.87)
Upper Colorado River	0.60 (0.31-1.04)
White River	0.95 (0.43-1.83)
Yampa River	0.49 (0.44-0.53)

Data from the Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division (WQCD) maintains a list of all waters in Colorado that exceed the total maximum daily loads for a variety of contaminants. The WQCD does not list the Yampa or White rivers as impaired for mercury levels. It should be noted, however, that impairment under this program relates to human effects and not necessarily to impacts to aquatic species. Water quality data for mercury collected from the Yampa River near Hayden (USGS Station 09244490) between 2016 and 2017 showed that the mercury concentrations ranged from 0.00052 to 0.00345 µg/L, with an average of 0.00183 µg/L (USGS 2018). There is currently not a fish consumption advisory for either the Yampa or White rivers. There are currently two fish consumption advisories within the LSFO for mercury. One of the advisories applies to Elkhead Reservoir, northeast of Craig, Colorado and one applies to Catamount Reservoir, east of Steamboat Springs, Colorado.

It is expected that about one-third (1,247,733 tons) of the coal from the LBA would be combusted at the Hayden Generating Station. The combustion location for the additional two-thirds of coal is speculative at this time. Coal from the Foidel Creek Mine is shipped to several power plants, with many contracts only lasting a year and destination plants often changing from year to year. Ultimately, any near or far field impacts from criteria or mercury emissions associated with coal combustion sources will have already received analysis as part of the permitting process or rule implementation from their respective regulatory agencies (state or EPA).

The Hayden Generating station has two combustion units, one which went online in 1965 and the second in 1976. Both units have several components designed to decrease air emissions, including: low nitrogen oxide (NOx) burners, fabric filter dust collectors (baghouses), and lime spray dryers (scrubbers). In addition, selective catalytic reduction units (SCRs) for the control of NOx emissions were installed on both units. Although not specifically designed to reduce mercury emissions, the SRC units oxidizes elemental mercury and allows better collection of mercury in the scrubbers and baghouses. The SCRs went into service in 2015 (Unit 1) and 2016 (Unit 2) and effect a 30 to 77% control of mercury. The units qualify as low emitting electric generating units (LEE) for mercury under the new EPA Mercury and Air Toxic Standards (MATS).

The 1,247,733 tons of federal coal from the LBA would supply the Hayden Station for approximately 332 days (based on a five year average). With the newly implemented controls the Hayden Station emitted 8.31 lbs of mercury per year in 2016. Compared to the 2010 estimated total North America and global emissions of mercury, 60.7 and 1,960 metric tons (UNEP 2013), this would represent an insignificant amount of mercury (0.0062% and 0.00019%, respectively).

A mercury deposition network (MDN) monitoring site (Buffalo Pass – Summit Lake) is located east of Steamboat Springs, Colorado in the Routt National Forest. Since data has been collected at this site, annual mercury deposition (wet) has ranged from a low of 6.881 $\mu g/m^2$ in 2012 to a high of 14.747 $\mu g/m^2$ in 2011 (Forest Service 2018). The most recent deposition measurement is 8.184 $\mu g/m^2$ in 2016.

No current data or modeling is available to indicate how much of the mercury emitted by the Hayden Station alone is deposited annually within local airshed. However, a recent modeling effort to assess local mercury deposition from the Craig Generating Station was completed in 2017 (EPRI). Results from this modeling showed that mercury depositions from non-local sources accounted for 99% of mercury deposited within the local watersheds. Local Electric Generating Units (EGU) other than the Craig Station included the Hayden Station and the Bonanza Power Plant and accounted for approximately 0.2% of total annual deposition within the Yampa and White River Basins.

Of the amount of mercury emitted from the federal coal, it is reasonable to assume that some portion would deposit directly or indirectly into the Yampa River or its tributaries. Some of this mercury could be converted into methyl mercury and thereby has the potential to affect the Colorado River fish. In addition to impacts to individual Colorado River fish, impacts would also potentially occur to those species designated critical habitats in the region. As with any other listed species with designated critical habitat, the critical habitat for the four fish species all contain the PCEs that are required to be present and are determined to be necessary for the survival and recovery of the species. All four species' critical habitat contains the following PCEs (50 CFR 13378):

1. Water: This includes a quantity of water of sufficient quality (i.e. temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, etc.) that is delivered to a

specific location in accordance with a hydrologic regime that is required for the particular life stage for each species;
2. Physical Habitat: This includes areas of the Colorado River system that are inhabited or potentially habitable by fish for use in spawning, nursery, feeding, and rearing, or corridors between these areas. In addition to river channels, these areas also include bottom lands, side channel, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which when inundated provide spawning, nursery, feeding and rearing habitats, or access to these habitats;
3. Biological Environment. Food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the species. Predation and competition, although considered normal components of this environment, are out of balance due to introduced nonnative fish species in many areas.

Mercury from the combustion of federal coal at the Hayden Generating Station that is deposited either directly or indirectly into the designated critical habitat for these species would have the potential to impact the critical habitat. This would occur primarily by increasing the amount of contaminates present in those areas (PCE #1). It is difficult to quantify the level of this impact from the proposed action to critical habitats given the lack of information on how much mercury would make its way to critical habitat and how much would be converted to methyl mercury. However, with an estimated 0.2% of mercury deposition attributed to the Hayden Station and the Bonanza Power Plant, contributions of mercury into critical habitat from these two sources would likely be negligible when compared to total mercury depositions.

Selenium. In addition to mercury, impacts to listed fish species from increases in selenium from the combustion of coal could occur. Selenium, a trace element, is a natural component of coal and soils in the area and can be released to the environment by the irrigation of selenium-rich soils and the burning of coal in power plants with subsequent emissions to air and deposition to land and surface water. Contributions from anthropogenic sources have increased with the increases of world population, energy demand, and expansion of irrigated agriculture. Selenium, abundant in western soils, enters surface waters through erosion, leaching, and runoff.

Selenium is a micro-nutrient, necessary for proper cellular function of structural proteins and cellular defenses against oxidative damage. While small amounts of selenium are essential for proper cellular functioning, excess amounts can be toxic. Excess dietary selenium causes elevated selenium concentrations to be deposited into developing eggs, particularly the yolk (Buhl and Hamilton 2000). If concentrations in the egg are sufficiently high, developing proteins and enzymes become dysfunctional or result in oxidative stress, conditions that may lead to embryo mortality, deformed embryos, or embryos that may be at higher risk for mortality.

Water quality data collected from the Yampa River below Craig (USGS Station 09247600) between 1975 and January 2018 showed that selenium concentrations ranged from below detection limit to 17.0 µg/L. Quarterly measurements of selenium since 2005 show average selenium concentrations of 0.58µg/L (USGS 2018). Quarterly selenium measurements were also conducted on the Yampa River near Hayden (USGS Station 09244490) from 2010 through 2017, and show selenium concentrations ranging from 0.08 to 2.7µg/L, averaging 0.38µg/L (USGS

2018). It should be noted that selenium in water may be less important than dietary exposure when determining the potential for chronic effects to a species (USFWS 2014).

While the reportable limit of selenium in water is 1 μg/L, the safe level of selenium for protection of fish and wildlife in water is considered to be below 2 μg/L and chronically toxic levels are considered to be greater than 2.7 μg/L (USFWS 2014). Excess selenium in fish have been shown to have a wide range of adverse effects including mortality, reproductive impairment, effects on growth, and developmental and teratogenic effects including edema and finfold, craniofacial, and skeletal deformities.

Of the four Colorado River fish species, selenium would disproportionately affect the razorback sucker more than the other three species. As with all sucker species, the razorback sucker is a bottom feeder and more likely to ingest selenium that has precipitated to the river bottoms.

If combustion of coal from the lease modification occurs at the Hayden Station, selenium could be emitted and subsequently deposited. However, as it is not monitored as it is emitted, unlike mercury, there is no information as to how much is released. When selenium is present in flue gas, it tends to behave much like sulfur and is removed to some extent via the sulfur dioxide (SO_2) air scrubbers in place (EPRI 2008). Because the amount of selenium in emissions from the Hayden Station is not measured, impacts cannot be measured or detected in a manner that permits meaningful evaluation.

Mercury and Selenium from Mine Discharge or Runoff

Middle Creek and Foidel Creek flow through the area of the LBA. Fish Creek is to the north of the LBA. Foidel Creek is a perennial tributary of Middle Creek, and Middle Creek and Fish Creek are perennial tributaries to Trout Creek; Trout Creek is a perennial tributary to the Yampa River. Runoff from the area affected by the proposed action would flow to Middle Creek and Foidel Creek, with a small portion of the LBA draining towards Fish Creek. Foidel Creek, Middle Creek, Fish Creek, and Trout Creek are not listed as impaired under CDPHE Section 303(d); however, all three creeks and their tributaries are on the Colorado Monitoring and Evaluation list for sediment (CDPHE 2018b). Water Quality Standards for Middle Creek, Foidel Creek and Fish Creek have temporary modifications for selenium and iron.

Longwall mining in the vicinity has occurred since approximately 1988 and runoff water from the subsided areas as well as some mine inflow water, has flowed or been released into Fish Creek or Foidel Creek after treatment in accordance with all state and federal regulations. Surface flows from disturbed and reclaimed areas are intercepted and treated in sedimentation ponds prior to discharge to meet the EPA's National Pollutant Discharge Elimination System (NPDES) standards. The State of Colorado CDPHE Water Quality Control Division (WQCD) administers the NPDES for the EPA and the Colorado Discharge Permit System (CDPS) issues discharge permits. TC's hydrologic monitoring program is subject to ongoing review under CDPHE's WQCD required Discharge Monitoring Reports. TC has five CDPS permits; each permit has 1-6 outfalls or monitoring sites.

Water discharge from the mine inflow water is also managed under TC's CDPS permit. Mine inflow water collects in underground sump rooms and is then pumped to the surface where it passes through the water treatment facility. This water is then either discharged to Fish Creek or returned underground for use in mining activities. Mine water can also be channeled and treated through surface settling ponds prior to discharging into Foidel Creek, or it can be returned for use underground. The discharge sites are rarely used because the Foidel Creek mine makes use of and recycles much of the mine inflow water in various mining activities, especially dust suppression. If necessary, discharges are treated to meet CDPS permit effluent limits. In 2016, discharge into Fish Creek occurred from May through early July. Water quality samples taken from monitoring points in Fish and Foidel Creek show average selenium concentrations of 1.1 µg/L. Mercury was below detection limit for all samples (EPA 2018e). The selenium standard for Fish and Foidel Creeks is temporarily modified to current conditions, but the unmodified acute and chronic standards are 18.4 µg/L and 4.6 µg/L, respectively. None of the 2017 samples exceeded either value (EPA 2018e).

It is unknown if no mercury or a trace amount of mercury is being released by mine discharge as samples are below the detection level. It is known that some selenium is being released. However, the main tributary to the Yampa River in this area, Trout Creek, is meeting water quality standards and is not listed as impaired. Impacts from both mercury and selenium to Colorado River Fish are described above and these would be the same for potential contamination from mine discharge or runoff.

5.2 Lineage Greenback Cutthroat Trout

Mercury. Cutthroat trout of greenback lineage are known to reside in only one stream within the boundary of the LSFO. BLM does not manage any surface portions of the creek or surrounding area but does administer the subsurface federal mineral estate within portions of the watershed. The Routt National Forest manages most of the land within the Deadman Gulch watershed. The closest BLM land is approximately 5 miles south/west of Deadman Gulch. This population is outside of the 50 km buffer (31 mile radius) for local deposition of mercury from coal combustion at the Hayden Station. Since mercury would be deposited outside the local airshed, mercury from the federal coal could conceivably reach the one greenback stream that occurs in Routt County. However, with the small amount of mercury expected to be emitted from this coal, this impact would be negligible. In addition, this population of trout lives in a cold water stream and its main food is insects, even further reducing potential impacts.

5.3 Yellow-billed Cuckoo

Mercury. Mercury is an environmental contaminant that can also have adverse effects on riparian wildlife (Scheuhammer et al. 2012; Wentz et al. 2014). For riparian birds such as cuckoos, mercury is accumulated via ingestion of aerial insects emerging from benthic life stages in aquatic environments containing mercury or from associated predatory spiders (Cristol et al. 2008; Edmonds et al. 2012; Evers et al. 2012; Buckland-Nicks et al. 2014; Gann et al. 2014). Dietary total mercury concentrations associated with adverse effects to birds are generally greater than 0.1 mg/kg WW (U.S. Department of the Interior [DOI] 1998). Once ingested, MeHg rapidly moves into the bird's central nervous system, resulting in behavioral and neuromotor disorders (Tan et al. 2009; Scheuhammer et al. 2012). The developing central nervous system in avian embryos is especially sensitive to this effect, and permanent brain lesions and spinal cord degeneration are common (DOI 1998, Bryan et al. 2003, Scheuhammer et al. 2007). Therefore, adverse effects are described for the eggs, embryos, nestlings and/or fledglings associated with elevated mercury burdens in the female parent and due to foraging.

Uptake of mercury by birds has been shown to generally impact fish eating birds more severely than insectivorous birds (Zolfaghari et al. 2009, Boening 2000). Additionally, Howie (2010) found that the lateral extent of elevated mercury levels in birds and invertebrate prey species varied from approximately 250 to 650 meters from an affected water body. After this distance, mercury levels in the blood and feathers could not be distinguished from background levels, indicating that only those individuals that forage adjacent to affected water bodies show signs of bioaccumulation of mercury.

No information is available on the levels of mercury in the Yampa River invertebrates within the analysis area. Any yellow-billed cuckoos present in the analysis area would be at risk for mercury contamination. The risk would be low considering that the primary food sources for the cuckoo are generally not aquatic.

6.0 CUMULATIVE EFFECTS

As it pertains to Section 7 Consultation, cumulative effects are defined as: those effects of future State or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the federal action subject to consultation (50 CFR 402.02). Cumulative effects do not include any past or ongoing action, but “involve only future non-Federal actions”. Future Federal actions requiring separate consultation (unrelated to the proposed action) are not considered in the cumulative effects section.

Declines in the abundance or range of many special status species have been attributed to various human activities on federal, state, and private lands, such as human population expansion and associated infrastructure development; construction and operation of dams along major waterways; water retention, diversion, or dewatering of springs, wetlands, or streams; recreation, including off-road vehicle activity; expansion of agricultural or grazing activities, including alteration or clearing of native habitats for domestic animals or crops; and introductions of non-native plant, wildlife, or fish or other aquatic species, which can alter native habitats or out-compete or prey upon native species. Many of these activities are expected to continue on state and private lands within the range of the various federally protected wildlife, fish, and plant species, and could contribute to cumulative effects to the species within the action area of the Proposed Actions. Species with small population sizes, endemic locations, or slow reproductive rates, or species that primarily occur on non-federal lands where landholders may not participate in recovery efforts, would be generally be highly susceptible to cumulative effects.

Reasonably foreseeable future activities that may affect river-related resources within the Yampa and White River watersheds include coal mining and combustion, oil and gas exploration and development, irrigation, urban development, recreational activities, livestock grazing and activities associated with the Upper Colorado River Endangered Fish Recovery Program. Implementation of these projects affects the environment including but not limited to, water quality, water rights, socioeconomic and wildlife resources.

7.0 EFFECTS DETERMINATIONS

7.1 Colorado River Fish

Continued combustion of federal coal from the Foidel Mine at the Hayden Generating Station would release both mercury and selenium into the environment. However, the Hayden Generating Station would continue to operate without the 1,247,733 tons of federal coal by using state or fee coal or by purchasing coal from various sources. Of the amounts emitted annually, it can be reasonably assumed that a portion would deposit either directly or indirectly into critical habitat. Since non-local sources of mercury account for 99% of deposition in the local area, mercury deposition from Hayden Station emissions are likely insignificant when compared to total mercury depositions.

In the future, mercury and selenium, which are globally transmitted pollutants, would continue to accumulate within the Yampa and White River Basins from both local and global sources. Given the potential for the release of mercury from the combustion of federal coal in the local airshed and the subsequent deposition into critical habitat, the Proposed Action “May Affect, is Likely to Adversely Affect” the Colorado River fish. Additionally, while potentially not significant alone, the deposition of mercury into critical habitat from the Proposed Action along with other regional and global sources of mercury may be affecting the PCEs for that critical habitat. Therefore, the Proposed Action “May Affect, is Likely to Adversely Affect” the critical habitat for the four Colorado River fish species.

7.2 Lineage Greenback Cutthroat Trout

One linage greenback cutthroat trout population exists in Routt County, within the boundaries of the LSFO. This population is outside of the 31 mile analysis area for local deposition of mercury from coal combustion at the Hayden Station. Since mercury would be deposited outside the local airshed, mercury from the federal coal could conceivably reach the one greenback stream that occurs in Routt County. However, with the small amount of mercury expected to be emitted from this coal, this impact would be negligible. In addition, this population of trout lives in a cold water stream and its main food is insects, even further reducing potential impacts. Therefore it is determined that the Proposed Action “May Affect, but is Not Likely to Adversely Affect” lineage greenback cutthroat trout.

7.3 Yellow-billed Cuckoo

While proposed critical habitat exists within the analysis area, there have been no confirmed sightings of the yellow-billed cuckoo in the analysis area since 2008. Additionally, it is not known if the previous sightings represented nesting pairs or migrants. As this species is a migrant that may not return to previous nesting locations in subsequent years, the potential to suffer adverse impacts from mercury would be less than non-migrant species. Therefore it is determined that the Proposed Action “May Affect, but is not Likely to Adversely Affect” yellow-billed cuckoos or proposed critical habitat for this species. Additionally, while mercury deposition may affect aquatic insects, these are not the primary prey item for yellow-billed cuckoos. Therefore, it is determined that the Proposed Action is not likely to destroy or adversely modify the proposed critical habitat for cuckoos.

8.0 CONSERVATION MEASURES

The BLM, LSFO is partnering with the USGS to conduct a mercury study related to fish in the Yampa and White River Basins. The purpose of this study is to determine the level of mercury in higher trophic level fish and apply this knowledge to Colorado River Fish conservation and management. BLM contributed $65,000 to this effort in 2016 and is expected to contribute an additional $15,000 in 2018.

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United States Department of the Interior

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TAILS 06E24100-2018-F-0271

September 5, 2018

Memorandum

To: Field Manager, Little Snake Field Office, Bureau of Land Management, Craig, Colorado

From: Western Slope Supervisor, Ecological Services Field Office, Grand Junction, Colorado Ann Timberman

Subject: Biological Opinion on the Twentymile Coal, LLC (TC) Lease-By-Application (LBA) COC78449

This memorandum and the attached Biological Opinion (BO) responds to Bureau of Land Management (BLM) request for initiation of consultation with the Fish and Wildlife Service (Service) on effects of the subject project to species and habitats listed under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.; [Act]). BLM's request received June 8, 2018, included a biological assessment (BA) entitled Biological Assessment for the Peabody Twentymile Coal, LLC Lease-by-Application COC78449. Peabody Energy owns the Twenty Mile Coal Company, which mines coal from the Foidel Creek Mine, and is seeking the subject coal lease offered by BLM. BLM analyzed the effects from the subject project to a number of listed species identified in the biological assessment (BA); the final determinations of BLM are presented below.

Species	Listing status	Determination
Colorado pikeminnow (*Ptychocheilus lucius*)	endangered, critical habitat	Likely to adversely affect
Razorback sucker (*Xyrauchen texanus*)	endangered, critical habitat	Likely to adversely affect
Humpback chub (*Gila cypha*)	endangered, critical habitat	Likely to adversely affect
Bonytail (*Gila elegans*)	endangered, critical habitat	likely to adversely affect
Greenback cutthroat trout (*Oncorhynchus clarki stomias*)	threatened	Not likely to adversely affect
Western yellow-billed cuckoo (*Coccyzus americanus*)	threatened proposed critical habitat	Not likely to adversely affect Not likely to adversely affect Not likely to destroy or adversely modify
Canada lynx (*lynx canadensis*)	threatened	No effect
North American wolverine (*Gulo gulo luscus*)	proposed threatened	No effect

The Service has prepared a BO with a finding that the proposed project is not likely to jeopardize the four endangered fish, nor is it likely to destroy or adversely modify their critical habitats (attached). We also concur (below) with BLM's determinations for the greenback cutthroat trout and western yellow-billed cuckoo (cuckoo) and its proposed critical habitat.

For the North American wolverine and Canada lynx, we acknowledge your determination of no effect, but neither 7(a)(3) of the Act, nor implementing regulations under section 7(a)(2) of the Act require the Service to review or concur with this determination; therefore the Service will not address these species further. However, we do appreciate you informing us of your analysis for these species.

Concurrence for western yellow-billed cuckoo and its proposed critical habitat

No cuckoos have been found at or near the Foidel Creek Mine or the Hayden Generating Station (Hayden Station). Cuckoo habitat is not present at, or adjacent to, these facilities. Critical habitat has been proposed for the western yellow-billed cuckoo (79 FR 48547), including a unit along the Yampa River between the towns of Craig and Hayden. Cuckoos and their proposed critical habitat are found along the Yampa River within the airshed analyzed for mercury deposition from the Hayden Station, as outlined in the BA and discussed in our BO below.

We have records of only five cuckoos from the Yampa proposed critical habitat unit. The most recent observation was from 2016, the next most recent observation from 2008. We do not know whether any of these cuckoos were nesting or not. There is potential for contamination of cuckoo insect prey and habitats from mercury emissions from the Hayden Station. However, we have no data on mercury levels from cuckoos or their prey in this area. Aquatic insects are more likely to accumulate mercury from the environment than terrestrial insects due to the mercury methylation process which takes place in the presence of anoxic lentic environments (Sandheinrich and Wiener 2011). Aquatic insects (e.g., dragonflies, caddisflies) are only a minor component of a cuckoo's diet (79 FR 48587).

You have determined that your proposed action may affect, but is not likely to adversely affect the cuckoo. You have also determined that your proposed action is not likely to adversely affect, nor destroy or adversely modify, proposed critical habitat for the cuckoo. We concur with your determinations. We base our concurrence on the rationale provided in the BA and additional Service review and analysis. We would like to point out, however, that many questions remain regarding the cuckoo's status and the potential contaminant levels in the action area; new information could lead to different conclusions in the future.

Concurrence for greenback cutthroat trout

No greenback cutthroat trout (i.e., on the westslope, "green lineage cutthroat trout" (Service 2014a, Metcalf et al. 2012) or "lineage greenback cutthroat trout," per the BA or "Lineage GB cutthroat trout" (Rogers 2012)) are found within the project analysis area or anywhere within the Yampa or White River watersheds. No critical habitat has been designated for this species. However, there is one population of green lineage cutthroat trout in southern Routt County, the county in which the coal would be mined and a portion of it burned, and within the boundary of the BLM Little Snake Field Office. This green lineage cutthroat trout stream is outside of the project area of analysis, however, and outside of the project area watersheds. Because some coal combustion emissions from the project would be deposited outside the project area of analysis, mercury deposition from the federal coal could conceivably reach this stream. However, with the small amount of mercury expected to be emitted from this coal and the distance this stream is from the Hayden Station where a portion of the coal would be combusted, we consider this amount of mercury to be insignificant. We concur with your determination that the project may affect, but is not likely to adversely affect the greenback cutthroat trout.

We conclude informal consultation under section 7 of the Act for the cuckoo, its proposed critical habitat, and the greenback cutthroat trout. Further consultation pursuant to section 7(a)(2) of the Act is not required at this time. As provided in 50 CFR §402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) If the amount or extent of taking specified in the incidental take statement is exceeded; (b) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the BO; or (d) If a new species is listed or critical habitat designated that may be affected by the identified action.

In accordance with section 7 of the Act and its implementing regulations, this BO incorporates the best scientific and commercial information available on the effects of the proposed action to federally listed species and their critical habitats, including from the mining and combustion of coal resulting in mercury and selenium emissions and subsequent deposition and accumulation in listed species within the Yampa and White River Basins. A complete record of this consultation is on file at the Service's Western Colorado Ecological Services Field Office, in Grand Junction, Colorado.

If you have questions regarding this consultation, please contact Creed Clayton at (970) 628-7187.

Cc: CPW, NW Office, Senior Aquatic Biologist, 711 Independent Ave., Grand Junction, CO 81505 (Lori Martin) (lori.martin@state.co.us)

BIOLOGICAL OPINION

On effects to the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail

from the

COC78449 Lease-by-Application at the Foidel Creek Coal Mine

TAILS No. 06E24100-2018-F-0271

Colorado pikeminnow (*Ptychocheilus lucius*)

FISH AND WILDLIFE SERVICE
Mountain Prairie Region
Grand Junction, Colorado

Western Slope Supervisor, Ecological Services Ann Timberman

Date 9/5/2018

Purpose of this Document

In 1973, Congress passed the Endangered Species Act (ESA) in order to "...*provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved*..." (ESA section 2). Included in section 7 of that Act, is the requirement that every federal agency must insure that any action "…*authorized, funded, or carried out…is not likely to jeopardize the continued existence of any endangered or threatened species*…". To meet this requirement, Congress required that the action agencies request assistance from the U.S. Fish and Wildlife Service (Service) and seek their biological opinion (BO) regarding whether the proposed action is likely to jeopardize the continued existence of a listed species.

This document is that required examination of the BLM's proposed action (coal lease-by-application or LBA) and the Service's BO on the proposed action's effects to the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail (four endangered fish). This BO also determines whether the proposed action would destroy or adversely modify critical habitats for the four endangered fish.

This BO relies on the 2016 regulatory definition of "destruction or adverse modification" of critical habitat (Federal Register, February 11, 2016, Volume 81, No. 28 p. 7226) which states, "*Destruction or adverse modification* means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features."

Background

As a result of a legal challenge (*WildEarth Guardians v. U.S. Office of Surface Mining et al.*, Case 1:13-cv-00518-RBJ (D. Colo. 2015)), the District Court of Colorado required the Office of Surface Mining and Reclamation Enforcement (OSMRE) to review their approval of mining plans at the Colowyo and Trapper Mines in Moffat County, Colorado (including any effects from the action of mining plan approval) and complete additional analysis under the National Environmental Policy Act (NEPA). Among other things, the court's findings indicated that the indirect effect of combustion at the Craig Generating Station, where the coal would be burned, from coal mined under the plan should be considered as "reasonably foreseeable" under NEPA and should be included in the NEPA analysis. The Court's direction to explore those indirect effects under NEPA had the unintended consequence of leading to an examination of these effects under section 7 of the ESA.

Indirect effects under regulations implementing section 7 of the ESA are defined as "...those that are caused by the proposed action and are later in time, but still are <u>reasonably certain to occur</u>." (Emphasis added.) This definition differs from the NEPA phrase "reasonably foreseeable." This difference may reflect a distinction between the procedural nature of NEPA vs. the substantive nature of section 7 and is touched on briefly in the Federal Register notice finalizing the 1986 regulations on conducting section 7 consultation (FR June 3, 1986, Volume 51, No. 106, p. 19933).

OSMRE did not have discretion or authority over determining where the Colowyo and Trapper mined coal would be taken to be combusted. OSMRE also did not have discretion or authority regarding the manner in which the coal would be combusted. In the past, coal mined at the Colowyo and Trapper mines has been burned at the Craig Generating Station to produce power. The decision space in between OSMRE's plan approval and the combustion of the coal at the Craig Generating Station may make the causal connection somewhat less than reasonably certain. However, OSMRE assumed for analysis pursuant to section 7 of the ESA the causal connection for indirect effects.

Similarly, and to be consistent with the court ruling mentioned above, BLM determined that in addition to underground mining, combustion of federal coal is a reasonably foreseeable action. Although the BLM has no discretion or decisions regarding this action, the BLM is requesting that coal combustion be included as an indirect effect of the proposed action for the purposes of this consultation.

Consultation History

ESA section 7 consultation has not been completed for this LBA. No water depletions are expected from the LBA or subsequent mining operations.

The Service issued a BO in 2016 pursuant to a 2015 BA and consultation request by the BLM for the COC54608 Coal Lease Modification at the Foidal Creek Mine (Service 2016). That consultation analyzed the effects to listed species from the combustion of 112,000 tons of coal that was expected to be burned at the Hayden Station (one third of the coal contained in the lease). In the 2016 BO and associated correspondence memo, the Service concurred with BLM's determinations of Not Likely to Adversely Affect for the greenback cutthroat trout as well as the western yellow-billed cuckoo and its proposed critical habitat. The Service also determined that the proposed COC54608 Lease Modification was not likely to jeopardize the four endangered Colorado River fish species (Colorado pikeminnow, razorback sucker, humpback chub, and bonytail), nor destroy or adversely modify their respective critical habitats.

1.0 PROPOSED ACTION

The Foidel Creek Mine is located in the central portion of Routt County, Colorado (Township 5 North, Range 86 West, and Township 5 North, Range 87 West), approximately 9 miles South of the Yampa River and south of State Highway 40 between the towns of Steamboat Springs to the east and Craig to the west. Topography in the area and adjacent lands ranges in elevation from approximately 6,600 feet to 7,800 feet.

The BLM, Little Snake Field Office (LSFO) produced a BA and is preparing an environmental assessment to analyze the environmental effects of this coal LBA. Peabody Energy's Twentymile Coal, LLC (TC) has submitted a LBA to the BLM LSFO seeking to obtain an additional 640 acres at the Foidel Creek Mine. TC currently operates the Foidel Creek Mine, which is an underground longwall coal. TC has been mining at the Foidel Creek Mine by underground methods since 1983. The Foidel Creek Mine is made up of six federal coal leases, private coal leases, and state coal leases. According to the BA, it produced approximately 2.6

million tons of coal in 2016 and 3.8 million tons of coal in 2017. The BA contains a map of the lease area and Foidel Creek Mine (BA Map 2).

1.1 Action Area

The description of action area is informed by the following definitions.

Action – "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies….. or (d) actions directly or indirectly causing modifications to the land, water, or air." (50 C.F.R. § 402.02)

Action Area – "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." (50 C.F.R. § 402.02)

Effects of the action – *" refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that will be added to the environmental baseline….* **Indirect effects** *are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.* **Interrelated actions** *are those that are part of a larger action and depend on the larger action for their justification.* **Interdependent actions** *are those that have no independent utility apart from the action under consideration*." (50 C.F.R. § 401.02) [Emphasis added]

Based on the area where "modifications to the land, water, or air" (directly or indirectly) from this proposed action occur and can be perceived, the action area for this BO covers: 1) the Foidel Creek Mine, 2) the local deposition airshed (airshed) (BA Map 2), and 3) critical habitats designated for all four endangered fish species found along the Yampa and White Rivers down to where each meets the Green River, which are withino and downriver from the airshed. The airshed encompasses the Foidel Creek Mine and Hayden Station and was based on an EPA mercury modeling analysis (EPA 1997). It extends out 31 miles (50 km) from the Hayden Station, and generally encompasses the area from Steamboat Springs west to Craig and beyond, and from the Flat Top Mountains north to the Elkhead Mountains (BA Map 2). The airshed includes portions of Moffat, Rio Blanco, and Routt Counties. Defining the air quality region of impact through a topographic airshed methodology allows for an assessment that utilizes the theoretical motion of the atmosphere, the blocking features of local topography and the location of emissions sources. This area also approximates the Upper Yampa subbasin (HUC 8) in the Hydrologic Classification System produced and maintained by the U.S. Geological Survey (USGS) (see https://water.usgs.gov/GIS/huc.html). Additionally, this action area encompasses the primary area of mercury deposition attributed to coal combustion at local coal-fired power plants according to a new mercury deposition modeling effort by the Electric Power Research Institute (EPRI 2017).

1.2 Mining

The proposed LBA is for the Wolf Creek Seam, a coal seam below the Wadge Coal Seam. It is estimated that the federal coal reserves included in the LBA would total approximately

4,679,000 recoverable tons of high volatile, group A, bituminous coal. Coal recovery from the preparation plant is approximately 80% or 3,743,200 tons of saleable coal.

1.3 Coal Combustion

In addition to underground mining, combustion of federal coal is a reasonably foreseeable action. However, the BLM has no discretion or decisions regarding this action. This is an independent, but reasonably foreseeable future activity.

