

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 2: Chapters 5 & 6

September 2008



2	Proposed Oil Shale and Tar Sands Resource Management Plan Amendments	2
8	to Address Land Use Allocations in Colorado, Utah, and Wyoming	8
5	and Final Programmatic Environmental Impact Statement	5

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 2: Chapters 5 & 6

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

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 2 CONTENTS

NOTATION xix

ENGLISH/METRIC AND METRIC/ENGLISH EQUIVALENTS xxv

5 EFFECTS OF TAR SANDS TECHNOLOGIES 5-1

5.1 Assumptions and Impact-Producing Factors for Individual Facilities by
Commercial Tar Sands Technology..... 5-2

5.1.1 Surface Mine with Surface Retort or Solvent Extraction Projects 5-3

5.1.2 In Situ Facilities with Steam Injection or Combustion..... 5-8

5.1.3 Transmission Line and Crude Oil Pipeline ROWs..... 5-9

5.1.4 Workforce Operational Details and Employer-Provided Housing 5-10

5.1.5 Expansion of Electricity-Generating Capacity 5-10

5.1.6 Refining Needs for Tar Sands Development Projects 5-11

5.1.7 Additional Considerations and Time Lines 5-11

5.2 Land Use 5-12

5.2.1 Common Impacts..... 5-12

5.2.1.1 Other Mineral Development Activities..... 5-13

5.2.1.2 Acquisition, Conversion, or Transfer of Water Rights 5-15

5.2.1.3 Grazing Activities 5-15

5.2.1.4 Recreational Land Use..... 5-15

5.2.1.5 Specially Designated Areas, Potential ACECs, and Areas
with Wilderness Characteristics..... 5-16

5.2.1.6 Wild Horse and Burro Herd Management Areas..... 5-17

5.2.1.7 Different Tar Sands Development Technologies..... 5-17

5.2.2 Mitigation Measures 5-18

5.3 Soil and Geologic Resources 5-19

5.3.1 Common Impacts..... 5-19

5.3.1.1 Soil Resources..... 5-19

5.3.1.2 Geologic Resources 5-21

5.3.2 Mitigation Measures 5-22

5.4 Paleontological Resources 5-23

5.4.1 Common Impacts..... 5-23

5.4.2 Mitigation Measures 5-24

5.5 Water Resources 5-25

5.5.1 Common Impacts..... 5-25

5.5.1.1 Ground Surface Disturbance..... 5-27

5.5.1.2 Water Use..... 5-28

5.5.1.3 Discharge, Waste Handling, and Contaminant Sources 5-30

5.5.1.4 Alteration of Hydrologic Flow Systems 5-33

5.5.2 Water Budget for Individual Tar Sands Projects 5-35

5.5.2.1 Overall Water Budget 5-35

CONTENTS (Cont.)

