U.S. NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

DIVISION OF FUEL CYCLE SAFETY, SAFEGUARDS AND ENVIRONMENTAL REVIEW

DRAFT ENVIRONMENTAL ASSESSMENT
FOR THE MARSLAND EXPANSION AREA
LICENSE AMENDMENT APPLICATION

DOCKET NO. 40-8943

December 2017

TABLE OF CONTENTS

List of Figures ix

List of Tables xi

Executive Summary xiii

Abbreviations and Acronyms xvii

1 Introduction 1-1
- 1.1 Background 1-1
- 1.2 Purpose and Need for the Proposed Action 1-1
- 1.3 Proposed Action 1-2
- 1.4 Review Scope 1-4
- 1.5 Structure of this Environmental Assessment 1-5

2 Proposed Action and Alternatives 2-1
- 2.1 Description of the In Situ Recovery Process 2-1
- 2.2 Site Location 2-2
- 2.3 Proposed Action 2-5
  - 2.3.1 Satellite Facility and Wellfield Construction 2-5
    - 2.3.1.1 Preconstruction 2-5
    - 2.3.1.2 Construction 2-6
  - 2.3.2 Operations 2-7
  - 2.3.3 Aquifer (Groundwater) Restoration 2-8
  - 2.3.4 Decommissioning 2-10
  - 2.3.5 Effluents and Waste Management 2-11
    - 2.3.5.1 Airborne Effluents 2-12
    - 2.3.5.2 Liquid Waste 2-12
    - 2.3.5.3 Solid Wastes 2-14
- 2.4 No-Action Alternative 2-14

3 Affected Environment 3-17
- 3.1 Land Use 3-17
  - 3.1.1 Classifications and Productivity 3-19
  - 3.1.2 Industrial Uses 3-20
- 3.2 Geology, Soils, and Seismology 3-21
  - 3.2.1 Regional Geology 3-21
    - 3.2.1.1 Regional Stratigraphy 3-21
    - 3.2.1.2 Regional Structure 3-22
    - 3.2.1.3 Paleontological Resources 3-23
  - 3.2.2 Local Geology 3-24
    - 3.2.2.1 Local Stratigraphy 3-24
    - 3.2.2.2 Marsland Expansion Area Local Structure 3-27
  - 3.2.3 Soils 3-30
  - 3.2.4 Seismology 3-31
    - 3.2.4.1 Intensities of the Historical Significant Earthquakes 3-33
    - 3.2.4.2 USGS Seismic Hazard Maps 3-33
- 3.3 Water Resources 3-34
  - 3.3.1 Surface Water Resources 3-34

3.3.1.1 Surface Water Flow....3-37
3.3.1.2 Surface Water Quality....3-38
3.3.2 Groundwater Resources....3-39
3.3.2.1 Regional Groundwater Resources....3-39
3.3.2.2 Local Groundwater Resources....3-46
3.3.2.3 Basal Chadron Sandstone Aquifer—Uranium-Bearing Aquifer....3-47
3.3.2.4 Groundwater Quality....3-47
3.3.2.5 Level of Confinement—Basal Chadron Sandstone Aquifer....3-48
3.3.3 Water Use....3-50
3.3.3.1 Dawes County Water Use....3-50
3.3.3.2 Marsland Expansion Area Water Use....3-51
3.4 Ecological Resources....3-52
3.4.1 Terrestrial Ecology....3-53
3.4.1.1 Vegetation....3-53
3.4.1.2 Animals....3-55
3.4.2 Aquatic Ecology....3-57
3.4.3 Threatened, Endangered, Proposed, and Candidate Species....3-57
3.4.3.1 Federally and State-Listed Species....3-57
3.4.3.2 Other At-Risk Species....3-62
3.5 Climate, Meteorology, and Air Quality....3-63
3.5.1 Climate and Meteorology....3-63
3.5.2 Air Quality....3-64
3.6 Historic and Cultural Resources....3-65
3.6.1 Federal Undertaking....3-65
3.6.2 Cultural History....3-65
3.6.2.1 Prehistoric Periods....3-66
3.6.2.2 Proto-Historic and Post-Contact Tribes (400 Years Before the Present to Present Day)....3-66
3.6.2.3 Euro-Americans (300 Years Before the Present to Present Day)....3-68
3.6.3 Identified Historic and Cultural Resources....3-69
3.6.3.1 National Register of Historic Places Properties....3-69
3.6.3.2 Nebraska Historical Landmarks....3-70
3.6.3.3 Previous Cultural Resources Surveys....3-70
3.6.4 Tribal Consultations for the Marsland Expansion Area....3-72
3.6.5 Places of Religious or Cultural Significance....3-73
3.6.5.1 Background....3-73
3.6.5.2 Potential Places of Religious or Cultural Significance....3-75
3.7 Demographics and Socioeconomics....3-76
3.7.1 Population Distribution....3-76
3.7.2 Local Socioeconomic Characteristics....3-77
3.7.3 Housing and Commercial Uses....3-78
3.7.4 Environmental Justice Characteristics....3-78
3.8 Transportation....3-79
3.9 Noise....3-81
3.10 Visual and Scenic Resources....3-82
3.11 Public and Occupational Health and Safety....3-82
3.11.1 Air Characteristics....3-83
3.11.2 Groundwater Characteristics....3-85
3.11.2.1 Nonradiological Characteristics....3-85
3.11.2.2 Radiological Characteristics....3-86
3.11.3 Surface Water Characteristics....3-86

3.11.4 Baseline Vegetation, Food, and Fish Monitoring 3-86
3.11.5 Soil Characteristics 3-90
3.11.6 Sediment Characteristics....3-91
3.11.7 Baseline Direct Radiation Monitoring 3-92

4 Environmental Impacts 4-1
4.1 Land Use Impacts....4-2
4.1.1 Construction 4-2
4.1.2 Operations....4-4
4.1.3 Aquifer Restoration 4-5
4.1.4 Decommissioning 4-5
4.2 Geology and Soils 4-6
4.2.1 Impacts to Geology....4-6
4.2.2 Impacts to Soils....4-6
4.2.3 No-Action Alternative 4-9
4.3 Water Resources....4-10
4.3.1 Surface Water Impacts 4-10
4.3.1.1 Surface Water Quality 4-10
4.3.1.2 Surface Water Quantity 4-13
4.3.2 Groundwater Impacts 4-15
4.3.2.1 Groundwater Quantity 4-15
4.3.2.2 Groundwater Quality 4-20
4.3.3 No-Action Alternative 4-25
4.4 Ecological Resources....4-25
4.4.1 Impacts to Vegetation and Animals....4-25
4.4.1.1 Vegetation Impacts....4-25
4.4.1.2 Mammals and Birds....4-27
4.4.1.3 Reptiles and Amphibians 4-29
4.4.1.4 Fish and Macroinvertebrates....4-30
4.4.2 Protected Species and Habitats 4-30
4.4.2.1 Northern Long-Eared Bat 4-32
4.4.2.2 Whooping Crane 4-32
4.4.2.3 Swift Fox 4-32
4.4.2.4 Fish (Blacknose Shiner, Northern Redbelly Dace, Finescale Dace)....4-32
4.4.2.5 Other Species of Concern....4-33
4.4.3 No-Action Alternative 4-33
4.5 Climate, Meteorology, and Air Quality....4-34
4.5.1 Air Quality....4-34
4.5.2 Greenhouse Gas Emissions and Global Climate Change 4-35
4.5.2.1 Marsland Expansion’s Contribution to Atmospheric Greenhouse Gas Levels 4-35
4.5.2.2 Potential Effect of Climate Change on the Marsland Expansion Area....4-36
4.5.3 No-Action Alternative 4-36
4.6 Historic and Cultural Resources Impacts....4-36
4.6.1 Historic and Archaeological Resources 4-36
4.6.2 Places of Religious or Cultural Significance....4-37
4.6.3 No-Action Alternative 4-38
4.7 Demographics and Socioeconomics 4-39
4.7.1 Socioeconomic Impacts....4-39
4.7.2 Environmental Justice....4-40
4.7.3 No-Action Alternative 4-43
4.8 Transportation....4-43

4.8.1 Nonradiological Transportation Impacts 4-43
4.8.2 Radiological Transportation Impacts 4-45
4.8.3 No-Action Alternative 4-47
4.9 Noise 4-47
4.9.1 Construction 4-47
4.9.2 Operation 4-48
4.9.3 Aquifer Restoration and Decommissioning 4-48
4.9.4 No-Action Alternative 4-48
4.10 Visual and Scenic Resources 4-48
4.11 Public and Occupational Health and Safety 4-50
4.11.1 Nonradiological Effects 4-50
4.11.2 Radiological Effects 4-51
4.11.2.1 Exposure from Air Pathways 4-52
4.11.2.2 Exposure from Water Pathways 4-53
4.11.3 Accidents 4-53
4.11.4 No-Action Alternative 4-55
4.12 Hazardous Materials and Waste Management 4-55
4.12.1 Hazardous Materials 4-55
4.12.2 Waste Management 4-56
4.12.3 No-Action Alternative 4-56

5 Cumulative Impacts 5-1
5.1 Cumulative Impacts for Land Use 5-3
5.2 Cumulative Impacts for Geology and Soils 5-4
5.3 Cumulative Impacts for Water Resources 5-5
5.3.1 Surface Water 5-5
5.3.2 Groundwater 5-5
5.4 Cumulative Impacts for Ecological Resources 5-6
5.5 Cumulative Impacts for Air Quality 5-8
5.6 Cumulative Impacts for Historic and Cultural Resources 5-8
5.6.1 Historic and Archaeological Resources 5-9
5.6.2 Places of Religious or Cultural Significance 5-11
5.7 Cumulative Impacts for Demographics and Socioeconomics 5-12
5.7.1 Socioeconomics 5-12
5.7.2 Environmental Justice 5-13
5.8 Cumulative Impacts for Transportation 5-14
5.9 Cumulative Impacts for Noise 5-15
5.10 Cumulative Impacts for Visual and Scenic Resources 5-16
5.11 Cumulative Impacts for Public and Occupational Health and Safety 5-16
5.11.1 Nonradiological Impacts 5-16
5.11.2 Radiological Impacts 5-17
5.12 Cumulative Impacts for Hazardous Materials and Waste Management 5-18
5.12.1 Hazardous Materials 5-18
5.12.2 Waste Management 5-19
5.12.2.1 Liquid Wastes 5-19
5.12.2.2 Solid Wastes 5-19

6 Monitoring and Mitigation 6-1
6.1 Preoperational Baseline Monitoring 6-1
6.2 Operational Monitoring 6-2
6.2.1 Groundwater and Surface Water 6-2

6.2.2 Air Quality Monitoring....6-3
6.2.3 Environmental Monitoring....6-3
6.3 Mitigation Measures....6-4

7 Consultations....7-5

8 Conclusion....8-1

9 List of Preparers....9-1

10 References....10-1

LIST OF FIGURES

Figure 1-1	General layout of the MEA	1-3
Figure 2-1	The ISR process in the wellfield	2-2
Figure 2-2	Above-ground processing activities at a typical ISR expansion area	2-3
Figure 2-3	General location of the Marsland Expansion Area	2-4
Figure 2-4	Typical wellfield layout	2-7
Figure 3-1	MEA boundary and area of review	3-18
Figure 3-2	Structural features map of the Crawford Basin	3-23
Figure 3-3	National peak ground acceleration Seismic Hazard Maps in 2014 of USGS for 10-percent probability of exceedance in 50 years	3-34
Figure 3-4	Niobrara River Basin near the MEA	3-36
Figure 3-5	Groundwater flowpaths and timeframes	3-40
Figure 3-6	Geology of Upper Niobrara-White Natural Resources District	3-42
Figure 3-7	Groundwater flow directions within surficial aquifers based on 1995 potentiometric surface	3-43
Figure 3-8	Conceptualization of groundwater flow within the Basal Chadron Sandstone aquifer	3-45
Figure 3-9	Proposed access route between MEA satellite facility and Crow Butte license area	3-80
Figure 3-10	Locations of Environmental Air Sampling Stations	3-84
Figure 3-11	Surface water/sediment, vegetation, garden soil, and livestock sampling locations	3-88
Figure 5-1	Proposed timeline of construction, production, restoration and reclamation (top to bottom) at proposed CBR ISR expansion areas	5-2

LIST OF TABLES

Table 3-1 Land Use Definitions.....3-19
Table 3-2 Land Use within the MEA and within the Area of Review (2.25 miles (3.6 km) beyond the MEA Boundary).....3-20
Table 3-3 General Stratigraphic Chart for Northwest Nebraska.....3-21
Table 3-4 Approximate Thicknesses of MEA Geologic Units.....3-24
Table 3-5 Historical Earthquakes within 100 miles (161 km) of the MEA.....3-31
Table 3-6 Hydrostratigraphy in Southwestern Dawes County.....3-41
Table 3-7 Information on Domestic Wells Located Nearest to the MEA License Boundary.....3-52
Table 3-9 Expected Site Conditions.....3-64
Table 3-10 NRHP-Listed Properties in Proximity to the MEA (All in Dawes County).....3-70
Table 3-11 Historic Cultural Resources Sites and Isolated Finds Recorded during the Field Investigations at the MEA.....3-71
Table 3-12 2010 and 2016 Estimated Population of Counties within a 50-Mile (80-km) Radius of the MEA.....3-77
Table 3-13 Poverty and Minority Populations (2009–2013 Estimates).....3-79
Table 3-14 Census Data for Minority Type Populations of Dawes County, Nebraska.....3-79
Table 3-15 Census Data for Minority Type Populations of the City of Crawford, Nebraska..3-79
Table 3-16 Annual Average Daily Traffic Counts for the Roadways around the MEA and Existing Crow Butte License Area.....3-81
Table 3-17 Groundwater Nonradiological Characteristics.....3-85
Table 3-18 Groundwater Radiological Characteristics.....3-86
Table 3-19 Niobrara River Surface Water Radiological Characteristics.....3-87
Table 3-20 Vegetation Radiological Characteristics.....3-89
Table 3-21 Crops Radiological Characteristics.....3-89
Table 3-22 Livestock (Beef) Radiological Characteristics.....3-90
Table 3-23 Fish (Northern Pike) Radiological Characteristics.....3-90
Table 3-24 Soil Radiological Characteristics.....3-91
Table 3-25 Niobrara River Sediment Radiological Characteristics.....3-91
Table 3-27 Quarterly Net Gamma Exposure Results (mrem).....3-92
Table 4-1 Estimated Acres Disturbed by MEA Development.....4-4
Table 4-2 Impacts to Federally Listed Species.....4-31
Table 4-3 Impacts to State-Listed Species.....4-31
Table 4-4 Summary of MEA Plant Species that Have Been Identified as Being Used by the Oglala Sioux in Contemporary Times.....4-38
Table 4-5 Transportation of Materials during Operations.....4-44
Table 5-1 Comparison of Historic and Archaeological Resources Data for CBR Sites.....5-11

EXECUTIVE SUMMARY

By letter dated May 16, 2012, Crow Butte Resources, Inc. (CBR or the "licensee") submitted an application to the U.S. Nuclear Regulatory Commission (NRC) requesting an amendment to Source Materials License Number SUA-1534 (SUA-1534) to authorize in situ uranium recovery (ISR) operations at the Marsland Expansion Area (MEA), located near the town of Marsland, NE. The MEA would operate as an extension of the existing Crow Butte license area near Crawford, NE. The licensee would extract uranium from the MEA wellfields through an ISR process, conduct the ion-exchange portion of the uranium recovery process at the MEA, and then transport material to CBR's existing Central Processing Facility to complete the process. The purpose and need for the proposed action (permitting ISR operations at an expansion area) are to provide an option that allows for CBR to recover uranium from the ore body at a new area for continued yellowcake[1] production at the existing Crow Butte license area.

The NRC's Federal action is the decision to approve the existing CBR license to authorize the expansion of CBR's commercial-scale ISR uranium recovery operations to the MEA. If approved, the NRC would license CBR to conduct ISR operations at the MEA in accordance with the requirements in Title 10 of the *Code of Federal Regulations* (CFR) Part 40, "Domestic Licensing of Source Material."

In this draft environmental assessment (EA), the NRC analyzes the potential environmental impacts from the construction, operation, aquifer restoration, and decommissioning of the MEA. Chapter 1 presents background information, what is being proposed, the project's purpose and need, the review scope, and structure of this document. Chapter 2 discusses the details of the proposed action; Chapter 3 discusses the affected environment; and Chapter 4 discusses the potential impacts to the environmental resource areas, identified as follows:

- Land Use (Sections 3.1 and 4.1)
- Geology and Soils (Sections 3.2 and 4.2)
- Water Resources (Sections 3.3 and 4.3)
- Ecological Resources (Sections 3.4 and 4.4)
- Climate, Meteorology, and Air Quality (Sections 3.5 and 4.5)
- Historic and Cultural Resources (Sections 3.6 and 4.6)
- Demographics and Socioeconomics (Sections 3.7 and 4.7)
- Transportation (Section 3.8 and 4.8)
- Noise (Section 3.9 and 4.9)
- Visual and Scenic Resources (Section 3.10 and 4.10)
- Public and Occupational Health and Safety (Section 3.11 and 4.11)
- Hazardous Materials and Waste Management (Section 4.12)

Additionally, Chapter 5 analyzes potential cumulative impacts from past, present, and reasonably foreseeable future actions when combined with the potential environmental impacts from the proposed action. Chapter 6 describes the monitoring programs and mitigation measures while Chapter 7 presents the conclusions made from this analysis.

The NRC staff prepared this draft EA in accordance with NRC regulations in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory

---

[1] "Yellowcake" is the uranium oxide product of the ISR process that is used to produce various products, including fuel for commercially operated nuclear power reactors.

Functions," that implement the National Environmental Policy Act of 1969, as amended (NEPA) (Title 42 of the *United States Code* (U.S.C.) Section (§) 4321), and NRC staff guidance in NUREG-1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs," issued August 2003 (NRC, 2003a). This draft EA considers information from the licensee's license amendment application and independent sources to fulfill the requirements stated in 10 CFR 51.30(a).

This draft EA tiers from NUREG-1910, "Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities," issued May 2009 (ISR GEIS) (NRC, 2009a). The ISR GEIS provides a starting point for NRC analyses under NEPA for site-specific license applications for new ISR facilities, as well as for applications that amend or renew existing ISR licenses.

In preparing this draft EA, the NRC staff reviewed previous NEPA documents completed for the initial licensing of the Crow Butte license area and its subsequent license renewals; consulted with other Federal agencies, federally recognized Native American Tribes, and State and local government agencies; conducted site visits; and reviewed responses to NRC requests for additional information from the licensee.

Generally, in its NEPA evaluations, the NRC staff categorizes the potential environmental impacts of a proposed action as follows:

- SMALL—environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
- MODERATE—environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
- LARGE—environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The ISR GEIS (NRC, 2009a) considers impacts according to these categories. The NRC staff preliminarily finds that the impacts from the proposed action in this draft EA would be SMALL for most resource areas, with potential MODERATE impacts to specific aspects of the following three resource areas:

1. noise (temporary impacts to the nearest resident to the MEA during construction)
2. ecological resources (localized and temporary impacts resulting from the loss and slow recovery of forest habitat)
3. water resources (short-term lowering of the potentiometric surface of the Basal Chadron Sandstone aquifer)[2]

While potential MODERATE impacts would be expected for specific aspects of these resource areas, the impacts would be short-term and temporary; thus, the overall impacts related to these three resource areas would be SMALL.

[2] The potentiometric surface is the elevation that the water would rise to if a well were completed in an aquifer under pressure (i.e., confined).

Furthermore, the NRC staff preliminarily finds that potential cumulative impacts from the proposed action would not be detrimentally significant for all resource areas. There could be primarily beneficial and significant cumulative impacts for the socioeconomics resource area from additional tax revenue, employment, and local purchases.

At least 12 months before beginning any decommissioning activities at the MEA, CBR would submit a detailed decommissioning plan to the NRC for review and approval in accordance with License Condition 10.11 of SUA-1534 (SUA-1534 would be revised to be applicable to the MEA). CBR would use baseline data for soils, vegetation, and radiological conditions to guide the reclamation activities. Appropriate cleanup criteria for surfaces would need to be established in concert with NRC requirements.

Based on its review of the proposed action relative to the requirements set forth in 10 CFR Part 51, the NRC staff has preliminarily determined that amendment of SUA-1534, which would authorize the development of additional ISR operations at the MEA, would not significantly affect the quality of the human environment. Therefore, based on this preliminary assessment, an environmental impact statement (EIS) is not warranted, and, pursuant to 10 CFR 51.31, “Determinations Based on Environmental Assessment,” a Finding of No Significant Impact (FONSI) is appropriate.

In accordance with 10 CFR 51.33(a), the NRC staff is making this draft EA and the draft FONSI available for public review and comment for 45 days. The NRC will publish a Notice in the *Federal Register* announcing the availability of the draft EA and FONSI for comment and how comments may be submitted. After considering all received comments, the NRC staff will determine whether a final FONSI is appropriate or whether preparation of an EIS is warranted based on identified significant impacts from the proposed action. The NRC’s final determination will be published in the *Federal Register*.

ABBREVIATIONS AND ACRONYMS

ADAMS	Agencywide Documents Access and Management System
APE	area of potential effect
ARCADIS	ARCADIS U.S., Inc.
bgs	below ground surface
BMP	best management practice
BNSF	Burlington Northern Santa Fe (railroad)
BP	before the present
CBR	Crow Butte Resources, Inc.
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
cm	centimeter(s)
CNWRA	Center for Nuclear Waste Regulatory Analyses
CPF	Central Processing Facility
dB	decibel
dBA	A-weighted decibels
DDW	deep disposal well
DOT	U.S. Department of Transportation
E. coli	*Escherichia coli*
EA	environmental assessment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ER	environmental report
FONSI	Finding of No Significant Impact
FR	*Federal Register*
ft^2	square feet
gpm	gallon(s) per minute
ha	hectare(s)
ISR	in situ uranium recovery
ISR GEIS	NUREG-1910, "Generic Environmental Impact Statement for In-Situ Leach Uranium Mining Facilities," issued May 2009
IX	ion exchange
kg	kilogram(s)
km	kilometer(s)
L	liter
Lpm	liter(s) per minute
μCi	microcurie(s)
μmhos	micromho(s)
μR	microroentgen
m^2	square meter(s)
m^3	cubic meter(s)
MBTA	Migratory Bird Treaty Act
MEA	Marsland Expansion Area

mg	milligram
mi^2	square mile(s)
MIT	mechanical integrity testing
ml	milliliter(s)
MMI	Modified Mercalli Scale of Intensity
mrem	millirem
NAAQS	National Ambient Air Quality Standards
NAC	Nebraska Administrative Code
NDEQ	Nebraska Department of Environmental Quality
NDNR	Nebraska Department of Natural Resources
NE	Nebraska
NEPA	National Environmental Policy Act of 1969, as amended
NE SHPO	Nebraska State Historic Preservation Office
NGPC	Nebraska Game and Parks Commission
NHPA	National Historic Preservation Act
NMSS	NRC Office of Nuclear Material Safety and Safeguards
NPDES	National Pollution Discharge Elimination System
NPS	U.S. National Park Service
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NSHS	Nebraska State Historical Society
NTEA	North Trend Expansion Area
OSHA	Occupational Safety and Health Administration
pCi	picocurie(s)
PM_{10}	particulate matter less than 10 micrometers in diameter
ppm	part(s) per million
s	second
SAAQS	State Ambient Air Quality Standards
SARA	Superfund Amendments and Reauthorization Act
SD	South Dakota
SHEQMS	Safety, Health, and Environment Quality Management System
SPCC	Spill Prevention, Control, and Countermeasure
SWPPP	Storm Water Pollution Prevention Plan
TCEA	Three Crow Expansion Area
TCP	traditional cultural property
TDS	total dissolved solids
TR	Technical Report
U_3O_8	triuranium octoxide (yellowcake)
UBC	Uniform Building Code
UIC	Underground Injection Control
UMTRCA	Uranium Mill Tailings Radiation Control Act
USBR	U.S. Bureau of Reclamation
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers

USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VRM	Visual Resource Management
WY	Wyoming

1 INTRODUCTION

By letter dated May 16, 2012, Crow Butte Resources, Inc (CBR or the licensee) submitted a request to amend its U.S. Nuclear Regulatory Commission (NRC) Source Material License SUA-1534 (SUA-1534), which currently authorizes in situ uranium recovery (ISR) operations at the Crow Butte ISR project located in Dawes County, NE (CBR, 2012a). CBR requested authorization to expand its ISR operations to the proposed Marsland Expansion Area (MEA), which encompasses approximately 4,622 acres (1,870 hectares (ha)) and is located 11.1 miles (17.9 kilometers (km)) south-southeast of the existing Crow Butte Central Processing Facility (CPF).

The NRC staff has prepared this draft environmental assessment (EA) in accordance with the NRC requirements in 10 CFR 51.21, “Criteria for and Identification of Licensing and Regulatory Actions Requiring Environmental Assessments,” and 10 CFR 51.30, “Environmental Assessment,” and with the associated guidance in NUREG-1748 (NRC, 2003a).

The NRC staff’s review of CBR’s license amendment application includes both a safety review and an environmental review, conducted in parallel. The NRC’s decision to grant the license amendment will be based on the results of both the environmental and safety reviews. The results of the environmental review are documented in this draft EA. The staff’s safety analysis will be documented in a safety evaluation report.

