FES 08-32

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

Volume 1: Chapters 1, 2, 3, & 4

September 2008

BLM

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FES 08-32

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

Vol. 1

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Washington D.C. 20240
http://www.blm.gov

July 31, 2008

In reply refer to: 1610-5.G.1.4

Dear Reader:

In August 2005, the U.S. Congress enacted the Energy Policy Act of 2005, Public Law (P.L.) 109-58. In Section 369 of this Act, titled the "Oil Shale, Tar Sands, and Other Strategic Unconventional Fuels Act of 2005", Congress declared that oil shale and tar sands (and other unconventional fuels) are strategically important domestic energy resources that should be developed to reduce the nation's growing dependence on oil from politically and economically unstable foreign sources. To support this policy, Congress directed the Secretary of the Interior (the Secretary) to undertake a series of steps to establish a commercial leasing program for oil shale and tar sands. A principle provision mandated the Secretary to "...Complete a programmatic environmental impact statement for a commercial leasing program for oil shale and tar sands resources on public lands, with an emphasis on the most geologically prospective lands in Colorado, Utah, and Wyoming."

Enclosed are the Proposed Oil Shale and Tar Sands Resource Management Plan Amendments to Address Land Use Allocations in Colorado, Utah, and Wyoming and Final Programmatic Environmental Impact Statement (PRMP/FPEIS). The Bureau of Land Management (BLM) prepared the PRMP/FPEIS in consultation with cooperating agencies, taking into account public comments received during this planning effort and examines alternatives for making the BLM administered lands available for application for future commercial leasing of both oil shale and tar sands resources.

This PRMP/FPEIS has been developed in accordance with the National Environmental Policy Act of 1969 (NEPA) and the Federal Land Policy and Management Act of 1976. The PRMP/FPEIS is largely based on Alternative B, the preferred alternative in the Draft Resource Management Plan/Environmental Impact Statement (DRMP/DEIS), which was released on December 21, 2007. The PRMP/FPEIS contains the Proposed Plan Amendments, predictable impacts of the Proposed Plan Amendments, a Compact Disc (CD) of copies of all the written comments received during the public review period of the DRMP/DPEIS, and responses to these comments.

Because developing this and other alternative energy resources is of strategic importance in enhancing our Nation's domestic energy supplies, the Assistant Secretary, Land and Minerals Management, in the Department of the Interior is the responsible official for these proposed plan amendments. The Federal Land Policy and Management Act and its implementing regulations provide land use planning authority to the Secretary, as delegated to this Assistant Secretary. Because this decision is being made by the Assistant Secretary, Land and Minerals Management, it is the final decision for the Department of the Interior. This decision is not subject to administrative review (protest) under the BLM or Departmental regulations (43 CFR 1610.5-2).

As required by the NEPA, the Environmental Protection Agency (EPA) will publish a Notice in the *Federal Register* announcing the availability of the FPEIS. The BLM will wait at least 60 days after the publication of the EPA Notice before signing and issuing the Record of Decision (ROD) approving the plan amendments.

The ROD and approved plan amendments will be mailed or made available electronically to all who participated in the planning process and will be available to all parties through the "Energy" page of the BLM national website (*http://www.blm.gov/wo/st/en/prog/energy.1.html*), or by mail upon request.

Sincerely,

Michael D. Nedd
Assistant Director,
Minerals and Realty Management

FES 08-32

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

Volume 1: Chapters 1, 2, 3, & 4

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

September 2008

MISSION STATEMENT

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

BLM-WO-GI-08-005-3900-REV08

DOI No. FES 08-32

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

Lead Agency: U.S. Department of the Interior, Bureau of Land Management

Type of Action: Final, Administrative

Jurisdiction: Northwestern Colorado, Eastern Utah, and Southwestern Wyoming

Abstract: In August 2005, the U.S. Congress enacted the Energy Policy Act of 2005, Public Law (P.L.) 109-58. In Section 369 of this Act, titled the "Oil Shale, Tar Sands, and Other Strategic Unconventional Fuels Act of 2005," Congress declared that oil shale and tar sands (and other unconventional fuels) are strategically important domestic energy resources that should be developed to reduce the nation's growing dependence on oil from politically and economically unstable foreign sources. To support this policy, Congress directed the Secretary of the Interior (the Secretary) to undertake a series of steps to establish a commercial leasing program for oil shale and tar sands.

The proposed resource management plan amendments would amend 12 land use plans to describe the most geologically prospective areas administered by the Bureau of Land Management (BLM) where oil shale and tar sands resources are present, and designate which of these areas will be open for application for commercial leasing, exploration, and development. There are approximately 2.3 million acres of BLM-administered lands within this area that are the subject of this programmatic environmental impact statement (PEIS).

Three alternatives were considered in the PEIS, and the BLM has selected Alternative B as the Proposed Plan Amendment. This alternative was selected on the basis of consistency with the requirements of the Energy Policy Act of 2005, balanced use and protection of resources, the analysis of environmental impacts, and consideration of comments and recommendations from cooperating agencies and the public. The Proposed Plan Amendment is designed to ensure that oil shale and tar sands technologies can operate at environmentally acceptable levels before commercial development is authorized. The Proposed Plan Amendment would make 1,991,222 acres of lands containing oil shale resources available for application for commercial leasing and 431,224 acres of lands containing tar sands resources available for application for commercial leasing.

On the basis of the analysis in this PEIS, the BLM has determined that there is no environmental impact associated with amending land use plans to make lands available for application for commercial leasing but there may be impacts on land values. While the BLM has determined that there are no environmental impacts associated with the amendment of land use plans, it is intending to establish a commercial leasing program and has included a programmatic-level analysis of the potential impact of commercial oil shale and tar sand technologies as they are currently known.

Contacts: For further information about this PEIS, you may contact Sherri Thompson, Project Manager, BLM Colorado State Office, 2850 Youngfield St., Lakewood, CO 80215-7093; (303) 239-3758.