	5.5.2.2	Water Availability for Individual Tar Sands Projects in STSAs	5-37
	5.5.3	Mitigation Measures	5-40
5.6		Air Quality and Climate.....	5-42
	5.6.1	Common Impacts.....	5-42
	5.6.1.1	Impacts from Emissions Sources for Tar Sands Facilities.....	5-45
	5.6.2	Mitigation Measures	5-47
5.7		Noise	5-47
	5.7.1	Common Impacts.....	5-49
	5.7.1.1	Construction.....	5-49
	5.7.1.2	Vehicular Traffic.....	5-50
	5.7.1.3	Surface Mining with Surface Retort	5-50
	5.7.1.4	Surface Mining with Solvent Extraction.....	5-51
	5.7.1.5	In Situ Steam Injection.....	5-51
	5.7.1.6	In Situ Combustion	5-52
	5.7.1.7	Reclamation	5-52
	5.7.1.8	Transmission Lines	5-52
	5.7.1.9	Pipeline	5-53
	5.7.2	Mitigation Measures	5-53
	5.7.2.1	Preconstruction Planning	5-53
	5.7.2.2	Construction and Reclamation.....	5-54
	5.7.2.3	Operation.....	5-55
5.8		Ecological Resources	5-56
	5.8.1	Common Impacts.....	5-56
	5.8.1.1	Aquatic Resources	5-56
	5.8.1.2	Plant Communities and Habitats.....	5-61
	5.8.1.3	Wildlife (Including Wild Horses and Burros)	5-65
	5.8.1.4	Threatened, Endangered, and Sensitive Species.....	5-82
	5.8.2	Mitigation Measures	5-103
	5.8.2.1	Aquatic Resources	5-103
	5.8.2.2	Plant Communities and Habitats.....	5-104
	5.8.2.3	Wildlife (Including Wild Horses and Burros)	5-105
	5.8.2.4	Threatened and Endangered Species	5-107
5.9		Visual Resources.....	5-109
	5.9.1	Common Impacts.....	5-109
	5.9.1.1	Surface Mining with Surface Retorting	5-110
	5.9.1.2	Surface Mining with Solvent Extraction.....	5-110
	5.9.1.3	In Situ Steam Injection.....	5-113
	5.9.1.4	In Situ Combustion	5-114
	5.9.1.5	Other Associated Tar Sands Project Facilities.....	5-115
	5.9.2	Mitigation Measures	5-116
5.10		Cultural Resources	5-120
	5.10.1	Common Impacts.....	5-120

CONTENTS (Cont.)

5.10.2	Mitigation Measures	5-121
5.11	Socioeconomics	5-123
5.11.1	Common Impacts.....	5-123
5.11.1.1	Economic Impacts.....	5-123
5.11.1.2	Social Impacts.....	5-124
5.11.1.3	Agricultural Impacts	5-126
5.11.1.4	Recreation Impacts.....	5-127
5.11.1.5	Property Value Impacts.....	5-128
5.11.1.6	Transportation Impacts	5-128
5.11.2	Mitigation Measures	5-128
5.12	Environmental Justice.....	5-131
5.12.1	Common Impacts.....	5-131
5.12.1.1	Impact-Producing Factors.....	5-131
5.12.1.2	General Population.....	5-132
5.12.1.3	Environmental Justice Populations.....	5-134
5.12.2	Mitigation Measures	5-134
5.13	Hazardous Materials and Waste Management.....	5-135
5.13.1	Common Impacts.....	5-135
5.13.1.1	Surface Mining with Surface Retort	5-136
5.13.1.2	Surface Mining with Solvent Extraction.....	5-137
5.13.1.3	In Situ Steam Injection.....	5-138
5.13.1.4	In Situ Combustion	5-139
5.13.2	Mitigation Measures	5-140
5.14	Health and Safety.....	5-141
5.14.1	Common Impacts.....	5-143
5.14.1.1	Surface Mining.....	5-143
5.14.1.2	Surface Retorting and Solvent Extraction.....	5-144
5.14.1.3	In Situ Steam Injection and Combustion	5-145
5.14.2	Mitigation Measures	5-146
5.15	References.....	5-148
6	IMPACT ASSESSMENT FOR OIL SHALE AND TAR SANDS ALTERNATIVES	6-1
6.1	Oil Shale Alternatives.....	6-1
6.1.1	Impacts of Alternative A, No Action Alternative, Continuation of Current Management	6-2
6.1.1.1	Land Use	6-3
6.1.1.2	Soil and Geologic Resources	6-8
6.1.1.3	Paleontological Resources	6-10
6.1.1.4	Water Resources	6-11
6.1.1.5	Air Quality	6-15
6.1.1.6	Noise	6-15

CONTENTS (Cont.)