1.1 Background

The Crow Butte ISR project (hereafter referred to as “the existing Crow Butte license area”) is a commercial uranium recovery facility located in Dawes County, NE. The existing Crow Butte license area consists of uranium recovery systems and the Crow Butte CPF and is located approximately 4 miles (6.4 km) southeast of the city of Crawford, NE. The existing Crow Butte license area began operations in 1986 as a research and development facility and was later expanded, with commercial operations beginning in 1991. The NRC recently renewed SUA-1534, with the associated environmental review documented in an EA issued in October 2014 (NRC, 2014e). At present, commercial ISR production of uranium is occurring at the existing Crow Butte license area. Under SUA-1534, CBR is authorized, through its ISR process, to produce up to 2 million pounds (lbs) (907,185 kilogram (kg)) per year of tri-uranium octoxide (U_3O_8), also known as “yellowcake.”

1.2 Purpose and Need for the Proposed Action

The purpose and need for the proposed Federal action, NRC’s approval of CBR’s proposed license amendment, is to provide an option that allows the licensee to recover uranium at the MEA, process it into uranium-loaded resin at a satellite facility located within the MEA, and transport the loaded resin to the CPF for further processing into yellowcake. Approval of uranium recovery activities in the MEA would allow CBR to maintain uranium production at currently licensed quantities once uranium recovery activities cease at the existing Crow Butte license area (CBR, 2014, Section 1.2). Further development of domestic resources of uranium would contribute to the energy independence of the United States, considering that domestic production accounts for only about 17 percent of the total uranium purchased by U.S. civilian nuclear power reactors (EIA, 2013). It should be noted that, unless there are findings either in the safety review required by the Atomic Energy Act of 1954, as amended, or in the environmental analysis required under NEPA that would lead the NRC to reject a license application, the NRC has no role in a company's business decision to submit a license application to operate an ISR facility at a particular location.

1.3 Proposed Action

CBR proposes to conduct ISR operations at the MEA, shown in Figure 1-1, as an extension of the ISR operations at the existing Crow Butte license area. In this proposed action, the licensee would extract uranium-bearing water from the subsurface through 11 individual mine units, process the uranium from the water onto uranium-loaded resin at a satellite facility[3] located within the MEA, and transport the loaded resins to the CPF at the existing Crow Butte license area for further processing and production into yellowcake. As uranium recovery in each mine unit ends, the licensee would begin aquifer restoration activities in that mine unit. Following aquifer restoration at all 11 mine units, CBR would decommission the MEA according to an NRC-approved decommissioning plan.[4] Section 2.3 of this EA provides more details on the proposed activities to occur at the MEA.

CBR initiated the proposed Federal action by submitting an application to amend SUA-1534 for the existing Crow Butte license area to expand uranium recovery operations to the MEA. This amendment, if approved, would allow CBR to construct and operate the MEA and perform subsequent aquifer restoration and site decommissioning and reclamation activities. Based on the application, the NRC's proposed Federal action is to grant the license amendment.

3 "Satellite facility" as used in this Draft EA refers to the 1.8-acre (0.73-ha) area shown in Figure 1-1.

4 As discussed in Section 2.3.4 of this document, the decommissioning regulations in 10 CFR 40.42, "Expiration and Termination of Licenses and Decommissioning of Sites and Separate Buildings or Outdoor Areas," address both decommissioning of separate outdoor areas (e.g., wellfields in the case of ISR facilities) and overall, sitewide decommissioning associated with license termination. The NRC staff considers a licensee's decision to permanently cease injection of lixiviant in an ISR wellfield to be a decision to permanently cease principal activities in a separate outdoor area. Therefore, aquifer restoration in a wellfield, which takes place after lixiviant injection ceases, is a decommissioning activity under the separate outdoor area provisions of 10 CFR 40.42. Consistent with the ISR GEIS, this Draft EA refers to and discusses aquifer restoration separately from subsequent decommissioning activities (such as removal of structures and equipment, cleanup and removal of contaminated soil, and reseeding and recontouring of land) that would occur during the remainder of wellfield decommissioning, and during overall sitewide decommissioning for purposes of license termination.

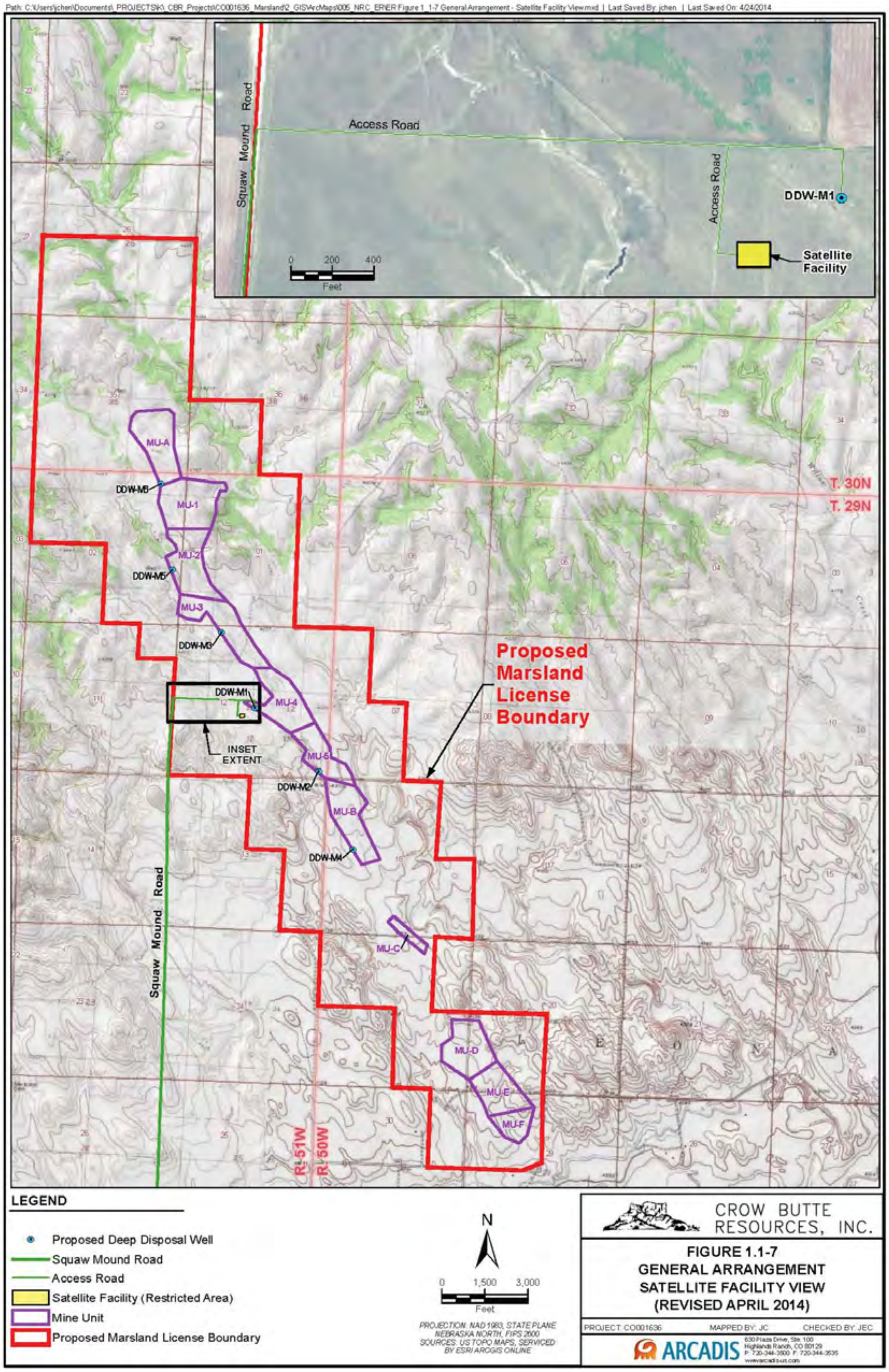


Figure 1-1 General layout of the MEA (Source: CBR, 2014, Figure 1.1-7)

1.4 Review Scope

The NRC staff performed this environmental review in accordance with the regulations in 10 CFR Part 51, which implement Section 102(2) of NEPA. This draft EA provides the results of the staff's environmental review; the staff's radiation safety review of the CBR request is documented separately in a safety evaluation report. The development of this draft EA was closely coordinated with the staff's safety review. In 40 CFR 1508.9, "Environmental Assessment," the Council on Environmental Quality (CEQ) defines an EA as a concise public document that briefly provides sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a Finding of No Significant Impact (FONSI).

NEPA requires that the NRC take a "hard look" at the environmental consequences of a proposed action and reasonable alternatives before making its decision. While taking a "hard look," the NRC can "tier" from previous NEPA analyses (i.e., use them as a starting point) that are related to the proposed action. In preparing this draft EA, the NRC used NUREG-1910, "Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities," issued in May 2009 (ISR GEIS) (NRC, 2009a) as a starting point. In the ISR GEIS, the NRC assessed potential environmental impacts from the construction, operation, aquifer restoration, and decommissioning of an ISR facility located in four specified geographic regions of the western United States. The Nebraska-South Dakota-Wyoming Uranium Milling Region, where the CBR facilities are located, is one of the regions the ISR GEIS defined and evaluated. The NRC staff relied on the ISR GEIS to identify potential impacts that would be similar for the MEA, and then examined site-specific information and concentrated the analysis in this draft EA on specific potential impacts not tiered from the ISR GEIS.

In addition to the ISR GEIS, the NRC staff reviewed and considered the following documents in the development of this draft EA:

- CBR's environmental report (ER) for the MEA, compiled by the NRC to incorporate revisions through April 2014 (CBR, 2014)
- CBR's technical report (TR) for the MEA, updated by CBR in response to requests for additional information (CBR, 2015, 2017)
- NUREG-0706, "Final Generic Environmental Impact Statement on Uranium Milling" issued September 1980 (NRC, 1980a)
- the safety evaluation report for the 2014 license renewal of the existing Crow Butte license area (NRC, 2014h)
- the existing Source Materials License SUA-1534 (NRC, 2014f)
- documents related to the NRC's consultation with Native American Tribes and State and local government agencies under Section 106 of the National Historic Preservation Act (NHPA) (NRC, 2012a, 2012b, 2013e–2013k)
- documents related to the NRC's communications with the U.S. Fish and Wildlife Service (USFWS) regarding Section 7 of the Endangered Species Act of 1973, as amended (NRC, 2013f; USFWS, 2013)

- documents related to specific areas of review used by the NRC staff for independent confirmation of the licensee's claims

In addition to NRC regulations, other Federal agency regulations would apply to the construction, operation, and decommissioning activities at the MEA, as described throughout this draft EA. Other Federal agencies with regulatory authority over different aspects of the proposed ISR activities at the MEA include the U.S. Environmental Protection Agency (EPA), USFWS, U.S. Department of Transportation (DOT), and the Occupational Safety and Health Administration (OSHA). EPA regulates water resources, air quality, ecological resources, hazardous materials, and waste management. DOT regulates the transportation of radioactive and nonradioactive materials and wastes (the NRC regulates the transportation packaging of radioactive materials and wastes). USFWS enforces Federal wildlife laws, including those related to the protection of endangered species, management of migratory birds, the restoration of nationally significant fisheries, and the conservation and restoration of wildlife habitat. OSHA is responsible for the protection of workers from occupational hazards not associated with the use of NRC-licensed material, while the NRC is responsible for worker safety for occupational hazards related to NRC-licensed material.

The Nebraska Department of Environmental Quality (NDEQ) is the State agency with regulatory authority over surface water and groundwater standards and uses, air quality, hazardous materials, and waste management. As part of these responsibilities, NDEQ reviews applications for underground injection control (UIC) permits and issues these permits in accordance with Nebraska Administrative Code (NAC) Title 122, "Rules and Regulations for Underground Injection and Mineral Production Wells." The Nebraska Game and Parks Commission (NGPC) regulates and manages the State's ecological resources. The Nebraska State Historic Preservation Office (NE SHPO), a division of the Nebraska State Historical Society (NSHS), administers the Federal National Register of Historic Places (NRHP) program and maintains several programs to identify, interpret, and preserve the information contained in archaeological sites.

1.5 Structure of this Environmental Assessment

Chapter 1 presents background information and descriptions of the proposed action, the project's purpose and need, the scope of the NRC staff's review, and the structure of this document. Chapter 2 describes the in situ recovery process, the site location, the proposed action, effluents and wastes, and the no-action alternative. Chapter 3 describes the affected environment for the MEA while Chapter 4 evaluates the potential environmental impacts from implementing the proposed action. Potential cumulative impacts are presented in Chapter 5. Chapter 6 describes CBR's monitoring programs and mitigation measures. Chapter 7 lists the agencies and persons consulted as part of the development of this EA. Chapter 8 presents the conclusion of this analysis. Chapter 9 presents the list of preparers, and Chapter 10 contains a bibliographic listing of all cited references.

2 PROPOSED ACTION AND ALTERNATIVES

This chapter describes the proposed Federal action, which is to grant a license amendment requested by CBR that would authorize ISR operations at the MEA. This chapter presents the proposed action (Alternative 1), and the no-action alternative (Alternative 2), in accordance with NEPA requirements. The NRC evaluated these alternatives with regard to the four phases of a uranium recovery operation: construction, operation, aquifer restoration, and decommissioning. Other information presented in this chapter includes a description of the in situ recovery process, the site location, and effluents and wastes.

2.1 Description of the In Situ Recovery Process

Chapter 2 of the ISR GEIS (NRC, 2009a) provides a generic description of the ISR process. The following information is intended to provide a brief summary of this process.

ISR Infrastructure

Underground:

- injection wells for introducing the leach solution into the uranium mineralization zone
- production and recovery wells for uranium production from the mineralization zone
- monitoring wells surrounding and within the ore body aquifer
- monitoring wells designed to detect potential releases to the overlying and underlying aquifers
- Deep disposal wells (DDWs) into which liquid wastes are injected for disposal
- buried pipelines to transfer groundwater extracted from the wellfields to the uranium processing circuit

Surface:

- central uranium processing facility
- header houses to control flow to and from the wellfields
- facility to house IX columns and reverse osmosis equipment for groundwater restoration, as well as staff office, restroom, and changing room
- access roads

Uranium is recovered with the use of a leach solution, called a lixiviant, during extraction. The lixiviant is pumped underground and into the ore zone through a series of injection wells in each wellfield, or mine unit. The wellfield contains an array of injection, recovery, and monitoring wells and interconnected piping used in the recovery process. As the lixiviant circulates through this production zone, it oxidizes and dissolves the mineralized uranium. A system of pumps draws the resulting uranium-rich solution (pregnant lixiviant) to recovery wells and then to a processing facility via a network of buried pipes. Monitoring wells surround the wellfield at different depths to detect lixiviant that might migrate out of the production zone. The migration of lixiviant out of the production zone is called an excursion. If an excursion occurs, pumping rates of the extraction wells would be adjusted to pull the escaped lixiviant back into the production zone. Figure 2-1 illustrates the process that would take place in each wellfield.

Figure 2-2 illustrates activities that take place above the ground surface (depending on the site, transportation may or may not occur among the processing steps). After extraction from the wellfield, the uranium is recovered from the “pregnant” lixiviant in a multi-step process. The first part of this process is the IX (ion exchange) circuit. During this process, the lixiviant from the production wells is piped to the IX columns. The solution flows down through the columns that are designed as pressurized, sealed systems to prevent solution overflow and to contain emissions of radon from the uranium. Within these columns, the uranium is adsorbed onto resin beads that selectively remove uranium from solution. The now-barren lixiviant is “recharged” and returned to the wellfield for reinjection and further uranium recovery. Because the barren lixiviant carries chloride that was exchanged for uranium on the resin, the chloride content of the water in the ore-bearing aquifer builds up with time as the lixiviant is recirculated. When the resin beads in the IX columns become saturated with uranium, the columns are brought offline and the lixiviant bypasses those columns to other columns with fresh resin beads.

The next step is the elution circuit. During elution, the uranium is removed from the resin by flushing it with a concentrated brine solution (eluent). The pregnant eluent then moves into a precipitation, drying, and packaging process to produce yellowcake.

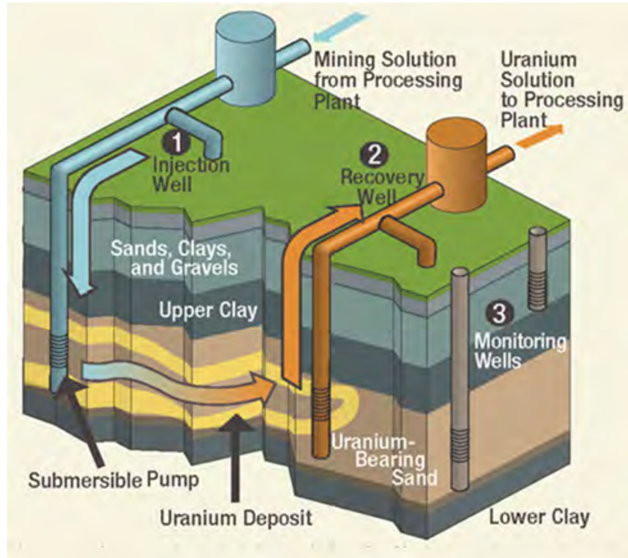


Figure 2-1 The ISR process in the wellfield (Source: NRC, 2013a, Figure 37)

Once the uranium recovery process in a specific wellfield has ended, the resulting groundwater in the wellfield contains constituents that were mobilized by the lixiviant. Therefore, aquifer restoration activities are undertaken to return the water parameters to applicable water quality standards. Finally, decommissioning activities are conducted to remove facilities, equipment, and any wastes from the site.

2.2 Site Location

The MEA is located in the southern portion of Dawes County, NE, approximately 11.1 miles (17.9 km) south-southeast of the Crow Butte CPF, as shown in Figure 2-3. The ore body at the MEA is located in the basal sandstone of the Chadron Formation (Basal Chadron Sandstone aquifer) at depths ranging from 800 to 1,250 feet below ground surface (bgs) (244 to 381 meters bgs). The width of the ore body varies from approximately 1,000 to 4,000 feet (305 to 1,219 meters) (CBR, 2014, Section 1.3.2.1).

All mineral resources leased within the MEA are privately owned, with the exception of a small portion of a section that is designated as State Trust Land. The surface and mineral rights are under lease between Cameco and the State of Nebraska for the State Trust Land. There are no Federal lands or minerals within the MEA boundary (CBR, 2014, Section 1.1.2).

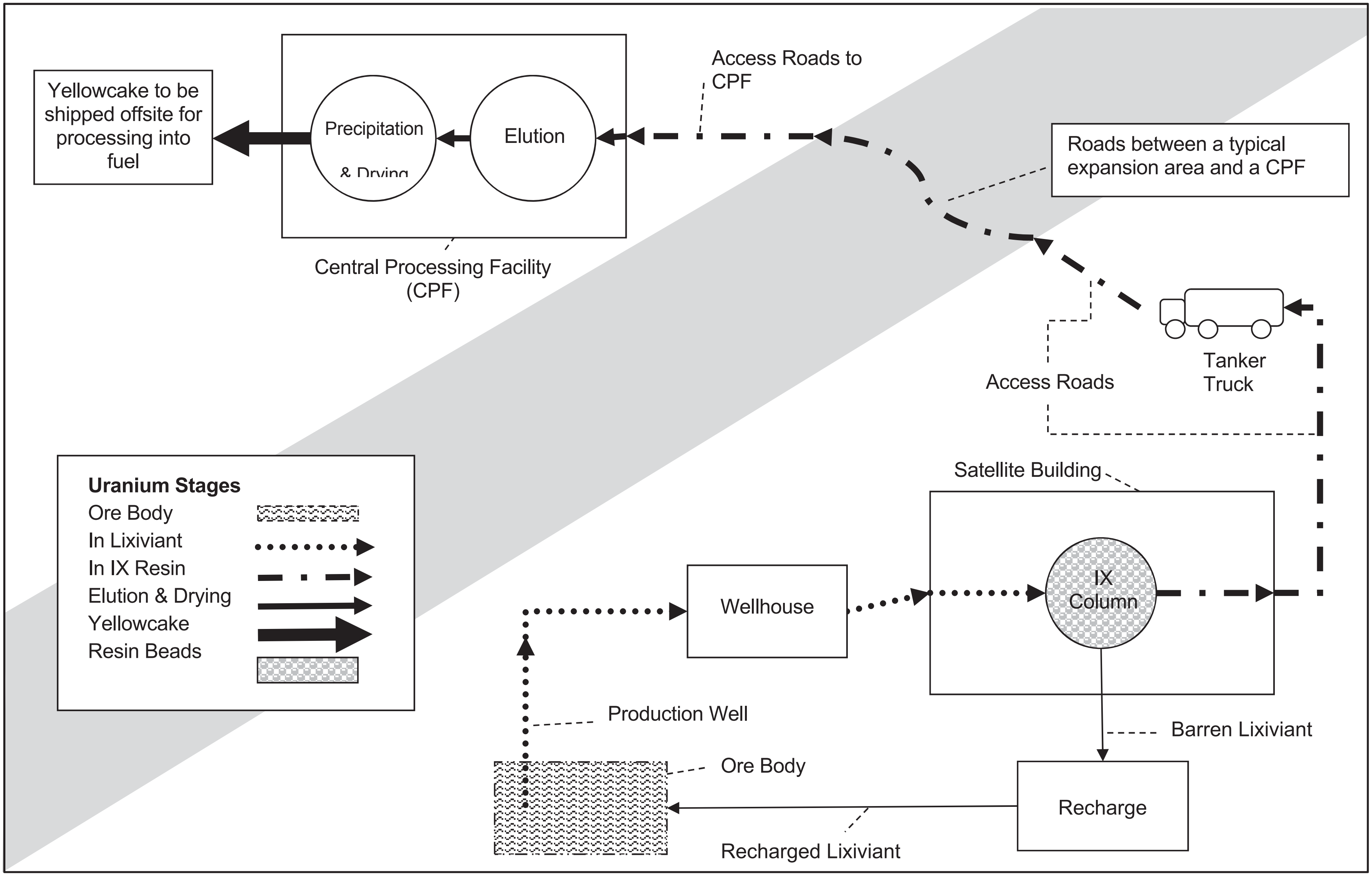


Figure 2-2 Above-ground processing activities at a typical ISR expansion area

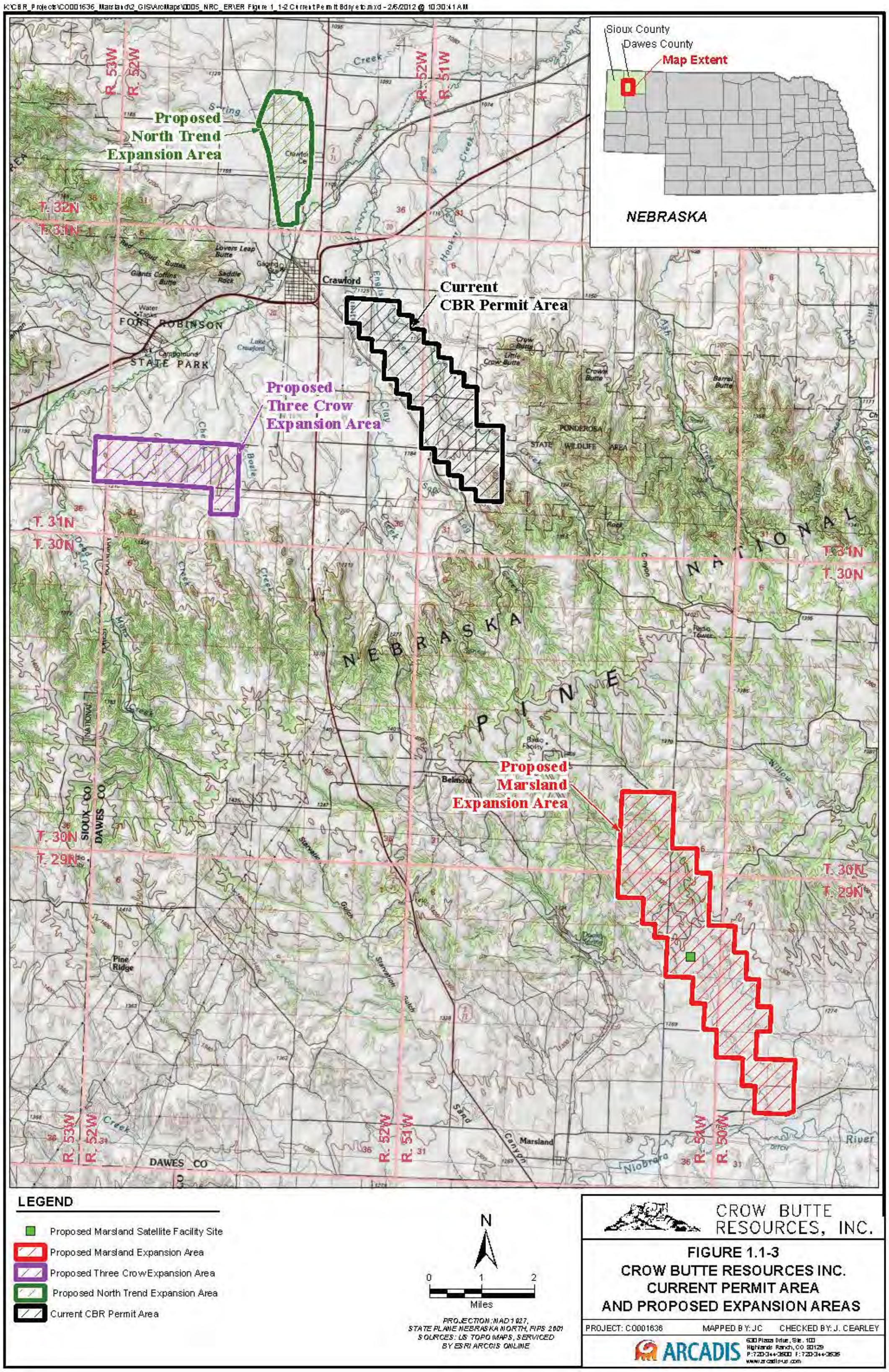


Figure 2-3 General location of the Marsland Expansion Area

Figure 1-1 shows the general layout of the proposed site. The MEA would contain a licensed area of approximately 4,622 acres[5] (1,870 ha) (CBR, 2014, Section 2.2). The following currently planned facilities would disturb approximately 592 acres (240 ha) of this proposed licensed area (CBR, 2014, Section 4.1.1):

- 11 mine units, including injection, production, and monitoring wells; wellhouses; piping; and access roads (587.6 acres (237 ha))
- a satellite facility, consisting of a satellite building (for the IX process) and associated facilities, including outside chemical storage facilities and a modular office building (1.8 acres (0.73 ha))
- up to six deep disposal wells (DDWs) (0.79 acre[6] (0.32 ha))
- access roads to the satellite facility and DDWs (1.7 acres (0.69 ha))

In addition to the currently planned 592 acres (240 ha) listed above, based on its current knowledge of the MEA ore body, CBR estimates that another 1,162 acres (470 ha) may be disturbed over the life of the project for new activities such as roadways, exploration or delineation drilling, new and expanded mine units, wellhouses, and underground piping (CBR, 2014, Section 4.1.1). As a result, over the life of the project (see Section 2.3), the licensee estimates that approximately 1,754 acres (710 ha) of the proposed licensed area of 4,622 acres (1,870 ha) may be disturbed.