Responsible Official:

Mike Nedd
BLM Assistant Director
Minerals and Realty Management
1849 "C" Street N.W.
Washington, D.C. 20240

This page intentionally left blank.

DOCUMENT CONTENTS

VOLUME 1

Executive Summary
Chapter 1: Introduction
Chapter 2: Descriptions of Alternatives
Chapter 3: Affected Environment
Chapter 4: Effects of Oil Shale Technologies

VOLUME 2

Chapter 5: Effects of Tar Sands Technologies
Chapter 6: Impact Assessment for Oil Shale and Tar Sands Technologies

VOLUME 3

Chapter 7: Consultation and Coordination
Chapter 8: List of Preparers
Chapter 9: Glossary
Appendix A: Oil Shale Development Background and Technology Overview
Appendix B: Tar Sands Development Background and Technology Overview
Appendix C: Proposed Land Use Plan Amendments Associated with Alternatives B and C for Oil Shale and Tar Sands
Appendix D: Federal, State, and County Regulatory Requirements Potentially Applicable to Oil Shale and Tar Sands Development Projects
Appendix E: Threatened and Endangered Species within the Oil Shale and Tar Sands Study Area
Appendix F: Proposed Conservation Measures for Oil Shale and Tar Sands Leasing and Development
Appendix G: Socioeconomic and Environmental Justice Analysis Methodologies
Appendix H: Approach Used for Interviews of Selected Residents in the Oil Shale and Tar Sands Study Area
Appendix I: Instream Flow Water Rights in the Piceance Basin, Colorado

VOLUME 4

Comments and Responses (CD in back of Volume 3)

This page intentionally left blank.

VOLUME 1 CONTENTS

NOTATION xxi

ENGLISH/METRIC AND METRIC/ENGLISH EQUIVALENTS xxvii

EXECUTIVE SUMMARY ES-1

ES.1 Background to the PEIS ES-1
ES.2 Description of the Planning Area ES-1
ES.3 Scoping Process ES-2
ES.4 Public Review of the Draft PEIS ES-2
ES.5 Cooperating Agencies ES-3
ES.6 Factors Common to Both Oil Shale and Tar Sands ES-4
ES.7 Alternatives ES-5
ES.7.1 No Action Alternative, Oil Shale ES-5
ES.7.2 No Action Alternative, Tar Sands ES-5
ES.7.3 Alternative B, Oil Shale ES-5
ES.7.4 Alternative B, Tar Sands ES-5
ES.7.5 Alternative C, Oil Shale ES-5
ES.7.6 Alternative C, Tar Sands ES-6
ES.8 Selection of the Proposed Plan Amendment ES-6
ES.9 Analysis of the Impacts of the Proposed Plan Amendment for Oil Shale and Tar Sands ES-6
ES.10 References ES-8

1 INTRODUCTION 1-1

1.1 Purpose and Need 1-2
1.1.1 Evolution of the Purpose and Need of the PEIS since Publication of the Notice of Intent 1-3
1.2 Scope of the Analysis 1-5
1.2.1 Direct, Indirect, and Cumulative Impact Analysis 1-11
1.3 Cooperating Agencies 1-13
1.4 Relationship of the Proposed Action to Other BLM and Cooperating Agency Programs, Policies, and Plans 1-14
1.4.1 BLM's Oil Shale Research, Development, and Demonstration Program 1-14
1.4.2 Combined Hydrocarbon Leasing Program and the Interim Final Rule for Leasing in STSAs Issued under the Revised MLA 1-16
1.4.3 Existing BLM Land Use Plans, Ongoing Planning Activities, and Resource Management Plan Revisions 1-17
1.4.4 Cooperating Agency Plans and Programs 1-19
1.4.5 BLM and USFS Energy Corridor Designation 1-20

CONTENTS (Cont.)

1.5 References 1-20

2 DESCRIPTIONS OF ALTERNATIVES 2-1

2.1 Introduction 2-1
2.2 Existing Statutory Requirements and BLM Policies Potentially Applicable to Oil Shale and Tar Sands Development 2-1
2.2.1 Existing Relevant Statutory Requirements 2-2
2.2.2 Existing Relevant BLM Policies and Mitigation Guidance 2-6
2.2.3 Management of BLM-Administered Lands 2-7
2.3 Oil Shale 2-10
2.3.1 Potential Commercial Oil Shale Development Technologies 2-11
2.3.2 Alternative A, No Action Alternative, Continuation of Current Management 2-17
2.3.3 Commercial Oil Shale Program Alternatives 2-23
2.3.3.1 Alternative B for a Commercial Oil Shale Program, the Proposed Plan Amendment 2-26
2.3.3.2 Alternative C for a Commercial Oil Shale Program 2-32
2.4 Tar Sands 2-39
2.4.1 Potential Commercial Tar Sands Development Technologies 2-41
2.4.2 Alternative A, No Action Alternative, Continuation of Current Management 2-44
2.4.3 Commercial Tar Sands Program Alternatives 2-44
2.4.3.1 Alternative B for a Commercial Tar Sands Program, the Proposed Plan Amendment 2-48
2.4.3.2 Alternative C for a Commercial Tar Sands Program 2-51
2.5 Alternatives and Issues Considered but Eliminated from Detailed Analysis 2-54
2.5.1 Alternatives Approving Issuance of Commercial Leases 2-55
2.5.2 Alternatives That Preclude Oil Shale and Tar Sands Leasing or Development 2-56
2.5.3 Alternatives Considering Alternate Energy Sources and Carbon Sequestration 2-56
2.5.4 Alternatives That Prohibit Leasing in Specific Areas 2-56
2.5.5 Off-Site Processing of Oil Shale 2-57
2.5.6 Establishment of Federal Subsidies 2-57
2.5.7 Carrying-Capacity Thresholds 2-57
2.5.8 Establishment of Trust Funds 2-58
2.6 Comparison of Alternatives 2-58
2.7 References 2-96

3 AFFECTED ENVIRONMENT 3-1

3.1 Land Use 3-1

CONTENTS (Cont.)