Based on past contracts and as stated in the BA, the BLM expects that about one-third (1,247,733 tons) of the coal from this LBA would be combusted at the Hayden Station (the nearest coal-fired power plant), near Hayden, Colorado. The combustion location for the additional two-thirds of the coal is speculative at this time. Most of the coal from the Foidel Creek Mine is shipped to several different power plants across the nation, with some contracts only lasting a year and destination plants often changing from year to year. This consultation will analyze the effects to the four endangered fish from the combustion of the 1,247,733 tons of coal expected to be burned at the Hayden Station. Without knowing where the rest of the coal would be combusted, it is impossible to consult on the effects of combustion from that coal at this stage.

The Hayden Station is approximately 19 air miles east of Craig, Colorado. Craig is also the closest location of endangered fish critical habitat. The Hayden Station has two combustion units, one of which went online in 1965 and the second in 1976. It produces 441 megawatts of electricity. Both units have several components designed to decrease air emissions, including: low NOx burners, fabric filter dust collectors (baghouses) and lime spray dryers (scrubbers). In addition, selective catalytic reduction units (SRCs) for the control of NOx emissions were installed in 2015-2016 (Xcel Energy 2018). Although not specifically designed to reduce mercury emissions, the SRC units will oxidize elemental mercury and allow better collection of mercury in the scrubbers and baghouses. The units qualify as low emitting electric generating units (LEE) for mercury under the EPA Mercury and Air Toxic Standards (MATS). Xcel Energy, which operates Hayden Station, states that Hayden Station one of the cleanest coal-fired generating stations in the region with advanced emissions control equipment.

The BLM has determined that mining operations at the Foidel Creek Mine do not result in a net water depletion from the Yampa River Basin; therefore, water depletions are not considered in this consultation. Additionally, Xcel Energy, which operates Hayden Station, states that the mine does not discharge any water offsite (Xcel Energy 2018).

1.4 Conservation Measures

Conservation measures are actions that will be taken by the Federal agency or applicant, and serve to minimize or compensate for, project effects on the species under review. In connection with the proposed action, the BLM, Little Snake Field Office, is partnering with the USGS to conduct a mercury study related to fish in the Upper Colorado River Basin, including the Yampa and White Rivers. The purpose of this study is to determine the level of mercury in higher trophic level fish and apply this knowledge to Colorado River Fish conservation and management. BLM contributed $65,000 to this effort in 2016 and $15,000 in 2018. The information obtained through this study, which is expected to be completed later in 2018, will advance the scientific information on the potential effects of coal combustion to the four endangered fish and will facilitate future conservation efforts for these species.

2.0 STATUS OF THE SPECIES AND CRITICAL HABITAT

The purpose of this section is to summarize the best available information regarding the current range wide status of the listed fish species. Additional information regarding listed species may be obtained from the sources of information cited for these species. The latest recovery goals for all four endangered fish, which provide information on species background, life history, and threats, can be found on the internet at: http://www.coloradoriverrecovery.org/documents-publications/foundational-documents/recovery-goals.html. Critical habitat for all four endangered fish species is addressed in the Critical Habitat section below.

2.1 Colorado Pikeminnow

2.1.1 Species description and status

The Colorado pikeminnow is the largest cyprinid fish (minnow family) native to North America and evolved as the main predator in the Colorado River system. Individuals begin consuming other fish for food at an early age and rarely eat anything else. It is a long, slender, cylindrical fish with silvery sides, greenish back, and creamy white belly (Sigler and Sigler 1996). Historically, individuals may have grown as large as 6 feet (ft) long and weighed up to 100 pounds (estimates based on skeletal remains) (Sigler and Miller 1963), but today individuals rarely exceed 3 ft or weigh more than 18 pounds (lbs) (Osmundson et al. 1997).

The species is endemic to the Colorado River Basin, where it was once widespread and abundant in warm-water rivers and tributaries from Wyoming, Utah, New Mexico, and Colorado downstream to Arizona, Nevada, and California. Currently, wild populations of pikeminnow occur only in the Upper Colorado River Basin (above Lake Powell) and the species occupies only 25 percent of its historic range-wide habitat (Service 2002b). Colorado pikeminnow are long distance migrators, moving hundreds of miles to and from spawning areas, and requiring long sections of river with unimpeded passage. They are adapted to desert river hydrology characterized by large spring peaks of snow-melt runoff and low, relatively stable base flows.

The Office of Endangered Species first included the Colorado pikeminnow (as the Colorado squawfish) in the List of Endangered Species on March 11, 1967 (32 FR 4001). It is currently protected under the ESA as an endangered species throughout its range, except the Salt and Verde River drainages in Arizona where it was reintroduced as an experimental, non-essential population (50 FR 30188). The Service finalized the latest Recovery Goals for the species in 2002 (Service 2002b), and is currently conducting a Status Review of the species (81 FR 33698). Recovery of Colorado pikeminnow is considered necessary only in the Upper Colorado River Basin (above Glen Canyon Dam, including the San Juan, and Green River subbasins) at this time because of the present status of populations and because existing information on Colorado pikeminnow biology support application of the metapopulation concept to extant populations

(Service 2002b). As a result, this BO will focus on the status of the Colorado pikeminnow in that unit.

2.1.2 Life history

The Colorado pikeminnow requires relatively warm waters for spawning, egg incubation, and survival of young. Males become sexually mature at approximately 6-7 years of age, which corresponds to a length of about 450-500 millimeters (mm) (18-20 inches (in.)) (Service 2002b, Osmundson and White 2017), and females mature 1 year later (Sigler and Sigler 1996).

Mature adults migrate to established spawning areas in late spring as water temperatures begin to warm, with migration events up to 745 river kilometers round-trip on record (463 mi) (Bestgen et al. 2005). Rates of movement for individuals are not precisely known, but 2 individuals made the approximately 400 km (250 mi) migration from the White River below Taylor Draw Dam to the Yampa River spawning area in less than 2 weeks. Spawning typically begins after peak flows have subsided and water temperatures are above 16° Celsius (°C) (60.8° Fahrenheit (°F)). Mature adults deposit eggs over gravel substrate through broadcast spawning and eggs generally hatch within 4 to 6 days (multiple references in Bestgen et al. 2005). River flows then carry emerging larval fish (6.0 to 7.5 mm long (0.2 to 0.3 in.)) downstream 40 to 200 km to nursery backwaters (25 to 125 mi), where they remain for the first year of life (Service 2002b).

Colorado pikeminnow reach lengths of approximately 70 mm by age 1 (juveniles) (2.8 in.), 230 mm by age 3 (subadults) (9 in.), and 420 mm by age 6 (adults) (16.5 in.), with mean annual growth rates of adult and subadult fish slowing as fish become older (Osmundson et al. 1997). The largest fish reach lengths between 900 and 1000 mm (35 to 39 in.); these fish are quite old, likely being 47 to 55 years old with a minimum of 34 years (Osmundson et al. 1997).

Reproductive success and recruitment of Colorado pikeminnow is pulsed, with certain years having highly successful productivity and other years marked by failed or low success (Service 2002b). The most successful years produce a large cohort of individuals that is apparent in the population over time. Once individuals reach adulthood, approximately 80 to 90 percent of adults greater than 500 mm (20 in.) survive each year (Osmundson et al. 1997; Osmundson and White 2009). Strong cohorts, high adult survivorship, and extreme longevity are likely life history strategies that allow the species to survive in highly variable ecological conditions of desert rivers.

Very little information is available on the influence of turbidity on the endangered Colorado River fishes. Osmundson and Kaeding (1989) found that turbidity allows use of relatively shallow habitats ostensibly by providing adults with cover; this allows foraging and resting in areas otherwise exposed to avian or terrestrial predators. Tyus and Haines (1991) found that young pikeminnow in the Green River preferred backwaters that were turbid. Clear conditions in these shallow waters might expose young fish to predation from wading birds or exotic, sight-feeding, piscivorous fish. It is unknown whether the river was as turbid historically as it is today. For now, it is assumed that these endemic fishes evolved under conditions of high turbidity. Therefore, the retention of these highly turbid conditions is probably an important factor in maintaining the ability of these fish to compete with nonnatives that may not have evolved under similar conditions.

2.1.3 Population Dynamics

The Colorado pikeminnow is endemic to the Colorado River Basin, where it was once widespread and abundant in warm-water rivers and tributaries. Wild populations of Colorado pikeminnow are found only in the Upper Basin of the Colorado River (above Lake Powell). Three wild populations of Colorado pikeminnow are found in about 1,090 miles of riverine habitat in the Green River, Upper Colorado River, and San Juan River subbasins (Service 2011a).

We measure population dynamics of Colorado pikeminnow separately in the Green, Upper Colorado, and San Juan River Basins because distinct recovery criteria are delineated for each of these three basins. In the 2002 recovery goals, preliminary abundance estimates for wild adults in the basins were: Upper Colorado River, 600 to 900; Green River, 6,000 to 8,000; and San Juan River, 19 to 50 (Service 2002b).

UPPER COLORADO RIVER

To monitor recovery of the Colorado pikeminnow, the Recovery Program conducts multiple-pass, capture-recapture sampling on two stretches of the Upper Colorado River which are roughly above and below Westwater Canyon (Osmundson and White 2009). In their most recent summary of those data (Osmundson and White 2017), the principal investigators conclude that though the population remained self-sustaining during the 23-year study period [1991-2013], low abundance and a recent rapid decline suggest long-term population persistence is tenuous.

The current downlisting demographic criteria for Colorado pikeminnow (USFWS 2002b) in the Upper Colorado River subbasin is a self-sustaining population of at least 700 adults maintained over a 5-year period, with a trend in adult point estimates that does not decline significantly. Secondarily, recruitment of age-6 (400–449 mm TL), naturally produced fish must equal or exceed mean adult annual mortality (estimated to be about 20 percent). The average of all adult estimates (1992 – 2010) is 644. The average of the five most recent annual adult population estimates is 658. Osmundson and White (2014) determined that recruitment rates were less than annual adult mortality in six years and exceeded adult mortality in the other six years when sampling occurred. The estimated net gain for the 12 years studied was 32 fish $\geq$ 450 mm TL. Whereas the Colorado River population may meet the trend or ‘self-sustainability’ criterion, it has not met the abundance criteria of ‘at least 700 adults’ during the most recent five year period. Updated graphs of Colorado pikeminnow abundance in the Colorado River are shown in Figure 1 (adults) and Figure 2 (subadults) (Service 2016a).

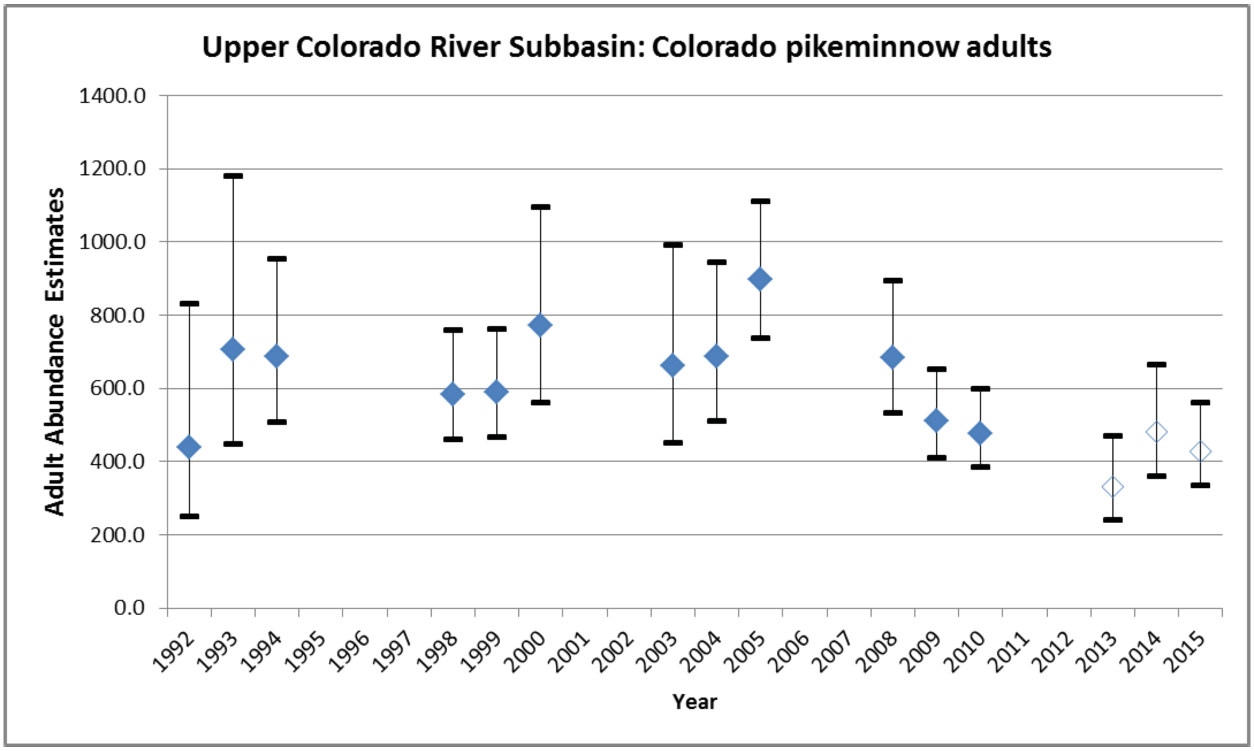

Figure 1. Adult Colorado pikeminnow population abundance estimates for the Colorado River (Osmundson and Burnham 1998; Osmundson and White 2009; 2014). Error bars represent the 95 percent confidence intervals. The 2013-2015 data are preliminary and represented by hollow data points (Service 2016a).

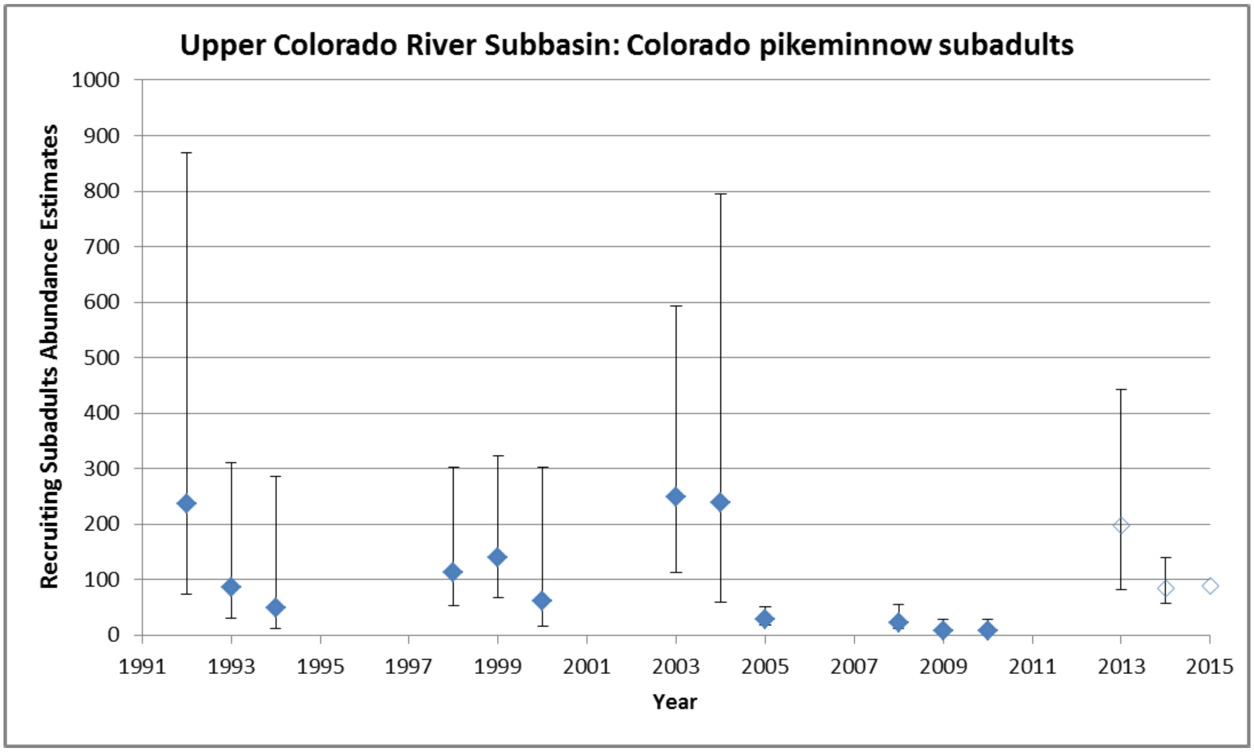

Figure 2. Colorado pikeminnow recruitment abundance estimates (calculated using the same mark recapture methodology as for the adults) for the Colorado River (Osmundson and White 2009, 2014; Service 2016a). Recruits are age-6 (400-449mm TL). Error bars represent the 95 percent confidence intervals. The 2013-2015 data are preliminary and represented by hollow data points (Service 2016a).

To summarize, in the Upper Colorado River subbasin, the Colorado pikeminnow subpopulation may be self-sustaining, but the number of adults is below the level needed for recovery. Recruitment is quite variable over time, but has exceeded adult mortality in approximately half of the years when measured over the past two decades. The number of age-0 (young of year) Colorado pikeminnow is also quite variable over time, but appears to be less, on average, since the year 2000 than prior to 2000 (Figure 5). Colorado pikeminnow are also generally distributed throughout the Colorado River now to the same extent that they were when they became listed.

GREEN RIVER

Population estimates for adult Colorado pikeminnow in the Green River subbasin began in 2000. Sampling occurs on the mainstem Green River from the Yampa confluence to the confluence with the Colorado River and in the Yampa and White rivers. The initial year of sampling did not include the lower Green River (from near the confluence of the White River to the confluence with the Colorado River). Beginning in 2001, the sampling regime has consisted of three years of estimates followed by two years of no estimates. In support of an ongoing Population Viability Analysis, Dr. Kevin Bestgen (Colorado State University) correlated the much more robust Mark/Recapture (M/R) population estimates of recent years with Catch per Unit Effort (CPUE: number of adults collected per hour of electrofishing) metrics. This correlation analysis allowed researchers to extend trend analyses back to 1991 (Figure 3) (Service 2016a). This retrospective and more expansive view of population trend indicates that the Recovery Program initiated M/R population estimates at a high point in historical abundance.

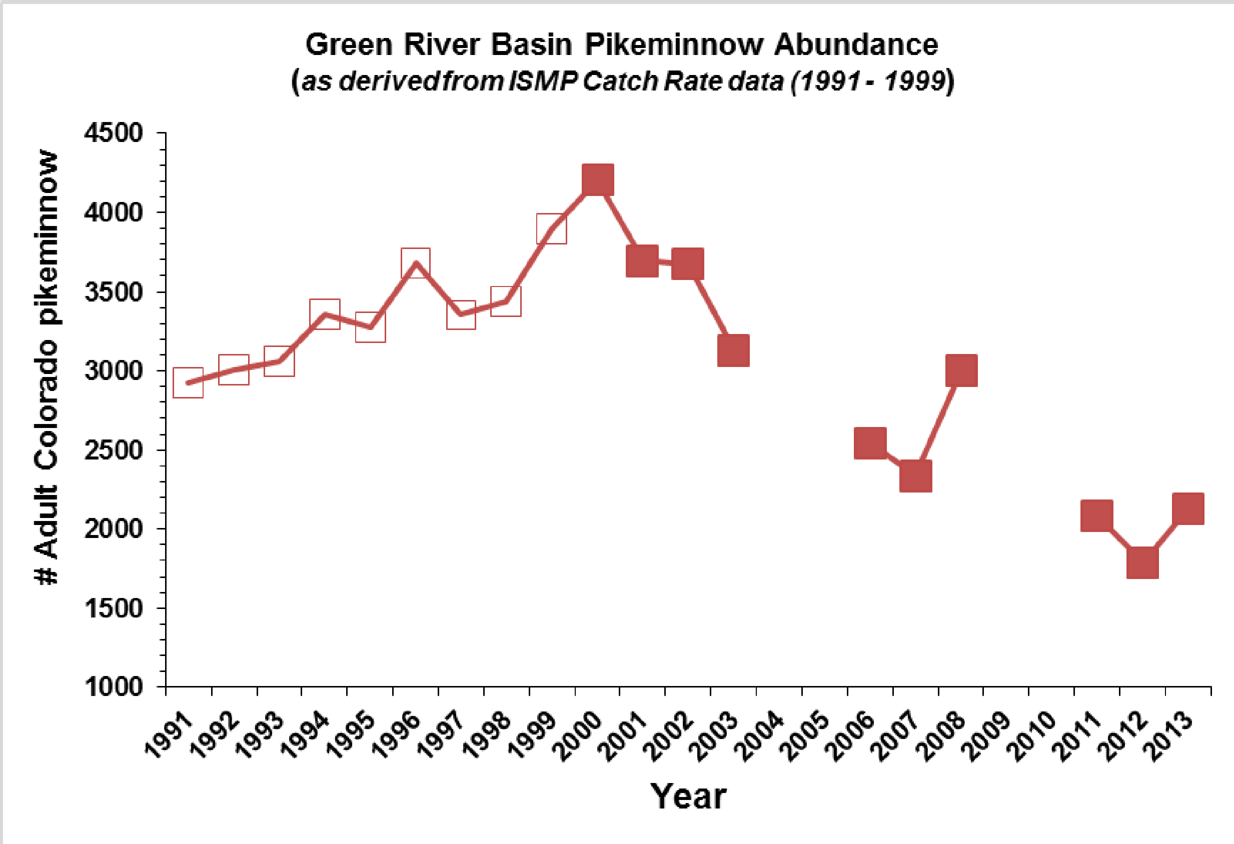

Figure 3. Adult Colorado pikeminnow population abundance estimates for the Green River Basin (1991–2013). Estimates from 2000–2013 are based on Mark/Recapture data analysis as reported in Bestgen et al. 2016 (in review). Pre-2000 data (open markers) were derived (via correlation analysis (Service 2016a).

The downlisting demographic criteria for Colorado pikeminnow in the Green River subbasin require that separate adult point estimates for the middle Green River and lower Green River do not show a statistically significant decline over a 5-year period, and each estimate for the Green River subbasin exceeds 2,600 adults (estimated minimum viable population [MVP] number) (Service 2002b). The average of the first two sets of adult estimates was 3,020 (between 2000 – 2008). The estimates for 2011-2013 are below 2,600 adults in each year.

Another demographic requirement in the 2002 Recovery Goals is that recruitment of age-6; naturally-produced fish must equal or exceed mean annual adult mortality. Estimates of recruitment age fish (subadults; 400–449mm TL) have averaged 1,455 since 2001, but have varied widely (Figure 4). Recruitment exceeded annual adult mortality only during the 2006–2008 periods. The numbers of recruits throughout the Green River subbasin were high in 2011, but declined in subsequent years.

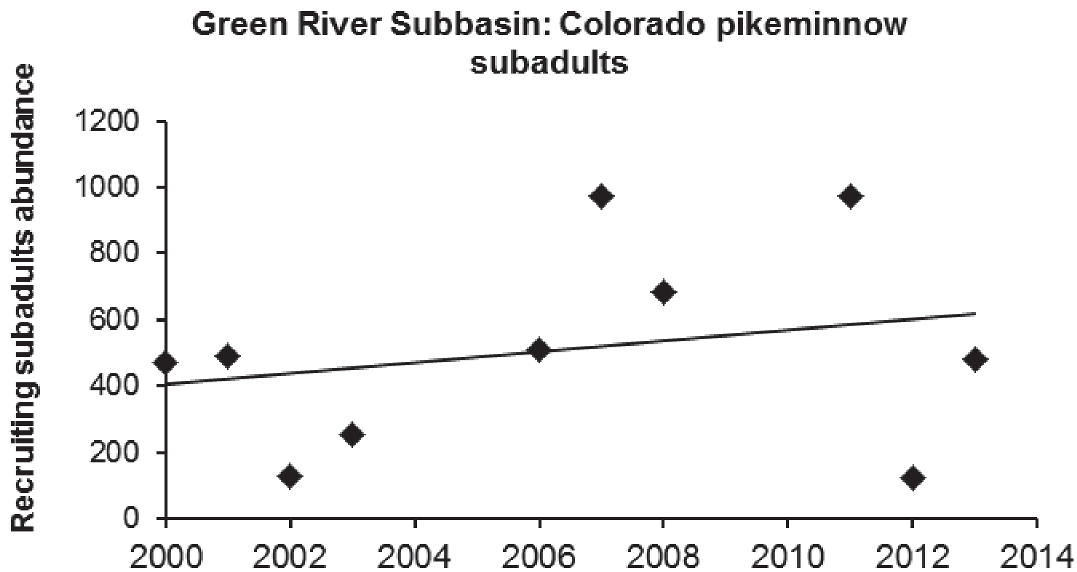

Figure 4. Estimated numbers of Colorado pikeminnow recruits (400–449 mm TL) in the Green River subbasin (Yampa, White, Middle Green, Desolation-Gray Canyons, and Lower Green) for 2001–2013 (Service 2016a).

Bestgen et al. (2010) recognized that the mechanism driving frequency and strength of recruitment events was likely the strength of age-0 Colorado pikeminnow production in backwater nursery habitats. Osmundson and White (2014) saw a similar relationship between a strong age-0 cohort in 1986 and subsequent recruitment of late juveniles five years later, but that relationship was more tenuous in later years. Researchers are particularly concerned with what appears to be very weak age-0 representation in the Middle Green reach (1999 thru 2008) and in the lower Colorado River (2001 thru 2008) (Figure 5). Bestgen and Hill (2016) reviewed fall densities of age-0 Colorado pikeminnow collected in the middle and lower Green River that date back to 1979. They compared those densities to August and September base flows and discovered that declines in summer base flow magnitude were correlated with declining densities of age-0 Colorado pikeminnow in both reaches. As a result, they recommended new base flow magnitudes to support increased age-0 production. Specifically, base flows between 1,700 and 3,000 cubic feet per second (cfs) in the middle Green River, and 1,700–3,800 cfs in the lower Green River, increase the frequency and magnitude of age-0 Colorado pikeminnow production (Service 2016a).

The Recovery Program and Reclamation have coordinated experimental higher summer base flow releases from Flaming Gorge in recent years based on the recommendations from Bestgen and Hill (2016). Base flow levels fell within these ranges for both reaches in 2015 and a significant increase in fall recruitment was observed, underscoring the value of manipulating Flaming Gorge Dam releases as a main recovery action to benefit Colorado pikeminnow recruitment in the Green River.

A preliminary analysis of age-0 densities and summer base flows on the lower Colorado River has revealed a similar relationship. Record high densities of age-0 pikeminnow were recorded from the lower Colorado River in 2015 (see Figure 5) when August–September base flows fell within a preferable range.

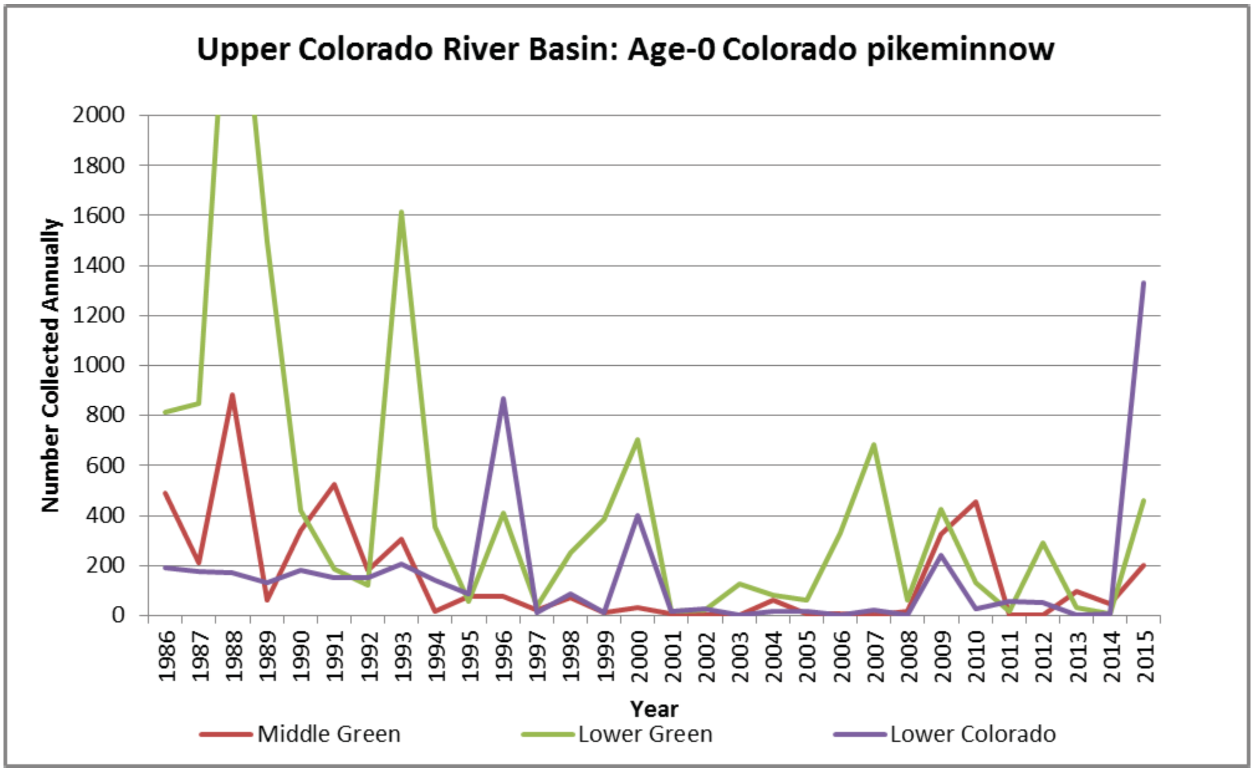

Figure 5. Numbers of age-0 Colorado pikeminnow collected each year from three different habitat reaches of river. A total of 2,892 Age-0 were collected in the lower Green River in 1988 (Service 2016a).

To summarize, in the Green River subbasin, the Colorado pikeminnow subpopulation appears to have declined somewhat and the number of adults is below the level needed for recovery. Recruitment is quite variable over time, and has not exceeded adult mortality in all years when measured over the past two decades. The number of age-0 Colorado pikeminnow is also quite variable over time, but fewer have been captured in the Green River, on average, since the year 2000 than prior to 2000 (Figure 5); in the Colorado River, age-0 year classes have been variable but showing a declining trend until 2015 when a strong age-0 year class was collected. Colorado pikeminnow are generally distributed throughout the Green River subbasin now nearly to the same extent that they were when they became listed, although their numbers have dwindled in the Yampa River and the reach in the White River above the Taylor Draw Dam is no longer occupied.

SAN JUAN RIVER

Unlike the Green and Upper Colorado River Basins, wild Colorado pikeminnow are extremely rare in the San Juan River. Between 1991 and 1995, 19 (17 adult and 2 juvenile) wild Colorado pikeminnow were collected in the San Juan River by electrofishing between RM 142 (the former Cudei Diversion) and Four Corners at RM 119 (Ryden 2000; Ryden and Ahlm 1996). The multi-threaded channel, habitat complexity, and mixture of substrate types in this area of the river appear to provide a diversity of habitats favorable to Colorado pikeminnow on a year-round basis (Holden and Masslich 1997). Estimates made during the seven-year research period between 1991 and 1997 suggested that there were fewer than 50 adult Colorado pikeminnow in a given year (Ryden 2000).

Monitoring for adult Colorado pikeminnow currently occurs every year on the San Juan River. In 2013, 149 Colorado pikeminnow were collected during monitoring from RM 180-77, the eighth consecutive year that more than 100 Colorado pikeminnow were caught in this reach (Schleicher 2014). However, only 7 of these fish were greater than 450 mm (18 in). In addition, 19 Colorado pikeminnow greater than 450 mm (18 in) were collected during the non-native fish removal trips in 2013 (Duran et al. 2014). In order to down-list the species, the San Juan River population of Colorado pikeminnow must reach at least 1,000 Age-5 fish (Service 2002).

The majority of individuals come from hatchery reared stocks supported by the San Juan River Recovery Implementation Program. This program has stocked more than 2 million age 0 and age 1+ fish in the San Juan River since 2002 (Furr and Davis 2009). River wide population estimates for age-2+ pikeminnow that have been in the San Juan River at least one year was approximately 4,600 and 5,400 individuals in 2009 and 2010, respectively (Duran et al. 2010; 2013). However, because few adult Colorado pikeminnow were detected in the San Juan River, this population estimate largely consists of juveniles. Other Colorado pikeminnow abundance estimates exhibit substantial annual variation, likely due to the effects of short-term retention from recent stocking events, but no clear population trends were evident in the San Juan River Basin (Durst 2014).