	6.1.1.7	Ecological Resources	6-15
	6.1.1.8	Visual Resources.....	6-39
	6.1.1.9	Cultural Resources	6-46
	6.1.1.10	Socioeconomics	6-49
	6.1.1.11	Environmental Justice.....	6-55
	6.1.1.12	Hazardous Materials and Waste Management.....	6-56
	6.1.1.13	Health and Safety	6-58
6.1.2		Impacts of Alternative B, the Proposed Plan Amendment	6-59
	6.1.2.1	Land Use	6-60
	6.1.2.2	Soil and Geologic Resources	6-65
	6.1.2.3	Paleontological Resources	6-65
	6.1.2.4	Water Resources	6-66
	6.1.2.5	Air Quality	6-68
	6.1.2.6	Noise	6-69
	6.1.2.7	Ecological Resources	6-69
	6.1.2.8	Visual Resources.....	6-80
	6.1.2.9	Cultural Resources	6-84
	6.1.2.10	Socioeconomics	6-84
	6.1.2.11	Environmental Justice.....	6-88
	6.1.2.12	Hazardous Materials and Waste Management.....	6-89
	6.1.2.13	Health and Safety	6-90
6.1.3		Impacts of Alternative C.....	6-92
	6.1.3.1	Land Use	6-92
	6.1.3.2	Soil and Geologic Resources	6-94
	6.1.3.3	Paleontological Resources	6-95
	6.1.3.4	Water Resources	6-95
	6.1.3.5	Air Quality	6-96
	6.1.3.6	Noise	6-97
	6.1.3.7	Ecological Resources	6-97
	6.1.3.8	Visual Resources.....	6-106
	6.1.3.9	Cultural Resources	6-111
	6.1.3.10	Socioeconomics	6-113
	6.1.3.11	Environmental Justice.....	6-113
	6.1.3.12	Hazardous Materials and Waste Management.....	6-113
	6.1.3.13	Health and Safety	6-114
6.1.4		Comparison of Oil Shale Alternatives	6-115
	6.1.4.1	Land Use	6-116
	6.1.4.2	Soil and Geologic Resources	6-118
	6.1.4.3	Paleontological Resources	6-119
	6.1.4.4	Water Resources	6-120
	6.1.4.5	Air Quality	6-121
	6.1.4.6	Noise	6-122
	6.1.4.7	Ecological Resources	6-122

CONTENTS (Cont.)

	6.1.4.8	Visual Resources.....	6-128
	6.1.4.9	Cultural Resources.....	6-129
	6.1.4.10	Socioeconomics.....	6-132
	6.1.4.11	Environmental Justice.....	6-133
	6.1.4.12	Hazardous Materials and Waste Management.....	6-133
	6.1.4.13	Health and Safety.....	6-134
6.1.5		Cumulative Impacts.....	6-135
	6.1.5.1	Overview of Assumptions and Impact-Producing Factors for Major Activities in the Study Area.....	6-137
	6.1.5.2	Projected Levels of Major Activities in the Study Area.....	6-145
	6.1.5.3	Cumulative Impacts Assessment for the Possible Oil Shale Development That Could Occur under Each of the Alternatives, B and C.....	6-178
6.1.6		Other NEPA Considerations.....	6-201
	6.1.6.1	Unavoidable Adverse Impacts.....	6-201
	6.1.6.2	Short-Term Use of the Environment and Long-Term Productivity.....	6-205
	6.1.6.3	Irreversible and Irrecoverable Commitment of Resources.....	6-206
	6.1.6.4	Mitigation of Adverse Effects.....	6-207
6.2		Tar Sands Alternatives.....	6-207
	6.2.1	Impacts of Alternative A, No Action Alternative, Continuation of Current Management.....	6-208
	6.2.2	Impacts of Alternative B, the Proposed Plan Amendment.....	6-209
	6.2.2.1	Land Use.....	6-210
	6.2.2.2	Soil and Geologic Resources.....	6-214
	6.2.2.3	Paleontological Resources.....	6-215
	6.2.2.4	Water Resources.....	6-216
	6.2.2.5	Air Quality.....	6-217
	6.2.2.6	Noise.....	6-218
	6.2.2.7	Ecological Resources.....	6-219
	6.2.2.8	Visual Resources.....	6-230
	6.2.2.9	Cultural Resources.....	6-235
	6.2.2.10	Socioeconomics.....	6-237
	6.2.2.11	Environmental Justice.....	6-239
	6.2.2.12	Hazardous Materials and Waste Management.....	6-240
	6.2.2.13	Health and Safety.....	6-241
6.2.3		Impacts of Alternative C.....	6-242
	6.2.3.1	Land Use.....	6-243
	6.2.3.2	Soil and Geologic Resources.....	6-244
	6.2.3.3	Paleontological Resources.....	6-245
	6.2.3.4	Water Resources.....	6-245
	6.2.3.5	Air Quality.....	6-245
	6.2.3.6	Noise.....	6-246

CONTENTS (Cont.)