2.3 Proposed Action

CBR estimates that construction and operation activities at the MEA would occur over about a 20-year period. Aquifer restoration at the MEA would begin about 5 years after uranium recovery operations begin and would continue concurrent with operations in other mine units, with restoration ending after about 20 years and final decommissioning activities and surface reclamation completed about 25 years after operations commence. The following sections identify the activities that would take place during these periods.

2.3.1 Satellite Facility and Wellfield Construction

2.3.1.1 Preconstruction

Before an applicant receives an NRC decision on a licensing request, certain preconstruction activities could take place. Such preconstruction activities do not meet the definition of "construction" given in 10 CFR 40.4, "Definitions." These activities include site excavation and preparation, such as clearing, grading, and constructing design components intended to control drainage and erosion as well as other mitigation measures; erection of fences and other access control measures that are not related to the safe use or security of radiological materials; construction of support buildings and infrastructure, such as paved roads and parking lots, exterior utility and lighting systems, domestic waste-water facilities, and transmission lines; and other

5 Throughout the Draft EA, numbers may not sum to expected totals because of rounding.
6 CBR states that while each DDW is expected to disturb 0.5 acre (0.2 ha), a number of the proposed DDWs overlap areas to be disturbed by uranium recovery mine unit development. As a result, an additional area of 0.79 acre (0.32 ha) is estimated for disturbance of habitat because of the placement of the six DDWs (CBR, 2014, Section 4.1.1).

activities that have no measurable relationship to radiological health and safety nor common defense and security. No radiological material would be present at the site during preconstruction activities. All preconstruction activities to be conducted before the NRC takes action on a licensing request must be performed with the necessary Federal, State, and local permits.

CBR has undertaken some preconstruction activities at the MEA, such as the establishment of environmental sampling stations; the drilling and installation of monitoring-well clusters for characterization; and the drilling of holes for ore body exploration, wellfield delineation, and geologic data collection (CBR, 2014, Sections 3.4.1.2 and 6.1). CBR may continue to conduct limited delineation drilling. Because these preconstruction activities do not depend on the NRC's approval of the license amendment, they are evaluated, where appropriate, as part of the cumulative impacts analysis presented in Chapter 5.

2.3.1.2 Construction

If the NRC approves CBR's license amendment request, CBR would construct the necessary surface and underground infrastructure at the MEA, including access roads, a satellite facility for the IX process (as described in Section 2.2), and wellfields. The surface infrastructure in the wellfields would include wellheads for each well, wellhouses to control flow to and from the wells and to and from the satellite facility, and some aboveground piping at the wellheads and in the wellhouses. The underground infrastructure in the wellfields would include injection and production wells drilled into the uranium ore body, monitoring wells, and buried pipelines linking the wells, wellhouses, and satellite facility (CBR, 2014, Section 1.3.2.6).

The MEA wellfields would be designed consistent with the wellfields at the existing Crow Butte license area. Figure 2-4 depicts a typical wellfield layout. CBR would use wells designed for use as either injection or recovery wells, so that wellfield flow patterns can be changed as needed to improve uranium recovery and restore the groundwater in the most efficient manner (CBR, 2014, Section 1.3.2.6).

Excursions of lixiviant at ISR facilities can contaminate adjacent aquifers with radioactive and trace elements mobilized by the uranium recovery process. To detect potential excursions, CBR would construct monitoring wells in the extraction zone (i.e., the Basal Chadron Sandstone aquifer) and overlying Brule Formation and Arikaree Group aquifers (CBR, 2014, Section 1.3.2.6). To monitor for vertical excursions, or movements of ISR fluids into overlying or underlying aquifers, CBR would construct shallow monitoring wells within the wellfield boundary at a density of 1 well per 4 acres (2 ha). Perimeter monitoring wells would be established in a ring within the Basal Chadron Sandstone aquifer where the injection and production wells would be located. CBR would use these wells to monitor baseline water quality and identify any changes that could be a sign of horizontal excursions, or lateral movements of process solutions outside of the uranium recovery area (CBR, 2014, Section 4.12.3.3).

Well construction would follow one of the three methods described in the MEA ER (CBR, 2014, Section 1.3.2.2) that NDEQ approved under the current Crow Butte Class III UIC Permit Number NE0122611. The three methods for well construction differ in the procedures for cementing and screen installations. The purpose of the cement is to stabilize and strengthen the casing and plug the space between the casing and the rock materials (i.e., annulus) of the hole to prevent the vertical migration of solutions. CBR would conduct appropriate geophysical logging and other tests as needed during the drilling and construction of the new wells.

CBR would initially construct two DDWs and their associated wellhouses and wellheads. These DDWs would accommodate all wastewater generated from startup through the end of groundwater restoration for the first several mine units. As new mine units opened, uranium recovery activities and groundwater restoration would result in increased wastewater volumes, and CBR estimates that an additional four DDWs may be needed to address wastewater generation over the life of the project (CBR, 2014, Section 3.12.2.2). The impact analysis in this draft EA addresses a total of six DDWs.

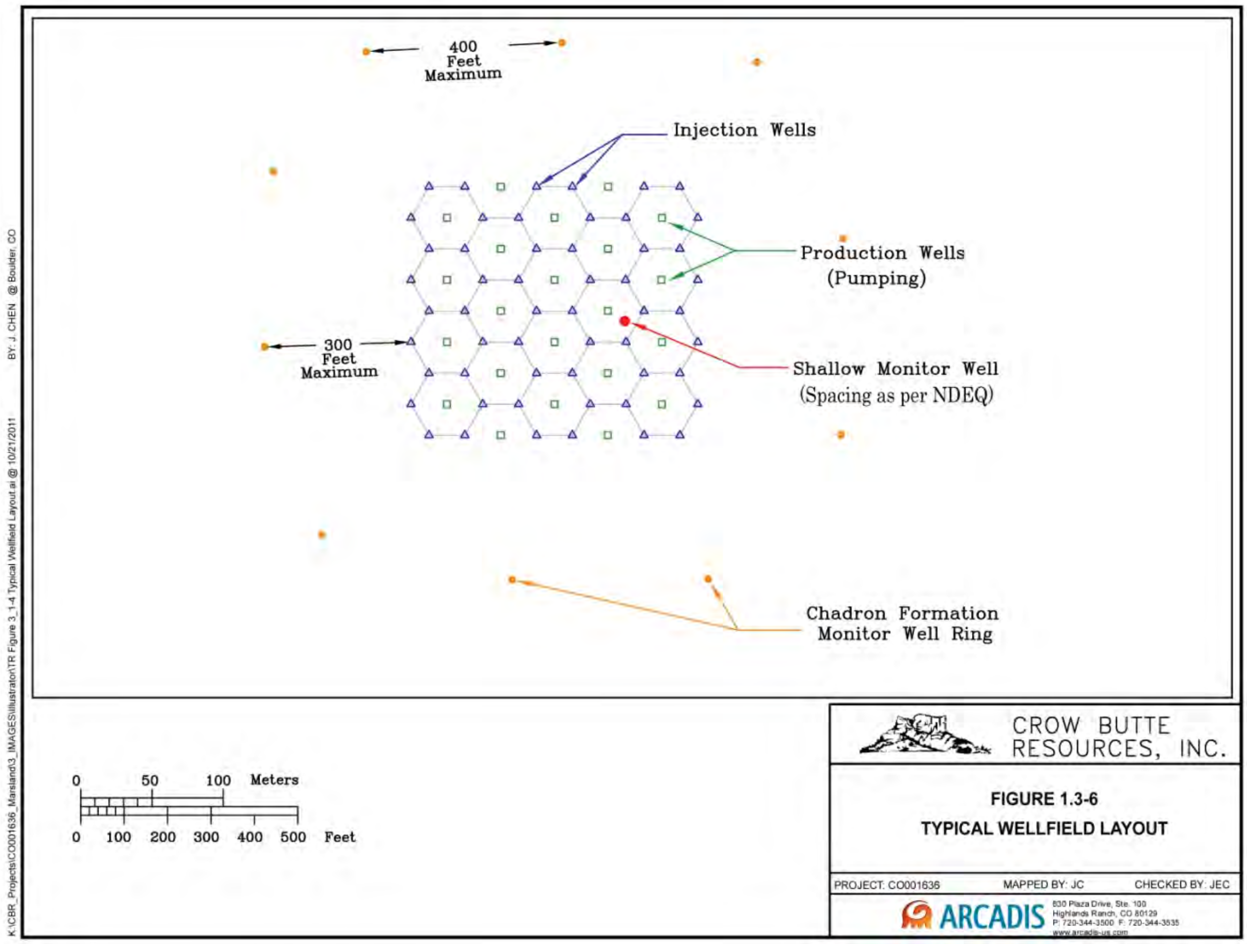


Figure 2-4 Typical wellfield layout (Source: CBR, 2014, Figure 1.3-6)

2.3.2 Operations

CBR would pump barren lixiviant into the ore body through a series of injection wells to extract uranium from the ore body. CBR would use an alkaline solution of sodium bicarbonate lixiviant. Since the groundwater at the MEA site naturally contains carbonate, an alkaline lixiviant would mobilize fewer hazardous elements from the ore body and would require less chemical addition than an acidic lixiviant (CBR, 2014, Section 2.3.1.1). As the lixiviant moved through pores in the ore body, it would dissolve uranium and other metals. CBR would pump the resulting ore-bearing lixiviant back out through production wells and collect the recovered lixiviant at wellhouses located in the wellfield (CBR, 2014, Section 1.3.2.6).

The lixiviant would enter the ore zone through the injection wells and flow to the production (recovery) wells at a maximum rate of 6,000 gallons per minute (gpm) (23,000 liters per minute (Lpm)). In accordance with License Condition 10.7 of SUA-1534 (NRC, 2014f), CBR is required to control the lateral movement of lixiviant by maintaining an inward hydraulic gradient within the perimeter monitoring well ring. To this end, CBR would adjust the wellfield production flow to a rate slightly greater than the injection flow. This difference between production and injection flow is called “process bleed.” The licensee assumes an anticipated bleed rate of 0.5 to 2.0 percent of the total wellfield production flow and used a rate of 1.2 percent for its analysis of the water balance in Appendix T to the MEA ER (CBR, 2014). The licensee would adjust bleed rates as necessary to maintain the inward pressure gradient from the start of uranium recovery operations through groundwater restoration until stability monitoring begins. The process bleed is anticipated to vary from approximately 25 to 65 gpm (95 to 246 Lpm) over the life of operations (CBR, 2014, Section 3.12.2.2). About 98 percent of groundwater used in production would be treated and re-injected to the wellfield. Injection pressure would be limited to less than 0.53 pound per square inch per foot (0.12 kg per square centimeter per meter) of well depth (CBR, 2014, Section 1.3.2.6).

Once the ore-bearing lixiviant is brought up from the ore body, CBR would pipe the lixiviant from the wellhouses to the MEA satellite facility, where an IX process would move uranium from the lixiviant to the IX resin. The satellite facility at the MEA would contain equipment for the IX circuit, filtration, resin transfer, and chemical addition systems within a 1.8-acre (0.73-ha) area (CBR, 2014, Figure 1.1-8). A 130-foot-by-100-foot (39.6-meter-by-30.5-meter) building in this area would hold the IX columns, water treatment equipment, resin transfer facilities, pumps for injection of lixiviant, wastewater tanks, and an employee break area. Bulk soda ash, carbon dioxide, and oxygen in compressed form or hydrogen peroxide (or both) would be stored adjacent to this building or in the wellfield (CBR, 2014, Section 1.3.2.7).

The now-barren lixiviant would be treated with sodium and carbonate chemicals as needed and pumped to the wellfield for reinjection into the mine unit. Once the majority of the resin in an IX column was filled with uranium, the column would be taken out of service and a tanker truck would transport the uranium-saturated resin to the Crow Butte CPF for completion of the ISR process. After the elution process at the Crow Butte CPF, another tanker truck would return the rejuvenated resin to the MEA satellite facility for reuse in the IX circuit (CBR, 2014, Section 1.3.2.4).

The MEA would operate at a maximum production flow rate of 6,000 gpm (23,000 Lpm) and would yield enough uranium to produce an average of 600,000 lbs (270,000 kg) of yellowcake (U_3O_8) per year. The process would use an additional 1,500 gpm (5,700 Lpm) of water for restoration (CBR, 2015, Section 3.1.7).

2.3.3 Aquifer (Groundwater) Restoration

CBR estimates that groundwater restoration in designated mine units would begin about 5 years after startup and end about 25 years after startup (CBR, 2014, Section 1.1.3.2). ISR operations at the MEA would result in the alteration of the geochemistry and the water quality in the uranium recovery zone (CBR, 2014, Section 2.2). This includes increases in various constituents (uranium, chloride, bicarbonate, sulfate, trace metals) in the groundwater (CBR, 2014, Section 3.4.3.4). When ISR operations at a mine unit indicate that continued uranium recovery is no longer economical, CBR would initiate groundwater cleanup to restore the affected groundwater. Stability monitoring would take place to demonstrate that applicable groundwater protection standards are met.

The primary goal of the groundwater restoration program is to return groundwater affected by uranium recovery operations to pre-injection baseline values on a mine-unit average, as determined by the baseline water quality sampling program. This sampling program would be performed for each mine unit before uranium recovery operations begin. CBR is required to restore groundwater quality to the standards listed in Criterion 5B(5) of Appendix A, "Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for Their Source Material Content," to 10 CFR Part 40, "Domestic Licensing of Source Material," as required by the Uranium Mill Tailings Radiation Control Act (UMTRCA). Under EPA requirements (40 CFR Part 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings"), groundwater restoration at ISR facilities must meet the UMTRCA standards rather than those associated with the Safe Drinking Water Act or analogous State regulations.

Under 10 CFR Part 40, Appendix A, Criterion 5B(5), at the "point of compliance" (mine unit after restoration), the concentration of a hazardous constituent must not exceed the following:

- the NRC-approved background concentration of that constituent in the groundwater established before injection of lixiviant for each mine unit in accordance with License Condition 11.3 (NRC, 2014f)

- the respective value given in the table in 10 CFR Part 40, Appendix A, Criterion 5C if the constituent is listed in the table and if the background level of the constituent is below the value listed

- an alternate concentration limit that would require that CBR submit a license amendment request (License Condition 10.6 (NRC, 2014f)) and receive NRC approval

The NRC staff would ultimately decide whether groundwater protection standards have been met under the license.

The licensee's planned groundwater restoration activities consist of the following four phases (detailed in CBR, 2014, Section 5.4.1.4):

- <u>Groundwater transfer</u> involves transferring groundwater between a mine unit beginning restoration and one where uranium recovery is beginning. This action would blend the water in the two mine units until they become similar in conductivity. As part of this action, recovered water may be treated by IX and filtration to lower the suspended solids if their concentration could block the injection well screens.

- <u>Groundwater sweep</u> involves pumping water from the wellfield without any reinjection, which results in an influx of baseline-quality water from the wellfield perimeter.

- <u>Groundwater treatment</u> occurs after groundwater sweep and involves pumping groundwater from production wells and treating the water using IX, reverse osmosis, and possibly Electro Dialysis Reversal treatment. In this step, CBR would remove solubilized uranium and possibly add a small amount of reductant into the reinjected water to reduce any pre-oxidized minerals and reduced the solubility of these minerals.

- <u>Wellfield recirculation</u> may be initiated after the groundwater treatment phase. CBR may recirculate solutions by pumping from the production wells and re-injecting the recovered solution into injection wells.

Once the above groundwater restoration steps are completed, CBR would sample the restoration wells and determine groundwater protection standards have been met, as averaged across the mine unit. Note that not all of the above phases may be conducted if CBR determines they are unnecessary for a mine unit (CBR, 2014, Section 5.4.1.4).

After CBR has determined that the groundwater protection standards have been met, CBR would notify the NRC that it is initiating the stabilization phase. The stabilization phase involves no extraction and injection of water or reductants, which would eliminate the inward hydraulic gradient. Instead, stability monitoring of restoration parameters would begin by sampling restoration wells and any monitoring wells that had been placed on excursion status during mining operations. CBR would conduct sampling once every other month for four quarters, and if the six samples show that the restoration values for all wells are maintained during the stabilization period with no significant increasing trends, then CBR would consider restoration complete and submit the restoration data to the NRC and NDEQ for review and approval (CBR, 2014, Sections 5.4.1.5 and 5.4.1.6).

2.3.4 Decommissioning

The decommissioning regulations in 10 CFR 40.42, "Expiration and Termination of Licenses and Decommissioning of Sites and Separate Buildings or Outdoor Areas," address both decommissioning of separate outdoor areas (e.g., wellfields in the case of ISR facilities) and overall, sitewide decommissioning associated with license termination. Aquifer restoration is the first decommissioning activity to take place in a wellfield.[7] Once aquifer restoration for a particular wellfield has been completed and accepted, the licensee can then proceed with other decommissioning activities in the wellfield. Final sitewide decommissioning for purposes of license termination requires submittal and approval of a decommissioning plan, and would generally not begin until aquifer restoration has been completed for all (or nearly all) wellfields.

Decommissioning activities at the MEA would include removing contaminated equipment and materials for disposal at an approved facility or for reuse; plugging and abandoning wells; removing soil contamination to meet cleanup limits; backfilling, recontouring, and revegetating disturbed areas; and monitoring the environment. A detailed description of surface reclamation activities that CBR would conduct can be found in the ER (CBR, 2014, Section 5.1). During surface reclamation, CBR would return disturbed lands to equal or better quality compared to their original condition before development for this proposed action. Surface reclamation activities at the MEA would include topsoil handling and replacement; contouring of disturbed lands; revegetation; removal of buried trunklines and pipes; and wellfield decommissioning, including well plugging and abandonment. The licensee committed to surveying and sampling all facilities and processing-related equipment and materials on site to determine contamination levels and to identify the potential for personnel exposure during decommissioning. At the end of decommissioning, the licensee would survey and release uncontaminated materials and equipment for reuse, if suitable. The licensee would relocate and dispose of nonradiological wastes in appropriate facilities, and radiologically contaminated materials at NRC-approved licensed facilities. CBR would be required under 10 CFR 40.42 to survey excavation areas for contamination and perform a final site soil radiation survey. The licensee noted that it would

---

[7] As noted in Section 1.3, although discussed separately for purposes of evaluating potential environmental impacts, aquifer restoration is a decommissioning activity under the separate outdoor area provisions of 10 CFR 40.42.

maintain records of information important to decommissioning in the office of the onsite radiation safety officer as required by 10 CFR 40.36."

Wellfield decommissioning would occur throughout MEA operation. When uranium extraction is complete within a mine unit and groundwater restoration has been completed and accepted, the licensee would schedule the wellfield for remaining decommissioning and surface reclamation activities. Wellfield decommissioning would include the removal of surface equipment, facilities and buried piping, and the plugging and abandonment of wells, followed by recontouring and removal of contaminated soil, as needed, and final revegetation. CBR estimates that a significant portion of equipment would meet radioactive release limits so that it could be disposed of at an unrestricted area landfill. Contaminated materials would be decontaminated until they were releasable or, if they could not be decontaminated, they would be disposed of at an NRC-licensed disposal facility (CBR, 2014, Section 5.1.3).

Before completing decommissioning of the satellite facility, CBR would conduct a radiological survey to characterize levels of contamination. The licensee would perform decontamination activities, such as power washing and use of a decontamination solution, as needed to remove loose contamination before decommissioning activities proceeded. CBR expects the equipment and materials in the building and the building itself to be decontaminated, dismantled, and released for use at another location. If these items cannot be decontaminated or reused, CBR would ship them to a permanent licensed disposal facility (CBR, 2014, Sections 5.1.4.1 and 5.1.4.2).

Final overall site decommissioning for purposes of license termination would begin after NRC approval of CBR's decommissing plan. Under License Condition 10.11 of SUA-1534 (NRC, 2014f), CBR is required to submit the decommissioning plan at least 12 months before final shutdown of mine unit extraction operations. CBR would reclaim all disturbed areas during final decommissioning and reclamation (CBR, 2014, Section 4.1.1). The licensee's objective for surface reclamation would be to return lands to a condition capable of supporting livestock grazing and providing habitat for wildlife species, blending the affected areas with adjacent undisturbed lands to reestablish original slope and topography and present a natural appearance (CBR 2014, Section 5.1.1).

Under License Condition 9.5 of SUA-1534 (NRC, 2014f), CBR is required to maintain a financial surety arrangement, established when the NRC grants a license, to provide assurance that the costs of aquifer restoration and site decommissioning are covered when facility operations end. The NRC revises the surety amount annually (NRC, 2009a, Section 2.6). CBR would maintain financial responsibility for groundwater restoration, facility decommissioning, and surface reclamation at the MEA (CBR, 2014, Section 2.2). The estimated decommissioning costs for the MEA would be added to the surety amount for the existing Crow Butte license area and would be submitted to NDEQ and the NRC for approval before commencement of construction activities at the MEA (CBR, 2014, Section 7.2.9).

2.3.5 Effluents and Waste Management

The ISR process at the MEA would produce airborne effluent and liquid and solid wastes requiring management.

2.3.5.1 Airborne Effluents

Radon-222 is naturally present in the ore body and dissolves in the lixiviant as it travels through the ore body to a production well; therefore, the radon contained in the pregnant lixiviant that is pumped from the wellfield to the MEA satellite facility can be released during the IX process. The MEA system uses pressurized downflow IX columns to minimize such releases (CBR, 2014, Section 2.2). Releases would occur when the individual columns were disconnected from the circuit and opened to remove the resin (CBR, 2014, Section 1.3.2.7). In addition, tanks associated with the IX process, such as those for resin transfer and wastewater, would be vented to the atmosphere outside the building (CBR, 2014, Sections 1.3.2.10 and 2.2). Radon emissions may also occur in a wellfield from wellheads and wellhouses.

Fugitive dust would be generated from site construction; well-site preparation; facility operations; and restoration, reclamation, and decommissioning activities.

There would be emissions of combustion engine exhaust from vehicles, well drilling equipment, and other small combustion sources that may be present at the MEA.

2.3.5.2 Liquid Waste

CBR plans to use DDWs as the primary liquid waste disposal system at the MEA (CBR, 2014, Section 3.12.2.1). CBR has applied to NDEQ for a permit to install and operate two Class I Nonhazardous Waste Injection Wells within the MEA license boundary. As shown in Figure 1-1 above, the DDWs would be located within the perimeter monitor well ring. All tankage, filtration, and process equipment would be located at the satellite facility. Feed from the satellite facility would pass through a set of bag filters and would be pumped to the DDW wellhouses. At each DDW wellhead, there would be a set of filters, flowmeters, check valves, and an annulus fluid tank. Under its NDEQ permit, CBR would be required to continually monitor and record pressures and flowrates (CBR, 2014, Section 3.12.2.1).

CBR's current plan is to rely on two DDWs to handle liquid waste disposal at the MEA. CBR has indicated that, should the need arise, it may add additional DDWs (up to a total of six) or propose to use other disposal options in later years as flows increase from new MEA mine units (CBR, 2014, Section 2.3.1.3). Other disposal options to support normal operations could include surge tanks, evaporation ponds, or land application. CBR's license (SUA-1534) authorizes use of these other disposal methods at the existing Crow Butte license area, but CBR has not requested authorization to use these other methods at the MEA as part of this proposed action. Therefore, to use these other methods at the MEA, CBR would need to request and receive an NRC license amendment, as well as an NDEQ permit. If CBR requested such an amendment, the NRC staff would conduct an environmental review as part of the review process. In the event of an extended facility shutdown during operations, and in order to continue maintaining hydraulic containment, CBR would dispose of groundwater extracted from the wellfields in an onsite DDW equipped with a portable generator, or CBR may need to transport the groundwater to the evaporation ponds in the existing CBR license area (CBR, 2015, Section 3.1.7).