Successful Colorado pikeminnow reproduction was documented in the San Juan River in 1993, 1995, 1996, 2001, 2004, 2007, 2009-2011, and 2013. A total of 58 larval Colorado pikeminnow were collected since 1993 (Farrington and Brandenburg 2014); however, there has been little to no recruitment documented in the San Juan River. A total of 48 Age-1+ Colorado pikeminnow were collected in 2013; all presumably the result of augmentation efforts (Farrington and Brandenburg 2014). Since 1998, Colorado pikeminnow were collected during small-bodied monitoring every year except 2001-2003; however, young of year (YOY) Colorado pikeminnow were stocked in each of these years prior to monitoring efforts so these fish were likely hatchery-reared (Service 2015c). Larval Colorado pikeminnow detections occurred throughout the San Juan River from Reach 4 (RM 106-130) downstream to Reach 1 (RM 0-16) (Farrington and Brandenburg 2014, Service 2015c). Franssen et al. (2007) found that maintenance of a natural flow regime favored native fish reproduction and provided prey at the appropriate time for Age-1 Colorado pikeminnow.

Tissue samples from Colorado pikeminnow caught during research conducted under the Recovery Program have been analyzed as part of a basin-wide analysis of endangered fish genetics. The results of that analysis indicate that the San Juan River fish exhibit less genetic variability than the Green River and Colorado River populations, likely due to the small population size, but they were very similar genetically to pikeminnow from the Green, Colorado, and Yampa rivers (Morizot in litt. 1996). These data suggest that the San Juan population is probably not a separate genetic stock (Holden and Masslich 1997; Houston et al. 2010).

To summarize, the Colorado pikeminnow was quite rare in the San Juan River in the 1990s, with an estimate of less than 50 adults. Since 2002, millions of young Colorado pikeminnow have been stocked into the river. Adult fish are still rather uncommon, however, and not nearly at the level yet needed for recovery. Despite low numbers of adults, reproduction is occurring to some extent, but recruitment is low. Most of the Colorado pikeminnow in the San Juan River are stocked juveniles. Through augmentation, Colorado pikeminnow are generally distributed throughout the San Juan River within critical habitat.

2.1.4 Threats

The Colorado pikeminnow was designated as an endangered species prior to enactment of the ESA, and therefore a formal listing package identifying threats was not assembled. Construction and operation of mainstem dams, nonnative fish species, and local eradication of native minnows and suckers in advance of new human-made reservoirs in the early 1960's were recognized as early threats (Service 2002a). According to the 2002 Recovery Goals for the species, the primary threats to Colorado pikeminnow populations are streamflow regulation and habitat modification (including cold-water dam releases, habitat loss, and blockage of migration corridors); competition with and predation by nonnative fish species; and pesticides and pollutants (Service 2002a).

Stream flow regulation, which includes mainstem dams; cause the following adverse effects to the Colorado pikeminnow and its habitat:

- block migration corridors,
- changes in flow patterns, reduced peak flows and increased base flows,
- release cold water, making temperature regimes less than optimal,
- change river habitat into lake habitat, and
- retain sediment that is important for forming and maintaining backwater habitats

In the Upper Basin, 435 miles of Colorado pikeminnow habitat have been lost by reservoir inundation from Flaming Gorge Reservoir on the Green River, Lake Powell on the Colorado River, and Navajo Reservoir on the San Juan River. Cold water releases from these dams have eliminated suitable habitat for native fishes, including Colorado pikeminnow, from river reaches downstream for approximately 45-65 miles below Flaming Gorge Dam, Navajo Dam, and the Aspinall Unit Dams on the Gunnison River (Osmundson 2011). In addition to main stem dams, many dams and water diversion structures occur in and upstream from critical habitat that reduce flows and alter flow patterns, which adversely affect critical habitat. Diversion structures in critical habitat can divert fish into canals and pipes where the fish become permanently lost to the river system. It is unknown how many endangered fish are lost in irrigation systems, but in some years, in some river reaches, the majority of the river flow is diverted into unscreened canals. Peak spring flows in the Green River at Jensen, Utah, have decreased 13–35 percent and base flows have increased 10–140 percent due to regulation by Flaming Gorge Dam (Muth et al. 2000).

Although a good portion of the recovery factor criteria (Service 2002a) are being addressed, nonnative fish species continue to be very problematic. Recovery Goals (Service 2002a, 2002b, 2002c, 2002d) identified predation or competition by nonnative fish species as a primary threat to the continued existence or the reestablishment of self-sustaining populations of Colorado pikeminnow and the other three endangered fishes (Martinez et al. 2014). Predation and competition from nonnative fishes have been clearly implicated in the population reductions or elimination of native fishes in the Colorado River Basin (Dill 1944, Osmundson and Kaeding 1989, Behnke 1980, Joseph et al. 1977, Lanigan and Berry 1979, Minckley and Deacon 1968, Meffe 1985, Propst and Bestgen 1991, Rinne 1991). Data collected by Osmundson and Kaeding (1991) indicated that during low water years nonnative minnows capable of preying on or competing with larval endangered fishes greatly increased in numbers.

The Colorado River Basin is an altered riverscape and the interaction of native and nonnative species with non-adapted and competing life histories has contributed to what may be the largest expansion of nonnative fishes and displacement of native fishes in a North America river basin (Martinez et al. 2014). At least 67 species of nonnative fishes have been introduced into the Colorado River Basin during the last 100 years (Tyus et al. 1982, Carlson and Muth 1989, Minckley and Deacon 1991, Tyus and Saunders 1996). Tyus et al. (1982) reported that 42 nonnative fish species have become established in the Upper Basin, and Minckley (1985) reported that 37 nonnative fish species have become established in the Lower Basin. Many of these species were intentionally introduced as game or forage fishes, whereas others were unintentionally introduced with game species or passively as bait fish. The numerous nonnative species have begun to overshadow the 14 native fish species in the basin.

Nonnative fishes compete with native fishes in several ways and include predation, habitat degradation, competition for resources, hybridization, and disease transmission (Martinez et al. 2014). The capacity of a particular area to support aquatic life is limited by physical habitat conditions and increasing the number of species in an area usually results in smaller populations of most species. The size of each species population is controlled by the ability of each life stage to compete for space and food resources and to avoid predation. Some life stages of nonnative fishes appear to have a greater ability to compete for space and food and to avoid predation in the existing altered habitat than do some life stages of native fishes. Tyus and Saunders (1996) cite numerous examples of both indirect and direct evidence of predation on eggs and larvae by nonnative species. The Recovery Program (Service 2016a) provides an expanded discussion about the worst-of-the-worst nonnative predators (smallmouth bass, northern pike, and walleye) in the Upper Colorado River Basin.

The Service has begun discussions about the potential downlisting of Colorado pikeminnow, but the biggest obstacle may become the existing and future threat of invasive ecological impacts by nonnative aquatic species, particularly predatory sport fishes. The most problematic nonnative fish species in the basin have been identified as northern pike, smallmouth bass, and channel catfish, although other nonnative percid, ictalurid, cyprinid, centrarchid and catastomid species continue to be problematic as well (Martinez et al. 2014). Although the main threat from nonnative predators is being eaten by one, the reverse can also be a problem—Colorado pikeminnow that have preyed on nonnative channel catfish have died from choking on the pectoral spines (McAda 1983, Pimental et al. 1985, Ryden and Smith 2002, Lapahie 2003). Arguably the biggest efforts of the Recovery Program today center on the control of nonnative species. Fish crews from state and Federal agencies now remove nonnative predators from over 600 miles of river annually at a cost of approximately $1.7 million (Service 2017).

Threats from pesticides and pollutants include accidental spills of petroleum products and hazardous materials; discharge of pollutants from uranium mill tailings; and high selenium concentration in the water and food chain (Service 2002a). Accidental spills of hazardous material into occupied habitat can cause immediate mortality when lethal toxicity levels are exceeded. Researchers now speculate that mercury may pose a more significant threat to Colorado pikeminnow populations of the Upper Colorado River Basin than previously recognized (Service 2015b). Osmundson and Lusk (2012) have recently reported elevated mercury concentrations in Colorado pikeminnow muscle tissue; the highest concentrations were from the largest adults collected from the Green and Colorado River subbasins.

To summarize, Colorado pikeminnow habitat loss and degradation from dams and diversions constructed decades ago generated some of the early, primary impacts to the species. Most of the long-term impacts from these structures continue and are unlikely to change significantly in the near term. In the remaining suitable habitats, nonnative fish species pose a significant ongoing threat and challenge to recovery. Contaminants, including mercury and selenium, pose a threat as well, but the magnitude of this threat is in need of further investigation.

2.2 Razorback Sucker

2.2.1 Species description and status

Like all suckers, the razorback sucker has a ventral mouth (Family: Catostomidae, meaning "down mouth"). It is a robust, river catostomid endemic to the Colorado River Basin (Sigler and Sigler 1996; Service 2002b) and is the largest native sucker to the western United States. The species feeds primarily on algae, aquatic insects, and other available aquatic macroinvertebrates using their ventral mouths and fleshy lips (Sigler and Sigler 1996). Adults can be identified by olive to dark brown coloration above, with pink to reddish brown sides and a bony, sharp-edged dorsal keel immediately posterior to the head, which is not present in the young. The species can reach lengths of 3 ft and weights of 16 pounds (7.3 kg), but the maximum weight of recently captured fish is 11 to 13 pounds (5 to 6 kg) (Sigler and Sigler 1996; Service 2002b). Taxonomically, the species is unique, belonging to the monotypic genus Xyrauchen, meaning that razorback sucker is the only species in the genus (Service 2002b). Like Colorado pikeminnow, razorback suckers may live to be greater than 40 years.

Historically, the razorback sucker occupied the mainstem Colorado River and many of its tributaries from northern Mexico through Arizona and Utah into Wyoming, Colorado, and New Mexico (Service 2002b). In the late 19th and early 20th centuries, it was abundant in the Lower Colorado River Basin and common in parts of the Upper Colorado River Basin, with numbers apparently declining with distance upstream (Service 2002b). Bestgen (1990) reported that this species was once so numerous that it was commonly used as food by early settlers and that a commercially marketable quantity was caught in Arizona as recently as 1949. Distribution and abundance of the razorback sucker declined throughout the 20th century across its historic range, and the species now exists naturally only in a few small, unconnected populations or as dispersed individuals. Specifically, razorback sucker are currently found in small numbers in the Green River, Upper Colorado River, and San Juan River Basins; the lower Colorado River between Lake Havasu and Davis Dam; Lakes Mead and Mohave; in small tributaries of the Gila River Basin (Verde River, Salt River, and Fossil Creek); and in local areas under intensive management such as Cibola High Levee Pond, Achii Hanyo Native Fish Facility, and Parker Strip (Service 2002b).

The razorback sucker is listed as endangered under the ESA under a final rule published on October 23, 1991 (56 FR 54957). The Service finalized the latest recovery plan for the species in 2002 (2002b), but is currently drafting an updated revision.

Separate, objective recovery criteria were developed for each of two recovery units (the Upper Colorado and Lower Colorado River Basins as delineated at Glen Canyon Dam) to address unique threats and site specific management actions necessary to minimize or remove those threats.

2.2.2 Life history

Except during periods before and after spawning, adult razorback sucker are thought to be relatively sedentary and have high fidelity to overwintering sites (Service 2002b). Adults become sexually mature at approximately 4 years and lengths of 400 mm (16 in.) (Zelasko et al. 2010), at which time they travel long distances to reach spawning sites (Service 2002b). Mature adults breed in spring (mostly April–June) on the ascending limb of the hydrograph, congregating over cobble/gravel bars, backwaters, and impounded tributary mouths near spawning sites (Service 2002b; Snyder and Muth 2004). Flow and water temperature cues may play an important role prompting razorback adults to aggregate prior to spawning (Muth et al. 2000). Tyus and Karp (1990) and Osmundson and Kaeding (1991) reported off-channel habitats to be much warmer than the mainstem river and that razorback suckers presumably moved to these areas for feeding, resting, sexual maturation, spawning, and other activities associated with their reproductive cycle.

Razorback sucker have high reproductive potential, with reported average female fecundity of approximately 50,000 to 100,000 eggs per fish (Service 2002b). They are broadcast spawners that scatter adhesive eggs over gravel-cobble substrate (Snyder and Muth 2004). High spring flows are important to egg survival because they remove fine sediment that can otherwise suffocate eggs. Hatching is limited at temperatures less than 10°C (50° F) and best around 20°C (68° F) (Snyder and Muth 2004). Eggs hatch 6 to 11 days after being deposited and larval fish occupy the sediment for another 4 to 10 days before emerging into the water column. Larval fish occupy shallow, warm, low-velocity habitats in littoral zones, backwaters, and inundated floodplains and tributary mouths downstream of spawning bars for several weeks before dispersing to deeper water (Service 2002b; Snyder and Muth 2004). It is believed that low survival in early life stages, attributed to loss of nursery habitat and predation by non-native fishes, causes extremely low recruitment in wild populations (Muth et al. 2000). Wydoski and Wick (1998) identified starvation of larval razorback suckers due to low zooplankton densities in the main channel and loss of floodplain habitats which provide adequate zooplankton densities for larval food as one of the most important factors limiting recruitment.

Razorback sucker in the Upper Basin tend to be smaller and grow slower than those in the Lower Basin, reaching 100 millimeters (4 in.) on average in the first year (Service 2002b). Based on collections in the middle Green River, typical adult size centers around 510 mm (20 in.) (Modde et al. 1996). Razorback suckers are long-lived fishes, reaching 40+ years via high annual survival (Service 2002b). Adult survivorship was estimated to be 71 to 73 percent in the Middle Green River from 1980-1992 (Modde et al. 1996; Bestgen et al. 2002) and 76 percent from 1990 to 1999 (Bestgen et al. 2002).

Outside of the spawning season, adult razorback suckers occupy a variety of shoreline and main channel habitats including slow runs, shallow to deep pools, backwaters, eddies, and other relatively slow velocity areas associated with sand substrates (Tyus and Karp 1989, Osmundson and Kaeding 1989, Osmundson and Kaeding 1991, Tyus and Karp 1990). Their diet consists primarily of algae, plant debris, and aquatic insect larvae (Sublette et al. 1990).

2.2.3 Population dynamics

Population estimates in the Upper Colorado River Basin during the 1980 to 1992 period were on average between 300 and 600 wild fish (Modde et al. 1996). By the early 2000s, the wild population consisted of primarily aging adults, with steep decline in numbers caused by extremely low natural recruitment (Service 2002b). Although reproduction was occurring, very few juveniles were found (Service 2002b).

In the early part of the 2000s, population numbers were extremely low. Population estimates from sampling efforts in the middle Green River had declined to approximately 100 by 2002, with researchers hypothesizing that wild fish in the Green River Basin could become extirpated because of lack of recruitment (Bestgen et al. 2002). Similarly, in the Upper Colorado River, razorback sucker were exceedingly rare. In the 2002 recovery plan, razorback sucker were considered extirpated in the Gunnison River, where fish were last captured in 1976 (Service 2002b). Similarly, in the Grand Valley, only 12 fish were collected from 1984 to 1990, despite intensive sampling (Service 2002b). No young razorback suckers were captured in the Upper Colorado River since the mid-1960s (Service 2002b).

Razorback sucker likely occurred in the San Juan River as far upstream as Rosa, New Mexico (now inundated by Navajo Reservoir) (Ryden 1997). In the San Juan River we know of only two wild razorback suckers that were captured in 1976 in a riverside pond near Bluff, Utah, and one fish captured in the river in 1988, also near Bluff (Ryden 2006). No wild razorback suckers were found during the 7-year research period (1991–1997) of the San Juan River Basin Recovery Implementation Program (Ryden 2006).

Because of the low numbers of wild fish, the Recovery Program has been rebuilding razorback sucker populations in the Upper Colorado River Basin with hatchery stocks. Since 1995, over 386,000 subadult razorback suckers have been stocked in the Green and Upper Colorado River Basins. Since 2013, fewer but larger razorback suckers have been stocked to increase survival. Preliminary population estimates have been generated for razorback sucker in the Colorado River Basin as a whole, and now generally exceed 3,000 (Figure 6). In the Green River Basin, estimates of large juvenile to adult razorback sucker in three reaches of the Green River ranged from 474 to over 5,000 within a reach. Although these estimates are highly imprecise, they provide further confirmation that stocked fish are surviving in the wild (Bestgen et al. 2012, Service 2016a).

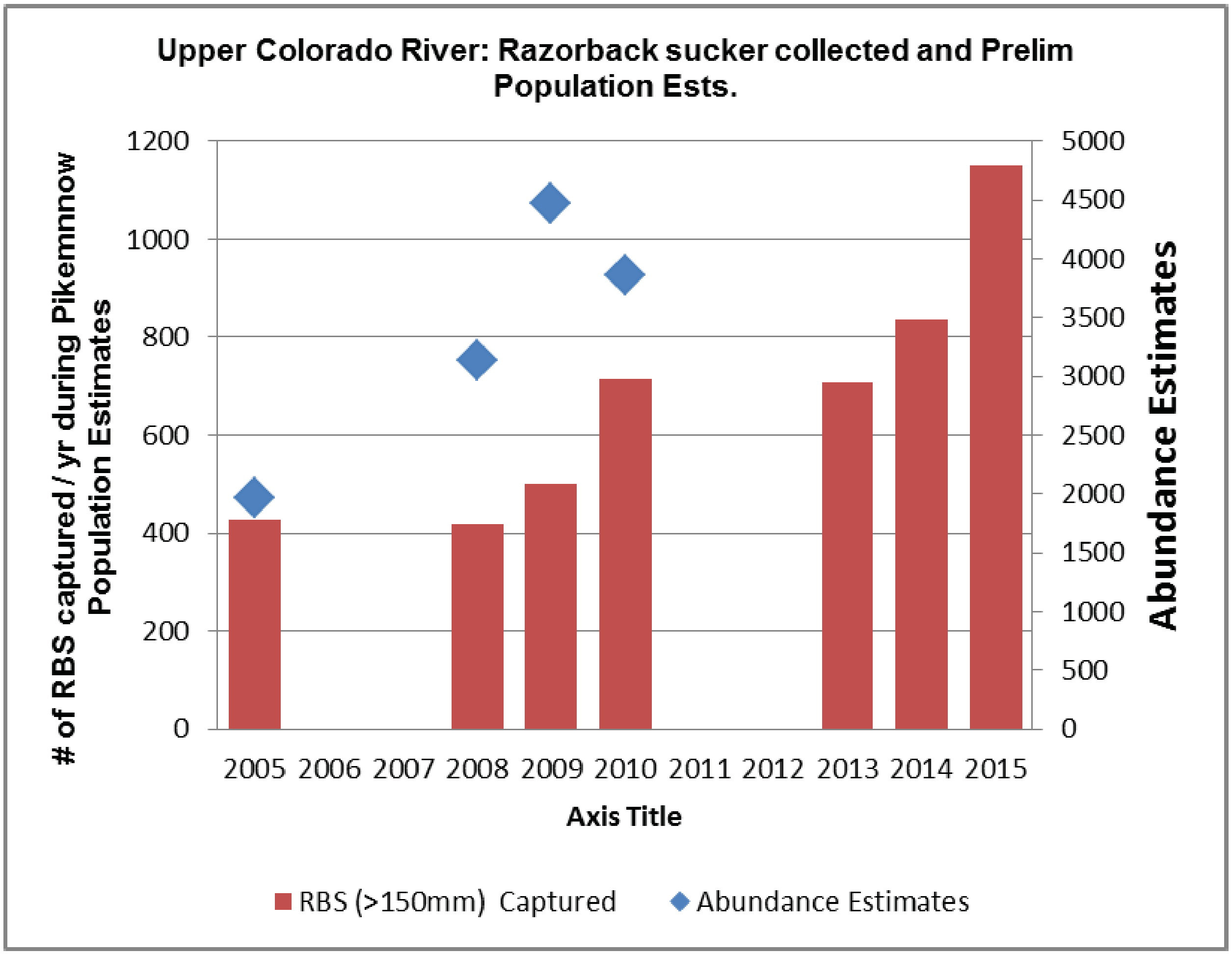

Figure 6. Captures and preliminary population estimates of the razorback sucker (juveniles and adults) in the Colorado River (Palisade, CO to the confluence of the Green River) (Service 2016a).

Razorback suckers stocked in the Green and Colorado Rivers have been recaptured in reproductive condition and often in spawning groups. Larval captures in the Green, Gunnison, and Colorado rivers document reproduction. Collections of larvae by light trap in the middle Green River have been generally increasing since 2003; in 2013, the largest collection of light trapped larvae occurred (7,376; Figure 7, Service 2016a). In 2011, researchers documented spawning by razorback sucker in the White River for the first time (Service 2016a).

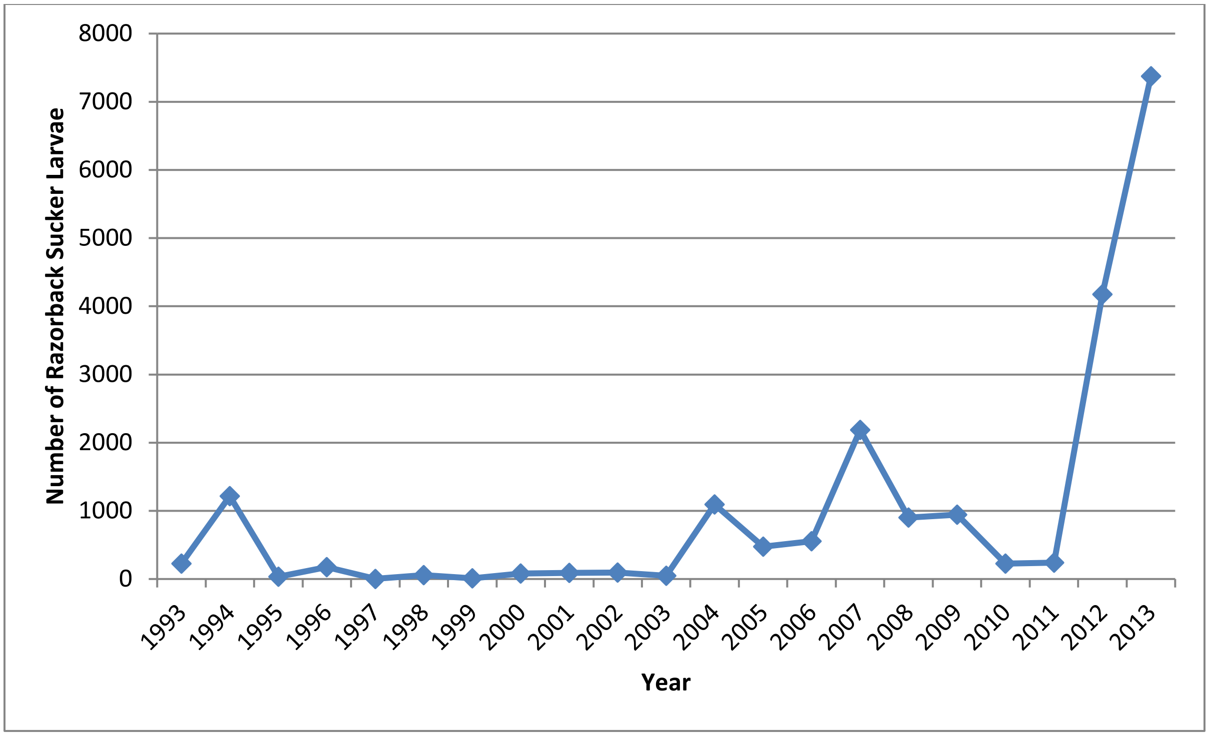

Figure 7. Numbers of razorback sucker larvae collected in light traps in the middle Green River since 1993.

Survival of larvae through their first year remains rare, largely due to a decrease in the availability of warm, food-rich floodplain areas and predation by a suite of nonnatives when the flood plain nursery habitats are available (Bestgen et al. 2011). Currently, perhaps the most productive site for young razorbacks is Stewart Lake at the Ouray National Wildlife Refuge along the Green River. In 2016, after a three-month inundation period at Stewart Lake, over 2,000 age-0 wild-produced razorbacks were captured and released to the Green River (Schelly et al. 2016). Nevertheless, the bottleneck to a self-sustaining wild population of razorback suckers is larval recruitment to juvenile life stages. However, occasional captures of juveniles (ages 0, 1, and 2) in the Green and Colorado rivers are starting to occur and indicate that survival of early life stages is occurring (Service 2017). Unfortunately, no wild-produced recruits have yet been detected anywhere in the Upper Colorado River Basin (Service 2016a, 2017).

In the San Juan River, 130,473 razorback suckers were stocked from 1994 through 2012. The number of endangered fishes stocked in the San Juan River is reported annually (see http://www.fws.gov/southwest/sjrip/). After stocking in the San Juan River began, river wide razorback sucker population estimates of 268 in October 2000 (Ryden 2001) have since grown to 1,200 in October 2004 (Ryden 2005), and to about 2,000 and 3,000 in 2009 and 2010, respectively (Duran et al. 2013). Additional mark-recapture data indicates increasing razorback sucker abundance estimates since 2009 (Durst 2014). However, because there is little to no documented recruitment in the San Juan River, this population increase should be attributed almost entirely to augmentation with hatchery-reared razorback suckers.

Three razorback suckers stocked in the San Juan River near Farmington, NM, for the San Juan Recovery Program were captured between Moab, UT and the state line with Colorado in 2008.

This demonstrates that exchange of stocked razorback sucker between the San Juan River and the Upper Colorado River is certain, and may have ramifications for recovery criteria. Researchers have confirmed that hundreds of razorback suckers are using both transitional inflow areas and fully lacustrine (lake-like) habitats in Lake Powell. Razorback suckers are spawning in the lake and there is now evidence that recruitment may be occurring (Service 2015b). While the role of Lake Powell in the recovery of razorback sucker is unclear, 75 individuals were detected in the San Juan arm of Lake Powell in 2011 (Francis et al. 2013).

In the Lower Colorado River Basin, Lake Mead has supported a relatively small (a few hundred adults) but stable, self-sustaining population of wild razorback sucker for over 20 years, with recruitment occurring every year in that time frame. The Lake Mead population is primarily found in the reservoir but may extend upstream into the lower Grand Canyon; however, cold-water releases from Glen Canyon Dam limit expansion into the upper Grand Canyon (Service 2002b). In 2012 and 2013, razorback suckers have been detected in the lower Grand Canyon; these were the first recorded sightings in Grand Canyon National Park since the 1990s. A population of over 3,000 razorback suckers in Lake Mohave has been created by an augmentation program using fry that were produced naturally in the lake. Razorback suckers are also stocked into Lake Havasu. In 2008, the population there was estimated to be around 1,600 fish (Service 2012a). However, they have not yet become a self-sustaining population with successful recruitment.

To summarize, the razorback sucker was facing extirpation in the Upper Colorado River Basin approximately 20 years ago. To build population numbers in the Green, Colorado, and San Juan River Basins, over a quarter of a million razorbacks have been stocked in these rivers. Stocking continues today and reproduction is occurring and increasing. Recruitment remains the most limiting factor for re-establishing a self-sustaining population in the wild.

2.2.4 Threats

According to the 2002 Recovery Goals for the species, the primary threats to razorback sucker populations are streamflow regulation and habitat modification (including cold-water dam releases, habitat loss, and blockage of migration corridors); competition with and predation by nonnative fish species; and pesticides and pollutants (Service 2002b). No new threats have emerged since the completion of this document. The Service's status review of razorback sucker completed in 2012 (Service 2012b) reported that 85 percent of the downlisting recovery factor criteria (Service 2002b) have been addressed to varying degrees; however, nonnative fish species continue to be problematic. A new species status assessment is currently being conducted for the species.

Recruitment failure is thought to be the primary reason for decline of the species throughout its range (Zelasko et al. 2010). Many researchers believe that nonnative species are a major cause for the lack of recruitment and that nonnative fish are the most important biological threat to the razorback sucker (e.g., McAda and Wydoski 1980, Minckley 1983, 59 FR 54957, Service 2002b, Muth et al. 2000). There are reports of predation of razorback sucker eggs and larvae by common carp, channel catfish, smallmouth bass, largemouth bass, bluegill, green sunfish, and red-ear sunfish (Marsh and Langhorst 1988, Langhorst 1989).

Marsh and Langhorst (1988) found higher growth rates in larval razorback sucker in the absence of predators in Lake Mohave, and Marsh and Brooks (1989) reported that channel catfish and flathead catfish were major predators of stocked razorback sucker in the Gila River. Juvenile razorback sucker (average total length 171 mm) stocked in isolated coves along the Colorado River in California, suffered extensive predation by channel catfish and largemouth bass (Langhorst 1989).

Carpenter and Mueller (2008) tested nine non-native species of fish that co-occur with razorback sucker and found that seven species consumed significant numbers of larval razorback suckers. The seven species consumed an average of 54 – 99 percent of the razorback sucker larvae even though alternative food was available (Carpenter and Mueller 2008). Lentsch et al. (1996) identified six species of nonnative fishes in the Upper Colorado River Basin as threats to razorback sucker: red shiner, common carp, sand shiner, fathead minnow, channel catfish, and green sunfish. Smaller fish, such as adult red shiner, are known predators of larval native fish (Ruppert et al. 1993). Large predators, such as walleye, northern pike (*Esox lucius*), and striped bass, also pose a threat to subadult and adult razorback sucker (Tyus and Beard 1990). Until recently, efforts to introduce young razorback sucker into Lake Mohave have failed because of predation by nonnative species (Minckley et al. 1991, Clarkson et al. 1993, Burke 1994, Marsh et al. 2003).

Overall, the threats to the razorback sucker from nonnative fish are similar to those facing the Colorado pikeminnow, as described above. See the discussion on threats to the Colorado pikeminnow above for further information, particularly regarding the threat to all endangered fish due to predation from nonnative species. One threat from nonnative species peculiar to the razorback sucker is from hybridization. While hybridization between native and endangered razorback sucker may occur in the wild at a low level (Buth et al. 1987), the mass release of any native suckers hybridized with nonnative suckers would threaten gene pools of wild native or endangered suckers. McDonald et al. (2008) revealed that hybridization of native bluehead (Catostomus discobolus) and flannelmouth (Catostomus latipinnis) suckers with the nonnative white sucker (Catostomus commersonii) increased introgression between the native suckers. This mechanism could ultimately pose an increased threat of hybridization for razorback sucker (USFWS 2002b).

Selenium, a trace element, is a natural component of coal and soils in many areas of the western United States and can be released to the environment by the irrigation of selenium-rich soils and the burning of coal in power plants with subsequent emissions to air and deposition to land and surface water. Contributions from anthropogenic sources have increased with the increases of world population, energy demand, and expansion of irrigated agriculture (Mayer et al. 2010). Selenium can enter surface waters through erosion, leaching, and runoff. Excess selenium in fish have been shown to have a wide range of adverse effects including mortality, reproductive impairment, effects on growth, and developmental and teratogenic effects including edema and finfold, craniofacial, and skeletal deformities (Lemly 2002, Hamilton et al. 2004; Holm et al 2005). Excess dietary selenium causes elevated selenium concentrations to be deposited into developing eggs, particularly the yolk (Buhl and Hamilton 2000, Lemly 2002, Janz 2010). If concentrations in the egg are sufficiently high, developing proteins and enzymes become dysfunctional, leading to embryo deformation and a higher risk of mortality. Embryos that do survive, hatch, and grow may experience an elevated risk of predation as small fish; thus selenium may be a contributing factor to the serious lack of recruitment seen throughout the range of the razorback sucker. Of all the endangered fish in the Colorado River system, concern regarding elevated selenium levels is greatest for the razorback sucker (Hamilton et al. 2002; Osmundson et al. 2010).

Hamilton (1999) hypothesized that historic selenium contamination of the Upper and Lower Colorado River Basins contributed to the decline of these endangered fish by affecting their overall reproductive success, including loss of eggs and larvae. Selenium concentrations in whole-body fish in the Colorado River Basin have been among the highest in the nation (Hamilton 1999). Several DOI National Irrigation Water Quality Program (NIWQP) studies in the Colorado River Basin have reported elevated levels of selenium in water, sediment, and biota, including fish (Hamilton 1999). In the NIWQP studies of 25 areas in the 15 western states, the middle Green River ranked 3rd for the highest median water concentration of selenium, 1st for sediment, and 1st for fish, and 14th for birds. The Gunnison River Basin/Grand Valley ranked 4th for the highest median water concentration of selenium, 2nd for sediment, 7th for fish, and 1st for birds (Engberg, 1998, as seen in Hamilton 1999). While selenium has been more the focus of contaminants research involving the razorback sucker, mercury, which can pose a threat to any animal species, could also pose a threat at elevated concentrations. Because the razorback sucker is not a top predator, as is the Colorado pikeminnow, we expect mercury bioaccumulation (through prey) to pose less of a problem for this species.