3.1.1 BLM Land Use Plans within the Study Area 3-2
3.1.1.1 Glenwood Springs Field Office, Colorado 3-2
3.1.1.2 Grand Junction Field Office, Colorado..... 3-8
3.1.1.3 White River Field Office, Colorado..... 3-9
3.1.1.4 Grand Staircase–Escalante National Monument, Utah 3-12
3.1.1.5 Monticello Field Office, Utah..... 3-14
3.1.1.6 Price Field Office, Utah 3-15
3.1.1.7 Richfield Field Office, Utah 3-20
3.1.1.8 Vernal Field Office, Utah 3-25
3.1.1.9 Kemmerer Field Office, Wyoming 3-33
3.1.1.10 Rawlins Field Office, Wyoming 3-40
3.1.1.11 Rock Springs Field Office, Wyoming 3-41
3.1.2 Recreational Land Use in the Three-State Study Area 3-42
3.2 Geological Resources and Seismic Setting..... 3-44
3.2.1 Piceance Basin 3-47
3.2.1.1 Physiography..... 3-47
3.2.1.2 Geologic Setting..... 3-47
3.2.1.3 Soils..... 3-47
3.2.1.4 Seismology..... 3-48
3.2.1.5 Mineral Resources 3-48
3.2.2 Uinta Basin 3-49
3.2.2.1 Physiography..... 3-49
3.2.2.2 Geologic Setting..... 3-49
3.2.2.3 Soils..... 3-49
3.2.2.4 Seismology..... 3-50
3.2.2.5 Mineral Resources 3-50
3.2.3 Green River Basin and Washakie Basin 3-51
3.2.3.1 Physiography..... 3-51
3.2.3.2 Geologic Setting..... 3-51
3.2.3.3 Soils..... 3-52
3.2.3.4 Seismology..... 3-52
3.2.3.5 Mineral Resources 3-52
3.2.4 Special Tar Sand Areas..... 3-53
3.2.4.1 Physiography..... 3-53
3.2.4.2 Geologic Setting..... 3-53
3.2.4.3 Soils..... 3-53
3.2.4.4 Seismology..... 3-54
3.2.4.5 Mineral Resources 3-54
3.3 Paleontological Resources 3-55
3.3.1 Piceance Basin 3-56
3.3.2 Uinta Basin 3-62
3.3.3 Green River and Washakie Basins..... 3-62
3.3.4 Special Tar Sand Areas..... 3-62

CONTENTS (Cont.)

3.4 Water Resources 3-62
3.4.1 Legal Framework of the Upper Colorado River Basin 3-63
3.4.1.1 Water Allocation 3-63
3.4.1.2 Basin Salinity and Surface Water Quality 3-63
3.4.1.3 Impaired Streams under the Clean Water Act 3-65
3.4.1.4 Water Use 3-65
3.4.2 Piceance Basin 3-77
3.4.2.1 Groundwater Resources 3-77
3.4.2.2 Surface Water Resources 3-80
3.4.3 Uinta Basin 3-83
3.4.3.1 Groundwater Resources 3-83
3.4.3.2 Surface Water Resources 3-85
3.4.4 Green River Basin and Washakie Basin 3-88
3.4.4.1 Groundwater Resources 3-88
3.4.4.2 Surface Water Resources 3-91
3.4.5 Special Tar Sand Areas 3-93
3.4.5.1 Groundwater Resources 3-93
3.4.5.2 Surface Water Resources 3-94
3.5 Air Quality and Climate 3-97
3.5.1 Climate 3-97
3.5.1.1 Meteorology 3-97
3.5.1.2 Global Climate Change 3-100
3.5.2 Existing Emissions 3-102
3.5.3 Air Quality 3-102
3.6 Existing Acoustic Environment (Noise) 3-109
3.7 Ecological Resources 3-110
3.7.1 Aquatic Resources 3-110
3.7.1.1 Oil Shale Basins 3-120
3.7.1.2 Special Tar Sand Areas 3-124
3.7.2 Plant Communities and Habitats 3-125
3.7.2.1 Piceance Basin 3-125
3.7.2.2 Uinta Basin 3-131
3.7.2.3 Green River and Washakie Basins 3-135
3.7.2.4 Special Tar Sand Areas 3-139
3.7.3 Wildlife 3-143
3.7.3.1 Amphibians and Reptiles 3-145
3.7.3.2 Birds 3-145
3.7.3.3 Mammals 3-150
3.7.3.4 Wild Horses and Burros 3-153
3.7.4 Threatened and Endangered Species 3-154
3.7.4.1 Species Listed under the Endangered Species Act 3-158
3.7.4.2 Species That Are Candidates for Listing under the Endangered Species Act 3-179

CONTENTS (Cont.)

3.7.4.3 BLM-Designated Sensitive Species and State-Listed Species 3-182
3.7.4.4 Other Species of Concern 3-183
3.8 Visual Resources....3-184
3.8.1 Introduction....3-184
3.8.2 Oil Shale Areas....3-187
3.8.2.1 Piceance Basin....3-187
3.8.2.2 Uinta Basin....3-188
3.8.2.3 Green River Basin....3-189
3.8.2.4 Washakie Basin....3-190
3.8.3 Special Tar Sand Areas....3-191
3.8.3.1 Argyle Canyon STSA....3-191
3.8.3.2 Asphalt Ridge STSA....3-191
3.8.3.3 Hill Creek STSA....3-192
3.8.3.4 Pariette STSA....3-192
3.8.3.5 P.R. Spring STSA....3-193
3.8.3.6 Raven Ridge STSA....3-193
3.8.3.7 San Rafael Swell STSA....3-193
3.8.3.8 Sunnyside STSA....3-195
3.8.3.9 Tar Sand Triangle STSA....3-196
3.8.3.10 White Canyon STSA....3-196
3.9 Cultural Resources....3-197
3.9.1 Piceance Basin....3-199
3.9.1.1 Prehistoric Context for Archaeological Sites, Features, and Structures....3-199
3.9.1.2 Historic Context for Archaeological Sites, Features, and Structures....3-200
3.9.1.3 Ethnohistoric Context and Traditional Cultural Properties 3-201
3.9.1.4 Surveys and Sites in the Study Area....3-202
3.9.2 Uinta Basin....3-203
3.9.2.1 Prehistoric Context for Archaeological Sites, Features, and Structures....3-203
3.9.2.2 Historic Context for Archaeological Sites, Features, and Structures....3-203
3.9.2.3 Ethnohistoric Context and Traditional Cultural Properties 3-204
3.9.2.4 Surveys and Sites in the Study Area....3-204
3.9.3 Green River and Washakie Basins....3-206
3.9.3.1 Prehistoric Context for Archaeological Sites, Features, and Structures....3-206
3.9.3.2 Historic Context for Archaeological Sites, Features, and Structures....3-206
3.9.3.3 Ethnohistoric Context and Traditional Cultural Properties 3-207
3.9.3.4 Surveys and Sites in the Study Area....3-208