6.2.3.7	Ecological Resources	6-247
6.2.3.8	Visual Resources.....	6-255
6.2.3.9	Cultural Resources	6-257
6.2.3.10	Socioeconomics	6-263
6.2.3.11	Environmental Justice.....	6-263
6.2.3.12	Hazardous Materials and Waste Management.....	6-264
6.2.3.13	Health and Safety	6-264
6.2.4	Comparison of Tar Sands Alternatives.....	6-265
6.2.4.1	Land Use	6-266
6.2.4.2	Soil and Geologic Resources	6-267
6.2.4.3	Paleontological Resources	6-267
6.2.4.4	Water Resources	6-268
6.2.4.5	Air Quality	6-269
6.2.4.6	Noise	6-269
6.2.4.7	Ecological Resources	6-270
6.2.4.8	Visual Resources.....	6-273
6.2.4.9	Cultural Resources	6-274
6.2.4.10	Socioeconomics	6-275
6.2.4.11	Environmental Justice.....	6-276
6.2.4.12	Hazardous Materials and Waste Management.....	6-276
6.2.4.13	Health and Safety	6-277
6.2.5	Cumulative Impacts	6-278
6.2.5.1	Overview of Assumptions and Impact-Producing Factors of Major Activities in the Study Area	6-280
6.2.5.2	Projected Levels of Major Activities in the Study Area	6-287
6.2.5.3	Cumulative Impacts Assessment for the Possible Tar Sands Development That Could Occur under Each of the Alternatives, B and C.....	6-302
6.2.6	Other NEPA Considerations.....	6-323
6.2.6.1	Unavoidable Adverse Impacts	6-323
6.2.6.2	Short-Term Uses of the Environment and Long-Term Productivity	6-326
6.2.6.3	Irreversible and Irretrievable Commitment of Resources.....	6-327
6.2.6.4	Mitigation of Adverse Impacts	6-328
6.3	Endangered Species Act Section 7 Requirements	6-329
6.4	References.....	6-331

FIGURES

5.9.1-1	Large-Scale Commercial Oil Sands Surface Mining, North of Fort McMurray, Alberta, Canada.....	5-111
---------	--	-------

FIGURES (Cont.)

5.9.1-2	Large-Scale Commercial Oil Sands Surface Mining Activity North of Fort McMurray, Alberta, Canada.....	5-111
5.9.1-3	Portion of a Large-Scale Commercial Oil Sands Processing Plant near Fort McMurray, Alberta, Canada.....	5-112
5.9.1-4	Close-up View of a Large-Scale Commercial Oil Sands Processing Plant near Fort McMurray, Alberta, Canada.....	5-112
5.9.1-5	Photo Mosaic of Existing Pilot-Scale Tar Sands Processing Facility Utilizing Surface Mining and Solvent Extraction on Asphalt Ridge near Vernal, Utah.....	5-113
5.9.1-6	In Situ Steam-Assisted Gravity Drainage Facility near Fort McMurray, Alberta, Canada.....	5-114
6.1.1-1	Overlap of Lands Made Available for Leasing under Alternative A with the Known Distribution of the Greater Sage-Grouse.....	6-25
6.1.1-2	Overlap of Lands Made Available for Leasing under Alternative A with the Summer and Winter Ranges of the Mule Deer.....	6-26
6.1.1-3	Overlap of Lands Made Available for Application for Leasing under Alternative A with the Summer and Winter Ranges of the Elk.....	6-27
6.1.1-4	Overlap of Lands Made Available for Application for Leasing under Alternative A with Wild Horse Herd Management Areas.....	6-29
6.1.1-5	Designated Critical Habitat of Endangered River Fishes That Cross Lands Made Available for Application for Leasing under Alternative A.....	6-31
6.1.1-6	Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative A in Utah.....	6-44
6.1.1-7	Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative A in Colorado.....	6-45
6.1.2-1	Overlap of Lands Made Available for Application for Leasing under Alternative B with the Known Distribution of the Greater Sage-Grouse.....	6-74
6.1.2-2	Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Mule Deer.....	6-75

FIGURES (Cont.)