To summarize, razorback sucker habitat loss and degradation from dams and diversions constructed decades ago posed some of the early, primary impacts to the species. Most of the long-term impacts from these structures continue and are unlikely to change significantly in the near term. In the remaining suitable habitats, nonnative fish species pose a significant ongoing threat and challenge to recovery. Contaminants, including mercury and selenium, pose a threat as well, but the magnitude of this threat is in need of further investigation.

2.3 Humpback Chub

2.3.1 Species description and status

The humpback chub is a medium-sized freshwater fish of the minnow family endemic to warm-water portions of the Colorado River basin. The species evolved around 3 to 5 million years ago (Sigler and Sigler 1996). The pronounced hump behind its head gives the humpback chub a striking, unusual appearance. It has an olive-colored back, silver sides, a white belly, small eyes, and a long snout that overhangs its jaw (Sigler and Sigler 1996). This fish can grow to nearly 500 mm (20 in.) and may survive more than 30 years in the wild (Service 2002c). The humpback chub does not have the swimming speed or strength of species such as the Colorado pikeminnow. Instead, it uses its large fins to "glide" through slow-moving areas, feeding on insects.

Historic distribution is surmised from various reports and collections that indicate the species inhabited canyons of the Colorado River and four of its tributaries: the Green, Yampa, White, and Little Colorado Rivers. Presently the species occupies about 68 percent of its historic habitat. Historic to current abundance trends are unclear because historic abundance is unknown (Service 2002c).

The Office of Endangered Species first included the humpback chub in the List of Endangered Species on March 11, 1967 (32 FR 4001). Subsequently, it was considered endangered under provisions of the Endangered Species Conservation Act of 1969 (16 U.S.C. 668aa) and was included in the United States List of Endangered Native Fish and Wildlife issued on June 4, 1973 (38 FR No. 106). It is currently protected under the Endangered Species Act of 1973 as an endangered species throughout its range (ESA; 16 U.S.C. 1531 *et. seq.*). The Service finalized the latest recovery plan for the species in 2002 (Service 2002c), but is currently drafting an updated revision. A new Species Status Assessment has also been drafted and is scheduled for completion in 2018 (Service 2017).

Separate, objective recovery criteria were developed for each of two recovery units (the Upper Colorado and Lower Colorado River Basins as delineated at Glen Canyon Dam) to address unique threats and site-specific management actions necessary to minimize or remove those threats.

2.3.2 Life History

The Humpback Chub has a variable diet, such that individuals consume a large array of food items under different river conditions. The species' life cycle is described as seven life stages including spawning, eggs, larvae, age-0, juveniles, sub-adults, and adults. During each life stage, the species requires certain resource conditions to successfully move to the next stage. The following eight resource categories are considered the most important for species success: 1. Diverse rocky canyon river habitat for spawning, nursery, feeding, and shelter, 2. Suitable river flow and temperature regimes for spawning, egg incubation, larval development, and growth, 3. Adequate and reliable food supply, including aquatic and terrestrial insects, crustaceans, and plant material, 4. Habitat with few nonnative predators and competitors that allow the young to survive and recruit to maintain self-sustaining populations, 5. Suitable water quality with few contaminants and little risk of spills of petroleum products and other toxic materials, 6. Unimpeded range and connectivity that allow free movement and access to habitats necessary for all life stages, 7. Persistent populations, each with reproductive potential, recruitment, and adult survival, to ensure redundancy, and 8. High genetic diversity within and across populations to maintain and ensure adaptive traits.

Unlike Colorado pikeminnow and razorback sucker, which are known to make extended migrations of up to several hundred miles to spawning areas, humpback chubs do not appear to make extensive migrations. Instead, humpback chub live and complete their entire life cycle in canyon-bound reaches of the Colorado River mainstem and larger tributaries characterized by deep water, swift currents, and rocky substrates (Service 2002c). Individuals show high fidelity for canyon reaches and move very little.

Like other large desert river fishes, the humpback chub is an obligate warm-water species that requires relatively warm temperatures for spawning, egg incubation, and survival of larvae. Mature humpback chub typically spawn on the descending hydrograph between March and July in the Upper Basin (Karp and Tyus 1990). Humpback chub are broadcast spawners who may mature as young as 2 to 3 years old. Eggs incubate for three days before swimming up as larval fish (Service 2002c). Egg and larvae survival are highest at temperatures close to 19 to 22°C (Service 2002c). Unlike larvae of other Colorado River fishes (e.g., Colorado pikeminnow and razorback sucker), larval humpback chub show no evidence of long-distance drift (Robinson et al.1998).

Recruitment appears to be successful in all known Upper Basin populations (Service 2002c). Survival of humpback chub during the first year of life is low, but increases through the first 2 to 3 years of life with decreased susceptibility to predation, starvation, and environmental changes. Survival from larvae to adult life stages was estimated at 0.1 percent (0.001) (Service 2002c). Survival of adults is high, with estimates approximating 75 percent based on Grand Canyon adults (Service 2002c).

Growth rates of humpback chub vary by populations, with fish in the Upper Basin growing slower than those in the Grand Canyon (Service 2002c). Individuals in Cataract Canyon were 50, 100, 144, 200, 251, and 355 mm total length from 1 to 6 years, respectively (Service 2002c). Based on sexual maturity and age-to-length ratios, adults are classified as those fish 200 mm or longer. Maximum life span is estimated to be 30 years in the wild.

Humpback chub move substantially less than other native Colorado River fishes, with studies consistently showing high fidelity by humpback chub for specific riverine locales occupied by respective populations. Despite remarkable fidelity for given river regions, individual humpback chub adults are known to move between populations. Movement by juveniles is not as well documented as for adults, but is also believed to be limited in distance. For example, no out-migration by young fish is seen from population centers such as Black Rocks and Westwater Canyon.

2.3.3 Population dynamics

The species is currently found as five extant populations, including four upstream of Lake Powell (Black Rocks, Westwater Canyon, Desolation/Gray canyons, and Cataract Canyon) and one downstream of Lake Powell (Grand Canyon). A sixth population in Dinosaur National Monument is considered functionally extirpated because individuals have not been collected since the early 2000s (Service 2017). The Little Colorado River population, found in the Grand Canyon, is the largest known population, harboring up to 10,000 fish (Service 2002c).

Recovery goal downlisting demographic criteria (USFWS 2002c) for humpback chub require each of five populations in the upper Colorado River basin to be self-sustaining over a 5-year period, with a trend in adult point estimates that does not decline significantly. Secondarily, recruitment of age-3 (150–199 mm TL) naturally produced fish must equal or exceed mean adult annual mortality. In addition, one of the five populations (e.g., Black Rocks/Westwater Canyon or Desolation/Gray Canyons) must be maintained as a core population such that each estimate exceeds 2,100 adults (estimated minimum viable population number).

Population estimates for the Upper Basin are shown in Figure 8. In a report on 2006–2007 estimates, researchers (Badame 2012) indicated that this population was trending downward. Badame (2012) linked declining catch of humpback chub in the upper portions of Desolation Canyon in the 2006–2007 estimates with increasing densities of nonnative smallmouth bass.

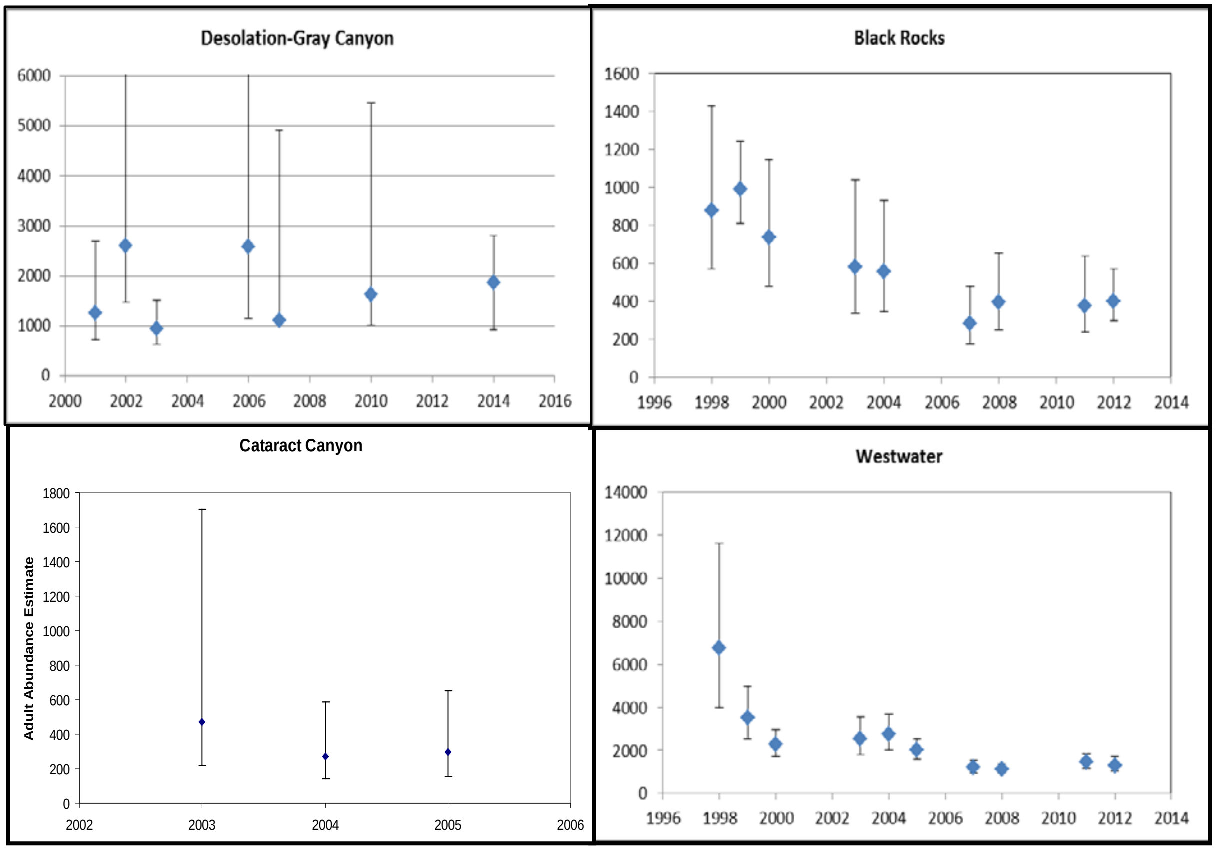

Figure 8. Adult humpback chub population estimates with confidence intervals for four populations in the upper Colorado River Basin (note that the scale differs among the graphs for the different populations). Clockwise from upper left: Desolation-Gray Canyons (from Badame 2011, 2012; Service 2015b); Black Rocks (from Francis and McAda 2011); Westwater Canyon (from Elverud 2011); and Cataract Canyon (from Badame 2008).

On the Colorado River in the Upper Colorado River Basin, three humpback chub populations are recognized. Black Rocks and Westwater Canyon have enough exchange of individuals that they are considered a single core population. Researchers caution that 78 largemouth bass and the same number of gizzard shad were collected in Black Rocks in 2012. This represents a ten-fold increase over the 2011 catch. However, the large declines in humpback chub densities in both Black Rocks and Westwater Canyons occurred in the late 1990's and are not attributed to more recent increases of nonnative predators in the Colorado River.

In 2008, the core population (Black Rocks/Westwater combined) dropped below the population size downlist criterion (MVP = 2,100 adults) for the first time (Figure 9). Population estimates in both Black Rocks and Westwater canyons declined dramatically during the first population estimation rotation in the late 1990s, but have remained relatively stable since that time. Colorado State University's recent robust population estimate analysis more clearly indicated that declines in the Westwater and Black Rock humpback chub populations are due to lapses in recruitment (i.e. adult survival rates have remained stable). Principle investigators agree that reinitiating an age-0 monitoring component is advisable. It should be noted that whatever is affecting humpback chub recruitment has not affected sympatric populations of native roundtail chub; roundtail chub populations in both canyons have remained stable or have increased since population estimation started. In addition to the potential and recent negative interactions between humpback chub and nonnative predators discussed above, both the Westwater and Black Rocks populations are at risk of potential chemical contamination due to the proximity of a railroad located on the right bank of the Colorado River which at times transports toxic substances.

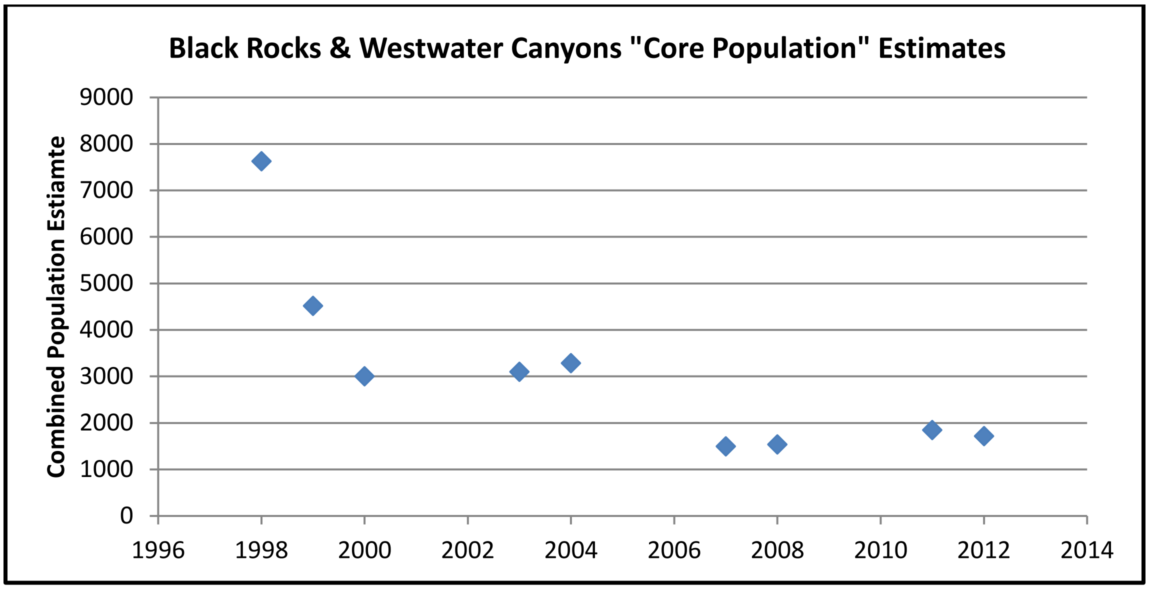

Figure 9. Combined population estimates for humpback chub in Black Rocks and Westwater Canyon based on a robust open model created by Drs.' Bestgen and White, Colorado State University. The 2002 Recovery Goal downlist criteria for these combined ("core population") estimates is 2,100 adults.

The Cataract Canyon humpback chub population is small, with estimates ranging in the hundreds of adults rather than thousands (Figure 8). The population trajectory is unclear and estimates are difficult to obtain in Cataract; therefore, catch-per-unit-effort (CPUE) has been determined to be an effective replacement (began in 2008 on a 2-years-on, 2-years-off sampling regime). In 2011, UDWR reported that the Cataract population appears to be stable with CPUE ranging between 0.010 and 0.035 fish/net-hour. The population is deemed likely to persist simply based on the consistent catch of adult and young life stages. Despite additional effort to sample below Big Drop Rapid in more recent years, no additional humpback chub were encountered in the new riverine habitat created by low Lake Powell levels.

2.3.4 Threats

The humpback chub was designated as an endangered species prior to enactment of the ESA, and therefore a formal listing package identifying threats was not assembled. Construction and operation of mainstem dams, nonnative fish species, and local eradication of native minnows and suckers in advance of new human-made reservoirs in the early 1960's were recognized as early threats (Service 2002c). According to the 2002 Recovery Goals for the species, the primary threats to humpback chub are streamflow regulation, habitat modification, predation by non-native fish species, parasitism, hybridization with other native *Gila* species, and pesticides and pollutants (Service 2002c). Two of eight originally documented populations of humpback chub were extirpated because of the construction of Flaming Gorge (Hideout Canyon) and Hoover dams (Black Canyon).

No new threats have emerged since the completion of the Recovery Goals. The Service's status review of humpback chub completed in 2011 (Service 2011b) reported that 60 percent of the recovery factor criteria (Service 2002c) have been addressed to varying degrees; however, nonnative fish species and issues dealing with the potential chemical contamination of the river from spills and pipelines continue to be problematic. Overall, the threats to the humpback chub from nonnative fish are similar to those facing the Colorado pikeminnow, as described above. See the discussion on threats to the Colorado pikeminnow above for further information, particularly regarding the threat to all endangered fish due to predation from nonnative species.

To summarize, humpback chub habitat loss and degradation from dams and diversions constructed decades ago posed some of the early, primary impacts to the species. Most of the long-term impacts from these structures continue and are unlikely to change significantly in the near term. In the remaining suitable habitats, nonnative fish species pose a significant ongoing threat and challenge to recovery. Contaminants, including mercury and selenium, may pose a lesser threat as well, but the magnitude of this threat is in need of further investigation.

2.4 Bonytail

2.4.1 Species description and status

The bonytail is a medium-sized freshwater fish in the minnow family, endemic to the Colorado River Basin. The species evolved around 3 to 5 million years ago (Sigler and Sigler 1996). Individuals have large fins and a streamlined body that typically is very thin in front of the tail. They have a gray or olive colored back, silver sides, and a white belly (Sigler and Sigler 1996). The mouth is slightly overhung by the snout and there is a smooth low hump behind the head that is not as pronounced as the hump on a humpback chub. A very close relative to the roundtail chub (*Gila robusta*), bonytail can be distinguished by counting the number of rays in the fins, with bonytail having 10 dorsal and anal fin rays (Sigler and Sigler 1996). The fish can grow to be 600 mm (24 in.) and are thought to live as long as 20 to 50 years (Sigler and Sigler 1996). Little is known about the specific food and habitat of the bonytail because the species was extirpated from most of its historic range prior to extensive fishery surveys, but it is considered adapted to mainstem rivers, residing in pools and eddies, while eating terrestrial and aquatic insects (Service 2002d).

The bonytail is currently listed as endangered under the ESA, under a final rule published on April 23, 1980 (45 FR 27710). The Service finalized the latest recovery plan for the species in 2002 (U.S. Fish and Wildlife Service 2002d), but is currently drafting an updated revision. Separate, objective recovery criteria were developed for each of two recovery units (the Upper

Colorado and Lower Colorado River Basins as delineated at Glen Canyon Dam) to address unique threats and site specific management actions necessary to minimize or remove those threats.

2.4.2 Life history

Natural reproduction of bonytail was last documented in the Green River in 1959, 1960, and 1961 at water temperatures of 18°C (Service 2002d). Similar to other closely related *Gila* species, bonytail in rivers probably spawn in spring over rocky substrates; spawning in reservoirs has been observed over rocky shoals and shorelines. While age at sexually maturity is unknown, they are capable of spawning at 5 to 7 years old. Recruitment and survival estimates are currently unknown because populations are not large enough for research to occur. Individuals in Lake Mohave have reached 40 to 50 years of age (Service 2002d), but estimates for river inhabiting fish are not available.

Fish researchers have speculated that the large fins and streamlined body of the Bonytail is an adaptation to torrential flows (Miller 1946; Beckman 1963). Of five wild specimens captured in the Upper Basin, four were captured in deep, swift, rocky canyon regions (i.e., Yampa Canyon, Black Rocks, Cataract Canyon, and Coal Creek Rapid), but the fifth was taken in a reservoir (Lake Powell). Vanicek (1967) who handled numerous Bonytail detected no difference in habitat selection from roundtail chub. These fish were generally found in pools and eddies at varying depths, sometimes adjacent to strong current. Adult Bonytail captured in Cataract Canyon and Desolation/Gray Canyons were sympatric with humpback chub in shoreline eddies among emergent boulders and cobble, and adjacent to swift current (Valdez 1990).

2.4.3 Population dynamics

Bonytail were once widespread in the large rivers of the Colorado River Basin (Service 2002a). The species experienced a dramatic, but poorly documented, decline starting in about 1950, following construction of mainstem dams, introduction of nonnative fishes, poor land-use practices, and degraded water quality (Service 2002d). Population trajectory over the past century and reasons for decline are unclear because lack of basin-wide fishery investigations precluded accurate distribution and abundance records.

Wild bonytail are now rarely found in the Green and Upper Colorado River Basins and are the rarest of all the endangered fish species in the Colorado River Basin. In fact, no wild, self-sustaining populations are known to exist upstream of Lake Powell. From 1977 to 1994 only 11 wild adults were reported from the Upper Basin (Valdez et al. 1994). Prior to the more recent stocking program, these rare bonytail had been captured on the Yampa River in Dinosaur National Monument, on the Green River at Desolation and Gray canyons, and on the Colorado River at the Colorado/Utah border and in Cataract Canyon. In the lower Basin, remnant populations presently occur in the wild in low numbers in Lake Mohave and several fish have been captured in Lake Havasu (and in Lake Powell) (Service 2002d)..

In response to the low abundance of individuals, the Recovery Program has implemented a stocking program to reestablish populations in the Upper Basin. Since 1996, over 380,000 tagged bonytail subadults have been stocked in the Green and Upper Colorado River Basins. To date, most stocked bonytail do not appear to survive very long after release into a given river, with relatively few surviving until the following year. A few recaptured bonytail have lived in-river for several years by now, however. So far, the bonytail stocking program has not been as successful as the razorback sucker stocking program. Researchers continue to experiment with pre-release conditioning and exploring alternative release sites to improve their survival.

Although bonytail have been stocked in the Upper Basin for a number of years now, there has been no evidence of natural reproduction until just recently. For the second consecutive year, hatchery-raised adult bonytail entered Stewart Lake from the Green River (south of Vernal, Utah) and evidently spawned during the inundation period. In 2016, nine specimens of age-0 *Gila* sp., tentatively identified as bonytail, were sampled during draining of the Lake that fall. These were released to the Green River (Schelly et al. 2016). Recruitment of wild bonytail from stocked fish has not yet been documented.

2.4.4 Threats

Reasons for decline of the species were identified as the physical and chemical alteration of their habitat and introduction of exotic fishes. The 1990 Bonytail Chub Recovery Plan further stated that the decline of the bonytail chub is attributed to stream alteration caused by construction of dams, flow depletion from irrigation and other uses, hybridization with other *Gila*, and the introduction of nonnative fish species (Service 1990b). Hence, the primary threats to bonytail populations are streamflow regulation and habitat modification (including cold-water dam releases, habitat loss, and blockage of migration corridors); competition with and predation by nonnative fish species; hybridization; and pesticides and pollutants (Service 2002d). No new threats have emerged since the 2002 recovery goals were published. The Service's status review of bonytail completed in 2012 (USFWS 2012c) reported that 72 percent of the recovery factor criteria (USFWS 2002d) have been addressed to varying degrees.

Overall, the threats to the bonytail from nonnative fish are similar to those facing the Colorado pikeminnow, as described above. See the discussion on threats to the Colorado pikeminnow above for further information, particularly regarding the threat to all endangered fish due to predation from nonnative species.

To summarize, bonytail habitat loss and degradation from dams and diversions constructed decades ago posed some of the early, primary impacts to the species. Most of the long-term impacts from these structures continue and are unlikely to change significantly in the near term. In the remaining suitable habitats, nonnative fish species pose a significant ongoing threat and challenge to recovery. Contaminants may pose a lesser threat as well, but the magnitude of this threat is in need of further investigation.

2.5 Critical Habitat

Critical habitat was designated for all four endangered fish simultaneously in 1994 in one Federal Register notice (59 FR 13374). It consists of river segments and associated areas within the 100-year floodplain within each species' historical range. Different reaches have been designated for each species, and are discussed for each species within the action area in the Baseline section below. Figure 10 shows critical habitat for the Colorado pikeminnow, which is confined to the Upper Colorado River Basin (above Lake Powell). Critical habitats for the other three endangered fish are found in the lower Colorado River Basin as well (59 FR 13374). Within the Upper Colorado River Basin, critical habitats for the other three endangered fish are largely subsets of that designated for the Colorado pikeminnow (i.e., shorter reaches) (Fig. 10). Within the Upper Colorado River Basin, critical habitat for the humpback chub and bonytail are identical.

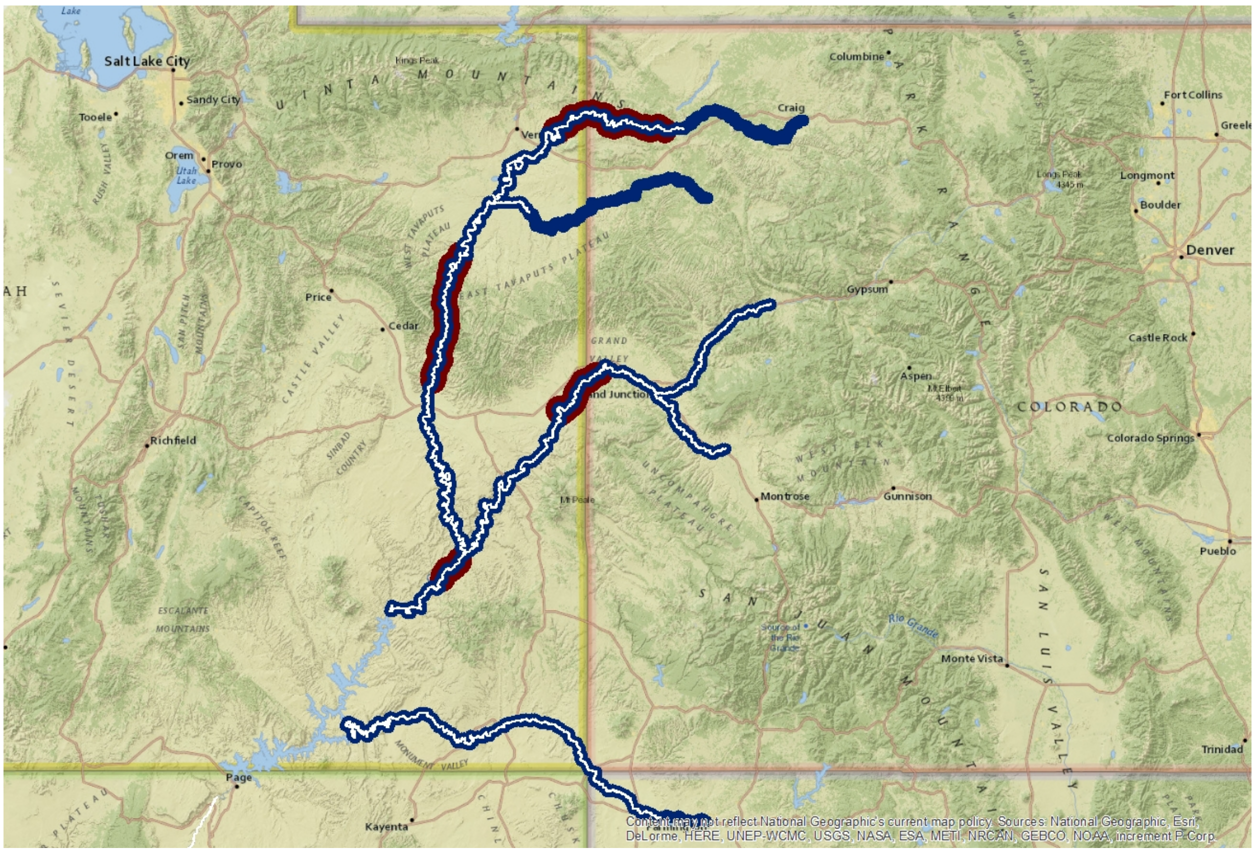

Figure 10. Designated critical habitat for the Colorado pikeminnow (blue), razorback sucker (white), and humpback chub/bonytail (together, brown).

Critical habitat is defined as specific geographic areas, whether occupied by a listed species or not, that are essential for its conservation and that are formally designated by rule. Many of these critical habitat reaches overlap throughout the Colorado River Basin. Critical habitat for the humpback chub and bonytail are primarily canyon-bound reaches, while critical habitat for the Colorado pikeminnow and razorback sucker include long stretches of river required for migration corridors and larval fish drift.

Concurrently with designating critical habitat, the Service identified physical or biological features (PBFs) of critical habitat, which are identical for all four endangered fish species. The PBFs essential to the conservation of a species for which its designated include: space for individual and population growth, and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and habitats that are protected from disturbance or are representative of the species historic geographic and ecological distribution. The physical and biological features of critical habitat are the same for each of the four endangered fish within the Colorado River system and include:

Water: a quantity of water of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminants, turbidity, etc.) that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage for the species;

Physical habitat: areas of the Colorado River system that are inhabited or potentially habitable for spawning, feeding, rearing, as a nursery, or corridors between these areas, including oxbows, backwaters, and other areas in the 100-year floodplain which when inundated provide access to spawning, nursery, feeding, and rearing habitats; and,

Biological environment: adequate food supply and ecologically appropriate levels of predation and competition.

2.6 Climate Change

In this section, we address climate change observations and modeled projections within the range of the species in the Upper Colorado River Basin. Climate change in the action area, a subset of the entire Colorado River Basin, is addressed under the Environmental Baseline section. The most current observations and projections for the southwestern United States, as well as more targeted areas, provide an indication of climate change in the Colorado River Basin. These include a rise in temperature, earlier peak spring streamflow, changes in precipitation, and potentially more frequent and severe droughts. Reasonably likely to occur changes to the timing and volume of stream flow are expected to present an increasing challenge to the quality of Colorado River endangered fish habitat.

Average annual temperatures in the Southwest have increased 1.6°F (+/- 0.5°F) during 1901-2010, and the most recent decade of 2001 to 2010 was recorded as the fourth driest decade over this time period (Hoerling et al. 2013). Five climate projections for temperature increases specific to western Colorado show the average annual temperature increasing over historical values (Colorado Water Conservation Board 2012). More specifically, they indicate a basin-wide average temperature increase of 3.6 °F by 2040.

Snowmelt makes up the majority of the annual flow in Colorado's major rivers. The peak spring streamflow in the Colorado River Basin, which is a function of snowmelt, has shifted earlier by about two weeks (Clow 2010). Climate projections indicate that snowmelt timing will continue to advance in response to additional warming (Rauscher et al. 2008, Reclamation 2016). Future changes to the total water content or volume of snowmelt are difficult to predict. Snowmelt volume is dependent in large part on precipitation and temperature. There is much uncertainty as to how precipitation may change in the future. Colorado's statewide precipitation trends have remained relatively stable since measurements began in 1900 but there is a range of projections for future precipitation amounts, from -5 percent to +6 percent statewide by 2050 (Lukas et al 2014). However, most projections of future hydrology in Colorado's river basins show reductions in streamflow, which would likely be attributed to increasing temperatures, evapotranspiration, and demand for anthropogenic uses.

The potential for earlier snowmelt and reduced streamflow could result in less water in endangered fish habitat, heightened interactions with nonnative species, higher concentrations of contaminants, life cycle changes, as well as the potential for aquatic disease spread to higher elevations and expansion of nonnative plant species in riparian areas (Ray et al. 2008). Although it is also possible that the warming of water temperatures at higher elevations could expand the range of the endangered fishes upstream and to tributaries which are currently too cold, any benefits of upstream range expansion from climate-induced water temperature increases could be offset by more widespread negative effects on other habitat attributes from reduced flows (Osmundson 2011).

Greenhouse gas emissions are going to continue, state-wide and nationally. If the current levels of emissions are maintained, or even somewhat decreased, the effects of climate change are still expected to gradually increase over time and contribute to reduced river flows and increased temperatures. Over the next decade or two, however, any potential changes are likely to be gradual and the magnitude of change is likely to be relatively small. Additionally, given that these endangered fish live in main-stem rivers, generally downstream from most of the dams on tributaries within the Upper Colorado River Basin, we expect that some of the effects of climate change in the area will be moderated by dam releases, particularly those that are done to benefit endangered fish. Dam releases and river flows through endangered fish habitat are further discussed in the Effects of the Action section below.