Activities at the MEA would result in the following main types of liquid waste:

- <u>Well drilling fluids</u> are used while drilling to lubricate and cool the drill bit, remove drill cuttings from the borehole, and seal the borehole walls to minimize fluid loss into the surrounding formation. This fluid has not been exposed to any uranium recovery process or chemicals, but it may contain elevated concentrations of naturally occurring radioactive material from the mineralized zone. It would also contain drill cuttings. The well drilling fluid would discharge to the drilling pit and evaporate. Once evaporated, the pits would be filled in with soil and the surface restored, burying the drill cuttings (CBR, 2014, Section 3.12.2.1).

- Well development water is generated when restoring the natural hydraulic conductivity and geochemical equilibrium of the aquifer after a well is constructed. Well development removes water and drilling fluids to allow formation water to enter. The well is developed until the water produced (known as well development water) runs clear (CBR, 2014, Section 1.3.2.5). This water has not been exposed to any uranium recovery process or chemicals, but it may contain elevated concentrations of naturally occurring radioactive material from the mineralized zone (CBR, 2014, Section 4.13.2.1). CBR would capture all water generated during well development in water trucks for discharge to a tank at the satellite facility. The tank would contain equipment to separate solids from the water. The filtered water would discharge to the DDW water supply tank for disposal in the onsite DDWs. The solids would be bagged for byproduct disposal (CBR, 2014, Section 3.12.2.1) in accordance with Section 11e.(2) of the Atomic Energy Act, as amended. The existing evaporation ponds at the existing Crow Butte license area would be used as a backup system to the tank (CBR, 2014, Section 4.2.1.1).

- Purge water collected during baseline or operational monitoring well sampling would be released to the ground. This waste occurs because several well volumes of water are purged to remove stagnant water in the well before a monitoring well is sampled to ensure that the sample contains representative water. If the monitoring well is on excursion status (i.e., if lixiviant or indicator parameters have been detected in the area monitored by that well), the licensee would collect and dispose of the purge water in the DDWs at the MEA or take it to the evaporation ponds at the existing Crow Butte license area (CBR, 2014, Section 4.13.2.2).

- Liquid process waste comes in two forms. As described in the ISR GEIS (NRC, 2009a, Section 2.4.3), the production wells extract slightly more water than is re-injected into the host aquifer, which creates a net inward flow of groundwater in the wellfield. This fluid, known as production bleed, is the primary source of liquid waste, estimated at 0.5 to 2.0 percent of the process flow of 6,000 gpm (22,712 Lpm) (CBR, 2014, Section 4.13.2.1). The production bleed would be disposed of in the DDWs.

  The second type of process waste is eluent bleed; since elution would take place at the Crow Butte CPF, this waste would not be produced at the MEA. However, CBR expects the eluent bleed stream at the Crow Butte CPF to increase by a maximum of 10 percent over the current 5 to 10 gpm (19 to 38 Lpm) because of MEA activities. CBR would manage the waste through reuse at the Crow Butte CPF or disposal in the DDWs at the Crow Butte CPF (CBR, 2014, Section 1.3.2.4).

- Wastewater produced during aquifer restoration, which would occur when uranium recovery operations have ceased, would result in the production of wastewater during groundwater sweep and groundwater treatment of the affected aquifer. During groundwater sweep, CBR would extract water from the uranium recovery zone so that baseline-quality water flows in to “sweep” the affected area. The water extracted would be treated using IX, reverse osmosis, and other treatment methods, so that most of the treated water could be reinjected and the rest disposed of in the DDWs.

Groundwater treatment activities involve the use of reverse osmosis to reduce the total dissolved solids (TDS) in the groundwater, producing clean water, reverse osmosis bleed, and brine. CBR would reinject the clean water into the formation and would dispose of the reverse osmosis bleed and brine in the DDWs (CBR, 2014, Section 4.13.2.2).

- Any stormwater runoff or snowmelt that is potentially contaminated from coming in contact with industrial materials (such as from tankage, diking, or curbing outside the satellite facility building) would be collected and disposed of in the DDWs. CBR would store all nonhazardous liquid wastes in sealed containers above ground before disposal by a waste disposal contractor at an approved waste disposal or recycling facility. CBR estimates that it would dispose of less than 50 gallons (189 liters) of waste petroleum products and chemicals annually (CBR, 2014, Section 3.12.2.1).

2.3.5.3 Solid Wastes

Solid waste generated at the MEA is expected to include spent resin, fine particles from the resin, empty chemical containers, miscellaneous pipe and fittings, and domestic trash. CBR would segregate the solid waste based on whether it was clean or had the potential for contamination with 11e.(2) byproduct materials. CBR would collect noncontaminated solid waste, or waste that may be successfully decontaminated, on site in designated areas and dispose of the waste in the nearest permitted sanitary landfill. Solid waste contaminated with 11e.(2) byproduct material that could not be decontaminated would be stored on site until a full shipment could be shipped to a licensed facility (CBR, 2014, Section 1.3.2.12). CBR estimates that MEA activities would produce approximately 700 yd^3 (535 m^3) of noncontaminated solid waste per year and approximately 60 yd^3 (45.6 m^3) of 11e.(2) byproduct materials per year. Under License Condition 9.9 in SUA-1534 (NRC, 2014f), CBR is required to maintain an agreement for solid waste disposal at a properly licensed facility (CBR, 2014, Section 3.12.3).

MEA construction and operation activities would also generate universal hazardous wastes such as spent waste oil and batteries. CBR estimates that the MEA satellite facility would produce approximately 211 gallons (800 liters) of waste oil per year, which would be disposed of by a licensed waste oil recycler (CBR, 201s4, Section 1.3.2.12).

The largest volume of solid wastes would be produced during facility decommissioning, as this waste would include the dismantled satellite facility and wellfield support facilities. Decommissioning surveys would consider soils for radiological content, and any soils exceeding NRC release limits would be removed and disposed of as 11e.(2) byproduct waste (CBR, 2014, Section 3.12.3).

CBR would conduct monitoring (see Chapter 6) to help ensure that these solid wastes and the measures described here to control them are as expected.

2.4 No-Action Alternative

The no-action alternative would consist of a denial of CBR's request to amend the license to permit ISR operations at the MEA. CBR would continue extraction operations in the existing Crow Butte license area for the extent of the license and any future renewals, or until uranium reserves are depleted and cannot be cost-effectively recovered. The primary activities would then be groundwater restoration, surface reclamation, and decommissioning of the existing Crow Butte license area, estimated to be completed in 2025 if other expansion areas are not licensed or if

CBR does not accept resin for processing from other regional non-CBR-owned facilities (CBR, 2014, Section 2.1.2).

Even if the license is not amended to authorize activities at the MEA, CBR has already accomplished certain preconstruction activities (not included in the definition of “construction” in 10 CFR 40.4) that do not require a license from the NRC. Preconstruction activities include the drilling and installation of monitoring-well clusters for characterization and the drilling of holes for ore body exploration, wellfield delineation, and geologic data collection. Under the no-action alternative, the drill holes associated with the MEA preconstruction activities would be properly plugged and abandoned and the wells would be properly decommissioned.

3 AFFECTED ENVIRONMENT

This chapter describes environmental resources in the MEA and an area of review within 2 miles (3.3 km) of the site boundary[8] (see Figure 3-1), unless otherwise noted. To provide a framework for the discussion in Chapter 4 of the potential impacts of the proposed project, this chapter describes the following resource areas: land use; geology, soils, and seismology; water resources; ecological resources; climate, meteorology, and air quality; historic and cultural resources; demographics and socioeconomics; transportation; noise; visual and scenic resources; and background radiological and chemical characteristics.

In the ISR GEIS (NRC, 2009a), the NRC described the environmental conditions and resources in areas of the Nebraska-South Dakota-Wyoming Uranium Milling Region[9] where ISR facilities have been licensed and may be proposed. The NRC staff used the regional description provided in the ISR GEIS as a starting point for identifying the site-specific baseline for the MEA.

3.1 Land Use

The MEA is located in southwestern Dawes County, NE, and is 11.1 miles (17.9 km) south-southeast of the Crow Butte CPF. The MEA is near the following communities (distances are approximate):

- Town of Marsland (4.6 miles (7.4 km) to the southwest of the MEA)
- City of Crawford (15.1 miles (24.3 km) to the northwest of the MEA)
- Town of Hemingford (15.4 miles (24.8 km) to the southeast of the MEA)
- City of Chadron (25 miles (40 km) to the northeast of the MEA)

The primary route to access the MEA is via Nebraska State Highway 2/71 west of Marsland, then east along Niobrara Street and River Road, and then north on either Squaw Mound Road or Hollibaugh Road (CBR, 2014, Section 3.1.1).

---

8 Regulatory Guide 3.46, “Standard Format and Content of License Applications, Including Environmental Reports, for In Situ Uranium Solution Mining,” issued June 1982 (NRC, 1982), recommends that the applicant provide information on adjacent lands and waters within a 2-mile (3.3-km) radius.

9 The Nebraska-South Dakota-Wyoming Uranium Milling Region includes the portions of northwestern Nebraska (Dawes and Sioux counties), western South Dakota (Custer, Fall River, Lawrence, and Pennington counties), and the extreme eastern portion of Wyoming (Crook, Niobrara, and Weston counties).

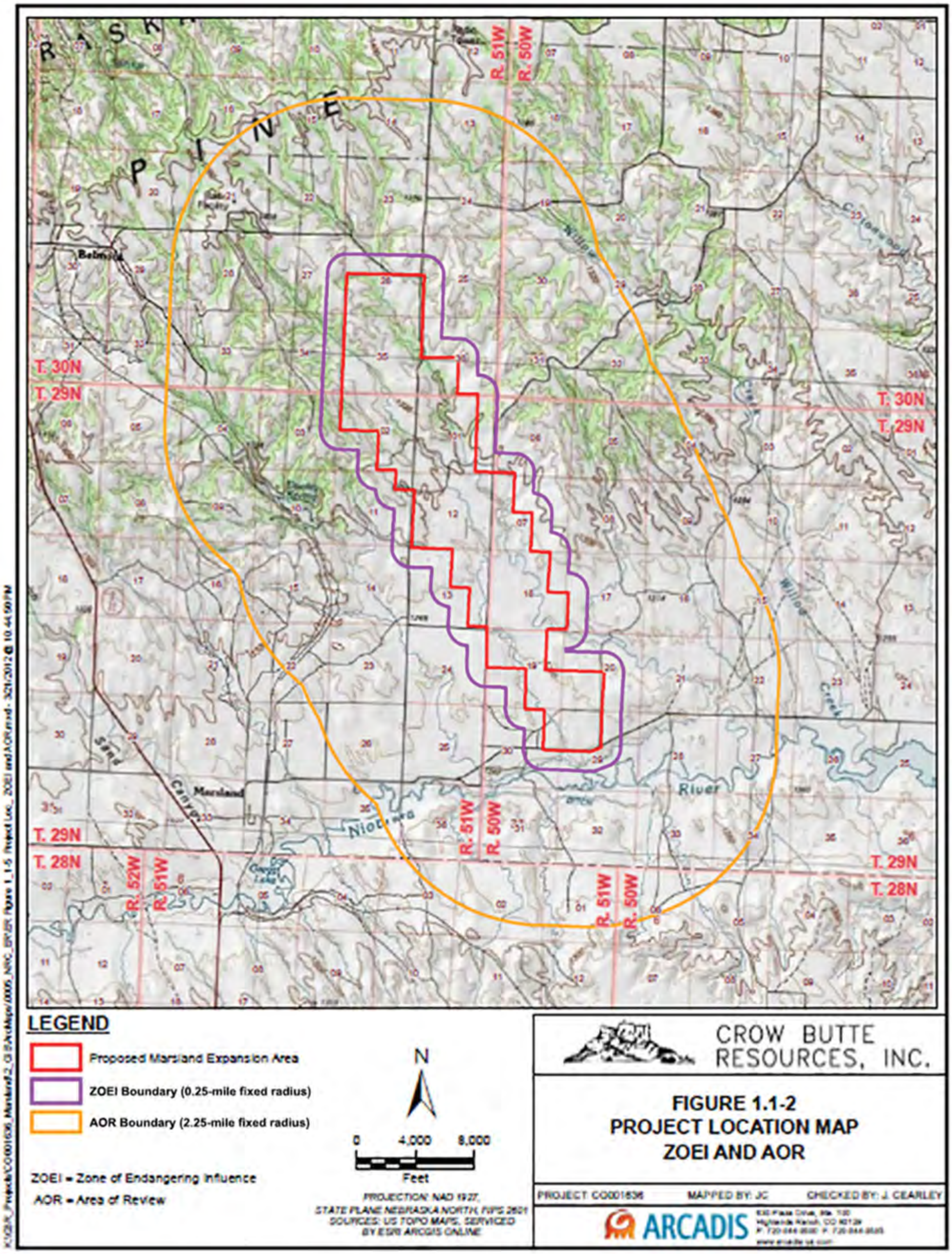


Figure 3-1 MEA boundary and area of review (Source: CBR, 2014, Figure 1.1-2)

3.1.1 Classifications and Productivity

Section 3.4.1 of the ISR GEIS (NRC, 2009a, Section 3.4) describes the land cover and subsequent use in Dawes and Sioux counties. ER Figure 3.1-1 (CBR, 2014) depicts land use within the MEA and a 2.25-mile[10] (3.6-km) area of review beyond the MEA boundary. CBR notes that land use patterns in the area have not changed in recent decades, reflecting the stagnant nature of economic activity (CBR, 2014, Section 3.1) and a slight decline in the populations of the city of Crawford and Dawes County, as described in Section 3.7. This area is primarily used for agricultural operations, mainly rangeland but also some cropland; Table 3-1 defines the different land use classifications. Table 3-2 lists the land uses within the MEA and the area of review.

Based on an estimated value of $121.70 per acre ($48.68 per hectare) per year for crop production (NASS, 2014), farmed lands in the area of review have a potential value (assuming full use of lands) of $355,900 per year, which includes $54,023 per year in the MEA. Based on an estimated value of $89.73 per acre ($35.89 per hectare) per year for livestock (NASS, 2014), existing rangeland within the area of review has a potential value (assuming full use of lands) of approximately $2.5 million per year, which includes $331,532 per year in the MEA.[11]

Table 3-1 Land Use Definitions

Land Use	Definition
Rangeland	Land, roughly west of the 100th meridian, where the natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs; used wholly or partially for the grazing of livestock. This category includes wooded areas where grasses are established in clearings and beneath the overstory.
Cropland	Harvested cropland, including grasslands cut for hay, cultivated summer-fallow, and idle cropland.
Forestland	Areas with a tree-crown density of 10 percent or more stocked with trees capable of producing timber or other wood products and exert an influence on the climate or water regime. This category does not indicate economic use.
Wetlands	Areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season. Water saturation (hydrology) largely determines how the soil develops and the types of plant and animal communities living in and on the soil. The prolonged presence of water creates conditions that favor the growth of specially adapted plants (hydrophytes) and promote the development of characteristic wetland (hydric) soils (EPA, 2012).
Recreational	Land used for public or private leisure, including developed recreational facilities such as parks, camps, and amusement areas, as well as areas for less-intensive use such as hiking, canoeing, and other undeveloped recreational uses.

Source: Unless otherwise referenced, adapted from CBR, 2014, Table 3.1-1

[10] NDEQ requires an assessment of a 2.25-mile (3.62-km) radius of the proposed project site boundary for the Class III UIC application (CBR, 2014, Section 3.1). Therefore, the licensee sometimes provided information for a 2.25-mile (3.62-km) area of review.

[11] Per acre values for cropland and rangeland are specific to Dawes County. Value of cropland equals the value of crop sales divided by the acres of land in farms used for cropland. Value of rangeland equals the value of livestock sales divided by the acres of land in farms used for livestock (NASS, 2014).

Table 3-2 Land Use within the MEA and within the Area of Review (2.25 miles (3.6 km) beyond the MEA Boundary)

Land Use Category	Percentage of the MEA	Percentage of the Area of Review
Rangeland	80	73
Cropland	10	7.8
Forestland	7.8	13.4
Wetlands	2.7	0.07
Recreation	0.0	3.3

Source: CBR, 2014, Table 3.1-2

Although Federal and State lands in Dawes County provide recreational opportunities (comprising 3.3 percent of the land in the AOR), and some hunting currently takes place within the MEA, no developed recreation facilities are located within the MEA or the area of review (CBR, 2014, Section 3.1.2.2). However, several recreation facilities and land areas that can be considered as potential wildlife habitat are located within 50 miles (80 km) of the MEA. The following list shows those within 20 miles (32 km) are of the MEA (with approximate distance from the MEA boundary) (CBR, 2014, Section 3.1.2.4 and Table 3.1-6):

- Box Butte Reservoir and Wildlife Area, 3 miles (4.8 km)
- Ponderosa Wildlife Management Area, 5 miles (8 km)
- Bighorn Wildlife Management Area, 7 miles (11.3 km)
- Fort Robinson State Park, 9 miles (14.5 km)
- Legend Buttes Golf Course, 11 miles (17.7 km)
- Roberts Trailhead and Campground, 11 miles (17.7 km)
- Crawford City Park, 12 miles (19.3 km)
- Peterson Wildlife Management Area, 14 miles (22.5 km)
- Fort Robinson Wildlife Management Area, 15 miles (24.1 km)
- Chadron State Park, 16 miles (25.7 km)
- Soldier Creek and Red Cloud Campground, 16 miles (25.7 km)
- Soldier Creek Wilderness, 16 miles (25.7 km)
- Whitney Lake, 16 miles (25.7 km)

3.1.2 Industrial Uses

Although several exploratory wells that target mineral resources, including uranium, and hydrocarbons have been drilled in the MEA and the area of review, no other industrial facilities are within the area of review (CBR, 2014, Section 3.1.2.5).

The nearest operating uranium recovery facility, and the only such facility within 50 miles (80 km) of the proposed MEA, is the existing Crow Butte license area, which is located 6 miles (9.7 km) northwest of the proposed MEA. CBR's proposed North Trend Expansion Area (NTEA) and proposed Three Crow Expansion Area (TCEA) are located near the existing Crow Butte license area (see Figure 2-3). Other uranium facilities in eastern Wyoming and western South Dakota are in different stages of development, but none of these existing or proposed uranium recovery facilities is located within 50 miles (80 km) of the MEA (CBR, 2014, Section 3.1.2.5).

3.2 Geology, Soils, and Seismology

3.2.1 Regional Geology

3.2.1.1 Regional Stratigraphy

The MEA is located near the northern limits of the High Plains section of the Great Plains physiographic province. The topography of the Marsland area includes gently sloping, rolling hills with outlying, broad ridges dissected by intermittent and perennial streams. The most prominent physiographic feature in the region is the Pine Ridge Escarpment, which rises roughly 300 to 900 feet (91 to 274 meters) above the basal plain and bounds three sides of the Crawford Basin (Figure 3-1).

As shown in Table 3-3, the geology of northwest Nebraska is divided into stratigraphic units that are, in general, based on their visible physical characteristics (lithology) (e.g., sandstone, mudstone). Geological units found in northwestern Nebraska include, from oldest to youngest,

Table 3-3 General Stratigraphic Chart for Northwest Nebraska

Geologic Period	Series	Formation or Group	Rock Types[a]	Thickness[b] (feet)
Tertiary	Miocene	Ogallala	SS, Slt	1,560*
	Oligocene/Eocene	Arikaree	SS, Slt	1,070*
		White River	SS, Slt, Cly	1,450*
Cretaceous	Upper	Pierre	Sh	1,500
		Niobrara	Chalk, Ls, Sh	300
		Carlile	Sh	200–250
		Greenhorn	Ls	30
		Graneros	Sh	250–280
		D Sand	SS	5–30
		D Shale	Sh	60
	Lower	G Sand	SS	10–45
		Huntsman	Sh	60–80
		J Sand	SS	10–30
		Skull Creek	Sh	220
		Dakota	SS, Sh	180
Jurassic	Upper	Morrison	Sh, SS	300
		Sundance	SS, Sh, Ls	300
Permian	Guadalupe	Satanka	Ls, Sh, Anhy	450
	Leonard	Upper	Ls, Anhy	150
		Lower	Sh	150
	Wolfcamp	Chase	Anhy	80
		Council Grove	Anhy, Sh	300
		Admire	Dolo, Ls	70
Pennsylvanian	Virgil	Shawnee	Ls	80
	Missouri	Kansas City	Ls, Sh	80
	Des Moines	Marmaton/ Cherokee	Ls, Sh	130
	Atoka	Upper/Lower	Ls, Sh	200
Mississippian	Lower	Lower	Ls, Sh	30
Pre-Cambrian			Granite	

a Rock type abbreviations: Anhy: anhydrate; Cly: claystone; Dolo: dolomite; Ls: limestone; Sh: shale; Slt: siltstone; SS: sandstone

b Maximum thickness based on Swinehart, et al., 1985

Note: To convert to meters, multiply by 0.3048

Source: CBR, 2015, Table 2.6-1

the Graneros Shale, Greenhorn Limestone, Carlile and Niobrara Shale formations underlying the Pierre Shale, the White River and Arikaree groups, and the overlying alluvium (i.e., stream) deposits (Collings and Knode, 1984; Miller and Appel, 1997; Hoganson et al., 1998; Swinehart et al., 1985). The White River Group includes, from oldest to youngest, the Basal, Middle, and Upper units of the Chadron Formation and the overlying Brule Formation. The Arikaree Group consists, from oldest to youngest, of the Gering Formation, the Harrison-Monroe Creek Formation, and the Upper Harrison Beds.

With respect to understanding and evaluating the most likely potential impacts of ISR activities at the MEA, the most important attribute of the stratigraphic unit is its permeability (how easy or difficult it is for water to move). The stratigraphic units are subdivided or combined into "hydrostratigraphic" units based on their transmissivity (permeability multiplied by thickness of the unit). Hydrostratigraphic units that can transmit sufficient quantities of water of sufficient quality to provide beneficial use are described as aquifers. Hydrostratigraphic units of low transmissivity are termed "aquitards," which, as described in greater detail below, may act as confining units.

3.2.1.2 Regional Structure

Figure 3-2 shows the structural features of the Crawford Basin and their proximity to the MEA and other existing or proposed CBR facilities in the area. The Crawford Basin is bounded by the Toadstool Park Fault on the northwest, the Chadron Arch and Bordeaux Fault to the east, and the Cochran Arch and Pine Ridge Fault to the south. The Chadron Arch is an anticlinal feature that strikes roughly northwest to southeast along the northeastern boundary of Dawes County (CBR, 2014, Section 3.3.1.3). The MEA lies just outside the southern boundary of the Crawford Basin along the Cochran Arch. The reported east-west trending Pine Ridge Fault is located along the northern edge of the Pine Ridge Escarpment, approximately 5 miles (8 km) north of the MEA.

The town of Marsland is located south of the Cochran Arch, while the city of Crawford is near the axis of the Crawford Basin. DeGraw (1969) proposed the Cochran Arch on the basis of subsurface data. The Cochran Arch trends east to west through Sioux and Dawes counties, parallel to the Pine Ridge Fault DeGraw (1969) proposed. Structural features within the MEA subparallel to the Cochran Arch have been recognized based on CBR drill hole data. The existence of the Cochran Arch may explain the structural high south of Crawford (Figure 3-2).