CONTENTS (Cont.)

3.9.4 Special Tar Sand Areas in East-Central and Southeastern Utah 3-210
3.9.4.1 Prehistoric Context for Archaeological Sites, Features, and Structures.....3-210
3.9.4.2 Historic Context for Archaeological Sites, Features, and Structures.....3-211
3.9.4.3 Ethnohistoric Context and Traditional Cultural Properties 3-212
3.9.4.4 Surveys and Sites in the Study Area 3-212
3.10 Socioeconomics 3-216
3.10.1 Past Oil Shale Development 3-216
3.10.2 Current Conditions.....3-220
3.10.2.1 Economic Environment 3-220
3.10.2.2 Social Environment.....3-226
3.10.3 Recreation Economy.....3-242
3.10.3.1 Economic Valuation of Public Lands Used for Recreation.....3-243
3.10.3.2 Economic Impact of Recreational Activities 3-245
3.10.4 Transportation.....3-246
3.10.4.1 Colorado.....3-246
3.10.4.2 Utah.....3-247
3.10.4.3 Wyoming.....3-248
3.11 Environmental Justice.....3-248
3.12 References.....3-256

4 EFFECTS OF OIL SHALE TECHNOLOGIES 4-1

4.1 Assumptions and Impact-Producing Factors for Individual Facilities by Commercial Oil Shale Technology..... 4-2
4.1.1 Surface Mine and Surface Retort Projects..... 4-3
4.1.2 Underground Mine and Surface Retort Projects..... 4-7
4.1.3 In Situ Retort Projects..... 4-10
4.1.4 Transmission Line and Crude Oil Pipeline ROWs..... 4-12
4.1.5 Workforce Operational Details and Employer-Provided Housing..... 4-13
4.1.6 Expansion of Electricity-Generating Capacity 4-13
4.1.7 Refining Needs for Oil Shale Development Projects 4-15
4.1.8 Additional Considerations and Time Lines 4-16
4.2 Land Use 4-17
4.2.1 Common Impacts..... 4-17
4.2.1.1 Other Mineral Development Activities..... 4-18
4.2.1.2 Acquisition, Conversion, or Transfer of Water Rights..... 4-19
4.2.1.3 Grazing Activities 4-20
4.2.1.4 Recreational Use 4-20
4.2.1.5 Specially Designated Areas, Potential ACECs (in Utah), and Areas with Wilderness Characteristics..... 4-21
4.2.1.6 Wild Horse and Burro Herd Management Areas..... 4-22

CONTENTS (Cont.)

4.2.1.7 Different Oil Shale Development Technologies 4-22
4.2.2 Mitigation Measures 4-23
4.3 Soil and Geologic Resources 4-24
4.3.1 Common Impacts 4-24
4.3.1.1 Soil Resources 4-24
4.3.1.2 Geologic Resources 4-27
4.3.2 Mitigation Measures 4-27
4.4 Paleontological Resources 4-28
4.4.1 Common Impacts 4-28
4.4.2 Mitigation Measures 4-29
4.5 Water Resources 4-30
4.5.1 Common Impacts 4-30
4.5.1.1 Ground Surface Disturbance 4-32
4.5.1.2 Water Use 4-33
4.5.1.3 Discharge, Waste Handling, and Contaminant Sources 4-36
4.5.1.4 Alteration of Hydrologic Flow Systems 4-38
4.5.2 Water Budget for Individual Oil Shale Projects 4-40
4.5.2.1 Colorado 4-45
4.5.2.2 Utah 4-46
4.5.2.3 Wyoming 4-46
4.5.3 Mitigation Measures 4-46
4.6 Air Quality and Climate 4-49
4.6.1 Common Impacts 4-49
4.6.1.1 Impacts from Emissions Sources for Oil Shale Facilities 4-52
4.6.2 Mitigation Measures 4-53
4.7 Noise 4-54
4.7.1 Common Impacts 4-56
4.7.1.1 Construction 4-56
4.7.1.2 Vehicular Traffic 4-57
4.7.1.3 Surface Mining with Surface Retort 4-58
4.7.1.4 Underground Mining with Surface Retort 4-58
4.7.1.5 In Situ Processing 4-58
4.7.1.6 On-Site Upgrading Operations 4-61
4.7.1.7 Reclamation 4-61
4.7.1.8 Transmission Lines 4-61
4.7.1.9 Pipeline 4-62
4.7.2 Mitigation Measures 4-62
4.7.2.1 Preconstruction Planning 4-62
4.7.2.2 Construction and Reclamation 4-63
4.7.2.3 Operation 4-64
4.8 Ecological Resources 4-65
4.8.1 Common Impacts 4-65
4.8.1.1 Aquatic Resources 4-65

CONTENTS (Cont.)