3.0 ENVIRONMENTAL BASELINE

The environmental baseline includes the past and present impacts of all Federal, State, and private actions and other human activities in the action area; the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal section 7 consultation; and the impact of State or private actions contemporaneous with the consultation process.

The action area is defined at 50 CFR 402 to mean "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the purposes of this consultation, the action area, as defined earlier, has been defined to include the mercury deposition airshed (Map 2 in BA), along with endangered fish critical habitats within and downstream from the airshed along the Yampa and White Rivers. A map of critical habitats for the four endangered fish is provided in the Status of the Species section above.

3.1 Critical Habitat In The Action Area

The PBFs of critical habitat are identical for all four endangered fish species and are discussed in section 2.5 above. Descriptions of critical habitats within the action area are provided below. The BA provides a map of showing critical habitat in the action area.

3.1.1 Colorado pikeminnow

Critical habitat designated for the Colorado pikeminnow along the Yampa River extends from the Highway 13 Bridge over the Yampa River down to the confluence with the Green River. This is an undammed, free-flowing, approximately 145-mile reach. Along the White River, it extends from Rio Blanco Lake down to the confluence with the Green River in Utah. Within this reach, Taylor Draw Dam above the town of Rangely, Colorado, built in 1984, completely blocks fish passage. Although Colorado pikeminnow previously occupied the White River above Taylor Draw Dam, that is no longer the case. Colorado pikeminnow currently occupy the 106-mile reach below Taylor Draw Dam.

3.1.2 Razorback sucker

Critical habitat designated for the razorback sucker along the Yampa River extends from the mouth of Cross Mountain Canyon to the confluence with the Green River in Utah. This approximately 55-mile reach is largely within Dinosaur National Monument. Critical habitat has been designated for the razorback sucker along the lower 24 miles of the White River as it travels through the Uintah and Ouray Indian Reservation.

3.1.3 Humpback chub and bonytail

Critical habitats designated for the humpback chub and bonytail along the Yampa River are identical and extend 45 miles from the boundary of Dinosaur National Monument downstream to its confluence with the Green River. No critical habitat has been designated along the White River for the humpback chub or bonytail. Critical habitats for all four endangered fish continue out of the action area downstream along the Green River below its confluence with the Yampa River and below its confluence with the Green River.

3.2 Endangered Fish In The Action Area

Broader population estimates, which may include fish in the action area, are provided above in the Status of the Species section. Additional information specific to the endangered fish populations and their threats in the Yampa and White Rivers is included here.

3.2.1 Colorado pikeminnow

Low numbers of Colorado pikeminnow were captured in the Yampa River during population estimation sampling in 2011-2013. Bestgen et al. (2013, p.4) states, “Captures were particularly low in the Yampa River, where only six Colorado pikeminnow were captured, in spite of high effort associated with northern pike and smallmouth bass removal sampling, as well as regular Colorado pikeminnow sampling passes (up to eight sampling passes).” And for 2013, only 8 Colorado pikeminnow were captured in the Yampa River, in spite of high effort, once again. Preliminary population estimates based on these captures are shown in Figure 11.

As part of the process of revising the 2002 Colorado Pikeminnow Recovery Goals into recovery plans, a recovery team for Colorado pikeminnow was assembled in late 2012 consisting of species and threat experts. During initial discussions in November 2012, the Recovery Team linked persistent low densities of adult Colorado pikeminnow in the Yampa River to persistent high densities of nonnative predators (e.g., smallmouth bass and northern pike; northern pike abundance shown in Figure 11). These estimates, which indicate that northern pike are outnumbering Colorado pikeminnow at least 3:1, point up the ongoing challenge of managing nonnative predators (Service 2015a). A published fish density model (McGarvey et al. 2010) supported the importance of competition among top predators in lotic systems and suggested that partitioning available energetic resources among multiple predator species would inevitably reduce carrying capacity for Colorado pikeminnow. Examination of historic and recent trends in densities of large-bodied Colorado pikeminnow, northern pike, and smallmouth bass in the middle Yampa River suggests that large-bodied invasive predators have functionally replaced Colorado pikeminnow as the river's top predator (Martinez et al. 2014).

The number of adult Colorado pikeminnow residing in the Yampa River has been greatly reduced, largely because of persistent high densities of nonnative predators, and perhaps also because of extended drought (Recovery Program 2015). The Recovery Program initiated a campaign to remove nonnative predators from the critical habitat reaches of the Yampa River in the early 2000s when it became apparent that smallmouth bass were decimating the native fish populations (Anderson 2005). Since that time removal efforts have increased both geographically (now encompassing ~ 170 miles of Yampa River + Catamount Reservoir) and in intensity (with some reaches receiving more than 10 removal passes/yr).

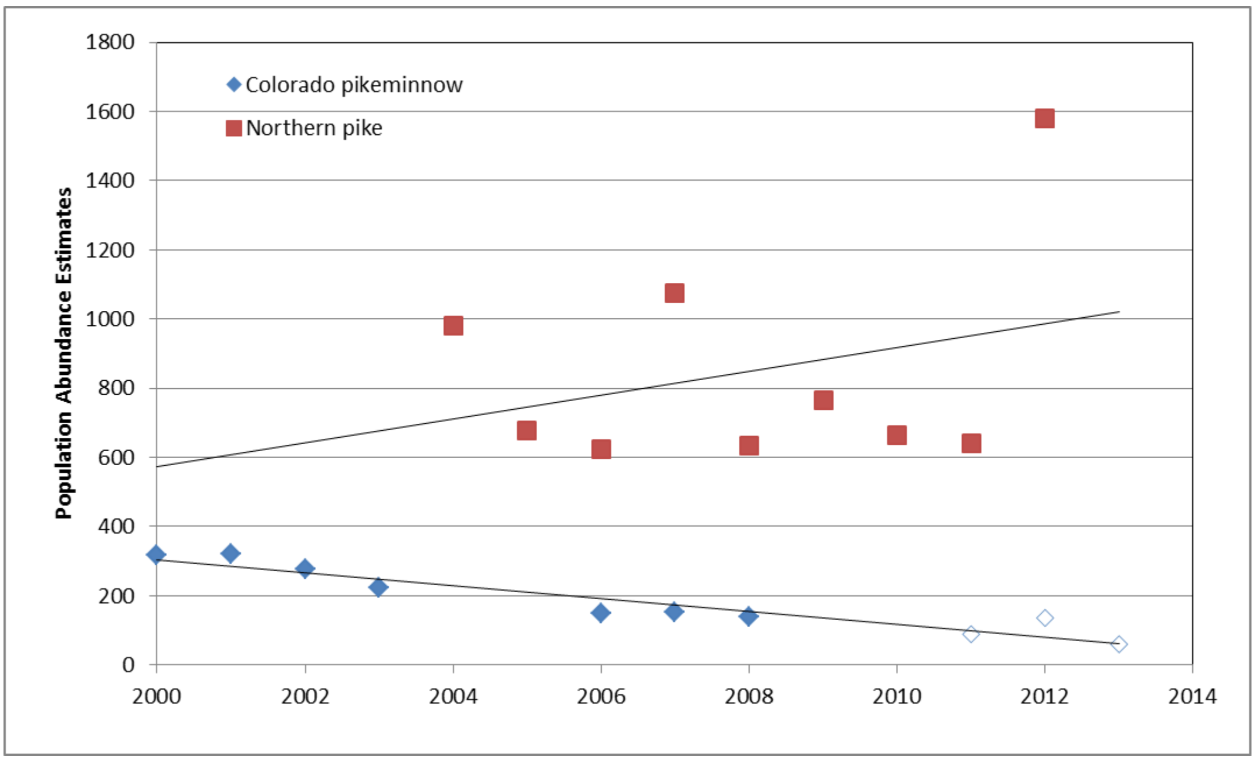

Figure 11. Comparison of Colorado pikeminnow population estimates (CPM) (2000 – 2008 data from Bestgen et al. 2010) and northern pike (Battige 2012) in the middle Yampa River. The 2011-2013 data points for Colorado pikeminnow are preliminary. Northern pike population estimates were not conducted in 2013.

As stated in Martinez et al. (2014), the dramatic decline of native fishes in the Yampa River provides a stark example of the cumulative detrimental impacts of an increase in the number and abundance of nonnative aquatic species, particularly increases in the range and abundance of invasive species including northern pike and smallmouth bass, and virile crayfish *Orconectes virilis*. The Yampa River has been previously described as the “crown jewel” of the upper Colorado River Basin due to its formerly robust native fish populations (Johnson et al. 2008) and its comparatively unregulated hydrograph. It contains designated critical habitat for all four of the endangered fish in the basin. In recent decades, the Yampa River has been progressively invaded by nonnative species, altering the native aquatic community and food web and increasing the threat of invasive impacts to native and endangered fishes (Johnson et al. 2008; Martinez 2014). Examples of these threats include the detection of Asian tapeworm *Bothriocephalus acheilognathi*, hybridization between native sucker species and nonnative white sucker *Catostomus commersoni*, and predation or apparent competition with and hyperpredation on native and endangered fishes (Martinez 2014). Endangered Colorado pikeminnow have steadily declined in the Yampa River, despite pikeminnow increases in four other major population areas in the Green River basin (Bestgen et al. 2010; Martinez et al. 2014). It has become imperative that preventive, eradication and control measures be diligently, vigorously, and more rapidly applied to restore the native aquatic community in the Yampa River (Martinez et al. 2014).

A somewhat higher number of Colorado pikeminnow currently occupy the White River, although numbers of adults have declined since population estimates began in the year 2000 (Bestgen et al. 2018). Numbers have declined from approximately 1000 adults in 2000 to around 400 adults in 2013, the most recent year for which we have a finalized estimate. Juvenile and subadult Colorado pikeminnow also utilize the White River on a year-round basis (Recovery Program 2015). Although fewer in number, there is no clear trend for recruits. Also fewer in number than adults, Colorado pikeminnow juveniles showed somewhat of an increasing trend since 2000 (Figure 11). Adult Colorado pikeminnow resident to the White River are known to spawn in the Green and Yampa rivers. However, in 2011, researchers documented for the first time Colorado pikeminnow spawning in the White River.

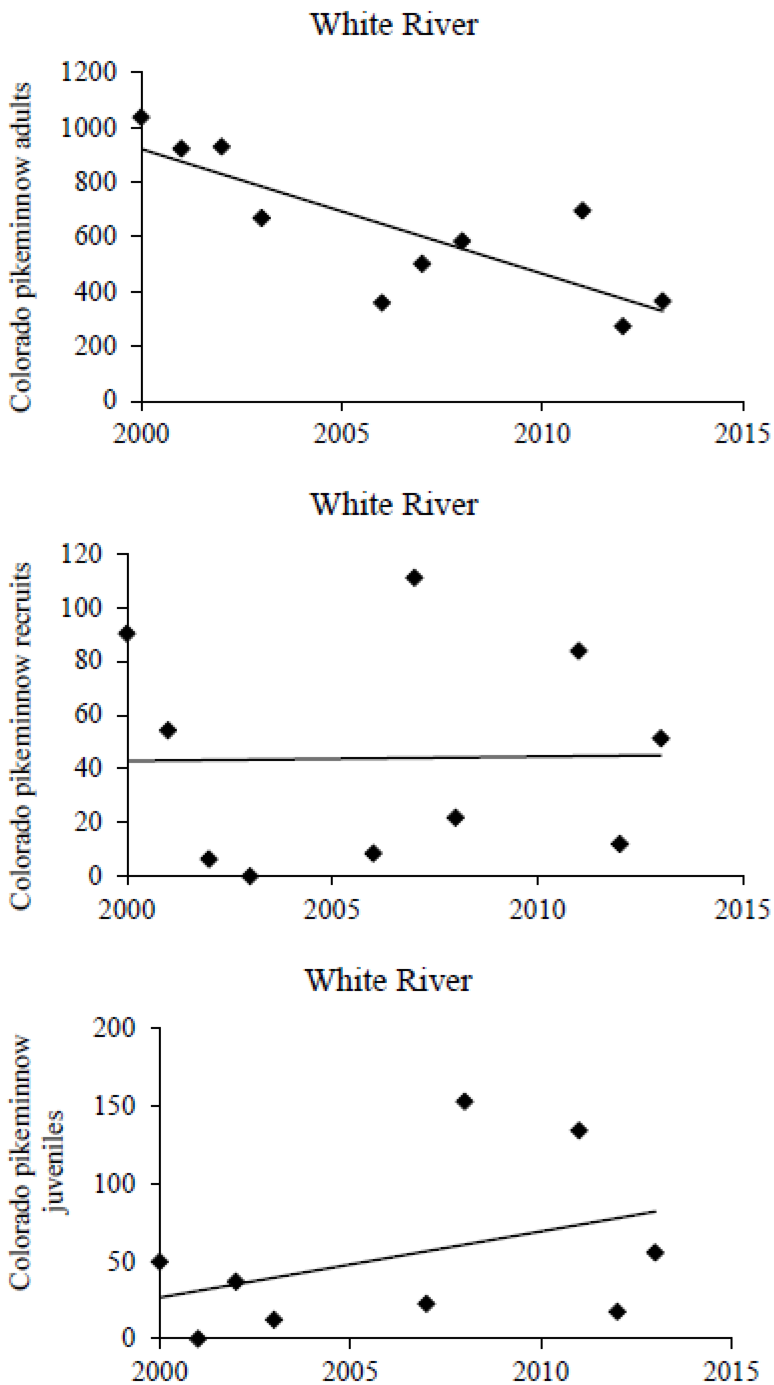

Figure 11. Abundance trends of Colorado pikeminnow adults (> 450-mm total length [TL]), recruits (400-449 mm TL), and juveniles (< 400 TL) in the White River, Utah and Colorado, 2000-2003, 2006-2008, and 2011-2013 (Bestgen et al. 2018).

3.2.2 Razorback sucker

Less is known about the numbers of the other three endangered fish within the Yampa and White Rivers. The Yampa River at the mouth of Yampa Canyon was an historical site for razorback sucker reproduction, and in fact, was the first such spawning site described in the Upper Colorado River Basin (McAda and Wydoski 1980, Bestgen 1990). More recently, only a few razorback larvae have been captured in the lower Yampa River in 2000, 2008, and 2011 (Bestgen et al. 2012). Although substantial numbers of razorback sucker do not occur in the Yampa River, scattered individuals can occasionally be found (Bestgen et al. 2012). No current population estimate of razorback sucker in the Yampa River is available due to low numbers captured in recent years.

Razorback suckers are not stocked into the Yampa River or White Rivers. They are, however, stocked into the Green River and can swim up and into the Yampa or White River. A few substantial captures of adult razorback suckers occurred in the lower White River in 2011. A passive integrated antenna array near the Bonanza Bridge (installed September 2012) demonstrated that razorback sucker and Colorado pikeminnow use the Utah portion of the White River in higher numbers than previously thought. However, a recent expansion of smallmouth bass in the White River is a cause for concern for this native fish stronghold (Recovery Program 2015). In 2011, researchers documented spawning by razorback sucker in the White River for the first time (Bestgen et al. 2012).

The current and increasingly most significant threat to the razorback sucker in the action area is from nonnative species, which is discussed in the Status of the Species section. See also the discussion regarding nonnative species in the Colorado pikeminnow Status of the Species and Baseline sections above, as this threat is similar for all endangered fish in the upper Colorado River basin, particularly regarding predation from nonnative predators.

3.2.3 Humpback chub

Few humpback chub remain in the Dinosaur National Monument (DNM) population that includes the Yampa and Whirlpool Canyons. This population declined upon completion of Flaming Gorge Dam in the 1960s and has been tenuous since. The population is now considered functionally extirpated because humpback chub have not been collected in this historic location since 2004 (Service 2017).

Population viability has been negatively impacted from multiple stressors, such as rotenone treatment in the Green River in 1962 (Holden 1991), cold hypolimnetic releases from Flaming Gorge Dam after 1963 (Holden and Crist 1981), expansion of nonnative fish (Modde and Haines 2006), and exceptionally low Yampa River flows in the early 2000s. Dam penstock modifications in 1978 warmed releases and native fish have reinvaded historic habitat in the Green River above the Yampa River confluence, but not the Humpback chub (Bestgen et al. 2006). Influxes of Smallmouth Bass occur when nearby production is high, but densities return to lower levels as nearby production is reduced. The habitat in DNM is otherwise suitable for humpback chub, but the number of fish is so low that intervention (e.g., fish translocation or stocking) will be necessary to restore this population.

Native fish communities remain strong in both Yampa and Whirlpool canyons despite large densities of nonnative fish in nearby reaches, but lack humpback chub. The altered thermal regime in the Green River upstream of the confluence with the Yampa River precludes humpback and roundtail chub from occupying this reach. Humpback chub residing in DNM are therefore more reliant on Yampa Canyon and the natural thermal regime found there. However, summer base flows in Yampa Canyon are an order of magnitude lower than any other Upper Basin locations where humpback chub are found. Furthermore, in the early 2000's Yampa Canyon experienced brief periods of no surface flow. Since 2007, the Recovery Program has augmented summer low flows in Yampa Canyon with a permanent pool (5,000 ac-ft) of fish water available in Elkhead Reservoir. The success of reestablishing a population of humpback chub in DNM will be dependent on the presence of adequate flow conditions. Humpback chub do not occupy the White River due to the lack of deep water canyon habitat.

The current and increasingly most significant threat to the humpback chub in the action area is from nonnative species, which is discussed in the Status of the Species section. See also the discussion regarding nonnative species in the Colorado pikeminnow Status of the Species and Baseline sections above, as this threat is similar for all endangered fish in the upper Colorado River basin, particularly regarding predation from nonnative predators.

3.2.4 Bonytail

All bonytail in Colorado's Rivers have originated from hatchery stock; there are no wild populations that have re-established yet. Approximately 2,800 bonytail were stocked from the Mumma Native Aquatic Species Restoration Facility into the Yampa River in 2016 (mean total length 325 mm) (Smith and Garcia 2016). More recently, bonytail have been stocked into the White River as well.

The current and increasingly most significant threat to the bonytail in the action area is from nonnative species, which is discussed in the Status of the Species section. See also the discussion regarding nonnative species in the Colorado pikeminnow Status of the Species and Baseline sections above, as this threat is similar for all endangered fish in the upper Colorado River basin, particularly regarding predation from nonnative predators.

3.3 Contaminants In The Action Area

3.3.1 Mercury

An analysis of mercury deposition and its effects on endangered fish in the San Juan River was completed for the Four Corners Power Plant (EPRI 2014). Over 100 times more coal was involved in the modeling for that effort than under consultation here, but the mechanics of mercury emissions and deposition analyzed there are informative for this consultation. Numerous activities, natural sources, and legacy sources have emitted mercury in the past and, given that mercury is a global pollutant, we can assume an unknown quantity of that mercury has been deposited in the action area over time. Since the surface area of water is low in the Yampa and White River Basins compared with land area, almost all mercury deposition falls on land, primarily as elemental or ionic mercury. The deposited mercury either evades back to the atmosphere or sequesters to soil. Over time, when overland flow takes place, soil is eroded from the catchment surface and carries adsorbed mercury (e.g., mercury ions; EPRI 2014) with it to the river. A very small portion (about 0.1 percent in the San Juan River, EPRI 2014) of ionic mercury deposited in the watershed enters surface waters. Because of the relatively large amount of past mercury deposited to the soils in a watershed from local, regional and global sources, mercury in water and fish are slow to respond to changes in mercury deposition, including reductions in the deposition of mercury (EPRI 2014). Thus, due to the time it takes for mercury to cycle through the environment, mercury emission and deposition in the action area that may have occurred in the past may continue to affect the listed species and critical habitats today and into the future, and yet are considered part of the environmental baseline.

Until 2016, water mercury concentrations in the Yampa and White Rivers, which includes all critical habitats in the action area, had not been measured within endangered fish critical habitat in over a decade. Older measurements were made at imprecise detection levels. Water mercury concentrations were tested in the White River above Kinney Reservoir (formed by Taylor Draw Dam) from 1990-1993 (USGS 2015). This reach of the White River is within the action area, as is all of the White River below Rio Blanco Lake, which marks the upper limit of critical habitat for the Colorado pikeminnow. Although total mercury was not detected in 6 of the 8 samples (lab reporting level unknown), the maximum concentration measured was 0.10 µg/L, which is 10 times the chronic aquatic toxicity standard of 0.01 µg/L; the level of concern was listed as High, but clearly more sampling was needed. Chronic toxicity is the development of negative effects as the result of long term exposure to a toxicant or other stressor. It can manifest as direct lethality but more commonly refers to sub-lethal endpoints such as decreased growth, reduced reproduction, or behavioral changes such as impacted swimming performance.

Total mercury concentrations of 0.20 and 0.1 µg/L were also measured in the 1990s in the Yampa River at the Maybell and Craig stations, respectively, although the median values for the datasets were below the detection limit (assumed to be zero) (USGS 2015). Despite occasional high water mercury concentrations, most values were low enough that the Yampa and White Rivers are not listed as impaired for mercury on the EPA 303(d) list (CDPHE 2012b) (all median values were below the detection limit of 0.018 µg/L at the Craig station, unknown limit at the Maybell station).

As a result of a previous coal mine plan modification consultation at a different coal mine in Moffat County, water mercury testing by the USGS was funded beginning in 2016 at two stations in the Yampa River and two in the White River (all four in critical habitat for the Colorado pikeminnow) (see https://nwis.waterdata.usgs.gov/co/nwis/qwdata.). Over the past two years, all water mercury concentrations have been well below the state chronic standard of 0.01 µg/L for all samples except one; a one-time incursion above the state chronic standard occurred in the White River above Kinney Reservoir at 0.11 µg/L. The mean concentrations for both rivers has remained well below the state standard, however. Methylmercury (MeHg) was also tested in these samples—it ranged from approximately 3 to 12 percent of total mercury. Although mean total mercury did not appear to differ between the Yampa and White Rivers, the percent of total mercury as MeHg did appear to differ; mean MeHg in the Yampa River was 3.3 percent, whereas it was 11.0 percent in the White River.

As explained more fully in the Effects of the Action section below, and provided as reference here, mercury in whole body fish ≤ 0.2 micrograms per gram (µg/g) wet weight (WW) is an approximate threshold below which mercury tissue concentrations can be considered protective of juvenile and adult fish (see Beckvar et al. 2005 and further discussion in Effects of the Action section). Using the Model B regression equation (slope = 0.9048, intercept = -0.2387) developed by Peterson et al. (2005) for the northern pikeminnow (*Ptychocheilus oregonensis*), which is very similar physiologically to the Colorado pikeminnow, this translates to a value of 0.31 µg/g WW in muscle tissue. Muscle tissue is often sampled as muscle plugs—a small, circular, shallow sample of muscle tissue taken from a live fish without significant injury. Osmundson and Lusk (2012) found a range of 0.39 to 0.58 µg/g WW mercury in Yampa River pikeminnow muscle tissue, with a mean of 0.49. Colorado pikeminnow that were captured in the 1960's from the Yampa River and more recently tested had slightly higher mercury concentrations (all archival pikeminnow averaged 0.65 µg/g WW mercury in muscle tissue) (Osmundson and Lusk 2012). Additionally, muscle tissue samples taken from adult pikeminnow (length 20-26 inches) in the Yampa River in 2006 had levels of mercury between 0.42 and 0.68 µg/g WW, with a mean of 0.56 µg/g (CDPHE 2015).

Within the White River, Osmundson and Lusk (2012) found that mercury concentrations in pikeminnow muscle plugs were higher there than within any other occupied critical habitat unit, with muscle plug concentrations for these fish ranging from 0.43 to 1.83 µg/g WW (Osmundson and Lusk 2012). Roundtail chub (*Gila robusta*) were also tested in the White River as a part of the same study and were found to have elevated mercury levels as well (Osmundson and Lusk 2012). Whole body mercury concentrations in four adult pikeminnow (502-760 mm in length) taken from the White River immediately below Kinney Reservoir in 1986 ranged from 0.31 to 0.96 µg/g (after conversion to wet weight from dry weight (Krueger 1988)). Using the conversion factor derived from Peterson et al. (2005), the 1986 Colorado pikeminnow samples from the White River then ranged from concentrations of 0.50 to 1.75 µg/g WW mercury in muscle tissue (quite elevated). Osmundson and Lusk (2102) state that the White, Green, Colorado, and Yampa Rivers should be placed on the 303(d) list of state impaired waters due to these high mercury concentrations found in fish tissue.

To summarize, although the water mercury concentrations in the Yampa and White Rivers is below the chronic state standard, Colorado pikeminnow have repeatedly shown elevated mercury concentrations in both the Yampa and White Rivers. Some of the mercury concentrations measured in pikeminnow from the White River have been especially high. After reviewing several studies on mercury toxicity in fish, it is reasonable to assume that some individual Colorado pikeminnow are being adversely affected by elevated mercury tissue residues. However, we do not know what level of impact mercury has had on the Colorado pikeminnow at the population level in the action area in the past or currently. We do not know if it is limiting or preventing successful reproduction. Although likely to be lower than Colorado pikeminnow, due in large part to a lower trophic position, mercury levels have not been tested in the other three endangered fish species.

3.3.2 Selenium

During surface water sampling of the Yampa River between 1997 and 1998, selenium concentrations ranged from; <1 to 4.8 µg/L near Craig, CO, < 1 to 4.9 µg/L near Maybell, CO, and <1 to 3.6 µg/L near Deerlodge Park, CO (USGS 2001). The peak reported selenium concentrations for these sites occurred in March, possibly during the beginning of the snow runoff. Concentrations were <1 µg/L during May through October. A longer term data set from 1991 to 2011 for the Yampa River below Craig Colorado (USGS Station 09247600) (n=91), showed that close to half of the sample values were reported at less than the laboratory reporting level (0.030 µg/L), and the maximum reported selenium concentration was 17.0 µg/L (USGS 2015). The chronic aquatic life standard for selenium is 5 µg/L total and 4.6 ug/L dissolved (CDPHE 2012a). In sum, historic selenium concentrations measured in the Yampa River below Craig have exceeded the chronic aquatic life selenium standard approximately 10 percent of the time, but are generally below the standard, and this segment is not state listed under 303(d) of the Clean Water Act as impaired for selenium (CDPHE 2012b; USGS 2015).

According to USGS (2015) water sampling in the White River beginning in the 1990s, water selenium concentrations have always remained below the chronic aquatic life standard both above and below Taylor Draw Dam. More recently, water selenium samples have been taken by USGS in the Yampa River near Craig and near Maybell between 2015-2018. All were well below the state chronic aquatic life water quality standard (max 0.59 µg/L). Two samples were also collected from the White River above Kinney Reservoir near Boise Creek in 2015. Both were low (0.41 and 0.43 µg/L). (See https://nwis.waterdata.usgs.gov/co/nwis/qwdata.)

Because selenium bioaccumulates in aquatic food chains, selenium concentrations in fish tissue, rather than water, provide a better indication of potential adverse impacts. The available data is limited, but a few studies have provided selenium concentrations measured in fish tissue samples collected from the Yampa and White Rivers. Osmundson and Lusk (2012) reported on selenium in muscle plug samples taken from archival Colorado pikeminnow collected from the Yampa River during 1962-1966, which averaged 7.5 µg/g DW (5.9-10.1ug/g DW). According to Lemly (1995, p.281), these fish would be ranked into the “High” hazard category (after conversion of whole body to egg concentrations), which “denotes an imminent, persistent toxic threat sufficient to cause complete reproductive failure in most species of fish and aquatic birds.” Selenium concentrations in muscle plugs taken from five Colorado pikeminnow collected from the Yampa River during 1996 ranged from 1.7-2.8 ug/g DW (mean of 2.3 ug/g DW) (Hamilton et al. 2004) which places them in the “Minimal” hazard category (Lemly 1995). The Minimal hazard category indicates “that no toxic threat is identified but concentrations of selenium are slightly elevated in one or more ecosystem components (water, sediment, invertebrates, fish, birds) compared to uncontaminated reference sites; continued comprehensive environmental monitoring is recommended.” Thus, tissue selenium concentrations in Colorado pikeminnow from the Yampa River have varied over time, with earlier values indicating a high hazard and more recent values indicating a minimal hazard.

3.4 Climate Change In The Action Area

We discuss climate change on a global and regional level in the Status of the Species section above (2.6). That discussion includes the action area. In this section we provide further insights into the potential effects of climate change within the action area.

Native fish in the Colorado River Basin could potentially move upstream in response to periods of warming and drying associated with climate change, especially on the Yampa River because there are no barriers until relatively far upstream, beyond Steamboat Springs, Colorado. However, there are ten identified barriers within Colorado pikeminnow critical habitat upstream of Glen Canyon Dam/Lake Powell (Osmundson 2011), some with fish passage structures. In the White River, the Taylor Draw Dam precludes migration to potentially more favorable upstream areas.

In addition to the physical barrier dams create, the release of cold water can eliminate native fishes from the reaches immediately downstream from dams (Osmundson 2011). For example, the summer water temperatures coming out of the Aspinall Unit on the Gunnison River are about 5ºF (3ºC) cooler than other reaches in the Colorado River Basin (Service 2009), which in a warming environment could provide refuge for the listed fish. Unlike on all the other major rivers in the Upper Colorado River Basin, however, cold water dam releases have not caused the loss of usable habitat for the endangered fish along the Yampa and White Rivers (Osmundson 2011), neither is there any cool water refugia created in the face of increasing water temperatures along these rivers either.

If the modeled predictions of more frequent, more severe, and possibly longer-lasting droughts, along with generally warmer temperatures and less snowfall occur, it will likely become increasingly challenging to meet the established flow recommendations for the protection of listed and native fish in the Yampa and White Rivers (Service 2005). Additionally, reduced flow levels may also exacerbate contaminant issues, as less dilution of contaminants in the river may occur.

Climate change could also affect numbers of nonnative fish, which we believe to be the greatest threat to the endangered fish in the action area. As stated in Martinez et al. (2014), the challenges in restoring and conserving native aquatic species will likely become more difficult due to the interaction of invasive species and climate change. The abundance of nonnative species (e.g., smallmouth bass) can increase rapidly under favorable conditions such as low flow prolonged by drought. Reductions in water stores and stream flows due to climate change may intensify demand for remaining water supplies and may hasten proposed water development. Long-term climate and water development forecasts suggest flow scenarios for the Yampa River that will functionally mimic drought conditions, including reduced stream discharge, smaller stream size, and an increase in summertime water temperatures (Roehm 2004; Johnson et al. 2008). Several invasive species, including green sunfish (*Lepomis cyanellus*) and largemouth bass (*Micropterus salmoides*), have higher thermal tolerances than many of the fish species native to the Colorado River Basin. The projected increase in channel catfish growth rate (McCauley and Beitinger 1992) could increase piscivory by larger catfish in the Colorado River

Basin. See the discussion on nonnative fish in the Effects of the Action section below for further analysis.

Climate change and its effects on water temperature may also alter the dynamics of parasite and disease transmission and host susceptibility, exposing immunologically naïve native fish to outbreaks of pathogens. For example, thermophilic Asian tapeworm (*Bothriocephalus acheilognathi)* may become more widespread and increase its infection intensity due to higher water temperatures associated with lower summertime flows. Incidence of infection may be higher in small fish and infected fish may grow more slowly, prolonging their exposure to increased infection and predation, and potentially reducing the survival of native cyprinids (Martinez et al. 2014).

Given the uncertainties involved with climate change, including the possibility for both positive and negative effects on endangered fish, particularly at a local level and within the action area, it is currently not possible to predict precisely how endangered fish and their habitats will be affected. We believe that the primary net effects are likely to be a gradual increase in the competitive edge for some nonnative fish at the expense of native fish, including the four endangered fish in the Upper Colorado River Basin, gradual reductions in streamflow, and gradual changes to the timing of peak flows.

4.0 EFFECTS OF THE ACTION

In this section we analyze the direct and indirect effects of the action on the four endangered fish species and their critical habitats, together with the effects of other activities that are interrelated or interdependent with the proposed action, that will be added to the environmental baseline (per 50 CFR 402.02). Indirect effects are those that are caused by a proposed action and are later in time, but are still reasonably certain to occur. If a proposed action includes off-site measures to reduce or offset net adverse effects by improving habitat conditions and survival, the Service will evaluate the net combined effects of that proposed action and the off-site measures as interrelated actions. Interrelated actions are those that are part of a larger action and depend on the larger action for the justification; 'interdependent actions' are those that have no independent utility apart from the action under consideration (50 CFR 402.02). Future federal actions that are not a direct effect of the action under consideration, and not included in the environmental baseline or treated as indirect effects, are not considered in this consultation.