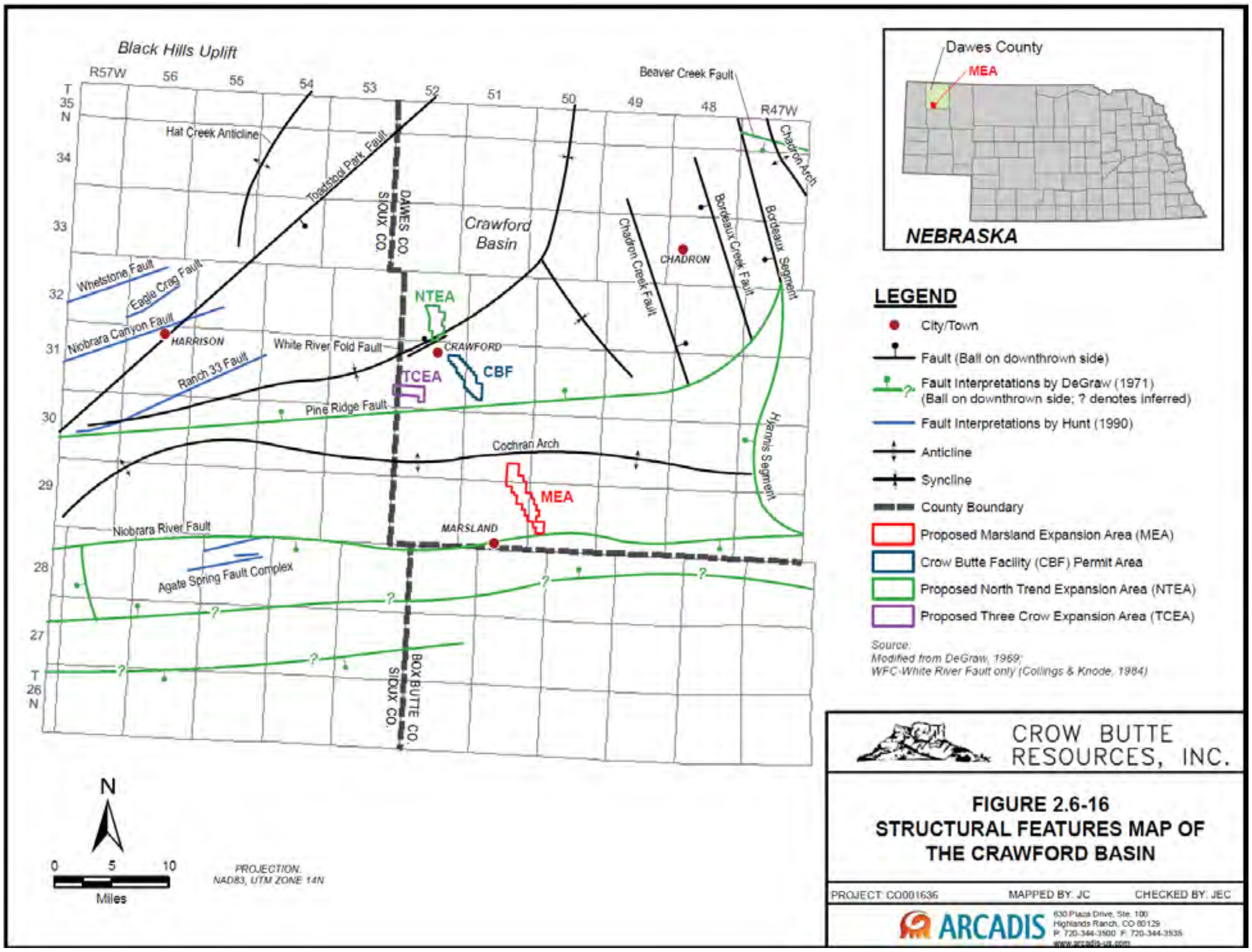


Figure 3-2 Structural features map of the Crawford Basin (Source: CBR, 2015, Figure 2.6-16)

3.2.1.3 Paleontological Resources

A significant number of mammalian fossils are present in the Arikaree Group and White River Group in northwestern Nebraska (CBR, 2014, Section 3.3.1.5). The Bureau of Land Management (BLM) has developed the Potential Fossil Yield Classification system to categorize the probability of geologic units to contain scientifically significant paleontological resources or noteworthy fossil occurrences. It has five levels, or classes, ranging from Class 1, which applies to geologic units that are not likely to contain significant fossils, through Class 5, which applies to geologic formations that have a high potential to yield scientifically significant fossils on a regular basis (BLM, 2009). Under the BLM ranking system, the White River Group, Arikaree Group, and Ogallala in Wyoming are considered to be highly fossiliferous and contain fossils that are at risk of human-caused adverse impacts or natural degradation. Although the fossils in Nebraska have not been ranked, their similar abundance suggests a similar ranking to those in Wyoming.

3.2.2 Local Geology

3.2.2.1 Local Stratigraphy

The sedimentary stratigraphy in the vicinity of MEA ranges from late Cretaceous through Tertiary age and consists of the following geological units in descending order: (1) alluvial sediments, (2) Arikaree Group (composed of the upper Harrison Beds, Monroe Creek-Harrison Formation, and Gering Formation), (3) White River Group[12] (composed of the Brule Formation and Chadron Formation), and (4) the Montana Group (Pierre Shale). Table 3-4 provides the approximate thicknesses for the various geologic units at the MEA.

Table 3-4 Approximate Thicknesses of MEA Geologic Units

Geologic Unit	Thickness[a]	
	Feet	Meters
Alluvium	<30	<9
Arikaree Group	40–160+	12–49+
Brule	350–550	107–168
Upper and Middle Chadron	360–450	110–137
Basal Chadron Sandstone Aquifer	20–90	6–27
Pierre Shale	750–1,000+	229–305+

a. Estimated from boring logs
Source: Adapted from CBR, 2015, Table 2.6-2

<u>Alluvium</u>

A top layer of quaternary alluvium as thick as 30 feet (9.1 meters) overlies the Arikaree Group along drainages in the MEA area (CBR, 2015, Section 2.6.1.1, page 2-44). In general, the alluvium consists of fragments of locally outcropping sedimentary rocks of the Arikaree Group, including sand, gravel, sandy soil horizons, and possibly weathered portions of the Arikaree Group.

<u>Arikaree Group</u>

The Arikaree Group underlies the alluvium and varies in thickness from 40 to 160 feet (12.2 to 48.8 meters) depending upon the degree of erosion. The Arikaree Group contains numerous interbedded channel and floodplain deposits along with eolian (i.e., deposited by wind) volcanoclastic deposits (CBR, 2014, Section 3.3.1.1). Based on grain size analysis of core samples, CBR reports that the interbedded lithologies within the unit include illite and smectite (i.e., clays), mudstones, siltstones, and fine-grained sandstones. The Arikaree Group

12 In its discussions of site geology, CBR uses the nomenclature found in the previous license applications (CBR, 2014, Section 3.3.1.1). Some studies of the regional geology (e.g., LaGarry, 1998) have proposed new nomenclature for some of the geologic layers within the MEA expansion area, including the proposal that the Basal Chadron Sandstone should be referred to as the Chamberlain Pass Formation. The U.S. Geological Survey does not identify a Chamberlain Pass Formation within the White River Group in Nebraska (USGS, 2016a). Furthermore, the NDEQ retained the traditional stratigraphic terms in the Class III Underground Injection Control (UIC) permit issued to CBR for the North Trend Expansion Area (NDEQ, 2011). And, stratigraphic nomenclature aside, nothing in the naming conventions for the geologic units in Nebraska or at the MEA changes the interpretation of the physical or hydrogeologic features of the rock units. Therefore, this Draft EA uses the USGS naming conventions presented in the application.

unconformably overlies the Brule Formation and is subdivided, from oldest to youngest, into the Upper Harrison Beds, Harrison-Monroe Creek, and Gering formations. Based on the isopach map (CBR, 2014, Figure 3.3-6) included in the MEA ER, the thickness of the undifferentiated (i.e., unable to distinguish between) Arikaree Group over the MEA generally ranges between 40 to over 160 feet (12 to over 49 meters), with increasing thickness from south to north.

The fine sand units within the Upper Harrison beds, fine-grained sandstones within the Harrison-Monroe Creek Formation, and coarse- to fine-grained sandstones of the Gering Formation represent local water-bearing units (CBR, 2014, Section 3.4.3.1).

White River Group

Brule Formation

The Brule Formation is subdivided into the Brown Siltstone Member, the Whitney Member, and the underlying Orella Member. The Brule Formation lies conformably (i.e., deposition uninterrupted by erosion) on top of the Chadron Formation (CBR, 2014, Section 3.3.1.1) and is overlain by sandstones of the Arikaree Group. The Whitney Member of the Brule Formation consists of a lower “brown siltstone” overlain by siltstones with rare interbeds of sandstone and volcanic ash (CBR, 2014, Section 3.3.1.1). The Whitney Member is overlain by siltstones, claystones, sandstones, and volcanic ashes of the Orella Member. The overall thickness of the undifferentiated Brule Formation in the MEA cross sections (CBR 2014, Figures 3.3-3a through 3.3-3n) and isopach map (CBR, 2014, Figure 3.3-7) ranges from approximately 350 to 550 feet (107 to 168 meters), generally thinning from north to south across the MEA.

The Brown Siltstone member of the upper Brule Formation constitutes the first overlying aquifer above the production zone within the Basal Chadron Sandstone aquifer (CBR, 2017, Section 2.7.2.2). The Brule Formation lies conformably on top of the Chadron Formation, the bottom layer of the White River Group.

Chadron Formation

The Chadron Formation includes the Upper Chadron Formation, Upper/Middle Chadron Formation, Middle Chadron Formation, and the Basal Chadron Sandstone aquifer.

Upper and Middle Chadron Formations

The Upper Chadron is a bentonitic clay grading downward to green and red clay, with some interbedded sandstone intervals. The Middle Chadron is also clay-rich with interbedded bentonitic clay and sand. The intermittent sandstones that occur between the Middle and Upper Chadron units in other locations, such as the NTEA, are not present within the MEA.

The combined thickness of the Upper and Middle Chadron units ranges from approximately 360 to 450 feet (110 to 137 meters) and generally thins toward the south across the MEA (CBR, 2015, Figure 2.6-8). The Upper and Middle Chadron units are laterally continuous throughout the MEA (CBR, 2014, Figures 3.3-3a through 3.3-3n).

X-ray diffraction analyses of Upper Chadron samples indicate that the unit consists primarily of clays (mixed layered illite and smectite), calcite, and quartz (CBR, 2014, Section 3.3.1.1). On the basis of grain size analysis, these Upper Chadron samples are classified as siltstone, with more than 50 percent of the sample grain sizes falling in the silt-clay fraction range. X-ray diffraction analyses of Middle Chadron samples indicate that the unit is primarily composed of mixed layered illite and smectite. The relevance of these units being thick and consisting primarily of silts and clay is that their low permeabilities provide excellent confinement of the underlying ore zone (see Section 3.3.2.5). Furthermore, since these types of clays are self-annealing, their confinement properties are unlikely to be compromised by induced stresses (e.g., earthquakes).

Basal Chadron Sandstone Aquifer

The uranium deposit at the MEA is contained within the Basal Chadron Sandstone aquifer, which occurs at the base of the Chadron Formation. As described above, the Middle and Upper Chadron confining units separate the Basal Chadron Sandstone aquifer from the overlying Brule Formation. As Gjelsteen and Collings (1988) describes, the Basal Chadron Sandstone aquifer was deposited by a braided-river system in early Oligocene time (23 to 34 million years ago), and an unconfined water-table aquifer was established in the coarse-grained sediments making up the aquifer in what is now the Basal Chadron Sandstone. During that time, the water-table aquifer was in hydraulic connection with the river system, and groundwater flow was parallel to the flow in the river. Because the sands of the Basal Chadron Sandstone aquifer were originally deposited on the impermeable Pierre Shale, vertical flow was restricted to within the channel sands and the Basal Chadron Sandstone aquifer was not hydraulically connected with underlying aquifers. The Basal Chadron Sandstone aquifer grades into less permeable silts and clays about 9 miles (14.5 km) to the east and 12 miles (19.3 km) to the west of the MEA.

The uranium within the Basal Chadron Sandstone aquifer deposits are roll-front deposits, which form by the precipitation of uranium from uranium-rich, oxidizing waters as they move into or through a reducing (i.e., low oxygen) aquifer (Gjelsteen and Collings, 1988). When the uranium precipitates, it forms a crescent-shaped “front” through the host rock (i.e., sandstone).

The lower part of the Basal Chadron Sandstone aquifer is coarse-grained, arkosic (i.e., high feldspar mineral content) sandstone with common, discontinuous interbedded thin silt and clay lenses of varying thickness. Occasionally, the lower portion of the Basal Chadron Sandstone aquifer is a very coarse, poorly sorted conglomerate (i.e., gravel-size pebbles within a fine-grained matrix). The Basal Chadron Sandstone aquifer has not undergone significant chemical, physical, or biological change since its initial deposition and lithification into rock, apart from weathering. The sands are relatively uncemented, with calcite and silica cement present only in minor amounts (Gjelsteen and Collings, 1988). Because the properties of the Basal Chadron Sandstone aquifer are relatively unchanged since their deposition within a stream environment, they would retain their primary porosity (i.e., fractures have not formed and would not develop), and thus groundwater flow and lixiviant movement is much more predictable. This facilitates the design and operation of the ISR activities and the monitoring of their performance.

At the MEA, the Basal Chadron Sandstone aquifer occurs at depths ranging from about 817 to 1,130 feet bgs (267.3 to 344.4 meters bgs). It was encountered in all exploration holes and is laterally continuous throughout the MEA (CBR, 2014, Figures 3.3-3a through 3.3-3n). Its thickness ranges from approximately 20 to 90 feet (6.1 to 27 meters) and averages about 55 feet (16.8 meters) (CBR 2014, Figure 3.3-9). The thickest sections of the unit occur in the western portions of the MEA (CBR, 2014, Section 3.3.1.1). Uranium recovery would therefore be focused on a relatively thin and continuous unit that is naturally confined by overlying and underlying low-permeability units. This geometry simplifies the ISR process by requiring that hydraulic control (i.e., injection and pumping) be maintained only over a fairly restricted area. The great depths allow the Basal Chadron Sandstone aquifer to be isolated from overlying aquifers by several hundred feet of low-permeability confining units. The Basal Chadron Sandstone aquifer lies unconformably over the thick Pierre Shale.

Montana Group

The Montana Group, which comprises the Pierre Shale, underlies the White River Group. The Pierre Shale is a regional dark gray to black marine shale, with relatively uniform composition throughout. In Dawes County, the Pierre Shale can be up to 1,500 feet (457.2 meters) thick. Cross sections and a structure contour map created from borehole geophysical logs show that the Pierre Shale is laterally continuous throughout the MEA (CBR, 2014, Figures 3.3-3a through 3.3-3n).

The geophysical log of an oil and gas exploratory well (Hollibaugh No. 1) (CBR, 2014, Appendix C) within the MEA (located at Township 29N, Range 51W, Section 12) indicates that the Pierre Shale locally attains a thickness of about 890 feet (270 meters). Based on observations from geophysical logging, the thickness of the Pierre Shale in the vicinity of the MEA ranges from approximately 769 to more than 1,000 feet (234.4 to 304.8 meters). The top of the Pierre Shale was encountered in all MEA wells at depths ranging from approximately 947 to 1,258 feet bgs (288.7 to 383.5 meters bgs) (CBR, 2014, Section 3.3.1.1).

Oil and gas well geophysical logs indicate that there is a lack of permeable water-bearing zones within the Pierre Shale in the region of the MEA (CBR, 2014, Section 3.3.1.2). X-ray diffraction analyses of Pierre Shale samples indicate that the unit is composed primarily of clays (mixed layered illite and smectite) and quartz (CBR, 2014, Section 3.4.3.3). A particle grain-size distribution analysis of Pierre Shale samples shows a composition consisting of 60 to 51 percent silt-size and 39 to 48 percent clay-size particles. The measured vertical hydraulic conductivity of this regional unit at the existing Crow Butte license area is less than $5.47\text{x}10^{-14}$ feet per second ($1\text{x}10^{-10}$ centimeters per second). These very low conductivity values and the uniformity of the Pierre Shale over large distances creates an underlying confining layer to the Basal Chadron Sandstone aquifer throughout the MEA.

Underlying the Pierre Shale is a thick sequence of Mississippian-through Cretaceous-age strata that unconformably overlie Precambrian granite. Together with the Pierre Shale, the underlying Niobrara Formation, Carlile Shale, Greenhorn Limestone, and Graneros Shale compose a composite lower confining interval approximately 2,500 feet (762 meters) thick that immediately underlies the Basal Chadron Sandstone aquifer.

3.2.2.2 Marsland Expansion Area Local Structure

The closest structural features to the MEA are the reported Niobrara River Fault (or structure), which is assumed to parallel the Niobrara River and was described by Stout et al. (1971), and the reported Pine Ridge Fault to the north of the MEA, which DeGraw (1969) initially proposed. The mapping of these reported faults is based on regional lines of evidence, but no detailed study has been published. The Pine Ridge and Niobrara River faults are reported by some investigators (e.g., DeGraw, 1971; Swinehart, 1985) to pass approximately 5 miles (8 km) north and along the southern margin of the MEA, respectively (CBR, 2014, Figure 3.3-16).

To evaluate the existence of the reported Pine Ridge and Niobrara River faults, CBR created three regional north-south cross sections based on geophysical logs. These cross sections (CBR, 2015, Figures 2.6-22 through 2.6-24) extend from south of the Niobrara River (south of the MEA) northward though the MEA, across the existing Crow Butte license area and the NTEA. Each of the three sections intersects the reported traces of the Niobrara River and Pine Ridge faults. Cross section R1-R1’ extends through the middle of the MEA, whereas R0-R0’ and R2-R2’ are approximately 1 mile (2 km) to the east and west of R1-R1’, respectively. The cross sections are vertically exaggerated 10 times, and CBR used the top of the Pierre Shale, top of Chadron sandstone, and a pair of persistent marker beds discernable on the geophysical logs for stratigraphic correlation. CBR also presented cross sections extending down to the top of the Pierre (CBR, 2017, Figures 2.6-3a through 2.6-3n), which illustrate the orientation of formation bedding across the MEA.

Cross section R0-R0’ intersects the proposed Pine Ridge Fault at a point about 2 miles (3 km) west of where Souders’ (1981) cross section A-A’ crosses the fault trace. CBR notes that the surface of the Pierre Shale at this point vertically drops 22 feet (6.7 meters) over a distance of 2.3 miles (3.7 km). On cross sections R1-R1’ and R2-R2’, the Pierre Shale rises 24 feet (7.3 meters) and 29 feet (8.8 meters) from south to north as the location of the proposed fault is crossed, respectively. CBR considers that these topographic changes in the Pierre Shale surface are likely erosional rather than structural. CBR notes, contrary to the information in DeGraw (1969), that at no point on the CBR-generated cross sections is an offset of about 300 feet (90 meters) observed at the reported location of the Pine Ridge Fault. CBR further observes that, in contrast to the information presented by Souders (1981), no offset of about 120 feet (37 meters) is evident that impacts all overlying strata as would be expected by fault movement that occurred after deposition of the overlying strata.

CBR also investigated the presence of the Pine Ridge Fault south of the proposed TCEA (west of the MEA) and provided cross sections from this investigation in Appendix Z of the MEA application (CBR, 2014). According to CBR, these cross sections do not substantiate a reported north-side down vertical displacement of approximately 300 feet (90 meters), in contradiction to the information presented by DeGraw (1969) (CBR, 2014, Section 3.3.1.3). CBR also observes that in two of those cross sections, the elevation of the top of the Pierre Shale decreases southward, which is contradictory to a north-side down vertical displacement (CBR, 2014, Section 3.3.1.3). CBR concludes that, while not excluding the presence of a short-offset fault, the increases in elevation recorded for the top of the Pierre Shale are most likely a result of erosional topographic lows or structural dips resulting from flexing associated with the formation of the Crawford Basin. CBR further concludes that the exclusion of the existence of a large-offset fault eliminates the potential for such a feature to act as a boundary for groundwater flow and movement that could impact production operations at MEA (CBR, 2014, Section 3.3.1.3).

DeGraw (1969) initially proposed the existence of the Pine Ridge Fault based on a structure contour map of the pre-Tertiary surface of western Nebraska derived from oil and gas well data. The DeGraw (1969) structure contour map indicates that the fault exhibits north-side down displacement of about 300 feet (90 meters) immediately north of the MEA and about 500 feet (200 meters) farther to the east. Souders (1981) reported the presence of an unnamed fault with north-side down displacement where his cross sections A-A’ and B-B’ cross the trace of the Pine Ridge Fault as DeGraw (1969) delineated. These cross sections are approximately 2 and 12 miles (3 and 19 km), respectively, east of the CBR (2015, Section 2.6.1.3) easternmost cross section R0-R0’ and are based on limited test well data south of the fault and extrapolated from dip measurements of the top of the Pierre Shale where it crops out several miles to the north. In contrast to the greater fault displacement indicated by DeGraw (1969), the Souders (1981) cross sections indicate only about 120 feet (37 meters) of displacement on the fault extending down to the Pierre Shale. Swinehart et al. (1985) presented cross section B-B’ that also shows the presence of a fault where it crosses the trace of the Pine Ridge Fault indicated by DeGraw (1969). This cross section is approximately 11 miles (18 km) east of CBR (2015, Section 2.6.1.3) cross section R0-R0’ and indicates about 75 feet (23 meters) of north-side down displacement on the fault extending down to the Pierre Shale.

Swinehart et al. (1985, Figure 22) indicate the presence of the Niobrara River Fault across southern Dawes County. However, the accompanying structure contour maps (Swinehart et al., 1985, Figures 8, 11, and 15) for the base of Cenozoic and younger horizons do not indicate any corresponding structural offset along the proposed fault trace (nor any indication of a fault farther south). Moreover, no fault is shown in cross section B-B’ in Swinehart et al. (1985, Figure 5), approximately 7.5 miles (12 km) east of the southern limit of the MEA, where it crosses the trace of the proposed fault. The NRC staff has also evaluated cross sections presented in Souders (1981) that cross the trace of the Niobrara River Fault as DeGraw (1971) and Swinehart et al. (1985) propose. Cross sections A-A’, B-B’, and C-C’ in Souders (1981) intersect the proposed Niobrara River Fault trace at approximate distances from the southern limit of the MEA of 5 miles (8 km) (to the west) and 7.5 miles (12 km) and 17.5 miles (28.2 km) (to the east), respectively. The NRC staff finds that none of these cross sections indicates the presence of a fault at or near the reported location of the Niobrara River fault.

Stout et al. (1971) did not map the Niobrara River Fault but reported its location from apparent displacements. Stout et al. (1971) also indicated that the Niobrara River Fault appears to be a western extension of the Hyannis-North Platte Fault and forms the northern boundary of a graben (the area between two faults that has been displaced downward to form a valley) that contains the Niobrara River valley. Because the Niobrara River Fault is absent from the U.S. Geological Survey’s (USGS’s) compendium (USGS, 2010) of faults with evidence of movement between 1.6 million years and ago and the present, CBR has reported that the most recent movement along both faults was between 19.2 and 1.6 million years ago (CBR, 2014, Section 3.3.1.3).

CBR has also evaluated the possible presence of the Niobrara River Fault south of the MEA (CBR, 2014, Section 3.3.1.3). CBR notes that DeGraw (1971)[13] indicates the presence of the Niobrara River Fault parallel to the Niobrara River (CBR, 2014, Figure 3.3-16). As CBR observes, DeGraw (1971; cited as Stout et al., 1971) proposed that the land between the Niobrara River Fault and an unnamed fault (CBR, 2014, Figure 3.3-16) to the south has been displaced downward from the faulting, forming a graben that contains the Niobrara River valley. CBR notes that DeGraw (1971) does not present the basis for inferring the presence of these faults, and the pre-Tertiary surface structure contour map presented in DeGraw (1969) did not indicate the presence of any feature or displacement corresponding to the fault locations indicated in DeGraw (1971). CBR has reviewed Cameco geophysical data and generated a structure contour map of the top of the Pierre Shale (CBR, 2015, Figure 2.6-14). Based on this review, CBR notes the presence of a trough generally parallel to but slightly to the north of the proposed graben location. CBR states that the structural trough may represent a graben, a fold with the younger layers closer to the center of the structure “syncline” (related to the Cochran Arch) or a topographic feature present in the geologic past. CBR also constructed 14 geologic cross sections across the MEA based on geologic and geophysical borings (CBR, 2015, Figure 2.6-2). There are no vertical offsets within any of these cross sections of the MEA that would indicate faulting.

As discussed in greater detail in Section 3.3.2.5, the Basal Chadron Sandstone aquifer is confined by over- and underlying low-permeability rocks. Therefore, the only potential impact of faulting would be whether preferential pathways are allowing leakage through the confining layers. To evaluate the degree of confinement of the Basal Chadron Sandstone aquifer, CBR performed an

---

[13] In the CBR Technical Report, DeGraw (1971) was cited as Stout et al, (1971); this Draft EA cites the reference as DeGraw (1971).

aquifer pump test over the north-central portion of the MEA (CBR, 2014, Appendix F, Figure 1). This test involved pumping a well in the Basal Chadron Sandstone aquifer at 27 gallons (102 liters) per minute for about 4 days. During that time, CBR measured water levels (i.e., potentiometric surface) in nine observation wells completed in the Basal Chadron Sandstone aquifer and three observation wells open to the overlying Brule Formation. The radius of pumping influence was about 8,800 feet (2,683 meters) within the Basal Chadron Sandstone aquifer and no drawdown was observed in the Brule Formation monitoring wells that could be attributed to the pumping in the Basal Chadron Sandstone aquifer. The type curve matches are consistent with increasing transmissivity away from the pumping well (CBR, 2014, Appendix F, Appendix C). CBR would also perform additional aquifer pumping tests to provide coverage to demonstrate the natural confinement of the Basal Chadron Sandstone aquifer in the southern portion of the MEA (CBR, 2015, Section 2.6.1.3) and to identify hydrology boundaries.

In summary, the NRC staff has not found any evidence of any large-scale offsets in any of the geologic cross sections based on borehole data that indicate the existence of a Pine Ridge fault or faulting within the MEA. The potential presence of a Niobrara River Fault farther south of the MEA, however, is more uncertain. However, even if the Pine Ridge Fault and Niobrara River Fault (or structural feature) do exist, their presence would not lead to significant adverse environmental impacts for several reasons. First, based on groundwater velocity estimates provided in Section 3.3.2.1 of this EA, it would take at least 500 years for groundwater to migrate from the MEA to the reported Pine Ridge Fault, during which time any constituents of the lixiviant would attenuate through sorption and dilution. Second, ambient groundwater flow in the Basal Chadron Sandstone aquifer is to the northwest and away from the reported Niobrara River structural feature or fault. Third, once uranium extraction begins, groundwater flow would be toward the mine units and away from both the Pine Ridge Fault and Niobrara River Fault (or structural feature). Fourth, the ambient hydraulic gradients are strongly downward from the overlying aquifers of the Brule Formation and Arikaree Group to the Basal Chadron Sandstone aquifer (CBR, 2014, Section 3.4.3.3); therefore, mining fluids would not be able to migrate upward through any preferential pathways. Fifth, the downward gradient would become even more pronounced during recovery operations. And finally, CBR would conduct additional aquifer pumping tests that would be designed to identify hydraulic boundaries (CBR, 2015, Section 2.6.1.3) including those caused by faulting.