6.1.2-3 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Elk 6-76

6.1.2-4 Overlap of Lands Made Available for Application for Leasing under Alternative B with Wild Horse Herd Management Areas 6-78

6.1.2-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative B 6-79

6.1.2-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B in Colorado..... 6-81

6.1.2-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B in Utah 6-82

6.1.2-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B in Wyoming..... 6-83

6.1.3-1 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Known Distribution of the Greater Sage-Grouse6-101

6.1.3-2 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Mule Deer6-102

6.1.3-3 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Elk6-103

6.1.3-4 Overlap of Lands Made Available for Application for Leasing under Alternative C with Wild Horse Herd Management Areas6-105

6.1.3-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative C6-107

6.1.3-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C in Colorado.....6-108

6.1.3-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C in Utah6-109

FIGURES (Cont.)

6.1.3-8	Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C in Wyoming.....	6-110
6.1.5-1	Agricultural Water Uses in Colorado, Utah, and Wyoming in the Upper Colorado River Basin from 1970 through 2004	6-183
6.1.5-2	Municipal and Industrial Water Uses in Colorado, Utah, and Wyoming in the Upper Colorado River Basin from 1970 through 2004.....	6-183
6.1.5-3	Water Exports from the Upper Colorado River Basin in Colorado, Utah, and Wyoming from 1970 through 2004.....	6-184
6.1.5-4	Combined Water Uses and Losses in Colorado, Utah, and Wyoming in the Upper Colorado River Basin from 1970 through 2004	6-184
6.2.2-1	Overlap of Lands Made Available for Application for Leasing under Alternative B with the Known Distribution of the Greater Sage-Grouse	6-224
6.2.2-2	Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Mule Deer	6-225
6.2.2-3	Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Elk	6-226
6.2.2-4	Overlap of Lands Made Available for Application for Leasing under Alternative B with Wild Horse Herd Management Areas	6-228
6.2.2-5	Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative B	6-229
6.2.2-6	Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the Asphalt Ridge, Pariette, and Raven Ridge STSAs	6-231
6.2.2-7	Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the Argyle Canyon, Hill Creek, P.R. Spring, and Sunnyside STSAs.....	6-232
6.2.2-8	Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the San Rafael STSA	6-233

FIGURES (Cont.)

6.2.2-9 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the Tar Sand Triangle and White Canyon STSAs6-234

6.2.3-1 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Known Distribution of the Greater Sage-Grouse6-250

6.2.3-2 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Mule Deer6-251

6.2.3-3 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Elk6-252

6.2.3-4 Overlap of Lands Made Available for Application for Leasing under Alternative C with Wild Horse Herd Management Areas6-254

6.2.3-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative C6-256

6.2.3-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the Asphalt Ridge, Pariette, and Raven Ridge STSAs6-258

6.2.3-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the Hill Creek, P.R. Spring, and Sunnyside STSAs6-259

6.2.3-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the San Rafael STSA6-260

6.2.3-9 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the Tar Sand Triangle and White Canyon STSAs6-261

TABLES

5.1.1-1 Assumptions Associated with a Surface Mine with Surface Retort or with Solvent Extraction for Production Levels of 20,000 bbl/day of Syncrude 5-4

TABLES (Cont.)