Analysis challenges

There are many unique challenges to analyzing the effects of the proposed action. They are outlined below:

- We have an estimate as to the amount of mercury released from the combustion of Federal Twentymile coal at the Hayden Station, but there is currently a lack of specific information on the amount of selenium released during this process.

- There is currently a lack of reliable information on the amount of deposited mercury and selenium that eventually enters occupied and critical habitat and becomes available to be taken up by the four endangered fish species.

- The analysis is confounded by other sources of selenium and particularly mercury, a global pollutant, which also contribute to the amounts available to be taken up by the four endangered fish species.

- There is currently a lack of information regarding the specific effects of elevated mercury and selenium on any of the four endangered fish. Assumptions can be drawn only from information relative to other fish species.

These limitations make it very difficult to precisely describe effects to individuals of the four endangered fish species. To satisfy Congress's direction in 7(a)(2) regarding ensuring that an action not jeopardize a species, BLM and the Service must use the best available information and basic conservation biology principles to explore the overall impact to the populations that are likely to occur and how those effects relate to the likelihood of Jeopardy.

The BLM has committed to a conservation action--an analysis of mercury concentrations in fish tissue in the Yampa and White Rivers--as described above. The results of this effort will help to fill information gaps noted above and to provide data to inform the reasonableness of assumptions that have to be made to move the analysis forward. And as provided for in the regulations, reinitiation of this consultation is triggered if new information reveals effects to the species in a manner or to an extent that was not considered in this analysis.

In the discussion below we describe the effects of the action on the four endangered fish. There are many uncertainties and unanswered questions, however, leading us to necessarily make some reasonable assumptions. Some of these unanswered questions will be addressed through the mercury fish tissue analysis as described above. As BLM states in the BA, the primary impact from coal combustion to threatened and endangered species and their critical habitats is the emission and subsequent deposition of mercury and selenium. We agree, and discuss these effects below. Potential mercury and selenium contamination from mine discharge (runoff into surface or ground water) is also discussed. Note: BLM has determined that mining operations at the Foidel Creek Mine do not result in a net water depletion from the Yampa River Basin (BLM 2016), therefore, water depletions are not considered in this consultation.

4.1 Emissions from the Hayden Generating Station

4.1.1 Mercury

Mercury is a naturally occurring element. It can be found in soils and the atmosphere, as well as water bodies. Mercury is contained in coal and can be released upon combustion. Atmospheric transport is an important mechanism for the global deposition of mercury as it can be transported over large distances from its source regions and across continents (EPRI 2014, 2017). It is considered a global pollutant. Atmospheric mercury is primarily inorganic and is not biologically available. However, once this mercury is deposited to the earth, it can be converted into a biologically available form, methylmercury (MeHg), through a process known as methylation. Methylmercury bioaccumulates in organisms and biomagnifies up food chains, particularly in aquatic food chains. Organisms exposed to MeHg in their food can build up concentrations that are many times higher than the ambient concentrations in the environment.

Inorganic atmospheric mercury occurs in three forms:

- Elemental mercury vapor (Hg(0)), also referred to as gaseous elemental mercury (GEM);

- Gaseous divalent mercury, Hg(II), also referred to as reactive gaseous mercury (RGM) or gaseous oxidized mercury (GOM);

- Particulate mercury, Hg(p), also referred to as particle bound mercury (PBM); PBM can be directly emitted or can form when GOM adsorbs on atmospheric particulate matter.

In the global atmosphere, GEM accounts for more than 90 percent of total mercury, on average, while both GOM and PBM typically account for less than 5 percent (EPRI 2014). The reactive form of mercury (GOM) is often deposited to land or water surfaces much closer to their sources due to its chemical reactivity and high water solubility. PBM is transported and deposited at intermediate distances depending on aerosol diameter or mass. Within the atmosphere, numerous physical and chemical transformations of mercury can occur depending on many factors.

The various forms of mercury have very different physical and chemical characteristics, resulting in large differences in their removal rates from the atmosphere, and consequently, in their atmospheric lifetimes (EPRI 2014). GEM has a lifetime on the order of several months to more than a year because of its low reactivity, low water solubility, and slow deposition rate. Thus, it is considered a global pollutant since it is transported over long distances. On the other hand, the lifetimes of both GOM and PBM are much smaller, ranging from a few hours to days, because they are removed efficiently by dry and wet deposition, particularly GOM. Thus, mercury is a pollutant at all scales ranging from global to local.

Mercury is emitted by both natural and anthropogenic sources. Natural sources include volcanoes, geothermal sources, and exposed naturally mercury-enriched geological formations. These sources may also include re-emission of historically deposited mercury as a result of evasion from the surface back into the atmosphere, fires, meteorological conditions, as well as changes in land use and biomass burning. Anthropogenic sources of mercury include burning of fossil fuels, incinerators, mining activities, metal refining, and chemical production facilities. Coal combustion accounts for nearly half of the mercury emissions in the U.S., whereas smelters for non-ferrous metal production account for most of the mercury emissions in Canada and Mexico. Nearly 2,320 megagrams (Mg) of mercury are released annually from anthropogenic sources around the globe, with more than 30% coming from coal and oil combustion (EPRI 2017).

Once mercury is emitted from the smoke stacks at the Hayden Station it is transported some distance through the atmosphere before deposition on the landscape takes place. Apportioning the deposition of mercury based on emissions from multiple emissions sources is a complicated endeavor. However, as a result of a previous coal mine plan modification consultation at a different coal mine in Moffat County, such a mercury deposition modeling effort was conducted for the Yampa and White River watersheds by EPRI (2017). Three local coal-fired power plants were identified in the study: Craig Generating Station, Hayden Generating Station, and Bonanza Power Plant. The Bonanza Power Plant is approximately 115 miles west of the Hayden Station in Uintah County, Utah and the Craig Generating Station is approximately 22 miles to the west of the Hayden Station in Moffat County, CO. The Craig Generating Station, the focal point of the deposition modeling effort, is the largest power plant of the three. It emits 44 lbs of total mercury per year; together the Bonanza Power Plant and Hayden Station emit 33 lbs of total mercury per year, although the contributions of reactive mercury emissions (GOM) from the Bonanza and Hayden power plants are larger than from the Craig Station (EPRI 2017, p. 3-14). However, the contributions from all three power plants to the local watersheds are almost negligible when compared to outside sources. The contributions to the upper Yampa River watershed (where the Craig and Hayden stations are located) from the Bonanza and Hayden power plants combined is less than 0.01% of the total mercury deposition. The contribution from the Craig Station is 0.06%. Nearly all of the mercury deposition is coming from outside of the Yampa River Basin, as follows: China 11%, Other U.S. sources 11.3%, the rest of the world 77.6% (EPRI 2017, p. 4-11).

According to the BA, the 1,247,733 tons of federal coal from this LBA would supply the Hayden Station for approximately 332 days (based on a five year average). With newly installed emission controls, the Hayden Station emitted 8.31 lbs of mercury in 2016. If mercury emissions remain constant, the coal expected to be burned at the Hayden Station would <u>emit</u> approximately 7.55 lbs of mercury (332 days/365 days x 8.31 lbs = 7.55 lbs). For comparison, in 2011 the total emissions of mercury in the United States amounted to approximately 104,000 lbs (EPA 2016).

In a 1997 Mercury Study Report to Congress, the EPA undertook a modeling exercise to estimate the local <u>deposition</u> of mercury and subsequent impacts (EPA 1997). Deposition is dependent upon a variety of factors, including the chemical species of mercury (elemental, oxidized or particulate-bound), atmospheric conditions, climate, air quality and stack height. Elemental mercury can be transported over very long distances and the global pool of mercury is primarily composed of elemental mercury. Oxidized mercury and particulate-bound mercury are deposited by wet or dry deposition up to 500 miles from sources. According to the EPA's modeling and the 2015 BLM BA, the Hayden Station units would fall in between a small and medium coal-fired utility boiler based on stack height (Unit 1 – 250 ft and Unit 2 – 395 ft). Dry deposition for this type of facility would range from 2.8% to 7.5% of emissions within 31 miles (50 km) of the facility. Wet deposition would be predicted to range from 0.9% to 1.0% of emissions within 31 miles of the facility.

Using these figures, this would result in an expected 3.4 to 9.1 ounces (oz) of dry deposition within 31 miles of the Hayden Station from the 1,247,733 tons of Federal coal in the LBA (e.g., 7.55 lbs x 7.5% x 16 oz/lb = 9.1 oz) and 1.1 to 1.2 oz of wet deposition, for a total of 4.5 to 10.3 oz (127 to 291 grams) of total mercury (wet + dry) deposited within the action area by the combustion of the coal under this analysis. To put this amount of mercury in perspective, 225 g of mercury equates to approximately 1 tablespoon, if consolidated. However, even small amounts of mercury can be very toxic. It has been found that 1 gram of mercury, the amount in a single fever thermometer, deposited each year into a 20-acre lake can contaminate that lake, over time, to the point of having fish with mercury concentrations above the human consumptive advisory (IMERC 2004). The remaining mercury from the Hayden Station would be deposited further than 31 miles from the Hayden Generating Station, mostly outside of the Yampa and White River watersheds, and/or would be vertically diffused to the free atmosphere to become part of the global cycle. Prevailing winds in the Hayden area are predominantly from the west, therefore, the majority of deposition would be expected to occur east of the station, towards the mountains east of Steamboat Springs, CO. Wet deposition maps from the Mercury Deposition Network illustrate the majority of wet deposition in the local airshed does occur in mountainous areas.

A Mercury Deposition Network (MDN) monitoring site is located in Routt County just east of Steamboat Springs on Buffalo Pass. It is at the eastern edge of the airshed analyzed for this project (see map in BA). These monitoring stations measure the levels of mercury that are deposited during precipitation events (i.e. wet deposition). The Buffalo Pass site is the nearest MDN receptor to the action area. The Hayden Station is approximately 29 miles west of the Buffalo Pass MDN site. This site has provided data on the wet deposition of mercury to the MDN since 2007. According to the BA, data from this station in 2016 indicated that there was an annual wet deposition of 8.18 μg/m2 of mercury at that location from all sources.

4.1.2 Selenium

In addition to mercury emissions from the combustion of coal, another element known to be emitted is selenium. Selenium, a trace element, is a natural component of coal and soils in the region. While it may be released during combustion, it is not monitored at coal combustion stations to the same degree as mercury. No estimate as to the amount of selenium emitted annually and potentially deposited into the area was made in the BA.

When selenium is present in flue gas after combustion, it tends to behave much like sulfur and is removed to some extent via the Sulfur dioxide (SO_2) air scrubbers in place and also absorbs onto alkaline fly ash that is subsequently removed by a fabric filter bag house (EPRI 2008). Nevertheless, combustion of coal at the Hayden Station could result in some amount of selenium moving beyond pollution control processes, being emitted, and subsequently deposited on the landscape.

4.2 Discharge (Runoff) from the Foidel Creek Mine

The Foidel Creek Mine has been in operation for many years, first as an open pit coal mine, then as an underground mine. Longwall mining in the vicinity has occurred since approximately 1988. Middle Creek and Foidel Creek flow through the area of the LBA. Fish Creek is to the north of the LBA. Foidel Creek is a perennial tributary of Middle Creek, and Middle Creek and Fish Creek are perennial tributaries to Trout Creek; Trout Creek is a perennial tributary to the Yampa River. Runoff from the area affected by the proposed action would flow to Middle Creek and Foidel Creek, with a small portion of the LBA draining towards Fish Creek. Foidel Creek, Middle Creek, Fish Creek, and Trout Creek are not listed as impaired under CDPHE Section

303(d); however, all three creeks and their tributaries are on the Colorado Monitoring and Evaluation list for sediment (CDPHE 2018b).

Mine discharge may have contained some level of mercury and selenium since mining began. Past and current discharge levels up to this point are considered part of the baseline. As mining at the Foidel Creek Mine continues, mine discharge is expected to continue at current levels, which is considered part of the proposed action.

Surface flows from disturbed and reclaimed areas are intercepted and treated in sedimentation ponds prior to discharge to meet the EPA's National Pollutant Discharge Elimination System (NPDES) standards. The CDPHE Water Quality Control Division (WCQD) administers the NPDES for the EPA and the Colorado Discharge Permit System (CDPS) issues discharge permits. The mine's hydrologic monitoring program is subject to ongoing review under CDPHE's WQCD required Discharge Monitoring Reports. TC has five CDPS permits; each permit has 1-6 outfalls or monitoring sites.

Water discharge from the mine inflow water is also managed under TC's CDPS permit. Mine inflow water collects in underground sump rooms and is then pumped to the surface where it passes through the water treatment facility. This water is then either discharged to Fish Creek or returned underground for use in mining activities. Mine water can also be channeled and treated through surface settling ponds prior to discharging into Foidel Creek, or it can be returned for use underground. The discharge sites are rarely used because the Foidel Creek mine recycles much of the mine inflow water in various mining activities, especially dust suppression. If necessary, discharges are treated to meet CDPS permit effluent limits.

4.2.1 Mercury

According to the BA, water quality samples taken from monitoring points in Fish and Foidel Creek show that mercury was below detection limit for all samples. It is unknown if no mercury, or an undetectable amount of mercury, is being released by mine discharge as samples have been below the detection level. However, the main tributaries to the Yampa River in this area (Trout and Middle Creeks) are meeting water quality standards and are not listed as impaired.

Using these data, it is not possible to determine whether or not there is some amount or no amount of mercury being released from Foidel Creek Mine discharge. We can only say that mine discharges may possibly be releasing mercury that may ultimately reach the Yampa River at some concentration less than 1 μg/L. We believe it is reasonable to assume that the amount of mercury released in mine discharge, if any, is small in comparison to the mercury released into the environment through eventual combustion of the coal. Although the data is incomplete, it does not appear that the mercury in mine discharge, if any, is high enough to impair the Yampa River; the Yampa River downstream from the Foidel Creek Mine is not listed on the EPA 303(d) list of impaired waters for mercury.

4.2.2 Selenium

According to the BA, in 2016 discharge into Fish Creek occurred from May through early July. Water quality samples taken from monitoring points in Fish and Foidel Creek show average selenium concentrations of 1.1 µg/L. This concentration is below the chronic aquatic life standard criterion for selenium, which is 5 µg/L total and 4.6 ug/L dissolved (CDPHE 2012a). Note also that the Yampa River downstream from the Foidel Creek Mine is not listed on the EPA 303(d) list of impaired waters for selenium. It does not appear that mine discharge contributes selenium to the Yampa River in any appreciable amounts.

4.3 Effects to Endangered Fish

4.3.1 Mercury

Mercury is an environmental contaminant that can have adverse effects on riparian and aquatic wildlife (Scheuhammer et al. 2012; Wentz et al. 2014). Elevated levels of mercury in living organisms in mercury-contaminated areas may persist for as long as 100 years after the source of pollution has been discontinued (Eisler 1987). Eisler (1987, p. iii) states:

> Most authorities agree on six points: (1) mercury and its compounds have no known biological function, and the presence of the metal in the cells of living organisms is undesirable and potentially hazardous; (2) forms of mercury with relatively low toxicity can be transformed into forms of very high toxicity, such as methylmercury, through biological and other processes; (3) mercury can be bioconcentrated in organisms and biomagnified through food chains; (4) mercury is a mutagen, teratogen, and carcinogen, and causes embryocidal, cytochemical, and histopathological effects; (5) some species of fish and wildlife contain high concentrations of Hg that are not attributable to human activities; (6) anthropogenic use of Hg should be curtailed, as the difference between tolerable natural background levels of Hg and harmful effects in the environment is exceptionally small.

Aquatic systems receive mercury by direct deposition from the atmosphere and from overland transport from within the watershed (EPA 1997). Mercury primarily enters aquatic systems in an inorganic form where it can adsorb to suspended solids and settle to the bottom (EPA 1997). It can also be photo reduced in the upper few centimeters of the water's surface and then evade to the atmosphere. GOM at the sediment water boundary can be transformed into MeHg by sulfate-reducing bacteria, but this process can also go the other direction, depending on site-specific conditions. The most important areas for methylation are anoxic areas of the aquatic environment, such as wetlands or poorly mixed aquatic areas. The vast majority of mercury in fish tissue is in the form of MeHg (EPA 1997). Rates of methylation processes and bioaccumulation typically vary and depend on many factors.

The potential effects of mercury on fish are numerous. Lusk (2010) describes the potential affects as:

1. Potent neurotoxin:
    a. Affects the central nervous systems (reacts with brain enzymes, then lesions);
    b. Affects the hypothalamus and pituitary, affects gonadotropin-secreting cells;
    c. Altered behaviors: Reduced predator avoidance, reproduction timing failure;
    d. Reduced ability to feed (emaciation and growth effects).
2. Endocrine disruptor
    a. Suppressed reproduction hormones in male and female fish;

b. Reduce gonad size and function, reduced gamete production;
c. Altered ovarian morphology, delayed oocyte development;
d. Reduced reproductive success;
e. Transfer of dietary Hg of the maternal adult during oogenesis and into the developing embryo.

3. Inability to grow new brain cells or significantly reduce brain mercury.

Mercury contamination is a widespread problem across the United States. Nearly half of all lakes and reservoirs in the country are above the human health screening value for mercury (EPA 2009). The vast majority (97 percent) of health advisories issued by the EPA for the consumption of fish from lakes and reservoirs in 2008 were due to mercury, PCBs, dioxins and furans, DDT, and chlordane. Of these contaminants, mercury was by far the most commonly detected. Of the predacious fish sampled (as opposed to bottom-dwellers), 48.8 percent of the sampled population of lakes across the country had mercury tissue concentrations that exceeded the 0.3 micrograms per gram (parts per million) human health screening value for mercury, which represented a total of 36,422 lakes (EPA 2009).

4.3.3.1 Colorado pikeminnow

Of the four endangered fish in the Yampa and White Rivers, we expect the Colorado pikeminnow to be at greatest risk from exposure to mercury that has been deposited within the Yampa and White rivers from *project-related* emissions from the Hayden Station. This is due to two factors. First, Colorado pikeminnow have a higher likelihood of bioaccumulating mercury. Predatory organisms at the top of the food web generally have higher mercury concentrations in their bodies because mercury tends to biomagnify up through the food chain and concentrate in upper trophic levels (EPA 1997). Unlike the other three endangered fish, the Colorado pikeminnow is a top predator and is almost entirely piscivorous once it grows to be 80-100 mm (3 to 4 inches) long (Vanicek and Kramer 1969). The Colorado pikeminnow is also a long-lived fish, living 55 years or more (Osmundson et al. 1997). Thus, mercury will accumulate more rapidly and over a longer time period than in the other three endangered fish species.

Second, Colorado pikeminnow occupy habitats closer to the Hayden Generating Station than the other endangered fish and would, therefore, be exposed to the highest concentrations of mercury resulting *from the project*. Critical habitats designated for each endangered fish were based on areas of known occupancy. Only critical habitat designated for the Colorado pikeminnow is found within the 31-mile airshed identified for analysis in this consultation centered around the Hayden Station. The other three endangered fish and their critical habitats are found lower down in and along the Yampa River (razorback sucker, humpback chub, bonytail), and lower down in and along the White River (razorback sucker). We expect the contribution of mercury from the Hayden Station in the Yampa and White Rivers to diminish with distance from that point source through dilution (from additional water entering from tributaries) and removal (through biological uptake and potential adsorption to sediments).

Beckvar et al. (2005) suggested a threshold-effect level of $\leq$ 0.2 micrograms per gram (µg/g) wet weight (WW) mercury in whole body fish as being generally protective of juvenile and adult fish; concentrations below this level would not result in <u>any</u> detectible effects to these fish. To be able to compare concentrations in muscle tissue with whole body tissue, estimates have been calculated using the Model B regression equation and the intercept developed for Northern pikeminnow presented in Peterson et al. (2005), as explained earlier in the Environmental Baseline section. Using this equation, a concentration of 0.2 µg/g WW in whole body fish translates to a value of 0.31 µg/g WW in muscle tissue.

More recently, after an examination of numerous mercury studies, Sandheinrich and Wiener (2011) stated that freshwater fish begin to exhibit sub-lethal, yet detectible negative effects through changes in biochemical processes, damage to cells and tissues, and reduced reproduction at methylmercury concentrations of about 0.5-1.2 µg/g WW mercury in muscle tissue (0.3-0.7 µg/g WW mercury in whole body fish). They state that nearly all mercury in fish is in the form of methylmercury, as this is the form that bioaccumulates and biomagnifies up through the food chain. Note also that the EPA human health consumption advisory is 0.3 µg/g/day of mercury (WW) in fish tissue (EPA 2001).

As stated in the Environmental Baseline section above, we have historic information on the mercury concentrations found in Colorado pikeminnow tissue that were collected in the Yampa and White Rivers, but are lacking this historic data for the other three endangered fish. The mercury concentrations reported by Osmundson and Lusk (2012) ranged from 0.39 to 0.58 µg/g with a mean level of 0.49 µg/g in muscle plug samples taken from Colorado pikeminnow in the Yampa River. Prior to that, muscle plug samples taken from Colorado pikeminnow in the Yampa River in 2006 had concentrations of mercury between 0.42 and 0.68 µg/g (CDPHE 2015). Earlier still, Osmundson and Lusk (2012) reported on the mercury concentrations in muscle plugs taken from archival pikeminnow collected in the Yampa River during 1964-1966, which measured 0.41-0.88 µg/g total mercury. Most of these mercury concentrations are above the effects threshold suggested by Beckvar et al. (2005) (muscle tissue equivalent), but are below or at the concentrations identified by Sandheinrich and Wiener (2011) where negative effects would become detectible.

Osmundson and Lusk (2012) found that mercury concentrations in White River Colorado pikeminnow were higher than concentrations in Colorado pikeminnow in other river segments of critical habitat. They found a mean muscle tissue concentration of 0.95 µg/g in White River pikeminnow with a range of 0.43 to 1.83 µg/g (Osmundson and Lusk 2012). Colorado pikeminnow taken from the White River over 20 years earlier was reported at 0.5 to 1.75 µg/g of mercury in muscle tissue WW by Krueger (1988) (after conversion from whole body dry weight). The measured mercury concentrations indicate that some individuals of this endangered fish species with higher mercury concentrations have exceeded toxicity measurement thresholds and have mercury concentrations at a level where sub-lethal harmful effects become measurable in many other fish species (Sandheinrich and Wiener 2011).

Based on these results, we expect that some Colorado pikeminnow in the action area may already be experiencing chronic, sub-lethal harmful effects, such as potentially reduced reproductive success or reduced vigor, from elevated mercury concentrations. It should be noted, however, that piscivorous fish inhabiting fresh waters in the midwestern and eastern United States, and some waters in the western United States contaminated by mining activities, have been reported to contain concentrations exceeding 1.0 µg/g WW in muscle tissue (Sandheinrich and Wiener

2011). Thus, harmful effects to predatory fish from mercury are not isolated to this action area, but are part of a geographically widespread problem. These studies indicate that while harmful effects may begin to be measurable in individual fish with concentrations of 0.5 µg/g WW in muscle tissue, or possibly less, some adult fish can persist with muscle tissue concentrations exceeding 1.0 µg/g (WW) (Sandheinrich and Wiener 2011).

The harmful effects of methylmercury on fish populations at existing exposure levels in many North American freshwaters would be sub-lethal, such as cellular damage, reduced vigor, and reduced reproduction. Direct mortality due to methylmercury has been observed only at high concentrations (6-20 µg/g WW in muscle) (Sandheinrich and Wiener 2011).

Rather than direct mortality, we expect that chronic toxicity from exposure to mercury in the action area may be affecting the endangered fish, as discussed below. Chronic toxicity is the development of negative effects as the result of long term exposure to a toxicant or other stressor. It can manifest as direct lethality but more commonly refers to sub-lethal endpoints such as decreased growth, reduced reproduction, or behavioral changes such as impacted swimming performance.

Data from the Colorado Department of Public Health and Environment, Water Quality Control Division maintains a list of all waters in Colorado that exceed the total maximum daily loads for a variety of contaminants (CDPHE 2012b). Maintenance of this list is in accordance with Section 303(d) of the Federal Clean Water Act. The Water Quality Control Division does not list the Yampa or White Rivers as impaired for mercury levels.

Although not fully understood or quantified, we believe the primary impact from coal combustion to the Colorado River fish is from the emission and subsequent deposition of mercury and eventual integration into fish tissue. Mercury poses a greater threat to the Colorado pikeminnow, as compared to the other endangered fish in the action area, and a greater threat than selenium, which is discussed below. Mercury has no beneficial use at any concentration for vertebrates and is considered toxic at much lower tissue concentrations. The chronic aquatic life standard for mercury concentrations in water is more than two orders of magnitude smaller than that for selenium. In most endangered fish tissue samples analyzed from the action area, mercury was close to or somewhat above the more conservative safe tissue level presented by Beckvar et al. (2005) and some also above the higher risk threshold presented by Sandheinrich and Wiener (2011). As discussed below, selenium tissue concentrations tested in the action area have ranged from levels indicating a minimal hazard to those indicative of a high hazard.

It is possible that the mercury concentrations measured in Colorado pikeminnow might result in a minor reduction of vigor through reduced mental and physical reaction times, which would impact their ability to escape predation from northern pike, smallmouth bass, or other piscivorous predators. Reduced swimming ability could also lead to a reduction in feeding success (i.e., capturing other fish to eat). However, the nonnative competitors and predators in the action area, such as northern pike and smallmouth bass, are experiencing the same water mercury concentrations and therefore may not have a significant competitive advantage or increased predation success over Colorado pikeminnow in the presence of elevated mercury. There is also evidence, however, that different predaceous fish species bioaccumulate mercury at different rates even within the same river segment due, in part, to differences in fish physiology and diet (CDPHE 2015, MacRury et al. 2002, EPA 2004). In fact, CDPHE (2015) found average mercury levels in Colorado pikeminnow adults were more than twice as high as northern pike adults in the Yampa River, although the sample size was small and different river segments were sampled for each species (CDPHE 2015).

Despite the uncertainties outlined above, we can come to basic conclusions regarding the effect to endangered fish from the mining of TC coal and its eventual combustion. Given fish tissue mercury concentrations have been determined to be elevated in Colorado pikeminnow from both the Yampa and White Rivers, but in particular in the White River, and coal mining and combustion adds mercury to the system, this additional mercury adds to any negative effects resulting from mercury exposure. Based on the best available science, we believe some Colorado pikeminnow individuals are experiencing low, chronic negative health effects from mercury already in the action area. The mercury added by this project will add to the effects of this chronic condition, although the relative contribution of project-related mercury is assumed to be a very small percentage of the total mercury that has been and will continue to be deposited in the action area, as explained above.

Additionally, as stated in the Baseline section above, mercury concentration measurements have been higher in Colorado pikeminnow taken from the White River than from the Yampa River despite the fact that there are two coal-fired power plants (the Craig and Hayden Stations) located along the Yampa River and none within the White River watershed. This adds evidence to the assumption that *local* coal combustion from these power plants does not appear to constitute the primary source of mercury contamination in these watersheds.

Despite the chronic, low-level harmful effects of mercury that Colorado pikeminnow are likely experiencing, we believe the population decline seen in Colorado pikeminnow populations within the Yampa and White Rivers over the past decade or more is primarily a result of increased nonnative species in these rivers, especially northern pike and smallmouth bass. As explained in the baseline section above, these nonnative fish populations have increased and have applied increasing pressure on the Colorado pikeminnow population. Coal emissions from the Hayden Station have been largely constant since it became fully operational in the 1970s. The more recent decline of Colorado pikeminnow numbers in the action area coincides more closely with the expansion of nonnative fish, rather than any increase in mercury in the action area.

In addition, as discussed in the Baseline section above, the decline in Colorado pikeminnow numbers within the Yampa River has been more dramatic than the decline seen within the White River. This contrasts with the fact that mercury concentration measurements have been lower in Colorado pikeminnow taken from the Yampa River than from the White River.

While some Colorado pikeminnow individuals are likely to be experiencing low-level harmful effects from mercury in the system, we do not believe that the additional amount of mercury from the project will be enough to significantly or measurably reduce population numbers, reproduction, or constrain Colorado pikeminnow distribution.

4.3.3.2 Razorback sucker

The effects to the razorback sucker from project-generated mercury are similar to those described for the Colorado pikeminnow above, although likely to be less severe in the action area. The razorback sucker is not a piscivorous fish and would not bioaccumulate mercury as rapidly. Additionally, the razorback sucker does not occur as far upstream in the Yampa and White Rivers as the Colorado pikeminnow; thus, it does not occur as close to the point-sources for mercury resulting from the project. As with the Colorado pikeminnow, we believe nonnative species are the primary limiting factor for razorback sucker numbers, successful recruitment, and their distribution within the action area. While the evidence indicates that some razorback sucker individuals are likely being adversely affected by mercury in the system, we do not see evidence indicating that the negative effects from project-related mercury rise to the level of reducing population numbers, are limiting reproduction, or are constraining razorback sucker distribution.

4.3.3.3 Humpback chub

The effects to the humpback chub in the action area from project-generated mercury are similar to those described for the Colorado pikeminnow above, although perhaps less severe. The humpback chub is not a top predator and may not bioaccumulate mercury as rapidly. Additionally, the humpback chub does not occur as far upstream in the Yampa River as the Colorado pikeminnow, and is not known to occupy the White River in any significant way; thus, it does not occur as close to the point-sources for mercury resulting from the project. As with the Colorado pikeminnow, we believe nonnative species are the primary limiting factor for humpback chub numbers, successful recruitment, and their distribution within the action area. While the evidence indicates that some humpback chub individuals are likely being adversely affected by mercury in the system, we do not see evidence indicating that the negative effects from project-related mercury rise to the level of reducing population numbers, are limiting reproduction, or are constraining humpback chub distribution.

4.3.3.4 Bonytail

The effects to the bonytail in the action area from project-generated mercury are similar to those described for the Colorado pikeminnow above, although perhaps less severe. The bonytail is not a top predator and may not bioaccumulate mercury as rapidly. Additionally, the bonytail does not occur as far upstream in the Yampa River as the Colorado pikeminnow, and has only recently been stocked into the lower White River; thus, it does not occur as close to the point-sources for mercury resulting from the project. As with the Colorado pikeminnow, we believe nonnative species are the primary limiting factor for bonytail numbers, successful recruitment, and their distribution within the action area. While the evidence indicates that some bonytail individuals are likely being adversely affected by mercury in the system, we do not see evidence indicating that the negative effects from project-related mercury rise to the level of reducing population numbers, are limiting reproduction, or are constraining bonytail distribution.

4.3.2 Selenium

Selenium is required in the diet of fish at very low concentrations (0.1 µg/g) (Sharma and Singh 1984), but at higher concentrations it becomes toxic. The safe level of selenium concentration in water for protection of fish and wildlife is considered to be less than 2 ug/L, and chronically toxic levels are considered by some to be greater than 2.7 ug/L (Lemly 1993; Maier and Knight 1994). In Colorado, the chronic aquatic life standard for total selenium in water is 5 µg /L (=4.6 ug/L dissolved) (CDPHE 2012a). However, dietary selenium is the primary source for selenium in fish (Lemly 1993); selenium in water is less important than dietary exposure when determining the potential for chronic effects to a species (USEPA 1998).

Excess selenium in fish has been shown to have a wide range of adverse effects including mortality, reproductive impairment, effects on growth, and developmental and teratogenic effects including edema and finfold, craniofacial, and skeletal deformities (Lemly 2002). Excess dietary selenium also causes elevated selenium concentrations to be deposited into developing eggs, particularly the yolk (Lemly 2002, Janz et al. 2010, Buhl and Hamilton 2000). If concentrations in the egg are sufficiently high, developing proteins and enzymes become dysfunctional or result in oxidative stress, conditions that may lead to embryo mortality, deformed embryos, or embryos that may be at higher risk for mortality.