3.2.3 Soils

CBR describes the soils in the MEA based on information obtained from the Natural Resources Conservation Service Web Soil Survey in 2011 (CBR, 2014, Section 3.3.1.6). CBR identifies 31 soil map units in the project area (CBR, 2014, Figure 3.3-20 and Table 3.3-7), which consist of shallow-to-deep silt, loams, and loamy very fine sands formed by the weathering of bedrock and surficial sediments. The loamy and fine sandy texture of most soils in the MEA are characterized by good drainage and high infiltration rates as well as susceptibility to wind and water erosion, especially in areas of disturbed vegetation (CBR, 2014, Section 3.3.1.6).

Soils in the MEA formed through the weathering of Tertiary bedrock material, loess (windblown silt), colluvium, or unconsolidated alluvium. Soils in the project area are shallow-to-deep silt loams and loamy very fine sands. Soil depth, grain size, and drainage typically increase closer to the Niobrara River and away from the steeper uplands of the MEA (SCS, 1977). A soil association is a landscape that has a distinctive proportional pattern of soils, consisting of one or more major soils and at least one minor soil. The General Soil Map of Dawes County, NE, describes the three soil associations that dominate the MEA, which are generally segregated north to south according to topographic and physiographic regimes and parent material, as follows (SCS, 1977):

- The Canyon-Alliance-Rosebud soil association is generally found in the northern portion of the MEA and makes up approximately 40 percent of the project area. This upland soil association consists of loamy and silty soils that are deep to shallow, gently sloping to steep, and well-drained that formed in material weathered from sandstone (SCS, 1977).

- The Busher-Tassel-Vetal soil association is found on uplands and footslopes and makes up about 35 percent of the project area. This soil association consists of sandy soils that are deep to shallow, very gently sloping to steep, well-drained to somewhat excessively drained that formed in colluvium and in material weathered from sandstone.

- The Valent-Dwyer-Jayem soil association makes up about 23 percent of the project area and is typically found in uplands adjacent to the Niobrara River in the southern portion of the MEA. This soil association consists of sandy soils that are deep, gently sloping to steep, and well-drained to excessively drained. Together, the Valent- and Dwyer-series soils (which are typically mapped as one unit) make up 68 percent of the association, with Jayem-series soils and minor soils and land types both making up about 16 percent each.

3.2.4 Seismology

To evaluate the seismic hazards in the region of the MEA, CBR presented (CBR, 2015, Section 2.6.1.4) (1) catalogs of earthquakes that have occurred in Nebraska in the vicinity of the Chadron and Cambridge Arches from 1884 to 2009 and earthquakes that have occurred from 1992 through 2007 within 125 miles (201.2 km) of the city of Crawford, WY, and in the State of South Dakota; (2) the Modified Mercalli Scale of Intensity (MMI) for most of the significant historical earthquakes in the region, including those that occurred in Wyoming and South Dakota; and (3) the 2008 USGS National Seismic Hazard Maps (USGS, 2008). In addition to the catalogs of historical earthquakes from the MEA TR catalogs (CBR, 2015, Section 2.6.1.4), the NRC staff compiled a catalog of historical earthquakes of magnitude 2.5 or greater within a 100-mile (161 km) radius of the MEA, using the most up-to-date earthquake catalogs available (NRC, 2012e; USGS, 2016c). Table 3-5 shows the results of the NRC staff's search, which included a few more events than those presented in the MEA TR. The events with magnitudes larger than 3.0 are magnitudes 3.2 (on July 14, 1920), 3.7 (on May 25, 1941), and 3.3 (on February 25, 1942).

Table 3-5 Historical Earthquakes within 100 miles (161 km) of the MEA

Year	Month	Day	Hour	Min.	Sec.	Lat.	Long.	Depth	Magnitude (Richter Scale)	Distance (miles)	Distance (km)
1895	10	11	23	55	0	43.900	-103.300	NR[a]	3.36	97	156
1895	10	12	1	25	0	43.900	-103.300	NR	3.38	97	156
1920	7	14	23	0	0	43.200	-103.200	NR	3.16	48	78
1924	12	30	22	10	0	43.500	-103.500	NR	3.59	70	113
1924	12	30	22	15	0	43.500	-103.500	NR	2.65	70	113
1924	12	30	22	20	0	43.500	-103.500	NR	2.65	70	113
1924	12	30	22	30	0	43.500	-103.500	NR	2.65	70	113
1933	8	8	0	0	0	41.900	-103.700	NR	2.98	47	76
1934	7	30	7	20	0	42.700	-103.000	NR	4.1	19	30
1936	10	30	10	30	0	43.500	-103.500	NR	2.65	70	113

Year	Month	Day	Hour	Min.	Sec.	Lat.	Long.	Depth	Magnitude (Richter Scale)	Distance (miles)	Distance (km)
1938	3	24	13	11	0	42.700	-103.400	NR	3.31	16	25
1941	5	25	6	25	0	43.500	-103.500	NR	3.7	70	113
1942	2	25	14	3	0	42.500	-104.400	NR	2.65	59	94
1942	2	25	14	15	0	42.500	-104.400	NR	3.31	59	94
1942	2	25	14	30	0	42.500	-104.400	NR	2.65	59	94
1943	5	16	19	40	0	43.500	-103.500	NR	2.65	70	113
1964	3	24	6	12	0	43.500	-103.500	NR	3.38	70	113
1964	3	28	3	0	0	42.700	-104.100	NR	3.31	45	73
1964	3	28	10	8	46.5	43.000	-101.800	30	4.84	81	131
1964	3	28	10	24	50	42.800	-101.700	NR	3.28	81	131
1964	8	22	3	28	11	42.900	-104.700	NR	3.84	79	127
1975	5	16	5	57	1	43.200	-103.700	NR	2.65	53	86
1975	8	25	10	0	34.7	42.570	-101.550	29	2.58	87	140
1978	5	7	16	6	23	42.260	-101.950	38	3.72	68	110
1981	9	13	22	16	29.7	43.040	-101.850	5	3.23	80	129
1983	5	6	6	14	46.9	42.955	-102.198	5	2.98	62	100
1987	1	1	8	2	24	42.788	-103.482	5	3.08	23	37
1989	2	9	5	15	45.8	42.685	-101.898	5	3.49	70	113
1990	1	28	4	59	59.1	43.313	-102.504	5	3.72	68	109
1990	3	2	4	15	27	43.300	-102.500	5	2.94	67	108
1992	11	2	6	54	10.3	42.740	-104.389	5	2.9	60	97
1993	2	20	13	8	10.1	42.830	-101.461	5	3.19	94	151
1994	3	18	22	51	43.1	43.400	-103.500	5	2.48	63	102
1996	4	9	2	48	8.1	43.069	-104.102	5	3.24	58	94
1996	5	3	7	47	51.5	43.045	-104.022	5	2.78	54	87
1998	6	18	16	26	38.32	42.622	-103.003	5	3.08	15	24
2003	5	25	7	32	33.3	43.087	-101.794	5	3.91	84	136
2004	1	5	2	53	16.5	43.598	-103.995	5	2.48	85	136
2006	9	7	6	23	20	42.977	-102.236	5	2.28	61	98
2007	4	24	9	35	1.26	42.580	-102.940	5	2.38	17	27
2008	8	22	23	1	31.81	43.075	-104.289	5	2.78	66	106
2011	3	10	1	38	13.68	42.861	-104.087	5	2.9	49	79
2011	11	14	6	51	38.38	43.043	-103.415	5	4.0	38	62
2011	11	15	9	31	46.13	43.050	-103.504	5	3.3	40	65
2011	11	19	8	28	4.43	42.911	-103.082	5	2.8	30	48
2012	1	16	13	41	10.18	43.487	-102.996	5	3.0	69	112
2012	10	18	5	21	11.11	42.212	-101.952	5	3.6	69	112
2013	12	12	9	43	20.41	43.818	-103.318	5	3.5	91	147
2016	07	17	23	41	5.65	43.310	-103.161	5	2.8	56	90

a. NR indicates that the depth was not reported.
Sources: NRC, 2012e, USGS Advanced National Seismic System (ANSS) Catalog (2009 to present, accessed on 6/22/2017); NCEDC, 2017.

The historical earthquakes in Table 3-5 directly reflect the seismic activity level in the region surrounding the MEA. Table 3-5 shows that most of the earthquakes are in the magnitude range of 2.5 to 3.5, with only three events at or above magnitude 4.0. In general, earthquakes below 4.0 on the Richter scale do not cause damage, and earthquakes around 3.0 are the smallest that can be felt. Table 3-5 also indicates that there was not a single event recorded within less than15 miles (24.1 km) of the proposed facility in the 120 years of recording history. These historical data indicate that the MEA is located in a very aseismic region.

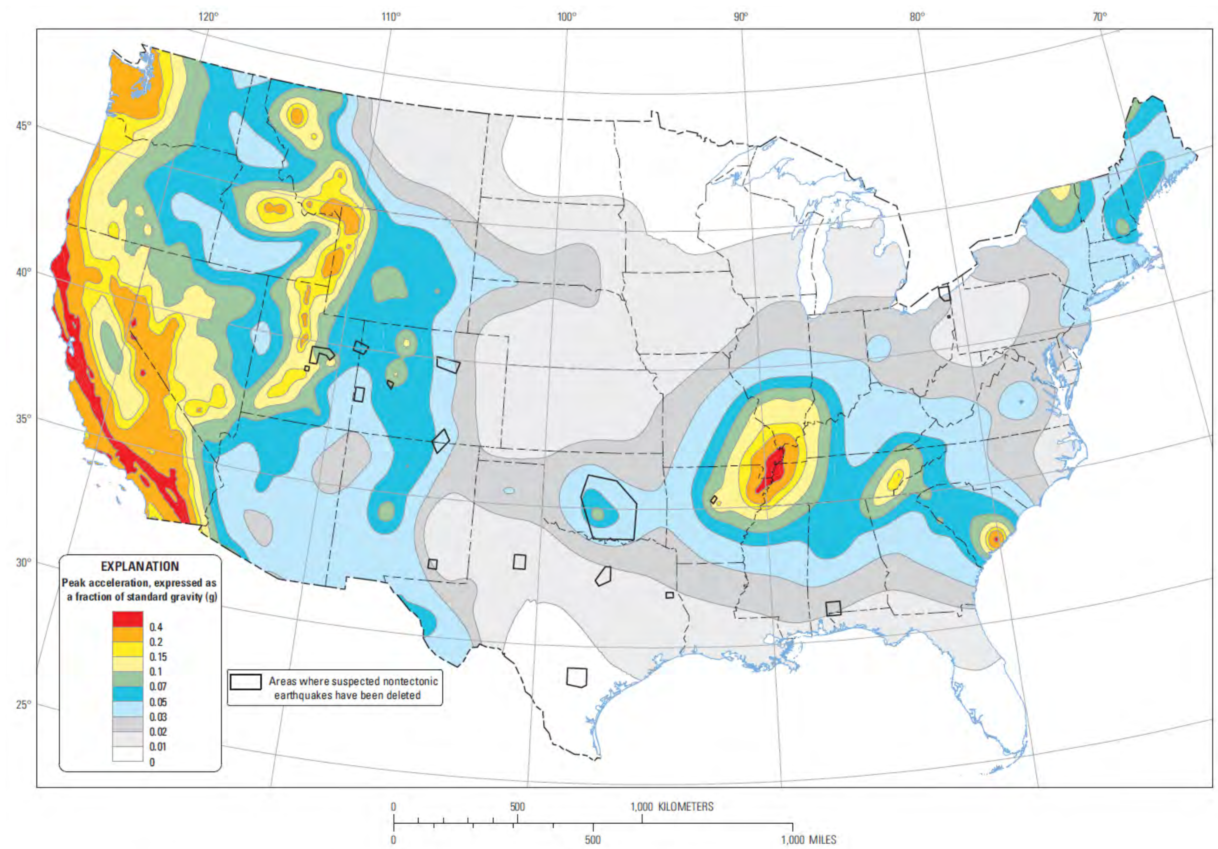
3.2.4.1 Intensities of the Historical Significant Earthquakes

The MMI scale is a measure of the intensity of an earthquake. The scale quantifies the effects of an earthquake on the earth's surface, humans, objects of nature, and manmade structures on a scale from I (not felt) to XII (total destruction). It is usually the highest in the epicentral region of an earthquake and decreases with increasing distance from the epicenter. The MMI is distinct from earthquake magnitude, which is a measure of the energy released from an earthquake.

CBR presents the historical observations of the MMI intensities for those significant earthquakes listed in the two catalogs (CBR, 2015, Section 2.6.1.4). Earthquakes in the region had MMI intensities ranging from I to VI, with the majority between I and III. According to the MMI scale, earthquakes with MMIs of VI may result in slight damage to structures, such as chimneys; events with lower MMI intensity levels may be felt but without damage. Only one earthquake with an MMI of VI has been recorded in the region. This event occurred on July 30, 1934; it was centered in Dawes County (near Chadron) and resulted in damaged chimneys, plaster, and china.

3.2.4.2 USGS Seismic Hazard Maps

CBR presents the 2008 USGS National Seismic Hazard Maps (USGS, 2011), which show expected ground accelerations (CBR, 2015, Section 2.6.1.4). The most recent USGS map (USGS, 2014), which is essentially unchanged from the 2008 version for the region around the MEA, shows that the MEA is located in a region with peak accelerations of about 2–5 percent gravity (gravity = 9.8 meters per second squared or 32.2 feet per second squared) (Figure 3-3). These accelerations are considered very low in the United States.



Ten-percent probability of exceedance in 50 years map of peak ground acceleration

Figure 3-3 National peak ground acceleration Seismic Hazard Maps in 2014 of USGS for 10-percent probability of exceedance in 50 years (Source: USGS, 2014)

3.3 Water Resources

3.3.1 Surface Water Resources

In order to assess potential impacts, it is important to understand the “watershed” of the area. A watershed is the area of land where all of the water that falls on it and drains off of it goes to the same place. The general vulnerability, probable magnitude, and likely nature of potential impacts to surface water from the ISR operations at the MEA would be based primarily on the proximity of the surface water to MEA operations, the size and flow volumes of the surface water, the water’s current uses and quality, and whether there are any potential pathways from the MEA to the surface water body.

The MEA is located within the Niobrara River Basin along the southern flank of the Pine Ridge escarpment. The Pine Ridge escarpment rises about 300 to 900 feet (91 to 274 meters) above the basal plane and forms a surface water divide between waters that flow to the Niobrara River to the south and those that flow into the White and Hat Creek basins to the north. The nearest MEA mine unit boundary is approximately 0.42 mile (0.7 km) from the Niobrara River (CBR, 2014, Section 3.4.2.1).

The Niobrara River originates in eastern Wyoming near the town of Mansville in Niobrara County. The river flows in an east-southeast direction into western Nebraska (see Figure 3-4), across Sioux County in Nebraska, east through the Agate Fossil Beds National Monument, past the southern boundary of the MEA, and through the Box Butte Reservoir approximately 3 miles (4.8 km) to the east of the southeast corner of the MEA license boundary. From the reservoir, the river flows eastward across northern Nebraska and joins the Snake River approximately 13 miles (20.9 km) southwest of Valentine, NE. The Niobrara River rejoins the Keya Paha River approximately 6 miles (9.7 km) west of Butte, NE. The river eventually reaches a point of confluence with the Missouri River northwest of Niobrara, NE, in northern Knox County (CBR, 2014, Section 3.4.2.1).

The Niobrara River watershed encompasses approximately 11,870 square miles (mi^2) (30,743.3 square kilometers (km^2)) in Nebraska and extends approximately 300 miles (480 km), making up about 15 percent of the state's area (NDEQ, 2005). The western part of the basin is characterized by flat tablelands bordered on the north by the Pine Ridge escarpment and on the southeast by the Sandhills. In the central and eastern portions of the basin, the steep, fast-flowing river has formed a narrow valley, with the precipitous walls rising hundreds of feet to meet the adjoining uplands. There, the valley walls along the river and its major tributaries are covered by eastern deciduous forests, Rocky Mountain forests, or, in some localities, a mixture of both (NDEQ, 2005).

In the high plains, the flows of the Niobrara and its tributaries are variable. Streams originating in the Sandhills flow perennially, have a high percentage of base flow in relation to the total annual discharge, and serve to stabilize the flow of the Niobrara River (NDEQ, 2005). Surface water withdrawals for irrigation, return flows, and wastewater discharges can affect the stream volume, and the presence of storage reservoirs alters the flow in the upper Niobrara River. The Nebraska Public Power District operates a hydroelectric generating facility on the Niobrara River near the town of Spencer, which is several hundred miles downstream of Marsland, NE. This generating facility is the only one on the main tributary of the river.

The U.S. Bureau of Reclamation (USBR) constructed the Box Butte Reservoir between 1941 and 1946. The primary purpose of the Box Butte Reservoir is to facilitate irrigation and provide secondary benefits for recreation, fish, and wildlife (USBR, 2008). The Box Butte Reservoir and Dam have altered the hydrology of the Niobrara River by diverting water for irrigation (Alexander et al., 2010). The reservoir is part of the Mirage Flats Irrigation Project, which consists of the Box Butte Reservoir, the Dunlap Diversion Dam and associated canal, and laterals to irrigate 11,662 acres (47.2 km^2) (USBR, 2008). Dunlap Diversion Dam is located approximately 10 miles (16.1 km) downstream of the Box Butte Reservoir Dam.

Based on available maps and CBR site investigations, the MEA has no surface water impoundments, lakes, or ponds. Rainfall runoff occasionally creates temporary small pools in a few places within the MEA, but there is no evidence of persistent stream flow. Dooley Spring, Willow Creek, and other ephemeral structures are usually dry and are the only potentially available features to route surface waters within the MEA. These features lack defined banks, have no streambeds, and would only be expected to carry water during significant precipitation events (CBR, 2014, Section 4.5.3).

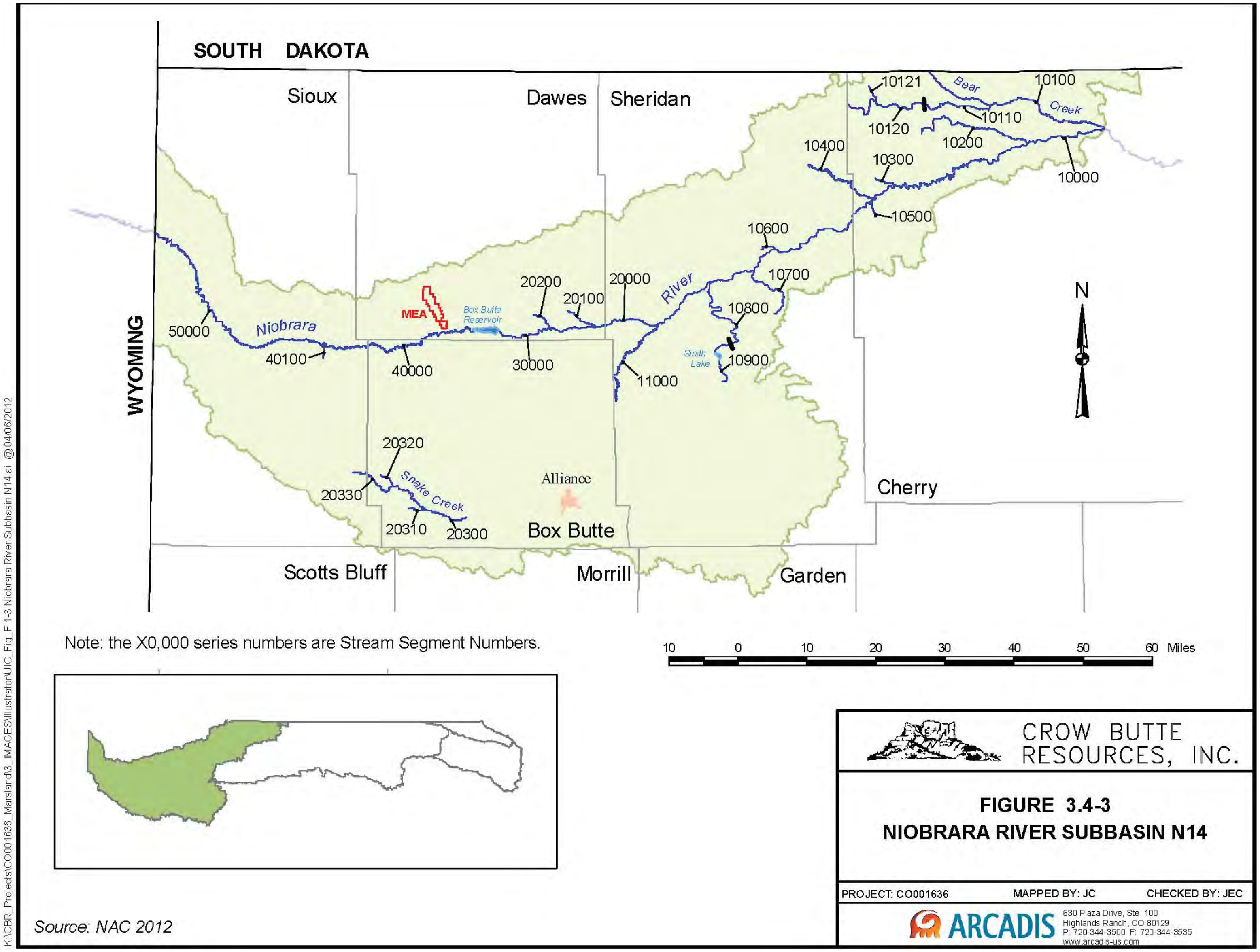


Figure 3-4 Niobrara River Basin near the MEA (Source: CBR, 2014, Figure 3.4-3)

3.3.1.1 Surface Water Flow

The Niobrara is a perennial river, and the Nebraska Department of Natural Resources (NDNR) maintains a summary of flow volumes measured at various points along the river. Between 1956 and 2002, annual average stream flows at the four gaged Niobrara River sites have declined significantly. At the Wyoming State line, the Niobrara's flow averaged 2,615 acre-feet per year (3,225,600 m^3 per year) between 1956 and 2002 (Gaul et al., 2004). NDNR also found that the amount of surface water available for diversion from the Niobrara River upstream of the Mirage Flats canal diversion has continued to decrease since the project was completed (NDNR, 2014). More recent work also concludes that flows are decreasing over time (NDNR, 2014).

From 1947 to 2002, flow averaged 20,334 acre-feet per year (25,082,000 m^3 per year) above Box Butte Reservoir and 17,018 acre-feet per year (20,991,000 m^3 per year) below the reservoir (after evaporation) (NDNR, 2004). These flow rates indicate that the river gains water as it flows eastward. Alexander et al. (2010) also indicated that groundwater is the primary source of flow into the Niobrara River in the vicinity of the MEA and that, in this area of the river, the discharge of the river is steady and persistent, with overbank flooding uncommon except during winter ice jams.

The flow information that CBR tabulated and provided in Tables 6.1-13 and 6.1-14 and Figure 6.1-9 in the ER (CBR, 2014) shows average flows at the joint USGS and NDNR gaging stations located at the Wyoming–Nebraska border, at Agate, above Box Butte Reservoir, and below Box Butte Reservoir. The mean flow at the State line gaging station was 2,150 acre-feet per year (2,652,000 m^3 per year) between 1999 and 2010, which is less than the reported average of 2,615 acre-feet per year (3,225,600 m^3 per year) between 1956 and 2002. Mean stream flow measured at the USGS gaging station at Agate (approximately 30 miles (48 km) upstream of the MEA) between 2006 and 2010 was 7,602 acre-feet per year (9,376,900 m^3 per year). The mean flow measured from 1999 to 2010 at the gaging station above the Box Butte Reservoir was 14,263 acre-feet per year (17,593,000 m^3per year). The mean flow measured at the gaging station below the Box Butte Reservoir in 2011 was 12,600 acre-feet per year (15,541,737 m^3 per year), the most recent flow data published and summarized by NDNR (2016a).

Mean flow measured at the gaging station below the Box Butte Reservoir over the same timeframe was 10,425 acre-feet per year (12,859,000 m^3 per year). These data indicate that, although the Niobrara River is gaining water from west to east, the mean flows have decreased with time.

USBR monitors the contents of the Box Butte Reservoir daily. The average value for the water volume of the reservoir between 2003 and 2013 was 9,627 acre-feet (11,871,692 m^3) (CBR, 2014, Section 6.1.3.3). Since the 1950s, groundwater depletions of base flow and numerous farm conservation practices have greatly reduced inflow into the reservoir (USBR, 2008). Because Box Butte Reservoir is used as a source of irrigation water downstream of the reservoir dam, the reservoir storage content (in acre-feet) can vary considerably over the course of a year.

The reservoir's highest elevations occur in May and June, while September and October exhibit the lowest reservoir elevations following irrigation releases (USBR, 2008). Under an agreement among the Mirage Flats Irrigation District, NGPC (which manages recreation at the reservoir), and USBR, a minimum pool elevation is maintained at 3,978 acre-feet (4,906,800 m^3) to support and maintain a viable fishery resource in the reservoir (CBR, 2014, Section 6.1.3.3).

3.3.1.2 Surface Water Quality

NDEQ has collected flow and water quality data for a number of years at the Niobrara River sampling stations both above and below the Box Butte Reservoir (CBR, 2015, Section 2.9.4.2). CBR (2015, Table 2.9-26) summarizes nonradiological water quality data obtained from NDEQ for the sampling station above Box Butte Reservoir between 2003 and 2011. NDEQ water quality data from 2008 are the only available data for the Niobrara River below Box Butte Reservoir (CBR, 2015, Table 2.9-28).