5.1.2-1	Assumptions Associated with In Situ Facilities with Steam Injection or Combustion for Production Levels of 20,000 bbl/day of Syncrude	5-8
5.1.4-1	Estimated Housing Distribution of Incoming People and Acres Impacted by Employer-Provided Housing for the Construction and Operations Phases of Commercial Tar Sands Development.....	5-11
5.5.2-1	Estimated Water Consumption for Tar Sands Development.....	5-36
5.6.1-1	Counties within the Tar Sands Study Area That Could Be Affected by Air Pollutant Emissions	5-44
5.7.1-1	Noise Levels at Various Distances from Typical Construction Equipment	5-49
5.7.1-2	Noise Levels at Various Distances from Heavy Truck Traffic.....	5-50
5.7.1-3	Noise Levels from a Surface Mine with Surface Retort Site and a Surface Mine with Solvent Extraction Site	5-51
5.7.1-4	Noise Levels from an In Situ Steam Injection Site.....	5-51
5.8.1-1	Potential Impacts on Aquatic Resources Resulting from Commercial Tar Sands Development.....	5-57
5.8.1-2	Potential Impacts on Plant Communities Resulting from Commercial Tar Sands Development.....	5-62
5.8.1-3	Potential Impacts on Wildlife Species Resulting from Commercial Tar Sands Development.....	5-67
5.8.1-4	Potential Impacts of Commercial Tar Sands Development on Threatened, Endangered, and Sensitive Species.....	5-84
5.8.1-5	Potential Impacts of Commercial Tar Sands Development on BLM-Designated Sensitive Species, Federal Candidates for Listing, and State Species of Special Concern.....	5-86
5.8.1-6	Potential Effects of Commercial Tar Sands Development on Federally Listed Threatened, Endangered, and Proposed Species	5-99
5.11.1-1	ROI Economic Impacts of Tar Sands Development.....	5-124
5.11.1-2	ROI Demographic and Housing Impacts of Tar Sands Development.....	5-125

TABLES (Cont.)

5.11.1-3	ROI Community Impacts of Tar Sands Development.....	5-125
5.11.1-4	Total ROI Impacts of Reductions in Recreation Sector Employment Resulting from Tar Sands Development.....	5-127
5.14-1	Potential Health Impacts Associated with Tar Sands Development.....	5-142
6.1.1-1	ACECs in the Study Area Not Closed to Mineral Leasing, Alternative A.....	6-6
6.1.1-2	Areas with Wilderness Characteristics That Overlap with Lands Made Available for Application for Commercial Oil Shale Leasing under Alternatives A, B, and C and the Amount of Overlap	6-7
6.1.1-3	Potential ACECs That Overlap with Lands Made Available for Application for Commercial Oil Shale Leasing under Alternatives A, B, and C and the Amount of Overlap	6-8
6.1.1-4	Streams and Approximate Miles of Each Stream in the Geologically Prospective Areas of the Oil Shale Basins and in the Vicinity of Areas To Be Considered for Leasing under Each of the Alternatives.....	6-17
6.1.1-5	Acres of Important Wildlife Habitat Identified for Protection in BLM Land Use Plans That Are Present in the Alternative A Oil Shale Lease Allocation Areas	6-24
6.1.1-6	Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in Alternative A Available for Leasing.....	6-28
6.1.1-7	Potential Impacts of RD&D Projects on State-Listed Threatened and Endangered Species and Species of Special Concern, Federal Candidates for Listing, and BLM-Designated Sensitive Species.....	6-32
6.1.1-8	Potential Effects of RD&D Projects on Federally Listed Threatened, Endangered, and Proposed Species.....	6-37
6.1.1-9	Visually Sensitive Areas That Could Be Affected by Oil Shale Projects Developed in the Alternative A Lease Areas.....	6-46
6.1.1-10	Total Employment Comparing Each ROI and State.....	6-50
6.1.1-11	Total Personal Income Comparing Each ROI and State.....	6-51
6.1.1-12	Total Population Comparing Each ROI and State	6-51

TABLES (Cont.)