Of the four Colorado River fish species, we expect that excess selenium would disproportionately affect the razorback sucker somewhat more than the other three species (Hamilton et al. 2002; Osmundson et al. 2010). As with all sucker species, the razorback sucker is a bottom feeder and more likely to ingest selenium that has adsorbed to river sediments. Simpson and Lusk (1999) and Osmundson and Lusk (2011) reported on the concentrations of selenium in muscle tissues collected from Colorado pikeminnow and razorback suckers from the San Juan River. They found higher concentrations in razorback sucker than in Colorado pikeminnow; however, the average difference was only modest (3.5 mg/kg in razorback suckers vs. 3.0 mg/kg in Colorado pikeminnow, dry weight).

As stated in the Baseline section, the Yampa River has not exceeded the aquatic chronic toxicity standard for selenium. Water selenium concentrations in the White River have always registered below the chronic standard. Neither river is listed as impaired in the 303(d) EPA Clean Water Act list.

4.3.2.1 Colorado pikeminnow

Despite low water selenium concentrations in the Yampa and White Rivers, selenium was detected at high levels in Colorado pikeminnow tissue in the 1960s in the Yampa River. In the White River, the few Colorado pikeminnow that were tested in the 1980s showed that their selenium fish tissue levels indicated a minimal hazard. We do not know where current selenium fish tissue levels stand in Colorado pikeminnow in the Yampa or White Rivers, but given that water concentrations in these two rivers are generally below the chronic standard, we have no recent data indicating that there is immediate cause for alarm. This contrasts with the water selenium concentrations that have been measured within Colorado pikeminnow critical habitat along the Gunnison River, for example, where surface waters have often exceeded Colorado Water Quality Standards for selenium (CDPHE 2011).

As stated above, we believe nonnative species are the primary limiting factor for Colorado pikeminnow numbers, successful recruitment, and their distribution within the action area. While we do believe that further sampling and testing for selenium is warranted, we do not see any evidence indicating that potential effects from selenium rise to the level of reducing population numbers, are limiting reproduction, or are constraining Colorado pikeminnow distribution.

4.3.2.2 Razorback sucker

We have no data on past or current selenium fish tissue levels in razorback sucker in the Yampa or White Rivers. However, water selenium concentrations in these two rivers are generally below the chronic standard; we have no indication that there is immediate cause for alarm. This contrasts with the water selenium concentrations that have been measured within razorback sucker critical habitat along the Gunnison River, for example, where surface waters have often exceeded Colorado Water Quality Standards for selenium (CDPHE 2011).

As stated above, we believe nonnative species are the primary limiting factor for razorback sucker numbers, successful recruitment, and their distribution within the action area. While further sampling and testing for selenium is warranted, we do not see any evidence indicating that potential effects from selenium rise to the level of reducing population numbers, are limiting reproduction, or are constraining razorback sucker distribution.

4.3.2.3 Humpback chub

We have no data on past or current fish tissue selenium concentrations in humpback chub in the Yampa or White Rivers. However, water selenium concentrations in these two rivers are generally below the chronic standard. Very few humpback chub currently occupy the Yampa River, if any, and we have no data indicating that they occur in the White River. We have no data indicating that there is immediate cause for alarm, although further sampling and testing for selenium is warranted.

As stated above, we believe nonnative species are the primary limiting factor for humpback chub numbers, successful recruitment, and their distribution within the action area. While further sampling and testing for selenium is warranted, we do not see any evidence indicating that potential effects from selenium rise to the level of reducing population numbers, are limiting reproduction, or are constraining humpback chub distribution.

4.3.2.4 Bonytail

We have no data on past or current selenium fish tissue levels in bonytail in the Yampa or White Rivers. However, water selenium concentrations in these two rivers are generally below the chronic standard. Bonytail have only recently been stocked into the lower Yampa and White Rivers. We have no data indicating that there is immediate cause for alarm, although further sampling and testing for selenium is warranted.

As stated above, we believe nonnative species are the primary limiting factor for bonytail numbers, successful recruitment, and their distribution within the action area. While further sampling and testing for selenium is warranted, we do not see any evidence indicating that potential effects from selenium rise to the level of reducing population numbers, are limiting reproduction, or are constraining bonytail distribution.

4.4 Effects to Critical Habitat

In addition to impacts to individual Colorado River fish, impacts would also potentially occur to those species' designated critical habitats in the action area. The PBFs of critical habitat for all four endangered fish are identical and contain the following (50 CFR 13378):

1. Water: This includes a quantity of water of sufficient quality (i.e. temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, etc.) that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage for each species;
2. Physical Habitat: This includes areas of the Colorado River system that are inhabited or potentially habitable by fish for use in spawning, nursery, feeding, and rearing, or corridors between these areas. In addition to river channels, these areas also include bottom lands, side channel, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which when inundated provide spawning, nursery, feeding and rearing habitats, or access to these habitats;
3. Biological Environment. Food supply, predation, and competition are important elements of the biological environment and are considered components of this feature. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the species. Predation and competition, although considered normal components of this environment, can be out of balance due to introduced nonnative fish species.

4.4.1 Colorado pikeminnow

Mercury from the combustion of TC coal at the Hayden Generating Station that is deposited either directly or indirectly into the designated critical habitat for this species would have the potential to adversely impact its critical habitat. As stated in the Baseline section above, critical habitat for the Colorado pikeminnow occurs within the mercury deposition zone of analysis for this project. An increase in the amount of mercury in river water negatively impacts water quality (PBF #1). As stated in the Emissions section above, more than 99.9 percent of the mercury deposition within the action area is estimated to have been generated outside of the action area (EPRI 2017). Additionally, Federal coal from the LBA area would only be a portion of the coal combusted at the Hayden Station, so the impact from the proposed action to critical habitat is likely to be relatively small. Nevertheless, when added to the other regional and global sources of mercury being deposited into the action area and the mercury already within the system, additional mercury from the proposed action is likely to result in an adverse impact to critical habitat through a reduction in water quality.

Although potentially smaller than mercury, impacts to critical habitat from selenium added to the system through coal combustion, together with selenium added to the system by other sources, may also result adverse impacts to critical habitat for the endangered fish. However, current water quality data from the Yampa and White Rivers indicate that selenium levels have not exceeded the chronic aquatic life standard, and are likely to have less of an impact on water quality in critical habitat than mercury.

The Yampa and White Rivers are not currently listed as impaired for either mercury or selenium on the EPA 303(d) list (CDPHE 20102b). Considering together the contributions of mercury and selenium from the project to the Yampa and White Rivers in the context of existing water quality data, the weight of evidence indicates that PBF #1 in Colorado pikeminnow critical habitat is likely to be adversely affected through a reduction in water quality. However, water quality is not and would not be compromised to a point that it no longer would provide water of sufficient quality essential for the conservation of the species.

As discussed in the Status of the Species and Baseline sections above, endangered fish physical habitat (PBF #2) and the biological environment (PBF #3) are currently experiencing the most severe impacts, which are unrelated to the project (e.g., dams and diversions impacting PBF #2, nonnative species impacting PBF #3).

4.4.2 Razorback sucker

Razorback sucker critical habitat would be affected in a similar way by the project that Colorado pikeminnow critical habitat would be, as described above, but we expect the impacts to be of a lesser magnitude. Razorback sucker critical habitat does not extend as far up the Yampa or White Rivers and is, therefore, further from the point source of the Hayden Generating Station. Razorback sucker critical habitat is located downstream from, but not within, the mercury deposition airshed analyzed for this consultation. Mercury and selenium contributions to the action area diminish with distance from this point source. This increases our confidence that the project would not diminish water quality to a point where critical habitat can no longer provide the PBFs essential for the conservation of the species.

4.4.3 Humpback chub and bonytail

Critical habitat for the humpback chub and bonytail are identical in the action area. Their critical habitats would be affected in a similar way by the project that Colorado pikeminnow critical habitat would be, as described above, but we expect the impacts to be of a lesser magnitude. No critical habitat has been designated for the humpback chub or bonytail along the White River. Humpback chub and bonytail critical habitat does not extend as far up the Yampa River as Colorado pikeminnow or razorback sucker critical habitats and is, therefore, further from the point source of the Hayden Generating Station. Humpback chub and bonytail critical habitat is located downstream from, but not within, the mercury deposition airshed analyzed for this consultation. This increases our confidence that the project would not diminish water quality to a point where these critical habitats can no longer provide the PBFs essential for the conservation of these two species.

4.5 Cumulative Effects

The implementing regulations for section 7 define cumulative effects as "...*those effects of future State, or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation.*" 50 CFR § 402.02

Within the action area, two coal fired power plants exist, the Craig Generating Station and the Hayden Station. The effects from all non-federal coal combusted at both of these two power plants, which is expected to continue (i.e., reasonably certain to occur), are considered to be cumulative effects.

Mercury deposition from *non-federal* actions generated both within and outside of the action area are considered part of the cumulative effects. Thus, the bulk of the mercury that will be deposited in the action area in the future will come from regional and global non-federal actions (e.g., coal-fired power plants in Asia). These regional and global mercury sources have been depositing and will continue to deposit mercury within the action area. We assume that these inputs will continue at roughly the same deposition rate that the action area has experienced in the past. We have no information about any increase or decrease of coal-fired power plants globally, or of the increasing use of pollution control measures that would work to reduce mercury emissions.

Therefore, we assume a continuation of the mercury inputs into the action area that have been ongoing for years. These inputs have contributed to the current state of the action area regarding mercury, and will continue to maintain current mercury levels within the action area through future emissions, which is described in the Baseline section above. The effects to the endangered fish and their critical habitats from mercury within the action area are described in the Effects of the Action above. We are not assuming an increase or decrease in mercury inputs or outputs to the action area, and thus, do not expect a worsening of the condition of the endangered fish or their critical habitats from mercury contamination. Instead we expect a continuation of the status quo—chronic, sub-lethal insults to the most sensitive individuals, which does not rise to the level of a large and readily detectable decrease in numbers, reproduction, or distribution.

4.6 Jeopardy discussion and Conclusion

After reviewing the current status of the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the project, as described in this biological opinion, is not likely to jeopardize the continued existence of the four endangered fish. We have reached this conclusion based on the following reasons:

- Of the four endangered fish, mercury concentrations in the action area in fish tissue have only been reported for the Colorado pikeminnow, which is the species most likely to bioaccumulate mercury. Mercury concentrations in many Colorado pikeminnow within the action area have been somewhat elevated in the past and indicate that the species is likely to be experiencing negative, sub-lethal impacts from mercury that are not insignificant. We do not have evidence, however, that mercury in the action area in general, or the mercury released by project activities in particular, is causing population level effects for any of the endangered fish species.

- To the extent a degraded baseline condition exists within the endangered fish from mercury contamination, we believe the proposed action does not contribute to the deepening of such degradation in a significant way. The baseline condition is not degraded by mercury to an extent that the likelihood of recovery would be reduced appreciably solely due to the additional amount of mercury that will result from the action.

- Data on fish tissue selenium concentrations in the action area are rather sparse and inconclusive and have not been collected in all four of the endangered fish. However, the most recent fish tissue concentrations do not indicate a risk to fish health.

- None of the four endangered fish species are meeting recovery targets within the Green River subbasin, which includes the Yampa and White Rivers in the action area. However, we believe this is primarily a result of nonnative species that have increased in the action area and large-scale habitat alteration (e.g., dams and diversions). These impacts are not increased as a result of the proposed action.

4.7 Destruction and Adverse Modification Discussion and Conclusion

After reviewing the current status of the critical habitats for the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail, the environmental baseline for critical habitats within the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the project, as described in this biological opinion, is not likely to destroy or adversely modify any of the critical habitats designated for the four endangered fish. We have reached this conclusion based on the following reasons:

- Despite a few elevated mercury concentrations in the water, most reported values in both the White and Yampa Rivers, which includes all critical habitats in the action area, have been below the detection limit or below the state standard. Neither the Yampa River nor the White River is on the 303(d) list of impaired waters for mercury. If the project is approved, current project activities would continue. Given this, we do not expect mercury water concentrations to increase from project activities if approved.

- Water selenium concentrations in the Yampa and White Rivers, which includes all critical habitats in the action area, have not exceeded the chronic aquatic life standard in the past, according to the best available data. Neither the Yampa River nor the White River is on the 303(d) list of impaired waters for selenium. If the project is approved, current project activities would continue. We do not expect water selenium concentrations to increase from project activities if approved.

5.0 INCIDENTAL TAKE STATEMENT

Section 9 of the Act, as amended, and federal regulations prohibit the take of endangered and threatened species, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Harm is further defined by the Service as an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Harass in the definition of ''take'' in the Act means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Under the terms of section 7(b)(4) and section 7(o)(2) of the Act, taking that is incidental to and not intended as part of the agency action is not considered to be a prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

As the Service explained in the effects section, there were many challenges to describing specific effects to individuals of the four endangered fish. Anticipation and exemption of incidental take is at the individual of the species scale and must be reasonably certain to occur (CFR 50 402.14(g)(7)). This requires that the Service build a reasonable basis to conclude that individuals of the four endangered fish will be subjected to adverse effects that in turn are reasonably certain to result in actual injury or death. In this biological opinion we are unable, based on the best available information, to find circumstances that support such a conclusion. Without, specific information on the potential range of effects to individuals, we are also unable to develop a surrogate for the potential take of the four endangered fish. Therefore, no take is anticipated or exempted by this incidental take statement.

We were, however, able to explain that the broad range of potential adverse effects to the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail in the action area would not be likely to result in jeopardy to any of these species or destruction or adverse modification to their critical habitats. This finding satisfies Congress' direction in 7(a)(2) of the Act that "*Each Federal agency ...insure that any action ...is not likely to jeopardize the continued existence of any endangered species or threatened species, or result in destruction or adverse modification of habitat...determined by the Secretary... to be critical*."

We also explained that BLM committed to further funding a study examining contaminant concentrations in fish tissue in the action area which will increase our knowledge regarding anticipated effects to individuals. This will assist in the effort to determine to what extent individual endangered fish (if any) are being subjected to mercury and selenium concentrations that are likely to lead to injury and death.

Monitoring and Reporting

BLM shall monitor the progress of the proposed action (including implementation of the conservation measure) and report that progress to the Service on an annual basis. The report shall be sent to the Western Colorado Ecological Services office by no later than March 31st.

This information can also be used by BLM to identify any potential need to reinitiate consultation on this action (see reinitiation triggers below).

6.0 CONSERVATION RECOMMENDATIONS

1. Efforts are underway to measure mercury concentrations in the White and Yampa Rivers both in fish and in the water. Riparian and aquatic insects living in and along these rivers, which are eaten by endangered fish (e.g., humpback chub, bonytail) and yellow-billed cuckoos, are likely to also contain some level of mercury. Should funding become available, we recommend that mercury concentrations be measured in insects that serve as food sources for these threatened and endangered species (e.g., large terrestrial insects found in cottonwood galleries and common aquatic insects found within endangered fish critical habitat).

7.0 REINITIATION

This concludes formal consultation on BLM's proposed action involving a coal lease by application at the Foidel Creek Mine and eventual combustion of a portion of that coal at the Hayden Generating Station. As provided in 50 CFR §402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) If the amount or extent of taking specified in the incidental take statement is exceeded; (b) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or (d) If a new species is listed or critical habitat designated that may be affected by the identified action.

As part of our approach to analysis we have had to make a series of assumptions. One of those assumptions is that the current levels of mercury in endangered fish tissue within the action area is similar to what has been measured in the past, as discussed in the Baseline and Effects of the Action sections above. The BLM-funded conservation measure, as described above, is expected to help shed new light on mercury concentrations in fish tissue in the action area. If the results of this or similar studies indicate that fish tissue concentrations are much higher than expected based on past sampling, reinitiation of this consultation may be necessary. Other future studies may contribute information relevant to the effects of the action and this consultation.

If, during implementation of the proposed action, changes in circumstances, situation, or information regarding the proposed action occur, BLM will assess the changes and any potential impacts to listed species, review the re-initiation triggers above, coordinate with the Service, and make a determination as to whether re-initiation is necessary.

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Appendix E

Socioeconomic Report for the
Peabody Twentymile Coal LLC Lease-by-Application

Socioeconomic Report

for the

Peabody Twentymile Coal, LLC
Lease-by-Application COC78449

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March 2018

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

ACS	American Community Survey
AML	Abandoned Mine Lands
BEA	Bureau of Economic Analysis
BLM	Bureau of Land Management
BLS	Bureau of Labor Statistics
CCD	Census County Division
CDLE	Colorado Department of Labor and Employment
CDOLA	Colorado Department of Local Affairs
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CPW	Colorado Parks and Wildlife
DRMS	Division of Reclamation, Mining and Safety
EIA	Energy Information Administration
FY	Fiscal Year
GDP	Gross Domestic Product
I-O	Input-output
IRS	Internal Revenue Service
LBA	Lease-By-Application
LSFO	Little Snake Field Office
NEPA	National Environmental Policy Act
ONRR	Office of Natural Resources Review
OSMRE	Office of Surface Mining Reclamation and Enforcement
RIMS II	Regional Input – Output Modeling System II
TC	Twentymile Coal, LLC

1.0 BACKGROUND

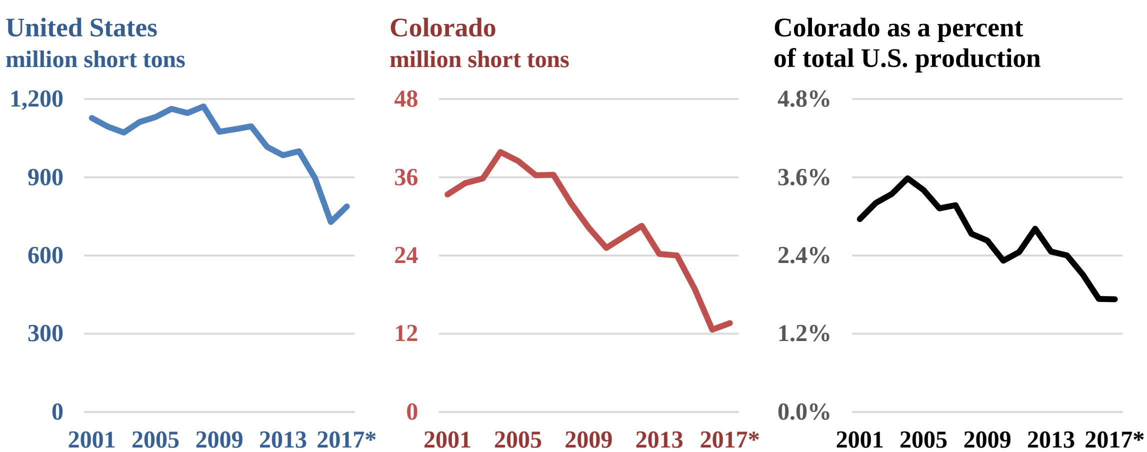
1.1 Current Proposal

Twentymile Coal, LLC (TC) has submitted an application to the BLM (Bureau of Land Management) Little Snake Field Office (LSFO) for a 640 acre coal Lease by Application (LBA) (COC78449) at its Foidel Creek Mine in Routt County, Colorado (Map 1). The proposed LBA is for the Wolf Creek coal seam within the existing Foidel Creek Mine permit boundary. If approved by the BLM and if developed by TC, the LBA would extend the life of the Foidel Creek Mine by approximately 2 years beyond its estimated 9 year productive life mining the remaining coal reserves in current leases (Nettleton 2018). This report assesses the potential impacts of LBA approval on the economies of Routt County and neighboring Moffat County, which are linked by mining industry ties and worker commuting patterns.

1.2 Overview of National and State Coal Production Revenues

Over 90% of the coal produced in the United States is used to generate electricity. The remainder is used to produce steel, cement, medicines, paper, fertilizers, plastics, synthetic fibers, and other industrial products.

As shown in Figure 1, coal production in the United States increased from 1.13 billion (short) tons in 2001 to 1.17 billion tons in 2008. It subsequently decreased to 728 million tons in 2016 before recovering slightly to an estimated 788 million tons in 2017, based on interpolated weekly production data (Energy Information Administration [EIA] 2018a, 2017, 2007, 2001).



Source: EIA 2018a, 2017, 2007, 2001.
* 2017 totals are from interpolated monthly aggregate production data in the EIA's Weekly Coal Production Report.

Figure 1. Annual Coal Production in the United States and Colorado, 2001 – 2017

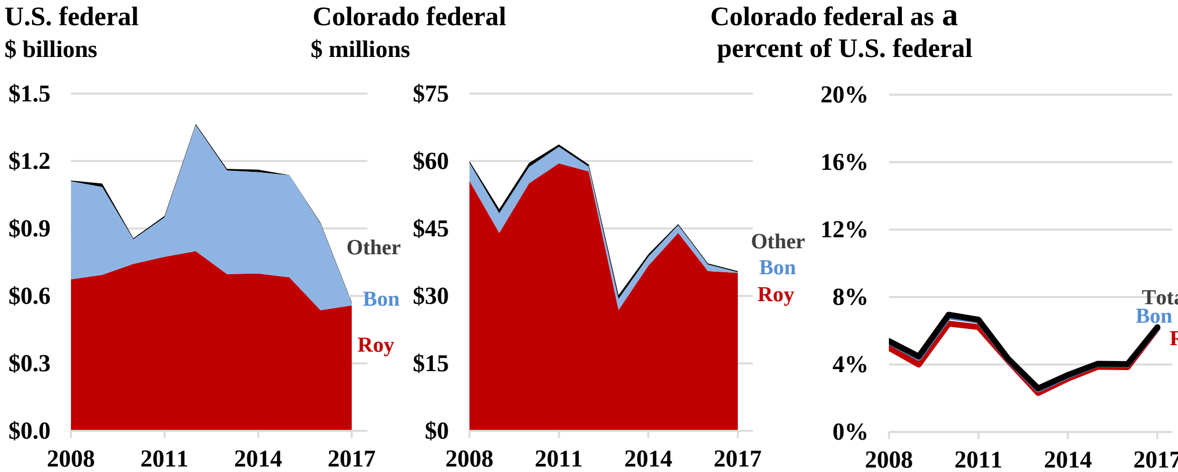
Coal production in Colorado has decreased at a greater rate than in the United States, causing the state's share of national coal production to decrease (see Figure 1). Colorado coal production increased from 33.41 million tons in 2001 (3.0% of total U.S. coal production) to 37.82 million tons in 2005 (3.4% of total U.S. coal production). Since then, Colorado's share of national coal production has fallen by half, to 1.7% of national production in 2017 (EIA 2018a, 2017, 2007, 2001). Although surface mines produce most of the nation's coal, underground mines produce the majority of coal in Colorado. Coal production from underground mines has fallen faster than production from surface mines since 2010. Underground mines accounted for 80% of Colorado's coal production in 2010 and 70% in 2017 (Colorado Division of Reclamation, Mining and Safety [DRMS] 2018). Longwall mining is the predominant method of underground coal mining in Colorado.

Coal production provides several sources of revenue to federal and state governments. Revenues from federal and state coal leases, abandoned mine reclamation fees, coal excise tax, and severance tax are foremost among these revenue sources.

1.2.1 Federal Coal Lease Revenues

Nearly 60% of the coal produced in Colorado is mined on lands in which the federal government owns the mineral estate. Revenues associated with federal coal leases include bonus payments, which are paid at the time the lease is issued, annual rent payments of at least $3 an acre, and a royalty rate on the gross value of production of 12.5% for surface coal and 8% for underground coal. For all types of coal leases, the BLM is authorized to reduce the royalty for the purpose of encouraging the recovery of federal coal and, in the interest of conservation of federal coal and other resources, whenever it is necessary to promote development or when the lease cannot be successfully operated under its terms. In no case can the royalty on a producing federal lease be reduced to zero (43 Code of Federal Regulations [CFR] §§3473.3-2(e), 3485(c)(1) (2013)). The BLM may approve royalty rate reductions for new leases.

Revenue collections from federal coal leases increased from $1.11 billion in fiscal year (FY) 2008 to $1.36 billion in FY 2012 (see Figure 2). This was largely due to a spike in bonus bid payments for coal leases, although higher royalty revenues from coal production sales also contributed. Royalty and bonus bid revenues have decreased steadily since FY 2012, and were $571 million in FY 2017. During this time federal royalty receipts from coal production decreased from $799 million to $558 million, and federal bonus bid payments from coal leases decreased from $561 million to $9 million, largely due to the coal leasing moratorium (Office of Natural Resources Revenue [ONRR] 2018a).



Source: ONRR 2018b.
Notes: Roy = federal royalties, Bon = bonus payments, Other = other revenues, which include minimum and estimated royalty payments, settlements agreements and interest. Coal revenues shown include federal onshore coal by accounting year. Percentages are cumulative.

Figure 2. Annual U.S. and Colorado Federal Coal Receipts by Source, FY 2008 – 2017

Royalty payments have accounted for almost all federal coal revenues from Colorado in recent years, largely because there has been little new federal coal leasing to support bonus bid payments. Federal coal receipts from Colorado peaked at $64 million in FY 2011 (6.7% of all federal onshore receipts), with $59 million coming from royalty payments. A decrease in federal royalty payments over the next two years caused receipts from Colorado to fall to $30 million in FY 2013 (2.6% of all federal onshore receipts). Most of the decline in royalty revenues came from Gunnison and Routt counties, where the state's two largest mines, the West Elk Mine in Gunnison County and Foidel Creek Mine in Routt County, are located. Federal revenue from Colorado coal production increased to $46 million in FY 2015, before flattening at $36 million in FY 2017. This was a less severe decrease than the fall in federal coal receipts throughout the remainder of the United States. Consequently, Colorado's share of total federal coal receipts increased from 4.0% in FY 2015 to 6.2% in FY 2017 (ONRR 2018b).

Federal coal lease revenues returned to the State of Colorado increased from $30.53 million in 2003 to $63.69 million in 2011 and decreased to $37.24 million in 2016. Over this period royalties accounted for 93% of Colorado's revenues from federal coal leases, bonus bid payments accounted for 6%, and rents and miscellaneous payments accounted for 1 percent (ONRR 2018a).

The Colorado Department of Local Affairs (CDOLA) distributes a share of the state's portion of federal royalty payments to counties, municipalities and school districts that are economically and socially impacted by mineral production on federal lands. The amount of federal royalties returned to counties depends primarily on the number of county residents employed in extractive industries and the amount of money credited to the state's mineral leasing fund generated within the county compared to the respective statewide totals (CDOLA 2011a).

Revenues from federal coal lease bonus payments in Colorado are divided equally between the state's Local Government Permanent Fund and Higher Education Maintenance and Reserve Fund. Revenues remain in the Local Government Permanent Fund unless royalty revenues fall below a target level, in which case they can be applied to direct distributions of royalties to local governments. Interest earned on the principal in the Higher Education Maintenance and Reserve Fund is used to fund maintenance and capital improvement projects at public institutions of higher education in the state. The principal remains in the fund unless revenue in the state's General Fund falls below a target level, in which case the principal can be used for operating expenses at public institutions of higher education (Colorado Legislative Council Staff 2008).

1.2.2 AML Fees

Active coal mine operators on federal, state and private mineral estates pay quarterly fees to the Abandoned Mine Lands (AML) program, which is administered by the Office of Surface Mining Reclamation and Enforcement (OSMRE) to fund the clean-up and reclamation of coal mine sites abandoned prior to the enactment of the Surface Mining Control and Reclamation Act of 1977. The AML fee is $0.315 per ton for surface coal and $0.135 per ton for underground coal, or 10% of the value of a mine's coal output, whichever is lower. Half of the collected AML fees are allocated to the state or tribe that collected them and distributed through grants to finance mine reclamation projects. The OSMRE uses the other half to reclaim abandoned mine sites across the country, fund health and retirement funds for mine workers, and cover operating expenses. Abandoned Mine Lands fee collections decreased from $280 million for FY 2008 to $160 million for FY 2017. From these collections, $140 million was distributed to states and tribes through regulatory and AML grants for FY 2009 and $79 million was distributed for FY 2018. Colorado received an additional $2.29 million of historic distributions, or $3.26 million after applying the national 6.6 reduction (OSMRE 2018).

1.2.3 Coal Excise Tax

All coal production is subject to an excise tax upon the first sale or use of the coal (Internal Revenue Service [IRS] 2005). Excise tax revenues are deposited into the Black Lung Disability Trust Fund and used to finance payments of black lung benefits to afflicted miners. The current excise tax rates are $0.55 per ton for surface coal and $1.10 per ton for underground coal, or 4.4% of the sale price, whichever is lower. On January 1, 2019, the excise rates are scheduled to decline to $0.25 per ton for surface coal and $0.50 per ton for underground coal, or 2% of the sale price, whichever is lower. Coal excise tax revenues peaked at $252.87 million in 2002 and decreased to $143.79 million in 2010 and $75.13 million in 2016 (IRS 2017).

1.2.4 State Severance Tax

Severance tax applies to production from all mineral leases. The first 300,000 tons of coal produced per calendar quarter are exempt from severance tax in Colorado. Colorado's severance tax on coal is based on a basic rate of $0.36 per ton and adjusted quarterly based on inflation. Coal produced from underground mines receives a 50% tax credit. In 2017, the quarterly severance tax rate on coal produced in Colorado averaged $0.808 per ton for surface coal and $0.404 per ton for underground coal (Colorado Legislative Council Staff 2018). Coal accounts for a small portion of the state's severance tax revenues, which are dominated by oil and gas. Between 2012 and 2016 net severance tax revenues (severance tax collections less refunds) from coal, molybdenum, and metallic minerals ranged from $12.04 million in 2012 to $5.06 million in 2016 and represented 5% of total severance tax revenues over this period (Colorado Department of Revenue 2016).

The counties and municipalities impacted by mineral production receive 50% of Colorado's severance tax revenues. The CDOLA allocates 70% of these funds to local governments through discretionary grants and loans, and distributes the remaining 30% directly to municipalities and counties impacted by mineral production. The allocation of severance tax revenue to counties depends on the proportion of residents in the county who are employed in extractive industries, the proportion of oil and gas well permits issued in the county, and the proportion of mineral production in the county relative to the respective statewide totals (CDOLA 2011a).

1.2.5 State Royalties

Royalty payments on state coal leases generate additional revenues to the state of Colorado. Royalty rates on state-owned coal are 12.5% for surface coal and 8% for underground coal. The Colorado State Board of Land Commissioners can reduce the state's royalty rate for many of the same reasons that the BLM can. Approximately 95% of the state royalties are distributed to the state School Trust, which funds K-12 public schools. The remaining 5% is allocated to trusts that fund higher education, Colorado Parks and Wildlife (CPW), state penitentiaries, and public buildings.

2.0 FOIDEL CREEK MINE

2.1 Study Area

TC has been mining at the Foidel Creek Mine by underground methods since 1983. Mining at the Foidal Creek Mine has historically occurred in the Wadge seam. The Foidel Creek Mine produced an average of 7.85 million tons of coal per year between 2001 and 2014, and was the most productive mine in the state. Development mining in the Wolf Creek seam began in 2015. The mine's output fell to 4.12 million tons in that year, and Gunnison County's West Elk Mine overtook the Foidel Creek Mine as the state's top coal producer. Longwall mining in the Wadge seam ended in June 2016 and began in the Wolf Creek seam in September 2016. The Foidel Creek Mine remained the second most productive mine in the state in 2017, with an output of 3.84 million tons of coal (DRMS 2018).

The Foidel Creek Mine is currently the only operating coal mine in Routt County. It is located in the western part of the county, approximately 7 miles from the town of Oak Creek, which had an estimated 2016 population of 914. The towns of Hayden (population 1,883) and Steamboat Springs (population 12,698) are each approximately 15 miles from the Foidel Creek Mine, and the city of Craig (population 8,823) is approximately 36 miles west of the mine in Moffat County (CDOLA 2017a).

Steamboat Springs is a popular tourist destination for skiing and other outdoor recreation activities. The cost of housing in Routt County is substantially higher than in Moffat County. According to the Census Bureau's 2012 - 2016 American Community Survey (ACS), the median home value in Routt County was $424,300, compared to a median home value of $170,000 in Moffat County. Over that period, nearly 44% of occupied homes in Routt County, and only 2% in Moffat County, had a value of $500,000 or more (Census Bureau 2017a). Consequently, many Routt County workers live in Moffat County. According to the 2009 – 2013 ACS (the latest period for which commuting data are available) 16% of employed Moffat County residents over the age of 16 (an estimated 1,015 workers) worked in Routt County (Census Bureau 2017b).