NDEQ analyzed the surface water samples for eight major ions, dissolved oxygen, turbidity, total suspended solids, temperature, nitrogen, and phosphorus and used these water quality data to classify the Niobrara River. The segment of the river located to the south of the MEA (NDEQ Water Quality Body ID N14-4000) is rated as Supported Beneficial Use for aquatic life, agricultural water supply, and aesthetics. However, it is also classified as Impaired for recreational use because of the measured presence of *Escherichia coli* (*E. coli*) (NDEQ, 2012b). This means that while this part of the river cannot be used for human consumption of water or recreation, it can support aquatic plants and animals and provide water for agricultural use.

Box Butte Reservoir is rated as Supported Beneficial Use for recreation, agricultural water supply, and aesthetics, but as Impaired for aquatic life (NDEQ, 2012b). The impairment classification is the result of a fish consumption advisory for northern pike because of elevated mercury levels identified in tissues. The 2012 assessment determined that this water body is also impaired for pH. These assessments remain the same in the 2014 assessment (NDEQ, 2014).

CBR established two water quality sampling locations on the Niobrara River, with one sampling point (N-1) upstream (west) of the MEA license boundary and one point (N-2) downstream (east) of the license boundary. In March 2013, CBR moved this downstream point closer to the MEA (approximately 2.3 river miles (3.7 km) upstream), to co-locate with the USGS/NDNR and NDEQ gaging stations (CBR, 2014, Section 6.1.3.4). The two sampling points are located to detect potential impacts from either of the two major ephemeral drainages that drain the MEA from northwest to southeast and connect to the Niobrara River between the two points (CBR, 2014, Figure 3.4-4).

CBR initially collected samples from these locations for baseline water quality analysis for nonradiological (quarterly) and radiological (monthly) parameters from January 2011 through March 2013. The results of the analyses indicated that background levels of radioactivity are low, with the majority of the results at or below the detection limits[14] (CBR, 2014, Table 6.1-32). Although still low, the reported levels for dissolved uranium (as a metal), with one exception, were all above the detection limits. For nonradiological parameters, the majority of the results for dissolved metals were reported at or below the detection limit (CBR, 2014, Table 6.1-33). A qualitative comparison indicates that the concentrations at N-1 and N-2 appear to be similar. This information would provide a baseline of existing water quality in the area.

[14] The term “detection limit,” also called the “reporting limit” in the ER, refers to the lower limit of detection from Regulatory Guide 4.14, “Radiological Effluent and Environmental Monitoring at Uranium Mills,” (NRC, 1980b). Regulatory Guide 4.14 defines the lower limit of detection as the smallest concentration of a material sampled that has a 95 percent probability of being detected, with only a 5 percent probability that a blank sample will yield a response interpreted to mean that the material is present. For radioactive material, “detection” means that it yields an instrument response that leads the analyst to conclude that activity above the system background is present.

From September 2013 through August 2014, CBR collected additional monthly samples to support baseline water quality analysis for radiological parameters at sampling locations N-1 and N-2 (CBR, 2015, Tables 2.9-29 and 2.9-30). The results of the radiological analyses indicate that baseline radiological levels were low, with the majority of the results at or below the detection limit (CBR, 2015, Table 2.9-31).

3.3.2 Groundwater Resources

3.3.2.1 Regional Groundwater Resources

An understanding of the general hydrogeology, availability and quality of groundwater, and impacts from other types of stresses placed on groundwater (e.g., irrigation) is important in predicting the potential impacts from the ISR activities at the MEA. The greatest potential for impacts to groundwater resources would be caused by the pumping and injection of lixiviant solution within the Basal Chadron Sandstone aquifer and any associated effects on the overlying aquifers. Therefore, this section focuses on examining important features of those aquifers.

The direction and speed of groundwater movement is determined by the various characteristics of aquifers and aquitards. The movement of water depends on the permeability and the porosity (the amount of open space in the material) of the subsurface rock. If the rock has characteristics that allow water to move relatively freely through it, then groundwater can move significant distances in just a few days. Groundwater can also move into deep aquifers, where it takes thousands of years to move back into the environment, or it can even go into deep groundwater storage, where it might stay for much longer periods. Figure 3-5 illustrates these different cases and depicts both unconfined and confined aquifers. In unconfined aquifers, water has simply infiltrated from the surface and saturated the subsurface material. If a well is drilled into an unconfined aquifer, a pump must be installed to push water to the surface. A confined aquifer is over- and underlain by aquitards that lead to higher pressures within the aquifer. This natural pressure in the aquifer, which is caused by the weight of overlying rocks and water, will force water in a well to a height above the top of the aquifer, and sometimes may be enough to push water in a well above the land surface, resulting in a flowing artesian well. Uranium recovery operations remove water from the confined aquifer, reducing the natural pressure in the aquifer and lowering the level that water will rise in a well. This is important when considering potential impacts, because the confined aquifer becomes less pressurized because of the uranium-recovery operation, users of domestic and livestock wells may need to pump their water from greater depths, which is more expensive.

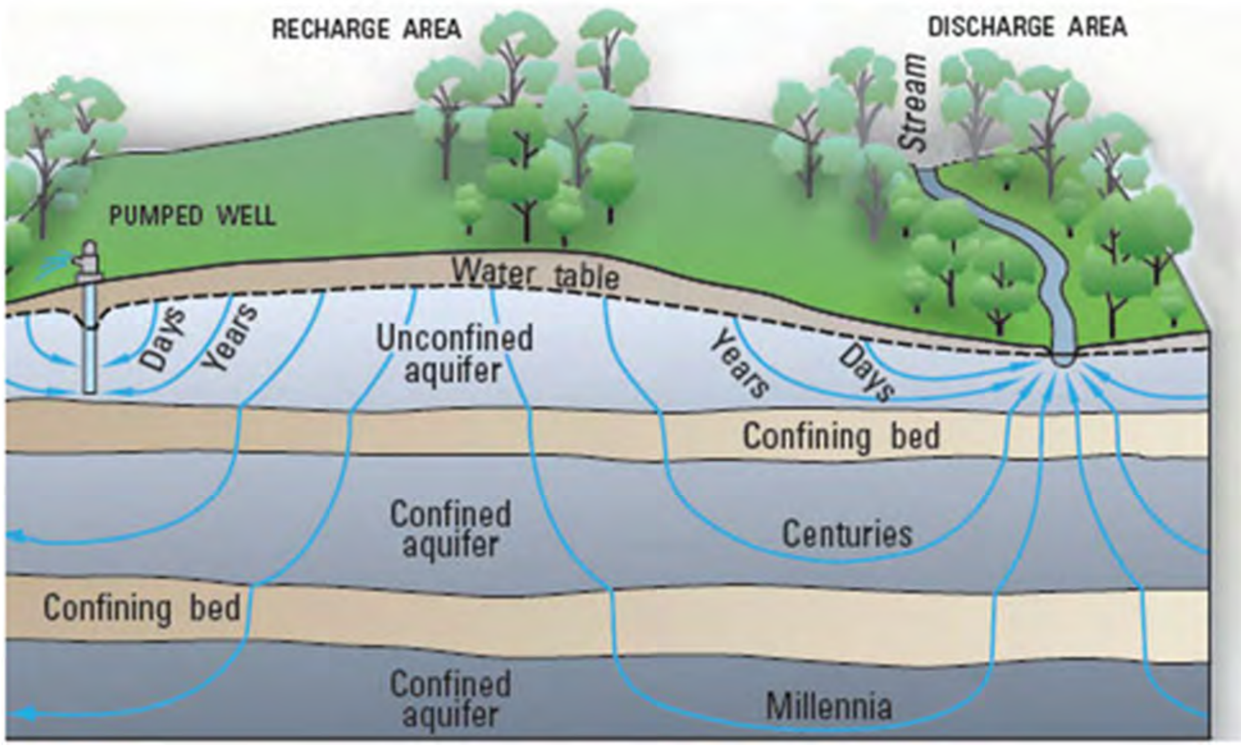


Figure 3-5 Groundwater flowpaths and timeframes (Source: USGS, 1998)

Some aquifers in the vicinity of the MEA are important because they provide a source of water to local residents. Lower-permeability bodies or rock or sediment (called confining beds or aquitards) control recharge and groundwater movement to adjacent aquifers. As described in greater detail in Section 3.3.2.5, the ore-bearing aquifer at the MEA is confined by the overlying and underlying aquitards, which act to keep the uranium recovery solutions within the ore-bearing aquifer. In addition, the presence of these aquitards permits pumping extraction rates to be much lower to maintain an inward hydraulic gradient, which is necessary to prevent excursions of lixiviant, than would otherwise be required in an unconfined aquifer. Table 3-6 summarizes the hydrostratigraphy in southwestern Dawes County.

As shown in Figure 3-6, the principal regional aquifers include the Arikaree and Ogallala Groups (identified as "Geology" features).

The Arikaree Group is at the surface along the Pine Ridge escarpment and consists primarily of very fine-to-medium grained sand, sandstone, and silt (NDNR, 2004). Where it underlies the Ogallala Group to the east, it is a major aquifer supplying water to large capacity irrigation wells.

The Ogallala Group is the surficial aquifer south of the Pine Ridge escarpment and consists of gravelly sand, siltstones, and clay (NDNR, 2004). This group is also a major regional aquifer supplying water to large capacity irrigation and other wells.

Table 3-6 Hydrostratigraphy in Southwestern Dawes County

Strata	Regional Hydrogeologic Characteristics
Alluvium	Aquifer—Unconfined; unsaturated to partially saturated, located along surface water bodies and insufficient yields to provide a water supply. Discontinuous/low aquifer potential
Arikaree Group	Aquifer—Unconfined; greatest yielding aquifer and supplies high-capacity irrigation wells south of the Pine Ridge Escarpment.
White River Groups	
Brule—Brown Siltstone Member	Aquifer—Unconfined; typically moderate yielding, supplies domestic and livestock wells both north and south of the Pine Ridge Escarpment.
Brule—Whitney and Orella Members	Aquitard—Upper confining layer to the Basal Chadron Sandstone aquifer
Upper Chadron Formation	Aquitard—Upper confining layer to the Basal Chadron Sandstone aquifer
Middle Chadron Formation	Aquitard—Upper confining layer to the Basal Chadron Sandstone aquifer
Basal Chadron Sandstone aquifer	Ore Extraction Zone—Confined aquifer; [1]low yielding, poor water quality, limited use as a water supply for domestic and livestock wells north of the Pine Ridge Escarpment. No private wells were identified south of the Pine Ridge Escarpment and within the MEA AOR.
Pierre Shale	Aquitard—Lower confining layer to Basal Chadron Sandstone aquifer.

Source: Adapted from CBR 2014, Section 3.4.3.3

The geologic units below the Arikaree and that crop out progressively to the north are, in order with increasing depth, the Brule, the Chadron, the Pierre Shale, and the Niobrara formation in the northeastern corner of Dawes County. None of these geologic units are productive aquifers (NDNR, 2004). The primary groundwater supply within Dawes County north of the Pine Ridge escarpment is the Brule Formation, typically encountered at depths from 50 to 350 feet (15.2 to 106.7 meters) (CBR, 2015, Section 2.2.4, page 2 9). The Brule is a tight formation with a hydraulic conductivity of less than 25 feet per day (7.6 meters per day) and is not considered to yield significant quantities of groundwater (Gaul et al., 2004). However, in some places, the Brule Formation may have a significant saturated thickness that could contain a “great deal of water,” although the unfractured hydraulic conductivity is very low (Gaul et al., 2004). Furthermore, a number of lithologic features have sufficient permeability to yield water from the Orella Member of the Brule Formation (i.e., sandy siltstones, overbank sheet sandstones, and occasional thick channelized sandstones). The features, however, are discontinuous and are not easily correlated over large distances. The lower Brule Formation consists almost entirely of silt and clay, while sandstone filled channels become more abundant toward the top of the formation (Gjelsteen and Collings, 1988). Arendt et al. (1980) have reported average uranium concentrations of 8.9 parts per million (ppm) in the upper Brule and 4.7 ppm in the lower Brule.

Spalding (1982) notes that groundwater from the local Brule sands is commonly used as a domestic and livestock water source because of its good chemical quality, low TDS, and shallow depth. Most of the wells are less than 100 feet (30.5 meters) deep.

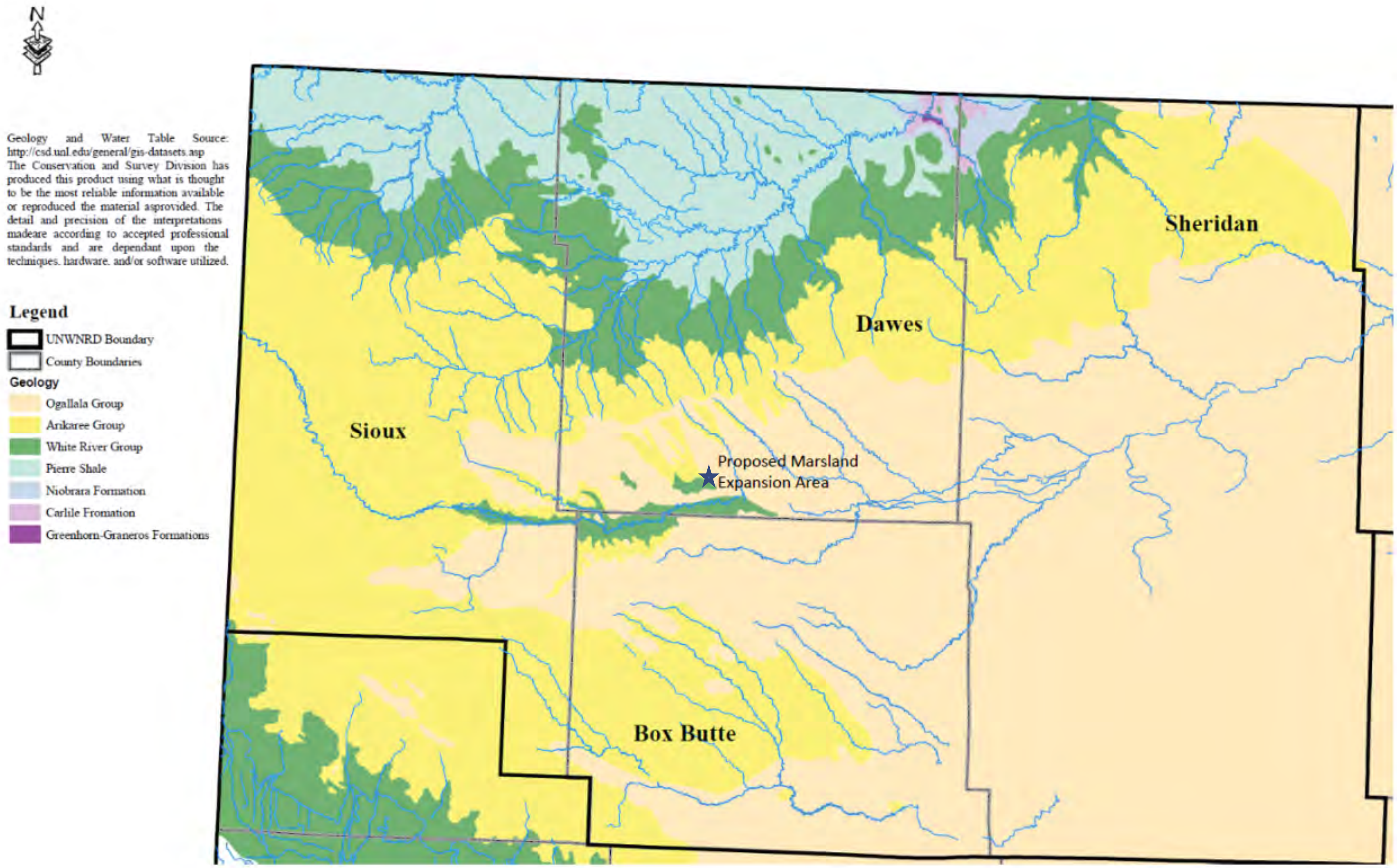


Figure 3-6 Geology of Upper Niobrara-White Natural Resources District (Source: modified from NDNR, 2004)

A potentiometric surface map developed in 1938 suggests that groundwater flow in the Brule aquifer and overlying units was east-southeast toward the Niobrara River over the MEA (Cady and Scherer, 1946). Souders et al. (1980) concluded the same in 1975. NDNR (2004) interpreted groundwater flow directions based on a 1995 potentiometric surface that shows all flow within the surficial aquifers south of the Pine Ridge escarpment converging on the Niobrara River (Figure 3-7). Ayer (2007) confirms these inferences of an east-southeast groundwater flow direction within the Brule and overlying units of southern Dawes County. The contours also indicate that this shallow groundwater is recharging the Niobrara River across the entire length of the county. This observation is supported by modeling of the Niobrara River Basin that concludes that the majority of the water flowing in the river is derived from groundwater (NDNR, 2014).

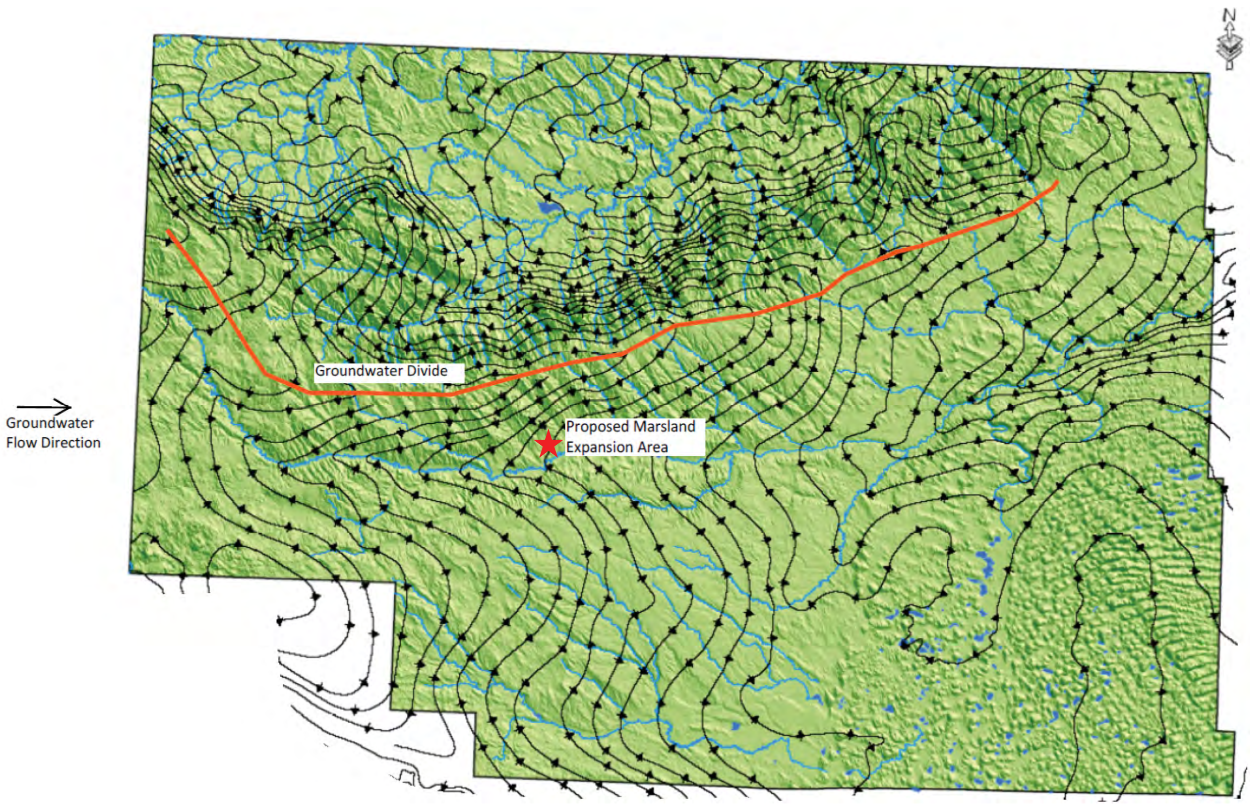


Figure 3-7 Groundwater flow directions within surficial aquifers based on 1995 potentiometric surface (Source: Modified from NDNR, 2004)

South of the Pine Ridge escarpment, groundwater flow in the Basal Chadron Sandstone aquifer is to the north (Gjelsteen and Collings, 1988). Although the Pine Ridge escarpment acts as a groundwater divide for the Brule and overlying aquifers, it does not create a hydraulic divide for groundwater flow within the Basal Chadron Sandstone aquifer. Groundwater within the Basal Chadron Sandstone aquifer flows from recharge areas farther south of Dawes County northward through the MEA, until discharging where erosion has exposed the unit on the land surface north of Crawford, WY (Gjelsteen and Collings, 1988). Collings and Knode (1984) indicate that the Basal Chadron Sandstone aquifer crops out about 20 miles (32 km) northwest of Crawford in Sioux County, NE. Gjelsteen and Collings (1988, page 278) also note that recharge to the Basal Chadron Sandstone aquifer is limited to leakage through the units on the topographically high Pine Ridge escarpment.

As conceptualized in Figure 3-8, groundwater flow in the Basal Chadron Sandstone aquifer is flowing toward the existing Crow Butte license area because of the ongoing pumping of the aquifer. In the vicinity of the MEA, groundwater flow in the Basal Chadron Sandstone aquifer is predominantly to the northwest and into the White River drainage basin. As discussed in Section 3.2.2.1, the Basal Chadron Sandstone aquifer was deposited in a fluvial stream environment within a regional paleochannel. The aquifer transitions into less-permeable silts and clays (corresponding to zero sandstone thickness) about 9 miles (14.5 km) to the east and 12 miles (19.3 km) to the west of the MEA (Dickinson, 1990). The absence of the Basal Chadron Sandstone aquifer in these areas prevents groundwater from moving farther east within the Basal Chadron Sandstone aquifer. Because the sandstone grades into very low-permeability clays and silts to the east and is confined above and below by low-permeability units, groundwater within the Basal Chadron Sandstone aquifer will not flow farther east than the "no flow" boundary depicted in Figure 3-8. Farther to the northeast, all of the rock formations above the Pierre Shale have been eroded, thereby preventing groundwater from migrating farther eastward beyond that boundary.

CBR estimated the maximum velocity in the vicinity of the Basal Chadron Sandstone aquifer at approximately 55 feet per year (17 meters per year) (CBR, 2014, Section 3.12.2.2). Gjelsteen and Collings (1988) estimated the average groundwater flow velocity at less than 20 feet per year (6 meters per year). The CBR velocity estimate is higher because that calculation used the maximum measured hydraulic gradients and hydraulic conductivities. CBR (2016, Appendix GG, Figure 23) presents the 2011 potentiometic surface for the Basal Chadron Sandstone aquifer. Based on this surface, the hydraulic gradient is about 0.0002 feet per foot (6.1×10^{-5} meter per meter). Using the same values of hydraulic conductivity (61.7 feet per day) and effective porosity (0.2) that CBR assumed, the groundwater velocity in the Basal Chadron Sandstone aquifer can be calculated at about 22.5 feet per year (6.85 meters per year). Placing this groundwater flow rate into perspective, it would take at least 450 years for groundwater to move from the proposed MEA license area boundary to the 2.25-mile (3.62-km) boundary of the area of review.

Because of the thickness and low hydraulic conductivity of the confining units, recharge and discharge to the Basal Chadron Sandstone aquifer are severely limited, and groundwater flow velocity is estimated to be less than 20 feet per year (6 meters per year) (Gjelsteen and Collings, 1988). Gjelsteen and Collings (1988) reported that groundwater from the Basal Chadron Sandstone aquifer contains 1,000 to 1,500 mg/L TDS, with sodium, bicarbonate, and sulfate as the dominant ions.

Waters from the Basal Chadron Sandstone aquifer generally contain about 2 parts per billion uranium, but values as high as 2,000 parts per billion have been reported (Ferret, 1987). Basal Chadron Sandstone aquifer waters are reducing (i.e., having a low oxygen content), at least in the vicinity of the uranium deposit (CBR, 2014, Section 3.3.1.2).

The high TDS of the Basal Chadron Sandstone aquifer water are characteristic of water with a low velocity and long residence time in the aquifer. The high sodium content resulted from the exchange of cations with the Pierre Shale, and the high sulfate content is the product of oxidation of pyrite contained in the sandstone or Pierre Shale.

Spalding and Struempler (1984) reported groundwater residence times estimated through isotopic age dating of groundwater samples at 150,000 to 250,000 years for groundwater in the Arikaree; 250,000 to 300,000 years for the Brule aquifer, and 300,000 to 500,000 years for the Basal Chadron Sandstone aquifer.