4.8.1.2 Plant Communities and Habitats 4-69
4.8.1.3 Wildlife (Including Wild Horses and Burros) 4-73
4.8.1.4 Threatened, Endangered, and Sensitive Species 4-91
4.8.2 Mitigation Measures for Ecological Resources 4-113
4.8.2.1 Aquatic Resources 4-113
4.8.2.2 Plant Communities and Habitats 4-114
4.8.2.3 Wildlife (Including Wild Horses and Burros) 4-115
4.8.2.4 Threatened and Endangered Species 4-117
4.9 Visual Resources 4-119
4.9.1 Common Impacts 4-125
4.9.1.1 Surface Mining with Surface Retorting 4-125
4.9.1.2 Underground Mining with Surface Retorting 4-132
4.9.1.3 In Situ Processing 4-133
4.9.1.4 Other Associated Oil Shale Project Facilities 4-134
4.9.2 Mitigation Measures 4-139
4.10 Cultural Resources 4-143
4.10.1 Common Impacts 4-143
4.10.2 Mitigation Measures 4-144
4.11 Socioeconomics 4-145
4.11.1 Common Impacts 4-149
4.11.1.1 Economic Impacts 4-149
4.11.1.2 Social Impacts 4-152
4.11.1.3 Social Disruption Impacts 4-155
4.11.1.4 Agricultural Impacts 4-156
4.11.1.5 Recreation Impacts 4-157
4.11.1.6 Property Value Impacts 4-158
4.11.1.7 Environmental Amenities and Economic Development Impacts 4-160
4.11.1.8 Transportation Impacts 4-160
4.11.2 Mitigation Measures 4-161
4.12 Environmental Justice 4-163
4.12.1 Common Impacts 4-164
4.12.1.1 Impact-Producing Factors 4-164
4.12.1.2 General Population 4-165
4.12.1.3 Environmental Justice Populations 4-167
4.12.2 Mitigation Measures 4-167
4.13 Hazardous Materials and Waste Management 4-168
4.13.1 Common Impacts 4-168
4.13.1.1 Surface Mining 4-170
4.13.1.2 Surface Retorting and Subsequent Upgrading 4-171
4.13.1.3 Underground Mining with Surface Retorting 4-173
4.13.1.4 In Situ Processing 4-174
4.13.2 Mitigation Measures 4-176

CONTENTS (Cont.)

4.14 Health and Safety 4-177
4.14.1 Common Impacts 4-180
4.14.1.1 Surface Mining 4-180
4.14.1.2 Surface Retorting 4-182
4.14.1.3 Underground Mining 4-184
4.14.1.4 In Situ Processing 4-185
4.14.2 Mitigation Measures 4-185
4.15 References 4-187

FIGURES

1.2-1 Most Geologically Prospective Oil Shale Resources within the Green River Formation Basins in Colorado, Utah, and Wyoming 1-7

1.2-2 Special Tar Sand Areas in Utah 1-8

2.3-1 Green River Formation Basins in Colorado, Utah, and Wyoming; the Most Geologically Prospective Oil Shale Resources; the Areas Where the Overburden above the Oil Shale Resources Is ≤500 ft; and Locations of the Six RD&D Projects 2-12

2.3-2 Locations of the Six RD&D Tracts and Associated PRLAs 2-14

2.3.2-1 Lands Available for Oil Shale Leasing under Alternative A in Colorado 2-18

2.3.2-2 Lands Available for Oil Shale Leasing under Alternative A in Utah 2-19

2.3.3-1 Lands Available for Application for Leasing under Alternative B for Commercial Oil Shale Development within the Most Geologically Prospective Areas in Colorado 2-28

2.3.3-2 Lands Available for Application for Leasing under Alternative B for Commercial Oil Shale Development within the Most Geologically Prospective Areas in Utah 2-29

2.3.3-3 Lands Available for Application for Leasing under Alternative B for Commercial Oil Shale Development within the Most Geologically Prospective Areas in Wyoming 2-30

FIGURES (Cont.)

2.3.3-4 Lands Available for Application for Leasing under Alternative C for Commercial Oil Shale Development within the Most Geologically Prospective Areas in Colorado 2-33

2.3.3-5 Lands Available for Application for Leasing under Alternative C for Commercial Oil Shale Development within the Most Geologically Prospective Areas in Utah 2-34

2.3.3-6 Lands Available for Application for Leasing under Alternative C for Commercial Oil Shale Development within the Most Geologically Prospective Areas in Wyoming 2-35

2.4-1 Special Tar Sand Areas in Utah 2-40

2.4.3-1 Lands Available for Application for Leasing under Alternative B for Commercial Tar Sands Development within the STSAs in Utah 2-49

2.4.3-2 Lands Available for Application for Leasing under Alternative C for Commercial Tar Sands Development within the STSAs in Utah 2-52

3.1.1-1 Distribution of BLM-, NPS-, USFS-, and USFWS-Administered Lands with Respect to Oil Shale and Tar Sands Resources 3-5

3.1.1-2 BLM Planning Areas in Colorado Where Oil Shale Resources Are Located 3-6

3.1.1-3 White River RMP Decisions Related to Oil Shale Leasing and Development 3-10

3.1.1-4 Portions of the Grand Staircase–Escalante National Monument and the Monticello and Richfield Field Offices Where Tar Sands Resources Are Located 3-13

3.1.1-5 Areas with Wilderness Characteristics in the Monticello Field Office in the Vicinity of the White Canyon STSA 3-16

3.1.1-6 Price Field Office RMP Planning Area 3-18

3.1.1-7 Areas with Wilderness Characteristics in the Price Field Office That Overlap with Oil Shale and/or Tar Sands Deposits 3-21

3.1.1-8 Potential ACECs in the Price Field Office That Overlie Oil Shale and Tar Sands Deposits 3-24

FIGURES (Cont.)