6.1.1-13	ROI Housing Units by Type	6-52
6.1.1-14	Annual State and ROI Public Service Expenditures Comparing Each ROI and State.....	6-53
6.1.1-15	Estimated ROI Economic Impacts of Oil Shale Development under Alternative A.....	6-54
6.1.2-1	ACECs in the Study Area Not Closed to Mineral Leasing and Available for Leasing under Alternative B	6-64
6.1.2-2	Perennial Streams Occurring within the Lease Areas with a 2-mi Buffer.....	6-68
6.1.2-3	Acres of Important Wildlife Habitat Identified for Protection in BLM Land Use Plans Present in the Alternative B Oil Shale Lease Areas	6-73
6.1.2-4	Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in the Alternative B Lease Areas	6-77
6.1.2-5	Visually Sensitive Areas That Could Be Affected by Commercial Oil Shale Projects within the Lease Areas Identified under Alternative B.....	6-85
6.1.3-1	Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in the Lease Areas Identified under Alternative C.....	6-104
6.1.3-2	Visually Sensitive Areas That Could Be Affected by Commercial Oil Shale Projects Developed in the Alternative C Lease Areas	6-112
6.1.4-1	Acreages Available for Potential Development under Alternatives A, B, and C	6-116
6.1.4-2	Amount of Available Acreage That Has the Potential to Contain Important Paleontological Resources	6-119
6.1.4-3	Perennial Stream Miles within the Four Oil Shale Basins.....	6-120
6.1.4-4	Acreage of Lands in Which Plant Communities and Habitats Could Be Impacted by Future Commercial Oil Shale Development.....	6-124
6.1.4-5	Acres of Important Wildlife Habitat Identified for Protection in BLM Land Use Plans Present in the Alternative A, B, and C Oil Shale Lease Areas	6-126

TABLES (Cont.)

6.1.4-6 Acreage of State-Identified Wildlife Habitat That Could Be Impacted by Commercial Oil Shale Development6-127

6.1.4-7 Threatened and Endangered Species and Selected Habitats Present in Potential Lease Sale Areas That Could Be Affected by Future Commercial Oil Shale Development6-128

6.1.4-8 Potentially Affected Sensitive Visual Resource Areas Associated with Lease Areas Identified in Alternatives A, B, and C.....6-130

6.1.4-9 Available Acreage under Each Alternative with the Potential to Contain Cultural Resources6-131

6.1.4-10 Estimated Acres Potentially Available for Application for Leasing for Commercial Oil Shale Development by State under Each Alternative6-133

6.1.5-1 Assumptions Associated with Oil and Gas Drilling6-137

6.1.5-2 Assumptions Associated with Coal Mining and Preparation6-139

6.1.5-3 Assumptions Associated with Coal-Fired Power Plants.....6-142

6.1.5-4 Projected Levels of Major Activities on BLM-Administered and Nonfederal Lands Considered in Cumulative Impacts Assessment for Oil Shale Development in Colorado6-146

6.1.5-5 Projected Levels of Major Activities for Seven Planning Areas Considered in the Cumulative Impacts Assessment for Oil Shale Development in Utah6-153

6.1.5-6 Projected Levels of Major Activities Considered in Cumulative Impacts Assessment for Oil Shale Development in Wyoming6-166

6.1.5-7 Energy Corridors on Public Lands in the Three-State Area6-174

6.1.5-8 Electric Power Generating Units in ROI Counties in the Three-State Area in 20056-175

6.1.5-9 Summary of Cumulative Long-Term Land Use for Oil Shale Development and Other Major Industrial Activities6-180

6.1.5-10 Major Water Uses in the Next 20 Years in the Three-State Study Area Compared with Use for Potential Oil Shale Development6-185

TABLES (Cont.)