Approximately 60% of the Foidel Creek Mine's current workforce lives in Moffat County (Brady 2018). The Foidel Creek Mine has additional links to Moffat County in that Craig is a service center for the region's coal mines, which, in addition to the Foidel Creek Mine, include the Colowyo Mine in Moffat and Rio Blanco counties, Trapper Mine in Moffat County, and the Sage Creek Mine (idle since September 2012) in Routt County. For these reasons, the Study Area for the current analysis was defined to include Routt and Moffat counties. Combined, these two counties accounted for 50% of Colorado's 2017 coal production (DRMS 2018).

2.2 Population

2.2.1 Current Conditions

The Study Area is sparsely populated, covering 6.8% of Colorado's land, yet having only 0.7% of its 2016 population. Based on CDOLA population estimates, in 2016 Routt and Moffat counties had an average of 10.4 and 2.8 persons per square mile, respectively, compared to a statewide population density of 53.2 persons per square mile.

In recent years the rate of population growth in the Study Area has been below the statewide average. Colorado's population increased from 4,338,801 in 2000 to 5,050,322 in 2010 and 5,538,180 in 2016, for an average annual growth rate of 1.5 percent. Between 2000 and 2010 Routt County's population increased from 20,123 to 23,439, for an average annual growth rate of 1.5 percent. The county's population increased to 24,679 in 2016, for average annual growth of 0.9% between 2010 and 2016. Moffat County's population has grown more slowly. Between 2000 and 2010 Moffat County's population increased from 13,182 to 13,806 (average annual growth of 0.5%) and decreased to 13,088 in 2016 (average annual growth of -0.9 percent) (CDOLA 2017a).

The CDOLA projects that, between 2016 and 2030, Colorado's population will increase by an average of 1.6% per year, and that the state's population will total 6,892,129 in 2030. CDOLA projects that Routt County's population will increase by an average of 2.1% per year between 2016 and 2030, when the county will have 32,916 residents. Slower growth is projected for Moffat County, which is projected to have 13,389 residents in 2030, for average annual growth of 0.2% between 2016 and 2030 (CDOLA 2017b).

2.2.2 Estimated Impacts

If the LBA is approved, mining operations at the Foidel Creek Mine would continue in the new lease tract at current mining levels and the mine's life would be extended by approximately 2 years. Employment at the mine would remain near current levels and there would be no impact on population levels or trends in the Study Area.

2.3 Employment and Income

Unless stated otherwise, all monetary values reported below are in nominal, or current year, dollars.

2.3.1 Current Conditions

Income. Personal income includes net earnings; dividends, interest, and rent (also known as investment income); and personal current transfer receipts, which are payments for services not currently performed. In Routt County the contribution of earnings to personal income is decreasing and the contribution of dividends, interest, and rent is increasing. Per capita personal income in Routt County increased from $34,594 in 2000 to $49,853 in 2010 and to $71,167 in 2016. As a portion of personal income, earnings decreased from 68.2% in 2000 to 48.6% in 2016, and income from dividends, interest and rent increased from 27.6% in 2000 to 44.1% in 2016. Current transfer payments increased from 4.2% of personal income in Routt County to 7.3% in 2016 (Bureau of Economic Analysis [BEA] 2017a).

Earnings are the primary source of income in Moffat County. The contribution of earnings to personal income is, however, decreasing, while the contribution of transfer receipts is increasing. Per capita personal income in Moffat County increased from $23,478 in 2000 to $31,880 in 2010 to $39,224 in 2016. As a portion of personal income, earnings decreased from 73.5% in 2000 to 64.0% in 2016, and transfer payments increased from 11.9% in 2000 to 19.6% in 2016. Dividends, interest, and rent accounted for 14.6% of personal income in Moffat County in 2010 and 16.4% in 2016 (BEA 2017a).

Employment. Routt County has a larger employment base than Moffat County. Total employment in Routt County (including wage and salary employment and self-employed individuals) increased from 18,584 jobs in 2000 to 20,862 jobs in 2010 (12.3% increase) to 22,994 jobs in 2016 (10.2% increase over 2010). In Moffat County, employment increased from 7,251 jobs in 2000 to 7,600 jobs in 2010 (4.8% increase). Employment in Moffat County was 7,206 in 2016, a 5.2% decrease compared to 2010 employment levels (BEA 2017a).

Sectoral Employment and Wages. In 2016 the largest sources of wage and salary employment in Routt County were Accommodation and Food Services (2,322 jobs), Retail Trade (1,624 jobs), Arts, Entertainment and Recreation (1,459 jobs), Health Care and Social Assistance (1,375 jobs), and Construction (1,100). Combined, these sectors provided 54% of Routt County's wage and salary employment in both 2010 and 2016. The mining sector accounted for 4% of Routt County's wage and salary employment in 2010 (519 jobs) and 2.7% in 2016 (400 jobs). In 2016, annual wages in Routt County averaged $43,249. The highest wages were in Management of Companies and Enterprises ($139,655), Finance and Insurance ($110,769), Mining ($91,896), and Utilities ($89,447). The lowest wages were in Accommodation and Food Services ($25,383) and Arts, Entertainment and Recreation ($26,667).

In 2016 the largest sources of wage and salary employment in Moffat County were Retail Trade (698 jobs), Health Care and Social Assistance (567 jobs), Public Administration (546 jobs), Mining (464 jobs), and Accommodations and Food Services (459 jobs) (Colorado Department of Labor and Employment [CDLE 2017]). Together, these sectors provided 57% of Moffat County's wage and salary employment in 2010 and 58% in 2016. The county's greatest job losses between 2010 and 2016 were in Mining (127 lost jobs), Public Administration (68 lost jobs) and Wholesale Trade (56 lost jobs). In 2016, annual wages averaged $46,039 in Moffat County. The highest wages were in Mining ($82,663) and Finance and Insurance ($53,969), and the lowest wages were in Accommodation and Food Services ($15,811) and Retail Trade ($29,480) (CDLE 2017).

Foidel Creek Mine Employment. The Foidel Creek Mine had 322 employees in 2001. Employment at the mine increased through most of the decade and peaked at 539 workers in 2009. The mine had 283 employees in 2016 and 269 workers in 2017 (DRMS 2018). The mine operates 24 hours a day, seven days a week.

Unemployment Rates. Unemployment rates in Routt and Moffat counties closely tracked the statewide unemployment rate between 2000 and 2016, with Routt County's unemployment rate generally lower than unemployment rates in Moffat County and Colorado. In 2000, the unemployment rate was 2.8% in Colorado, 2.5% in Routt County, and 3.6% in Moffat County. Reflecting the national economic recession and downturns in energy markets, unemployment rates peaked in 2010, at 8.7% in Colorado, 9.3% in Routt County, and 9.9% in Moffat County. Unemployment rates in all jurisdictions have decreased since then, and were 3.3% in Colorado, 2.7% in Routt County, and 4.0% in Moffat County in 2016. Recent declines in the Study Area's unemployment rates, especially in Moffat County, have been due in part to decreases in the size of the labor force (i.e. the number of people either employed or actively seeking employment). Labor force levels in 2016 were at their lowest since 2006 in Routt County and 2001 in Moffat County (Bureau of Labor Statistics [BLS] 2017).

Table 1 lists demographic and economic indicators in Routt and Moffat counties in 2000, 2010, and 2016.

Table 1.
Routt and Moffat County Demographic and Economic Indicators, 2000, 2010, and 2016[1]

Indicator	2000	2010	2016
Routt County			
Population[2]	20,123	23,439	24,679
Personal Income[3]	$685,488,000	$1,168,913,000	$1,754,119,000
Net earnings by place of residence[3,4]	$467,533,000	$718,659,000	$852,402,000
Dividends, interest and rent[3]	$189,280,000	$355,340,000	$773,051,000
Personal current transfer receipts[3,5]	$28,675,000	$94,914,000	$128,666,000
Per Capita Personal Income[3]	$34,594	$49,853	$71,167
Employment[3]	18,584	20,862	22,994
Unemployment Rate[6]	2.5%	9.3%	2.7%
Moffat County			
Population[2]	13,182	13,806	13,088
Personal Income[3]	$308,668,000	$440,330,000	$514,447,000
Net earnings by place of residence[3,4]	$226,969,000	$300,639,000	$329,225,000
Dividends, interest and rent[3]	$45,100,000	$60,345,000	$84,326,000
Personal current transfer receipts[3,5]	$36,599,000	$79,346,000	$100,896,000
Per Capita Personal Income[3]	$23,478	$31,880	$39,224
Employment[3]	7,251	7,600	7,206
Unemployment Rate[6]	3.6%	9.9%	4.0%

Sources and notes:
1 All monetary values are expressed in nominal, or current year, dollars.
2 CDOLA 2017a.
3 BEA 2017a.
4 Net earnings by place of residence equal earnings by place of work less contributions for government social insurance plus an adjustment for residence (net inflow of the earnings of interarea commuters.
5 Personal current transfer receipts includes income payments for which no current services are performed, and is the sum of government social benefits and net current transfer receipts from business.
6 BLS 2017.

2.3.2 Estimated Impacts

Economic Impact Analysis. Economic impact analysis is the analytical approach used to assess the measurable direct and indirect impacts that result from a project over a specified period of time. Only impacts that can be quantified are included in the analysis; intangible impacts, such as community character, social welfare and other values, are not included. Economic impact analysis focuses on the economic activity that occurs within a specified geographic area. This analysis estimates the economic impacts of LBA-COC78449 approval on the economies of Routt and Moffat counties.

The spending patterns associated with operations at the Foidel Creek Mine have spin-off or multiplicative impacts in the Study Area's local economy. The multiplicative impacts are identified as "indirect" and "induced" economic impacts. For example, when the Foidel Creek Mine purchases supplies from a local vendor, that vendor provides payroll to its employees and makes purchases from other local vendors. In turn, these other venders provide payroll to their employees and make purchases from other vendors and so one, providing the indirect impact of the initial dollar spent. Similarly, when the mine's employees spend their paychecks at local businesses, these businesses provide payroll to their employees, make purchases from other local vendors, and so on, creating the induced impact.

As a result, the mine's initial spending on business purchases, employee compensation and other operational expenses is circulated throughout the local economy numerous times. The number of times the initial dollars are circulated throughout the local economy can be estimated using economic multipliers. An economic multiplier summarizes the total impact that can be expected within a specific geographic area due to a given industry's level of business activity. Generally, industries that either spend more dollars locally, pay higher salaries, and/or sell their goods and services outside the local area are associated with larger multipliers.

The Regional Input-Output Modeling System II (RIMS II) developed by the BEA of the U.S. Department of Commerce estimates the indirect and induced jobs and income flows generated by direct local spending patterns. RIMS II generates multipliers that are based on the BEA's Benchmark Input-Output (I-O) accounts for the national economy and the BEA's regional economic accounts, which adjust the national I-O accounts to show a region's industrial structure and trading patterns. RIMS II is widely used by public and private researchers to estimate a project's economic impacts across a regional economy. For example, RIMS II has been used to estimate the economic impacts of defense spending (Rand Corporation 2015, Wichita State University 2009), and, in Colorado, it has been used to estimate the regional impacts of higher education (Development Research Partners 2016, Adams Group, Inc. 2007), mining (Tetra Tech 2009, 2010), power plants (Development Research Partners 2010), and health care (Colorado Health Foundation 2016, Colorado Trust 2011).

RIMS II multipliers estimate three types of economic impacts. First, the direct and indirect impacts of the Foidel Creek Mine on the gross output of the Study Area are estimated. (RIMS II multipliers combine indirect and induced impacts into a single "indirect" impacts category). This is the total value produced by local businesses and residents as a result of the value of the mine's output. Gross output includes the value of final products and intermediate goods (goods used to make final products), and is a larger value than gross domestic product (GDP), which is measured by value added and includes final output only. Second, the total direct and indirect employment needed in the Study Area to produce this level of output is estimated. These employees may be full-time or part-time, local or non-local workers. Third, the analysis estimates the typical direct and indirect earnings associated with this level of production.

The current analysis applied RIMS II multipliers for Coal Mining (RIMS Industry 212100) in Routt and Moffat counties to the Foidel Creek Mine's estimated output (sales), earnings (wages and benefits), and employment (full- and part-time jobs). Projected output was estimated by multiplying the mine's 2017 production of approximately 3.84 million tons by the average spot price of $41.80/ton for coal from Colorado (Uinta Basin) between January 5 and March 16, 2018 (EIA 2018b). Note that these estimates are no guarantee that these level of production or prices would occur in the future; actual production and prices would be dictated by several factors, including market conditions. Projected earnings were based on 2017 labor costs of approximately $40 million at the Foidel Creek Mine and projected employment was based on the mine's 2017 employment level of 269 workers. Current RIMS II multipliers are based on the BEA's 2007 Benchmark I-O accounts for the United States and 2015 regional data. Therefore, all sales and wages associated with LBA approval were discounted to 2015 dollars before applying the RIMS II multipliers. The expenditures and income estimated through RIMS II and reported below are expressed in constant 2016 dollars.

Output, Earnings and Employment Impacts. Table 2 summarizes the estimated annual impacts of the lease approval on output, earnings and employment in the Study Area. These impacts could be expected to occur during each year of mine operations in the LBA tract, which are expected to last approximately 2 years, and would end with mine closure. The RIMS II final-demand output multiplier of 1.5062 implies that each $1 of sales from the Foidel Creek Mine would generate an additional $0.5062 in sales at other businesses in the Study Area. Applying this multiplier to the mine's estimated annual output of $153.5 million indicates sales of approximately $77.7 million for other businesses and total sales of approximately $231.2 million in the Study Area. Because some of these sales would be for intermediate goods, the Study Area's economy, or gross domestic product, could be expected to expand by about $124.1 million during each year of mine operations (BEA 2017b).

Table 2.
Twentymile Coal LBA Approval
Estimated Annual Economic Impacts in the Study Area[1]

Impact Measure	Direct Impacts	Indirect Impacts[2]	Total Impacts
Output	$153,522,111[3]	$77,712,893	$231,235,003
Earnings	$38,230,245[4]	$32,801,551	$71,031,796
Employment	269[5]	254	523

[1] Source: RIMS II multipliers for Routt and Moffat counties (BEA 2017b). Dollar amounts are expressed in 2016 dollars.
[2] Includes indirect and induced effects.
[3] Based on estimated production of 3.5 million tons of coal and the EIA average January 5 – March 16, 2018 spot price of $41.80 for Colorado coal.
[4] Based on labor expenditures of approximately $40 million at the Foidel Creek Mine in 2017 (Brady 2018).
[5] Based on 2017 employment at the Foidel Creek Mine; includes full- and part-time jobs.

The direct-effects earning multiplier of 1.858 suggests that each $1 in earnings paid to Foidel Creek Mine employees would generate an additional $0.858 in earnings paid by other businesses in the Study Area. Applying this multiplier to the mine's estimated earnings of approximately $38.2 million indicates that earnings at other local business would be approximately $32.8 million and that total earnings in the Study Area would be approximately $71 million (BEA 2017b).

The direct-effects employment multiplier of 1.9429 implies that each job at the Foidel Creek Mine would generate an additional 0.9429 jobs at other businesses in in the Study Area. Applying this multiplier to the 269 jobs at the mine indicates that employment in the Study Area would include an additional 254 jobs at other businesses, and that the total employment in Routt and Moffat counties associated with mining operations would include 523 jobs (BEA 2017b).

2.4 Fiscal Conditions

2.4.1 Current Conditions

All monetary values reported below are in nominal, or current year, dollars.

County Revenues. Routt and Moffat county governments receive revenues from a variety of sources, including property, sales, and other taxes; fees for licenses, permits and services; and intergovernmental transfers. Between 2012 and 2017 revenues to Routt County government increased from $45.7 million to $53.2 million. The proportionate contribution of revenue source categories to total Routt County revenues remained relatively stable over this period; on average, property tax accounted for 36% of the county's revenues, intergovernmental transfers accounted for 31%, fees and charges for services accounted for 20%, and sales tax accounted for 11% (Routt County 2018a).

Between 2012 and 2018, Moffat County revenues increased from $85.3 million to $96.5 million. During this time the contribution of service charges to total county revenues increased from 49% to 68%, the contribution of property tax decreased from 14% to 10%, and the contribution of intergovernmental revenues and sales tax remained relatively stable at around 15% and 4%, respectively (Moffat County 2018).

Property Tax. Coal production contributes to county government revenues primarily through property taxes, which are based on assessed valuations and tax rates (mill levies). Reflecting the national economic recession and energy market downturns, assessed property values decreased in Routt and Moffat counties between 2010 and 2016. During this time, Routt County's total assessed valuation decreased from $1.5 billion to $1.1 billion and Moffat County's total assessed valuation fell from $473.4 million to $408.1 million (CDOLA 2018).

Coal accounts for a relatively small portion of Routt County's property tax base, which is dominated by residential and commercial property. Between 2010 and 2016 residential property accounted for 51% of Routt County's total assessed value, commercial property accounted for 21%, and natural resources (including coal) accounted for 4 percent. Vacant, industrial, agricultural, and state assessed (public utilities, pipelines, and railroads) properties made up the remaining 24% of Routt County's assessed value (CDOLA 2018).

Between 2010 and 2016 the assessed value of natural resources (including coal) was generally similar in Routt and Moffat counties. During this time the assessed value of natural resources averaged $46.7 million in Routt County and $45.8 million in Moffat County. The difference in assessed values for residential and commercial properties between the two counties was far greater. Between 2010 and 2016 the assessed value of residential and commercial properties averaged $820.4 million in Routt County and $98.3 million in Moffat County. Because of the disparity in residential and commercial property values, coal makes a greater contribution to Moffat County's tax base. Between 2010 and 2016, natural resources (including coal) accounted for 10% of Moffat County's total assessed value, state assessed property accounted for 45%, and oil and gas production accounted for 20 percent. Vacant, residential, commercial, industrial, and agricultural properties comprised the remaining 25% of Moffat County's assessed value (CDOLA 2018).

TC is the largest source of property taxes in Routt County (Yampa Valley Data Partners 2015). Between 2008 and 2017, TC paid annual property taxes on the Foidel Creek Mine that ranged from a high of $3.46 million in 2011 to a low of $1.48 million in 2017 (Hutchinson 2018). The tax revenues are distributed as follows: South Routt School District RE-3 (60%), Mesa County government (24%), Oak Creek Fire District (6%), South Routt Medical Center District (4%), Upper Yampa Conservation District (3%), Library District (2%), and Oak Creek Cemetery and Colorado River Water Conservation districts (each less than 1%). Table 3 lists property taxes paid by TC between 2008 and 2017, and their distribution across taxing jurisdictions in Tax District 51, where the Foidel Creek Mine is located.

Table 3.
Twentymile Coal Company Foidel Creek Mine Property Tax Distributions to Routt County Taxing Jurisdictions, 2008-2017[1]

Tax Year[2]	Property Taxes	South Routt SD RE-3	Routt County	Oak Creek Fire	South Routt Medical Center	South Routt Library	Oak Creek Cemetery	Water Conservation Districts: Colorado River	Water Conservation Districts: Upper Yampa
2008	$2,473,788	$1,534,632	$578,426	$129,193	$92,061	$44,075	$6,679	$8,745	$79,977
2009	$2,617,644	$1,638,075	$620,549	$102,421	$114,744	$29,193	$3,889	$9,092	$99,682
2010	$2,899,240	$1,823,613	$648,396	$153,772	$116,300	$42,745	$4,052	$10,437	$99,924
2011	$3,463,747	$2,180,996	$796,659	$179,628	$128,595	$62,912	$5,860	$12,146	$96,952
2012	$2,848,100	$1,739,754	$704,560	$146,827	$99,451	$53,832	$5,791	$11,488	$86,397
2013	$3,183,537	$1,877,623	$828,710	$210,796	$102,108	$56,391	$6,823	$12,380	$88,705
2014	$2,950,162	$1,722,806	$781,721	$203,290	$92,767	$50,878	$6,908	$11,203	$80,590
2015	$2,479,286	$1,464,531	$639,358	$171,052	$78,107	$42,912	$6,413	$9,060	$67,854
2016	$2,258,808	$1,296,311	$570,105	$148,830	$132,896	$37,224	$6,166	$8,211	$59,065
2017	$1,484,898	$852,393	$371,304	$101,945	$86,539	$24,239	$4,649	$5,368	$38,462

[1] Estimated annual property tax distributions are based on the assessed values of personal property and production at the Foidal Creek Mine and the mill levy for each tax district included in Tax Area 51 (Hutchinson 2018, Routt County 2018b). All monetary values are reported in nominal, or current year, dollars.
[2] Property taxes are due in the following calendar year.

Royalty and Severance Tax Revenues. Routt and Moffat counties receive a portion of the federal royalties and state severance tax paid on mineral production. These revenues are counted among each county's intergovernmental transfers.

Federal mineral royalty distributions to Routt county and municipal governments and school districts were $32,766 in 2010, $49,695 in 2015, and $2.03 million in 2016. Most of the fluctuation in royalty distributions is due to discretionary grant awards. Moffat county and municipal governments and school districts received $2.37 million in federal royalty distributions in 2010, $1.40 million in 2015, and $1.52 million in 2016 (CDOLA 2011b, CDOLA 2016a, CDOLA 2017c).

Severance tax distributions to local governments in Routt County were $490,659 in 2010, $3.21 million in 2015, and $709,290 in 2016. Local governments in Moffat County received $621,264 in severance tax distributions in 2010, $2.70 million in 2015, and $1.17 million in 2016 (CDOLA 2011c, CDOLA 2016b, CDOLA 2017c). Again, most of the fluctuation in severance tax distributions is due to discretionary grants.

Colorado counties receive additional severance tax and federal royalty revenues through Energy Impact Assistance Fund grants. The CDOLA awards these grants to counties, municipalities, school districts, special districts, and other political subdivisions that are socially and/or economically impacted by mineral production. Between July 1, 2008 and December 1, 2017, the CDOLA awarded $11,876,313 in energy impact grants to Routt County and $9,585,152 in energy impact grants to Moffat County (CDOLA 2017d and 2017e).

TC paid approximately $110 million in state royalties from the development of state-owned coal at the Foidel Creek Mine between 1996 and 2017 (Courtney 2018). Although royalty payments fluctuated year by year, state royalty revenues equaled roughly $5 million per year over this 22-year period. In September 2017 the Colorado State Board of Land Commissioners approved a 5 year royalty rate reduction from 8% to 5% payable on state-owned coal mined at the Foidel Creek Mine.

2.4.2 Estimated Impacts

If LBA-COC78449 is approved, TC would pay federal, state and local taxes on coal produced in the LBA tract for approximately 2 years. During this time all coal would be mined in the LBA tract. Assuming that mining would occur at current production (3.84 million tons) and price ($41.80/ton) levels, the annual fiscal impacts associated with lease approval would include the following:

- Approximately $12.8 million in federal mineral royalty payments, $6.3 million of which would be returned to Colorado. These estimated revenues are based on a royalty rate of 8% and would be lower if the BLM approved a reduced royalty rate for the new lease. Local governments in Routt and Moffat counties would receive a portion of the revenues through direct distributions and discretionary financial grants awarded by the state.
- Federal lease bonus revenues would fund public institutions of higher education in Colorado.
- Approximately $518,780 in AML fees, half of which ($259,400) would be returned to Colorado to fund coal reclamation projects.
- Approximately $1.9 million in coal excise tax revenues that would be used to finance payments of black lung benefits to afflicted miners.

- Approximately $1.07 million in severance tax revenues. Local governments in Routt and Moffat counties would receive a portion of these revenues through direct distributions and discretionary grants awarded by the state.
- Approximately $1.48 million in property tax revenues. This estimate is based on current mill levies and would be distributed to the South Routt School District RE-3, Mesa County government and library district, Oak Creek fire and cemetery districts, South Routt Medical Center District, and Upper Yampa and Colorado River Water conservation districts at the levels shown in Table 2.
- There would be no state royalty payments as the federal government owns the entire coal estate in the LBA tract.
- Federal and state governments would receive additional revenues through corporate and personal income taxes paid by TC and its employees.

With the exception of the bonus payment revenues, these impacts would occur annually during each year of mining in the LBA tract and would end with mine closure.

2.5 Environmental Justice

2.5.1 Current Conditions

Minorities and Low-Income Populations. Executive Order 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies and activities on minority populations and low-income populations (defined as those living below the poverty level). The 2012 - 2016 ACS estimated that during this period racial minorities, including persons of African American, American Indian, Asian, and Pacific Islander descent, and some other races or two or more races, comprised 15.7% of the population in Colorado, 5.2% of the population in Routt County, 5.3% of the population in Moffat County, and 3.1% of the Oak Creek Census County Division (CCD), where the mine is located. Persons of Hispanic origin, who may be of any race, comprised an estimated 21.1% of the population in Colorado, 6.9% of the population in Routt County, 14.6% of the population in Moffat County, and 2.8% of the population in the Oak Creek CCD (Census Bureau 2017c).

Between 2012 and 2016 the median household income was $62,520 in Colorado, $63,505 in Routt County, $53,664 in Moffat County, and $61,333 in the Oak Creek CCD. During this time low-income populations comprised 12.2% of Colorado's population, 10.2% of Routt County's population, 11.1% of Moffat County's population, and 12.0% of the Oak Creek CCD's population (Census Bureau 2017d).

American Indian Populations. As a portion of the total population, American Indian populations accounted for 0.9% of Colorado's population, 0.5% of Moffat County's population, 0.4% of Routt County's population, and 0.6% of the Oak Creek CCD's population (Census Bureau 2017c). There are no tribal lands in either Routt or Moffat counties.

Methodology to Identify Minority and Low-Income Populations. The Council on Environmental Quality (CEQ) provides guidance for addressing environmental justice (CEQ 1997). In accordance with this guidance, the potential for environmental justice concerns associated with LBA approval was evaluated against two population criteria thresholds:

- A 50% criterion population analysis to identify the areas where minority or low-income populations comprised 50% of more of the total population.

- A “meaningfully greater” criterion population analysis in which minority and low-income populations in Routt and Moffat counties and the Oak Creek CCD were compared to statewide reference populations. Within the current analysis, minority and low-income populations in a county or CCD that were equal to or greater than 120% of the relevant statewide population were identified as environmental justice populations that have the potential to be disproportionately affected by the proposed LBA. This criterion level was selected because it is commonly used for National Environmental Policy Act (NEPA) compliance with federal agencies.

Routt and Moffat counties and the Oak Creek CCD have no minority, tribal or low-income populations that meet either of these criteria population thresholds. This indicates that there are no environmental justice populations in the Study Area.

2.5.2 Estimated Impacts

Because there are no environmental justice populations in the Study Area, the lease approval would not result in environmental justice impacts. Continuing operations at the Foidel Creek Mine due to lease approval would support employment opportunities for under-advantaged groups, including minority and low-income populations in the region surrounding the mine.

3.0 CLOSURE AND RECLMATION

At current mining rates, TC expects that the Foidel Creek Mine has a remaining productive life of approximately 9 years without LBA approval and 11 years with LBA approval (Nettleton 2018). At the end of the mine’s productive life, mining at the Foidel Creek Mine would cease and closure and reclamation would be initiated. A small reclamation workforce would be required, but the majority of employment at the mine would end. Business revenues and employment at supporting industries in Routt and Moffat counties could fall due to the absence of spending by the mine and its employees. Local housing markets could potentially be affected by population losses if workers previously employed at the mine and supporting industries are unable to find employment in the Study Area. Enrollment in the South Routt School District RE-3 could also be affected if the families of former mine and support industry employees leave the area.

Federal, state, and local taxes linked to the mine’s production and employee income would also end. Although effects to the federal government from a reduction in mineral royalty, AML fees, and coal excise tax revenues; and effects to the State of Colorado from a reduction in mineral royalty and severance tax revenues are likely to be minor, local governments in the Study Area would not receive any royalty or severance tax distributions, potentially impacting the ability of local area service providers to meet residents’ needs. Routt County would be particularly affected because property tax revenues from production and assets at the Foidel Creek Mine would end.

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Appendix F

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Appendix G

List of Abbreviations and Acronyms

LIST OF ABBREVIATIONS AND ACRONYMS

µg/g	micrograms per gram
µg/L	microgram per liter
$\mu g/m^2$	micrograms per square meter
$\mu g/m^3$	micrograms per cubic meter
µmho/cm	micromhos per centimeter
amsl	above mean sea level
APCD	Air Pollution Control Division
APEN	Air Pollutant Emission Notice
AR5	Fifth Assessment Report
AQRVs	Air Quality Related Values
B20 percent	best 20 percent
BA	Biological Assessment
BART	Best Available Retrofit Technology
BEA	Bureau of Economic Analysis
BLM	Bureau of Land Management
BLS	Bureau of Labor Statistics
BMPs	Best Management Practices
BO	Biological Opinion
Btu	British Thermal Unit
CAA	Clean Air Act
CAAQS	Colorado Ambient Air Quality Standards
CAMx	Comprehensive Air-quality Model with extensions
CARMMS	Colorado Air Resources Management Modeling study
CASTNET	Clean Air Status and Trends Network
CCR	Code of Colorado Regulations
CDLE	Colorado Department of Labor and Employment
CDOLA	Colorado Department of Local Affairs
CDPHE	Colorado Department of Public Health and Environment
CDPS	Colorado Discharge Permit System
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH_4	methane
CMM	coal-mine methane
CMOP	Coalbed Methane Outreach Program
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CPW	Colorado Parks and Wildlife
CRS	Colorado Revised Statutes
DNR	Department of Natural Resources
DOI	U.S. Department of the Interior
DRMS	Division of Reclamation, Mining and Safety
dv	deciviews
DVB	base year
DVF	future year

EA	Environmental Assessment
eGRID	Emissions & Generation Resource Integrated Database
EIA	Energy Information Administration
EO	Executive Order
EPRI	Electric Power Research Institute
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
˚F	Fahrenheit
FCLAA	Federal Coal Leasing Amendments Act
FERC	Federal Energy Regulatory Commission
FLPMA	Federal Land Policy and Management Act
FMV	Fair Market Value
GER	Geologic and Engineering Report
GHGs	greenhouse gases
GVB	gob vent boreholes
GWP	Global Warming Potential
HAPs	hazardous air pollutants
ICE	internal combustion engines
I-O	Input-Output
IMPROVE	Interagency Monitoring of Protected Visual Environments
IPCC	Intergovernmental Panel on Climate Change
IWG	Interagency Working Group
kg/ha-yr	kilogram per hectare per year
km	kilometer
lb/MWh	pounds of emissions per megawatt-hour
LBA	Lease-by-Application
LEE	low emitting electric generating units
LOP	life of the project
LSFO	Little Snake Field Office
LUP	Land Use Plan
MATS	Modeled and Attainment Test Software
MDN	mercury deposition network
MeHg	methylmercury
MER	Maximum Economic Recovery
mg/kg	milligram per kilogram
mg/L	milligram per liter
MLA	Mineral Leasing Act
MMT	million metric tons
MPDD	mine plan decision document
mph	miles per hour
MSHA	Mine Safety and Health Administration
N	nitrogen
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NADP	National Acid Deposition Program
NCA	National Climate Assessment

NEPA	National Environmental Policy Act
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide
NOx	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSPS	New Source Performance Standards
NTN	National Trends Network
O_3	ozone
OMB	Office of Management and Budget
OSMRE	United States Office of Surface Mining, Reclamation and Enforcement
PGM	photochemical grid model
PM	particulate matter
$PM_{2.5}$	particulate matter less than 2.5 microns in effective diameter
PM_{10}	particulate matter less than 10 microns in effective diameter
ppb	parts per billion
PSD	Prevention of Significant Deterioration
RCP	Representative Concentration Pathway
RFD	Reasonably Foreseeable Development
RFMP	Reasonably Foreseeable Mine Plan
RIMS II	Regional Input-Output Modeling System
RMP	Resource Management Plan
ROM	run-of-mine
S	sulfur
SCC	social cost of carbon
SCRs	selective catalytic reduction units
SHPO	State Historic Preservation Officer
SMCRA	Surface Mining Control and Reclamation Act
SO_2	sulfur dioxide
SUIT	Southern Ute Indian Tribe
SVR	Standard Visual Range
TC	Twentymile Coal, LLC
TDS	Total Dissolved Solids
tpy	tons per year
UNEP	United Nations Environment Program
U.S.	United States
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
VAM	Ventilation Air Methane
VCG	Vessels Coal Gas, Inc.
VOCs	volatile organic carbons
W20 percent	worst 20 percent

WQCD	Water Quality Control Division
WRCC	Western Regional Climate Center
WW	wet weight