3.1.1-9 WSAs and Potential ACECs in the Richfield Field Office That Overlie the Tar Sand Triangle STSA 3-26

3.1.1-10 Areas with Wilderness Characteristics in the Richfield Field Office That Overlap with the Tar Sand Triangle STSA 3-27

3.1.1-11 Vernal Field Office RMP Planning Area 3-28

3.1.1-12 Split Estate Lands within the Hill Creek Extension of the Uintah and Ouray Reservation 3-30

3.1.1-13 Book Cliffs RMP Decisions Related to Oil Shale Leasing and Development 3-31

3.1.1-14 Wilderness Characteristics in the Vernal Field Office That Overlap with the Most Geologically Prospective Oil Shale Area and STSAs 3-34

3.1.1-15 Potential ACECs in the Vernal Field Office 3-38

3.1.1-16 BLM Planning Areas in Wyoming Where Oil Shale Resources Are Located 3-39

3.4.2-1 Yellow and Piceance Creeks and Their Tributaries in the Piceance Basin 3-82

3.4.3-1 Major Rivers and Their Tributaries in the Uinta Basin 3-86

3.4.4-1 Major Rivers and Their Tributaries in the Green River and Washakie Basins 3-92

3.4.5-1 Green River and Dirty Devil River Basins Drainage Map 3-95

3.5.1-1 Wind Roses at the 33-ft Level for Selected Meteorological Stations around the Study Area, 2000–2005 3-98

3.5.1-2 Annual Mean Temperature Change for Northern Latitudes 3-101

3.7.2-1 Ecoregions and Oil Shale Basin of Northwestern Colorado 3-126

3.7.2-2 Ecoregions and Special Tar Sand Areas of Southeastern Utah 3-133

3.7.2-3 Ecoregions and Special Tar Sand Areas of Northeastern Utah 3-134

3.7.2-4 Ecoregions and Oil Shale Basins of Southwestern Wyoming 3-136

3.7.3-1 North American Migration Flyways 3-146

FIGURES (Cont.)

3.7.3-2 Distribution of Wild Horse Herd Management Areas within the Oil Shale and Tar Sands Study Area....3-155

3.8.2-1 Landscape in the Piceance Basin....3-187

3.8.2-2 Landscape in the Uinta Basin....3-189

3.8.3-1 View from Wedge Overlook, San Rafael Swell near Castledale, Utah....3-194

3.8.3-2 White Canyon Bridge on State Route 95, San Juan County, Utah....3-197

3.10.2-1 State ROIs for Oil Shale and Tar Sands Development Areas....3-221

3.11-1 Minority Population Concentration in Census Block Groups within Oil Shale Resource Areas and Associated 80-km Buffer....3-252

3.11-2 Low-Income Population Concentration in Census Block Groups within Oil Shale Resource Areas and Associated 80-km Buffer....3-253

3.11-3 Minority Population Concentration in Census Block Groups within Tar Sands Resource Areas and Associated 80-km Buffer....3-254

3.11-4 Low-Income Population Concentration in Census Block Groups within Tar Sands Resource Areas and Associated 80-km Buffer....3-255

4.9.1-1 ATP Processor Retort Technology at Stuart Oil Shale Facility, Queensland, Australia....4-129

4.9.1-2 Stuart Oil Shale Facility, Queensland, Australia....4-130

TABLES

ES-1 Summary of the Proposed Plan Amendment for Oil Shale: Colorado, Utah, and Wyoming.... ES-7

ES-2 Summary of the Proposed Plan Amendment for Tar Sands: Utah.... ES-8

2.2.3-1 Existing ACECs Intersecting Oil Shale or Tar Sands Areas.... 2-8

TABLES (Cont.)

2.3-1 Total Size in Acres of the Green River Formation Basins, Most Geologically Prospective Oil Shale Areas, and Acres of BLM-Administered and Split Estate Lands within the Most Geologically Prospective Areas in Each State 2-13

2.3-2 Summary Information for the Six Oil Shale RD&D Projects 2-14

2.3.2-1 Summary of Activities and Conditions Assumed for Each of the Oil Shale Alternatives 2-21

2.3.3-1 Estimated Acres Potentially Available in Each State for Application for Leasing for Commercial Oil Shale Development under Alternative B 2-31

2.3.3-2 Estimated Acres Potentially Available in Each State for Application for Leasing for Commercial Oil Shale Development under Alternative C 2-36

2.3.3-3 Resources Covered by Stipulations and Restrictions in Place for Oil and Gas Leasing in Each State That Are Being Used to Identify Lands Not Available for Application for Leasing under Alternative C 2-37

2.4-1 Total Size in Acres of the 11 STSAs and Acres of BLM-Administered and Split Estate Lands within Each STSA 2-41

2.4.2-1 Summary of Activities and Conditions Assumed for Each of the Tar Sands Alternatives 2-45

2.4.3-1 Estimated Acres Potentially Available under Alternative B for Application for Leasing in Each STSA for Commercial Tar Sands Development 2-50

2.4.3-2 Estimated Acres Potentially Available under Alternative C for Application for Leasing in Each STSA for Commercial Tar Sands Development 2-53

2.4.3-3 Resources Covered by Stipulations and Restrictions in Place for Oil and Gas Leasing in the STSAs That Are Being Used to Identify Lands That Would Not Be Available for Application for Commercial Tar Sands Development Leasing under Alternative C 2-54

2.6-1 Summary Comparison of Potential Environmental Impacts of Amending Land Use Plans to Identify Lands Available for Application for Leasing for the Commercial Development of Oil Shale, Including RD&D, in Colorado, Utah, and Wyoming, and Environmental Impacts of Future Construction and Operation of Commercial Projects under the Three Alternatives 2-59

TABLES (Cont.)