6.2.2-1	Amount of Land Available for Application for Commercial Tar Sands Leasing under Alternatives B and C and the Corresponding Percentage of Total Public Lands by STSA	6-210
6.2.2-2	Areas with Wilderness Characteristics That Overlap with Lands Made Available for Application for Commercial Tar Sands Leasing under Alternatives B and C and the Amount of Overlap	6-213
6.2.2-3	Potential ACECs That Overlap with Lands Made Available for Application for Commercial Tar Sands Leasing under Alternatives B and C and the Amount of Overlap	6-215
6.2.2-4	Perennial Streams Occurring in Utah within the Lease Areas Identified under Alternative B	6-220
6.2.2-5	Streams and Approximate Miles of Each Stream in STSAs and in the Vicinity of Areas To Be Considered for Leasing under Alternatives B and C	6-221
6.2.2-6	Acres of Important Wildlife Habitat Identified for Protection in BLM Land Use Plans Present in Tar Sands Areas in Alternative B Available for Application for Commercial Leasing	6-223
6.2.2-7	Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in the Alternative B Lease Areas	6-227
6.2.2-8	Visually Sensitive Areas That Could Be Affected by Commercial Tar Sands Projects Developed in Lease Areas under Alternative B	6-236
6.2.3-1	Perennial Streams in Utah within the Lease Areas Identified under Alternative C	6-248
6.2.3-2	Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in the Alternative C Lease Areas	6-253
6.2.3-3	Visually Sensitive Areas That Could Be Affected by Commercial Tar Sands Projects Developed in Lease Areas under Alternative C	6-262
6.2.4-1	Available Acreage under Each Alternative with the Potential to Contain Important Paleontological Resources	6-268
6.2.4-2	Acres of Important Wildlife Habitat Identified for Protection in BLM Land Use Plans Present in the Alternative B and C Tar Sands Lease Areas	6-272

TABLES (Cont.)

6.2.4-3	Acreage of State-Identified Wildlife Habitat That Could Be Impacted by Commercial Tar Sands Development	6-272
6.2.4-4	Potentially Affected Sensitive Visual Resource Areas Associated with Lease Areas Identified under Alternatives B and C.....	6-274
6.2.4-5	Available Acreage under Each Alternative with the Potential to Contain Cultural Resources	6-275
6.2.4-6	Estimated Acres Potentially Available for Application for Leasing for Commercial Tar Sands Development by STSA under Each Alternative	6-276
6.2.5-1	Assumptions Associated with Oil and Gas Drilling	6-280
6.2.5-2	Assumptions Associated with Coal Mining and Preparation	6-282
6.2.5-3	Assumptions Associated with Coal-Fired Power Plants.....	6-285
6.2.5-4	Projected Levels of Major Activities for Seven Planning Areas Considered on BLM-Administered and Nonfederal Lands in the Cumulative Impacts Assessment for Tar Sands Development in Utah	6-288
6.2.5-5	Electric Power Generating Units in ROI Counties in Utah in 2005	6-302
6.2.5-6	Summary of Cumulative Long-Term Land Use for Tar Sands Development and Other Major Industrial Activities	6-304
6.2.5-7	Major Water Uses in the Next 20 Years in the Three-State Study Area Compared with Use for Potential Tar Sands Development.....	6-307

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	<i>Code of Federal Regulations</i>
CHL	combined hydrocarbon lease

Final OSTTS PEIS

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	<i>Federal Register</i>
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

Final OSTIS PEIS

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

Final OSTTS PEIS

NPS	National Park Service
NRA	National Recreation Area
NRHP	<i>National Register of Historic Places</i>
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	<i>United States Code</i>
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	NO _x	nitrogen oxides
CO	carbon monoxide	O ₃	ozone
CO ₂	carbon dioxide	Pb	lead
H ₂ S	hydrogen sulfide	SO ₂	sulfur dioxide
NH ₃	ammonia	SO _x	sulfur oxides
NO ₂	nitrogen dioxide		

UNITS OF MEASURE

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

ENGLISH/METRIC AND METRIC/ENGLISH EQUIVALENTS^a

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

Multiply	By	To Obtain
<i>English/Metric Equivalents</i>		
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 (°F) –32	0.5555	degrees Celsius (°C)
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)
<hr style="border-top: 1px dashed black;"/>		
<i>Metric/English Equivalents</i>		
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 (°C) +17.78	1.8	degrees Fahrenheit (°F)
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.