2.6-2 Summary Comparison of Potential Environmental Impacts of Amending Land Use Plans to Identify Lands Available for Application for Leasing for the Commercial Development of Tar Sands, Including RD&D, in Colorado, Utah, and Wyoming, and Environmental Impacts of Future Construction and Operation of Commercial Projects under the Three Alternatives 2-80

3.1.1-1 BLM Field Offices and Administrative Units, Existing Land Use Plans, and Estimated Surface Acreages Overlying the Most Geologically Prospective Oil Shale Resources and STSAs 3-3

3.1.1-2 Glenwood Springs Field Office ACECs That Overlap with Oil Shale Resources 3-8

3.1.1-3 White River Field Office ACECs That Overlap with Oil Shale Resources 3-11

3.1.1-4 Areas Recognized as Having Wilderness Characteristics in the Monticello Field Office That Overlap with the White Canyon STSA 3-17

3.1.1-5 Price Field Office WSAs and ACECs That Overlap with Tar Sands Resources 3-20

3.1.1-6 Areas Recognized as Having Wilderness Characteristics in the Price Field Office That Overlap with Oil Shale and Tar Sands Deposits 3-22

3.1.1-7 Potential ACECs in the Price Field Office Area That Meet R&I Criteria and Overlap with Oil Shale and Tar Sands Deposits 3-23

3.1.1-8 Vernal Field Office WSAs and ACECs That Overlap with Oil Shale and Tar Sands Resources 3-33

3.1.1-9 Areas Recognized as Having Wilderness Characteristics in the Vernal Field Office That Overlap with the Most Geologically Prospective Oil Shale Area and STSAs 3-35

3.1.1-10 Potential ACECs in the Vernal Field Office Area That Meet R&I Criteria and Overlap with Oil Shale and/or Tar Sands Resources 3-36

3.1.1-11 Rock Springs Field Office, WCAs, WSAs, and ACECs That Overlap with Oil Shale Resources 3-43

3.1.2-1 Federal and State Recreation Areas within a 50-mi Radius of the Most Geologically Prospective Oil Shale Areas and STSAs 3-45

TABLES (Cont.)

3.3-1 Summary of Programmatic-Level Paleontological Sensitivities of Geologic Units within the Piceance, Uinta, and Greater Green River Basins 3-58

3.4.1-1 Water-Impaired Streams in Oil Shale Basins and STSAs in 2006 3-66

3.4.1-2 Colorado Water Demand and Consumptive Use in 2000 and 2030 3-69

3.4.1-3 Utah Water Demand and Consumptive Use in 2000, 2020, and 2050 3-71

3.4.1-4 Wyoming Water Consumptive Use in 2000 and 2030 3-73

3.4.1-5 Upper Colorado Basin Depletion Projections 3-77

3.4.5-1 Groundwater Data within or near STSAs 3-93

3.5.1-1 Temperature and Precipitation Summaries at Selected Meteorological Stations in and around the Study Area 3-99

3.5.2-1 Annual Air Pollutant Emissions for Counties within the Study Area, 2002 3-103

3.5.3-1 Applicable Ambient Air Quality Standards and Prevention of Significant Deterioration Increments for the Study Area 3-105

3.5.3-2 Background Concentration Levels Representative of the Study Area.....3-106

3.5.3-3 PSD Class I and State Category I Areas Located within 50 mi of the Study Area 3-109

3.7.1-1 Fishes of the Upper Colorado River Basin 3-112

3.7.3-1 Number of Wildlife Species Occurring within the Oil Shale and Tar Sands Study Area 3-144

3.7.3-2 Wild Horse Herd Management Areas within the Oil Shale and Tar Sands Study Area 3-154

3.7.4-1 Federally and State-Listed Species According to Taxonomic Group That Occur in Counties with the Potential for Oil Shale or Tar Sands Development 3-157

3.7.4-2 Federally and State-Listed Species That Occur within Counties with the Potential for Oil Shale or Tar Sands Development.....3-158

TABLES (Cont.)

3.7.4-3 Occurrence of Species Listed or Candidates for Listing under the Endangered Species Act That Occur in Counties with the Potential for Oil Shale or Tar Sands Development 3-160

3.9.1-1 Site Types of Known Archaeological Sites in the Piceance Basin, Colorado 3-202

3.9.1-2 Eligibility Status of Known Archaeological Sites in the Piceance Basin, Colorado 3-203

3.9.2-1 Site Types of Known Archaeological Sites in the Uinta Basin, Utah 3-205

3.9.2-2 Eligibility Status of Known Archaeological Sites in the Uinta Basin, Utah 3-206

3.9.3-1 Site Types of Known Archaeological Sites in the Green River and Washakie Basins, Wyoming 3-209

3.9.3-2 Eligibility Status of Known Archaeological Sites in the Green River and Washakie Basins, Wyoming 3-210

3.9.4-1 Site Types of Known Archaeological Sites in the 11 Special Tar Sand Areas, Utah 3-214

3.9.4-2 Eligibility Status of Known Archaeological Sites in the 11 Special Tar Sand Areas, Utah 3-215

3.10.2-1 Jurisdictions Included in Each ROI 3-222

3.10.2-2 ROI Total Employment 3-223

3.10.2-3 State and ROI Unemployment Data 3-223

3.10.2-4 State and ROI Employment by Industry, 2004 3-224

3.10.2-5 State and ROI Personal Income 3-226

3.10.2-6 ROI Population 3-231

3.10.2-7 State and ROI Housing Characteristics 3-233

3.10.2-8 State and ROI Public Service Expenditures 3-235

3.10.2-9 State and ROI Local Government Employment, 2006 3-236

TABLES (Cont.)

3.10.2-10 State and ROI Public Health Employment, 2003 3-237

3.10.2-11 State and ROI Education Data, 2004 3-237

3.10.2-12 State and ROI Crime Rates 3-241

3.10.2-13 State Indices of Social Change 3-242

3.10.3-1 ROI Recreation Sector Activity, 2004 3-245

3.10.4-1 Baseline Average Daily Traffic Data for Project Area Roads 3-247

3.11-1 Minority and Low-Income Populations in the Oil Shale Resource Area and Buffer 3-250

3.11-2 Minority and Low-Income Populations in the Tar Sands Resource Area and Buffer 3-251

4.1.1-1 Assumptions Associated with a Surface Mine with Surface Retort with Production of 50,000 bbl of Shale Oil per Day 4-4

4.1.2-1 Assumptions Associated with an Underground Mine with Surface Retort with Production of 50,000 bbl of Shale Oil per Day 4-8

4.1.3-1 Assumptions Associated with an In Situ Retort Project with Production of 200,000 bbl of Shale Oil per Day 4-11

4.1.5-1 Estimated Housing Distribution of Incoming People and Acres Impacted by Employer-Provided Housing for the Construction and Operations Phases of Commercial Oil Shale Development 4-14

4.1.6-1 Assumptions Associated with a 1,500-MW and a 2,400-MW Conventional Coal-Fired Electric Power Plant 4-15

4.5.2-1 Water Budget for Oil Shale Development Projects 4-41

4.6.1-1 Counties within the Study Area That Could Be Affected by Air Pollutant Emissions 4-50

4.7.1-1 Noise Levels at Various Distances from Typical Construction Equipment 4-56

4.7.1-2 Noise Levels at Various Distances from Heavy Truck Traffic 4-57

TABLES (Cont.)

4.7.1-3 Maximum Achievable Noise Reductions for Design Features 4-60

4.8.1-1 Potential Impacts on Aquatic Resources Resulting from Commercial Oil Shale Development 4-66

4.8.1-2 Potential Impacts on Plant Communities Resulting from Commercial Oil Shale Development 4-70

4.8.1-3 Potential Impacts on Wildlife Species Resulting from Commercial Oil Shale Development 4-75

4.8.1-4 Potential Impacts of Commercial Oil Shale Development on Threatened, Endangered, and Sensitive Species 4-92

4.8.1-5 Potential Impacts of Commercial Oil Shale Development on BLM-Designated Sensitive Species, Federal Candidates for Listing, and State Species of Concern 4-94

4.8.1-6 Potential Effects of Commercial Oil Shale Development on Federally Listed Threatened, Endangered, and Proposed Species 4-110

4.11-1 Temporary Housing Assumptions 4-147

4.11.1-1 ROI Economic Impacts of Oil Shale Development 4-151

4.11.1-2 ROI Economic Impacts of Power Plant and Coal Mine Development 4-152

4.11.1-3 ROI Demographic and Housing Impacts of Oil Shale Development 4-153

4.11.1-4 ROI Demographic and Housing Impacts of Power Plant and Coal Mine Development 4-154

4.11.1-5 ROI Community Impacts of Oil Shale Development 4-155

4.11.1-6 ROI Community Impacts of Power Plant and Coal Mine Development 4-156

4.11.1-7 Total ROI Impacts of Reductions in Recreation Sector Employment Resulting from Oil Shale Development 4-158

4.14-1 Potential Health Impacts Associated with Oil Shale Development 4-178

4.14-2 Estimated Health Effects Associated with a Hypothetical One Million-bbl/day Oil Shale Industry 4-179

NOTATION

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

GENERAL ACRONYMS AND ABBREVIATIONS

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

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

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

NPS	National Park Service
NRA	National Recreation Area
NRHP	*National Register of Historic Places*
NSC	National Safety Council
NSO	No Surface Occupancy
NWCC	National Wind Coordinating Committee
OHV	off-highway vehicle
OOSI	Occidental Oil Shale, Inc.
OPEC	Organization of Petroleum Exporting Countries
OSEC	Oil Shale Exploration Company
OSEW/SPP	Oil Sands Expert Workgroup/Security and Prosperity Partnership
OSHA	Occupational Safety and Health Administration
OTA	Office of Technology Assessment
PA	Programmatic Agreement
PADD	Petroleum Administration for Defense District
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEIS	programmatic environmental impact statement
PFYC	Potential Fossil Yield Classification
P.L.	Public Law
PM	particulate matter
$PM_{2.5}$	particulate matter with a mean aerodynamic diameter of 2.5 μm or less
PM_{10}	particulate matter with a mean aerodynamic diameter of 10 μm or less
PPE	personal protective equipment
PRLA	preference right lease area
PSD	Prevention of Significant Deterioration
R&I	relevance and importance
RBOSC	Rio Blanco Oil Shale Company
RCRA	Resource Conservation and Recovery Act of 1976
RD&D	research, development, and demonstration
RF	radio frequency
RFDS	reasonably foreseeable development scenario
RMP	Resource Management Plan
ROD	Record of Decision
ROI	region of influence
ROS	Recreation Opportunity Spectrum
ROW	right-of-way
SAGD	steam-assisted gravity drainage
SAMHSA	Substance Abuse and Mental Health Services Administration
SDWA	Safe Drinking Water Act of 1974
SFC	Synthetic Fuels Corporation
SHPO	State Historic Preservation Office(r)

SIP	State Implementation Plan
SMA	Special Management Area
SMP	suggested management practice
SPR	Strategic Petroleum Reserve
SRMA	Special Recreation Management Area
SSI	self-supplied industry
STSA	Special Tar Sand Area
SWCA	SWCA, Inc., Environmental Consultants
SWPPP	Stormwater Pollution Prevention Plan
SWWRC	Sates West Water Resources Corporation
TDS	total dissolved solids
THAI	toe to head air injection
TIS	true in situ recovery
TMDL	Total Maximum Daily Load
TOSCO	The Oil Shale Corporation
TSCA	Toxic Substances Control Act of 1976
TSDF	treatment, storage, and disposal facility
UDEQ	Utah Department of Environmental Quality
UDNR	Utah Department of Natural Resources
UDWR	Utah Division of Wildlife Resources
UIC	underground injection control
USACE	U.S. Army Corps of Engineers
USC	*United States Code*
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VCRS	Visual Contrast Rating System
VOC	volatile organic compound
VRI	visual resource inventory
VRM	Visual Resource Management
WCA	areas recognized as having wilderness characteristics
WDEQ	Wyoming Department of Environmental Quality
WGFD	Wyoming Game and Fish Department
WRAP	Western Regional Air Partnership
WRCC	Western Regional Climate Center
WRSOC	White River Shale Oil Corporation
WSA	Wilderness Study Area
WSR	Wild and Scenic River
WTGS	wind turbine generator system
WYCRO	Wyoming Cultural Records Office

CHEMICALS

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

UNITS OF MEASURE

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

ENGLISH/METRIC AND METRIC/ENGLISH EQUIVALENTS[a]

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

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

[a] In general in this PEIS, only English units are presented. However, where reference sources provided both English and metric units, both values are presented in the order in which they are given in the source.

This page intentionally left blank.