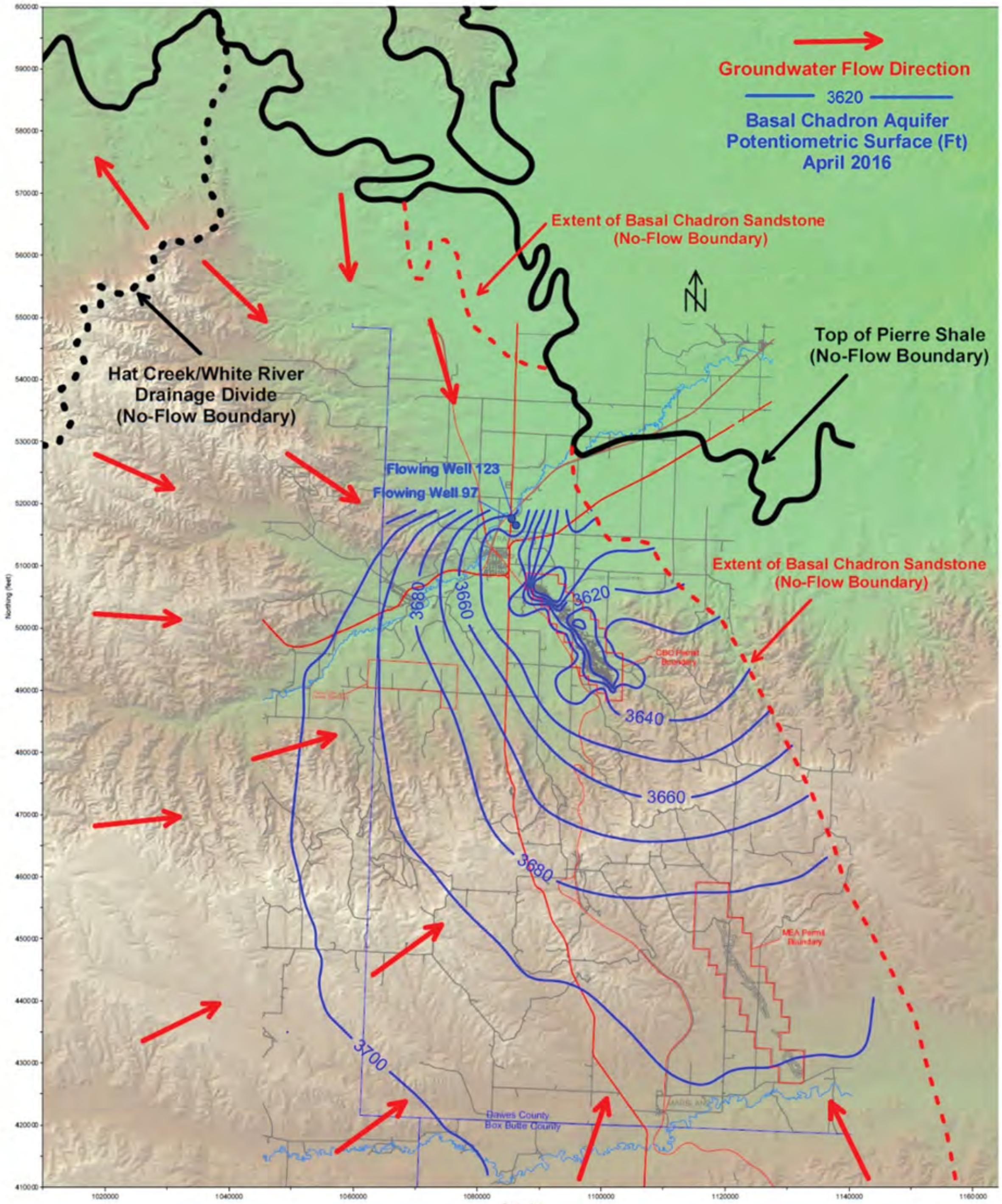


Figure 3-8 Conceptualization of groundwater flow within the Basal Chadron Sandstone aquifer (Source: CBR, 2016, Attachment E)

The Chadron Formation rests on the Pierre Shale throughout most of northwestern Nebraska. The Pierre Shale is a black marine shale that directly underlies the Chadron Formation. The Pierre Shale is considered a regional aquitard where estimates of hydraulic conductivity range from 10^{-7} to 10^{-12} centimeters per second (cm/s) (CBR, 2014, Section 3.4.3.3). At the CPF in the existing Crow Butte license area, the Pierre Shale vertical hydraulic conductivity has been measured at less than 10^{-10} cm/s (Wyoming Fuel Company, 1983).

The Pierre Shale is essentially impermeable to the degree that, in areas of exposure, water for domestic and agricultural needs is from wells open to other formations. The Sundance and Morrison formations (bottom to top) are water-bearing units below the Pierre Shale for which CBR obtained a permit for deep disposal of nonhazardous Class I liquid waste in the permit area (CBR, 2015, Section 4.2.1.8). The Lower Dakota, Morrison, and Sundance formations exhibit water quality that is not considered under State and Federal regulations to be underground sources of drinking water because of their measured concentrations of TDS (CBR, 2014, Section 3.12.2.1). Hence, CBR considered these water-bearing layers for deep well injection of liquid wastes during and after ISR operations.

3.3.2.2 Local Groundwater Resources

In the vicinity of the MEA, water has been observed in the alluvium, Arikaree Group, Brule Formation, and Basal Chadron Sandstone aquifer. However, the alluvial deposits are discontinuous and have not been shown to contain usable amounts of water. The Arikaree Group and the Brule Formation within the MEA meet the NDEQ definitions of an aquifer, while the alluvium does not. The presence of water has not been detected within any portions of the middle or upper Chadron Formation. As indicated in Table 3-6, the middle and upper Chadron Formation constitute the confining unit between the Basal Chadron Sandstone aquifer and the overlying aquifers of the Brule Formation and Arikaree Group.

In general, groundwater supplies in the vicinity of the MEA are limited because of the low permeability of the underlying lithology (CBR, 2014, Section 3.4.3.1). Locally, groundwater is obtained from aquifers within the Arikaree Group and Brule Formations. The primary groundwater supply is the Brule Formation, typically encountered at depths from approximately 50 to 350 feet bgs (15.2 to 106.7 meters bgs). In general, the static water level for Brule Formation wells in the MEA ranges from 50 to 150 feet bgs (15.2 to 45.7 meters bgs), depending on local topography. NDNR (Gaul et al., 2004) published a saturated thickness map of principal aquifers that indicates that the saturated thickness of aquifers south of the Pine Ridge Escarpment ranges from very thin or absent to more than 500 feet (152 meters).

The Basal Chadron Sandstone aquifer is the only water-bearing strata in the Chadron Formation that can be considered an aquifer. Groundwater from the Basal Chadron Sandstone aquifer is not used as a domestic supply within the MEA and area of review because of the greater depth (800 to 1,150 feet bgs (243.8 to 350.5 meters bgs)) and inferior water quality (Gosselin et al., 1996). In addition, it is economically impractical to install water supply wells into the deeper Basal Chadron Sandstone aquifer in the vicinity of the MEA, as opposed to the area north of the Pine Ridge Escarpment, where most Basal Chadron Sandstone aquifer wells either flow at the surface or have water levels very close to surface elevation because of artesian pressure.

Regional water level information for the Brule and overlying formations indicates that groundwater flow south of the Pine Ridge Escarpment is to the southeast toward the Niobrara River. This flow direction is consistent with that observed within the MEA, where groundwater generally flows to the southeast across the entire MEA toward the Niobrara River at a lateral hydraulic gradient of 0.011 feet per foot (CBR, 2014, Appendix F). Although the Brule Formation is the primary groundwater supply in the vicinity of the MEA, low production rates indicate that the higher-yield sandstone lenses of the Orella Member are discontinuous. Recharge to the Orella Member probably occurs directly within the MEA, as the unit is overlain by 50 to 210 feet (50.2 to 64 meters) of the higher permeability Arikaree Formation and 0 to 30 feet (0 to 9.1 meters) of unconsolidated alluvial and colluvial (i.e., eroded from hillslopes) deposits.

3.3.2.3 Basal Chadron Sandstone Aquifer—Uranium-Bearing Aquifer

In 2011, CBR conducted an aquifer pump test at the MEA to (1) demonstrate hydraulic communication between the production zone pumping well and the surrounding production zone observation wells, (2) assess the hydraulic characteristics of the Basal Chadron Sandstone aquifer within the test area, (3) evaluate the presence or absence of hydrologic boundaries in the production zone, and (4) demonstrate that sufficient confinement between the production zone and the overlying aquifer would exist during ISR operations. To perform the test, CBR pumped a well in the central portion of the MEA for 103 hours (4.29 days) at a rate of 27.08 gpm (102.5 Lpm). The radius of influence observed during the test was estimated to be about 8,800 feet (2,682.2 meters) (CBR, 2014, Appendix F). Although this distance does not cover the entire MEA (CBR, 2014, Figure 1), CBR would perform additional aquifer pumping tests that will provide coverage to demonstrate the natural confinement of the Basal Chadron Sandstone aquifer in the southern portion of the MEA (CBR, 2015, Section 2.6.1.3) and to identify hydrologic boundaries.

CBR relied on drawdown and recovery data collected during the aquifer pump test to estimate the hydrogeological properties of the ore-bearing aquifer and confining layers using one or more combinations of the widely accepted Theis (1935) drawdown and recovery methods and Jacob's Straight-Line Distance-Drawdown method (Cooper and Jacob, 1946).

Using data from the aquifer pump test, CBR estimated the average hydraulic conductivity, transmissivity, and storativity of the ore-bearing aquifer. These properties support estimates of how much water is flowing through and stored within the aquifer. The test results indicate a mean hydraulic conductivity of 25 feet per day (ranging from 7 to 62 feet per day) (8.82×10^{-3} cm/s), based on an average net sand thickness of 40 feet (12.2 meters) and a mean transmissivity of 1,012 ft^2 per day or 94 m^2 per day (ranging from 230 to 2,469 ft^2/day or 229 m^2/day). The mean storativity was 2.56×10^{-4} (ranging from 1.7×10^{-3} to 8.32×10^{-5}) (CBR, 2014, Section 3.4.3.2). The results of these tests provide the hydraulic properties of the mine unit that are used to design the wellfield and estimate extraction and injection rates, as applicable. These rates are important because 1 to 1.5 percent of the production pumping volumes would not be returned to the aquifer in order to maintain an inward hydraulic gradient (i.e., cone of depression). This inward gradient prevents the lixiviant from migrating away from the production zone. The volume of water not returned to the aquifer is termed "consumptive use" and forms the basis for estimating the potential impacts to groundwater quantity, as discussed in Section 4.3.2.

CBR presents the potentiometric map for the Basal Chadron Sandstone aquifer across the area of review based on data collected in 2011 (CBR 2014, Appendix F, Figure 14). Groundwater flows toward the northwest, based on the monitoring well data collected from within the MEA.

3.3.2.4 Groundwater Quality

Water quality results for all private water supply wells and MEA monitoring wells for the Arikaree and Brule formations indicate that TDS range from 202 to 1,280 milligrams per liter (mg/L), while TDS for the Basal Chadron Sandstone aquifer range from 791 to 1,400 mg/L (CBR, 2014, Table 6.1-10). Conductivity for the Arikaree and Brule formations ranges from 241 to

2,300 micromhos (μmhos)/cm, while conductivity for the Basal Chadron Sandstone aquifer ranges from 1,340 to 2,740 μmhos/cm (CBR, 2014, Table 6.1-4).

Dissolved uranium concentrations in the Arikaree and Brule formations for private and monitoring wells range from 0.0028 to 0.0282 mg/L and from 0.0038 to 0.0282 mg/L, respectively (CBR, 2014, Tables 6.1-4 and 6.1-5). Dissolved uranium concentrations at monitoring well locations completed in the Basal Chadron Sandstone aquifer range from less than 0.0003 to 0.0771 mg/L. Dissolved radium-226 concentrations in the Arikaree and Brule formations are up to 9.5×10^{-9} microcuries (μCi)/L for private wells and up to 3.48×10^{-7} μCi/L for monitoring wells. Dissolved radium-226 concentrations in monitoring wells completed in the Basal Chadron Sandstone aquifer are up to 3.48×10^{-7} μCi/L.

CBR observes that the radiological analytical results for the Arikaree and Brule formations were at levels that would be expected for background concentrations of the area. CBR supports this claim with radiological data collected from groundwater monitoring at both the NTEA and TCEA (CBR, 2015, Section 2.9.3.1).

Groundwater from the Basal Chadron Sandstone aquifer contains about 750 to 1,500 ppm TDS, with sodium, bicarbonate, and sulfate as the dominant ions (CBR, 2004, Table 6.1-4). The concentrations of nonradiological constituents are also consistent with the findings of other researchers, including Gjelsteen and Collings (1988), who reported that groundwater from the Basal Chadron Sandstone aquifer contains 1,000 to 1,500 mg/L TDS, with sodium, bicarbonate, and sulfate as the dominant ions.

3.3.2.5 Level of Confinement—Basal Chadron Sandstone Aquifer

The hydrologic isolation of the Basal Chadron Sandstone aquifer from both overlying and underlying aquifer(s) by very low permeability lithologic units results in a very high level of vertical confinement.

Immediately below the Basal Chadron Sandstone is the Pierre Shale, which is not a water-bearing unit. The Pierre Shale exhibits very low permeability and is considered a regional aquitard. Based on logs from gas exploration wells, the thickness of the Pierre Shale in the vicinity of the MEA ranges from 769 feet (234 meters) to 1,000 feet (3,328 meters) (CBR, 2017, Section 2.6.1.1) page 2-53). Regional estimates of hydraulic conductivity for the Pierre Shale range from 10^{-7} to 10^{-12} cm/s (Neuzil and Bredehoeft, 1980). The Pierre Shale has a measured vertical hydraulic conductivity of less than 10^{-10} cm/s (Wyoming Fuel Company, 1983), which is consistent with other studies in the region. Particle grain-size analyses of two core samples collected from the Pierre Shale within the MEA indicate a lithology of low-permeability silty clay. Furthermore, regional studies also indicate that there is no observed transmissivity between vertical fractures in the Pierre Shale, which appear to be short and not interconnected (CBR, 2014, Section 3.4.3.3).

Underlying the Pierre Shale is a thick sequence of low-permeability confining units. Together with the Pierre Shale, the underlying Niobrara Formation, Carlile Shale, Greenhorn Limestone, and Graneros Shale compose a composite lower confining interval approximately 2,500 feet (762 meters) thick that immediately underlies the Basal Chadron Sandstone aquifer (CBR, 2014, Section 3.3.1.1).

The upper confinement is composed of the Chadron Formation above the Basal Chadron Sandstone aquifer, (Middle and Upper Chadron), which consists of between 430 to 940 feet (131.1 to 286.5 meters) of smectite-rich (i.e., clay) mudstone and claystones. At the MEA, the combined thickness of the Upper and Middle Chadron units ranges from approximately 360 to 450 feet (110 to 137 meters), averages about 410 feet (125 meters), and generally thins toward the south across the MEA (CBR, 2017, Section 2.6.1.1). The Middle and Upper Chadron units are laterally continuous throughout the MEA (CBR, 2017, Figures 2.6-3a through 2.6-3n). The Orella (oldest and lowest) Member of the Brule Formation may have only minimal presence at the MEA, as it is readily distinguishable in drill cuttings or geophysical logs (CBR, 2017, Appendix HH).

Because significant water-bearing sandstones of the Middle and Upper Chadron are not present within the MEA, these low-permeability units isolate the Basal Chadron Sandstone aquifer from overlying aquifers with several hundred feet of clay and siltstones. CBR collected 13 core samples from mudstones and sandstones within the Brule Formation. Based on a Kozeny-Carmen analysis of the grain-size distributions, the geometric mean of hydraulic conductivity for all samples is 8.9×10^{-5} cm/sec, and the average intrinsic permeability of the core samples is about 4.2×10^{-7} cm/sec (CBR, 2017, Appendix EE). The average vertical hydraulic conductivity, which will control vertical migration, was determined from falling head permeameter tests on two cores to be 1.3×10^{-7} cm/sec (CBR, 2017, Appendix EE). These are very low permeabilities, and resistance to vertical flow would be significant because of the substantial thickness of the upper confining zone within the MEA. As a point of reference, EPA requires that clay liners at hazardous waste landfills be built so that the permeability is equal to or less than 10^{-7} cm/s (EPA, 1989).

A high degree of confinement of the Basal Chadron Sandstone aquifer is also supported by the fact that the potentiometric surface is between 360 and 500 feet (110 and 152 meters) above the top of the aquifer (CBR, 2017, Appendix GG, Figure 21). If the Basal Chadron Sandstone were to be in good hydraulic communication with the overlying units, the pressure within the aquifer would dissipate and reequilibrate to much lower levels than those observed in the overlying units.

Different geochemical signatures between the Basal Chadron Sandstone aquifer with overlying units also demonstrate confinement. Gjelsteen and Collings (1988) concluded that geochemical groundwater characteristics of the Brule and Chadron formations further indicate that the two units are not naturally interconnected. Their study notes that groundwater from the Basal Chadron Sandstone aquifer contains 1,000 to 1,500 (mg/L) TDS, with sodium, bicarbonate, and sulfate as the dominant ions. Based on that information the authors of the study conclude that the high TDS of the Chadron groundwater is characteristic of water with a low velocity and long residence time in the aquifer. In contrast, water from the Brule aquifer averages about 600 (mg/L) TDS, with calcium, sodium, and bicarbonate as the dominant ions (Gjelsteen and Collings 1988). The distinct geochemistry indicates hydraulic isolation of the aquifers.

As discussed in Section 3.3.2.3, CBR performed its most recent aquifer pump test (test #8) in the central portion of the MEA in 2011. The results of this test indicated that there is adequate confinement between the overlying Brule Formation and the Basal Chadron Sandstone aquifer, as evidenced by no discernible drawdown in the Brule Formation observation wells and the very low storativity obtained during the test, which is indicative of a confined aquifer (CBR, 2014, Appendix F). Storativity ranged from 1.7×10^{-3} to 8.32×10^{-5}, with an average value of 2.56×10^{-4} for the entire test area (geometric mean of all values). The aquifer pump test performed at the MEA, along with seven other aquifer pump tests CBR has performed (four at the existing Crow Butte license area and three at the proposed NTEA and the proposed TCEA), demonstrate that the Basal Chadron Sandstone aquifer is well confined over the test areas. These results are expected based on the depositional environment and lithology of the Basal Chadron Sandstone aquifer and overlying confining units.

In summary, the natural confinement of the Basal Chadron Sandstone aquifer is supported by several lines of evidence, including the following:

- The overlying and underlying strata consist of very low permeability materials and are laterally continuous.
- The water in the Basal Chadron Sandstone aquifer is under significant pressure (i.e., rises hundreds of feet above its uppermost extent), which would not occur if the overlying strata were not effective confining units.
- Potentiometric surfaces (i.e., water levels) measured within the Brule aquifer are several hundred feet higher than those measured in the Basal Chadron Sandstone aquifer (Section 3.2.2). Therefore, any amount of groundwater movement through the confining units would be downward from the Brule aquifer into the Basal Chadron Sandstone aquifer.
- The MEA 2011 aquifer pumping test indicated that the Basal Chadron Sandstone aquifer is confined (very low storativity) and hydraulically isolated from the overlying aquifers aquifer. CBR would conduct additional aquifer pumping tests to further confirm hydraulic isolation with the overlying aquifers (CBR, 2015, Section 2.6.1.3).
- The Basal Chadron Sandstone aquifer and the overlying aquifers have distinct geochemical signatures, based on comparison of their major anions and cations (e.g., calcium, sodium, sulfate, bicarbonate).
- Based on isotopic age dating (Section 3.3.2.1), the Arikaree aquifer (150,000 to 250,000 years old), Brule aquifer (250,000 to 300,000 years old) and Basal Chadron Sandstone aquifer (300,000 to 500,000 years old) have large groundwater age differences.

Vertical control of the uranium recovery solutions at the MEA would be ensured by the confining characteristics, associated hydraulic conductivities, and continuous extent of the confining beds. Additionally, strong vertically downward gradients exist at all locations within the MEA, indicating minimal, if any, risk for potential impacts to the overlying aquifers from the underlying Basal Chadron Sandstone aquifer under natural conditions. During uranium recovery operations, the potentiometric surface of the Basal Chadron Sandstone aquifer at the MEA would be lowered, creating an even greater downward flow potential. These downward hydraulic gradients would prevent potential vertical excursions from moving upward from the extraction zone to the overlying aquifers.

3.3.3 Water Use

3.3.3.1 Dawes County Water Use

USGS has assessed water use in each state by county every 5 years since 1950 (USGS, 2005). USGS works in cooperation with NDNR to gather water-use data for the state of Nebraska. The most recent data available are for 2015 (USGS, 2017).

Unless otherwise specified, the water use information provided in this section is from 2015 (USGS, 2017). USGS estimated water use in 2015 for Dawes County, including both groundwater and surface water use, is 1.37 million gallons (5.17 million liters) per day. USGS

(2017) does not provide irrigation estimates for 2015. However, irrigation using groundwater and surface water in 2010 accounted for a total of 5.35 million gallons (20.2 million liters) per day to irrigate an estimated 14,170 acres (57.3 km^2) (USGS, 2016b).

The total population served by public water supplies in 2015 was 7,320 individuals. The groundwater and surface water use were estimated at 380,000 gallons (1.4 million liters) per day and 800,000 gallons (3.0 million liters) per day, respectively. Domestic water needs of 1,735 individuals were met by groundwater at a rate of 190,000 gallons (708,955 liters) per day.

As of April 20, 2016, Dawes County had a total of 6,136 registered water wells used for a variety of purposes (NDNR, 2016b). Of the 6,136 registered wells, 3,200 are associated with CBR's uranium recovery activities. The registered wells also include 271 domestic, 279 livestock, and 95 irrigation wells. Although the NDNR's water well retrieval database does not include information on public water supply wells because of national security concerns, there are 16 public water supply wells in Dawes County. The nearest public water supply well to the MEA is more than 10 miles (16 km) to the northeast (SC&A, 2016).

3.3.3.2 Marsland Expansion Area Water Use

The town nearest to the MEA is Marsland, NE, whose centerpoint is located approximately 4.6 miles (7.4 km) southwest of the MEA satellite building (CBR, 2014, Section 1.1.2). There is no public water supply system for Marsland. The residences scattered throughout the MEA area of review obtain domestic water from private wells. Locally, groundwater is supplied from the Arikaree and Brule formations. The primary groundwater supply is the Brule Formation, typically encountered at depths from approximately 50 to 350 feet bgs (15.2 to 106.7 meters bgs).

CBR conducted a water user survey in 2010 and 2011 to identify and locate all private water supply wells within the 2.25-mile (3.62-km) area of review for the MEA (CBR, 2014, Section 6.1.2.1). The water user survey targeted the location, depth, casing size, depth to water, and flow rate of all wells within the area that were (or potentially could be) used as domestic, agricultural, or livestock water supply.

According to CBR (2016, Section 2.2.4), there are 135 private water supply wells within the license area and area of review but outside of the MEA itself. Of these active private wells, 16 are located within the license area. Of these 16 wells, 10 are active water supply wells, 5 are inactive, and 1 is an irrigation well. Three of the active wells are assigned to the Arikaree Formation, four wells are assigned to the Arikaree and Brule formations (because they are screened within both units), and three wells are assigned to the Brule Formation.

CBR's water use survey did not identify any wells within the MEA AOR completed in the Basal Chadron Sandstone aquifer. There is an economic incentive for residents to draw water from the Airkaree and Brule aquifers since these aquifers provide greater yields of higher quality water, and wells drawing water from the Basal Chadron Sandstone aquifer would have to be drilled to greater than 285 feet (87 meters) in depth (CBR, 2016, Section 2.2.4).

CBR estimates that the one occupied residence within the MEA would use about 400 gallons (1,514 liters) of water per day and the eight occupied residences within the 2.25-mile (3.62-km) area of review would use an additional 3,200 gallons (12,113 liters) of water per day. Private water wells are also used for livestock watering; CBR estimates that livestock consumption would be 186,114 to 248,152 gallons (704,518 to 939,356 liters) per day within the MEA area of review and 24,938 to 33,251 gallons (94,400 to 125,869 liters) per day within the MEA itself (CBR, 2016, Section 2.2.4).

The nearest permitted domestic wells to the MEA boundary are four wells located approximately 2 miles (3.2 km) from the northwestern MEA boundary and one well located about 2 miles (3.2 km) from the northeastern MEA boundary (NDNR, 2016b). Table 3-7 provides relevant information obtained from well permits for these wells. All of these wells are screened hundreds of feet above the top of the Basal Chadron Sandstone aquifer.

Table 3-7 Information on Domestic Wells Located Nearest to the MEA License Boundary

NDEQ Registration ID (ft-bgs)	Well Depth (ft (m)-bgs)	Static Water Level (ft (m)-bgs)	Pumping Level (ft (m)-bgs)	Estimated Yield (gpm) (Lpm)
G-118350	300 (91)	115 (35)	150 (46)	10 (38)
G-089968	155 (47)	98 (30)	140 (43)	16 (60)
G-103966	160 (49)	91 (28)	110 (33)	10 (38)
G-167918	280 (85)	195 (59)	253 (77)	15 (57)
G-116402	220 (67)	70 (21)	208 (63)	15 (57)

An NRC staff review of the well logs for irrigation and stock wells within 2 miles (3.2 km) of the Marsland boundary did not identify any wells screened within the Basal Chadron Sandstone aquifer.

3.4 Ecological Resources

A review of ecological resources begins at the level of an ecoregion. An ecoregion is a group of areas that have generally similar ecosystems and similar types, quality, and quantity of environmental resources. One system of ecoregions was developed by EPA (Chapman et al., 2001). The ISR GEIS (NRC, 2009a, Section 3.4-11) includes a map of these ecoregions and identifies the MEA as being located in the Western High Plains ecoregion (a Level III ecoregion) (Urbatsch and Eddy 1973). Within that ecoregion, the northern part of the MEA is located in the Pine Ridge Escarpment Level IV ecoregion, while the southern part is in the Sandy and Silty Tablelands Level IV ecoregion (Chapman et al., 2001). NGPC defines its own ecoregions of Nebraska (Chapman et al., 2001). NGPC identifies the area of the MEA as part of the Shortgrass Prairie ecoregion and describes in detail the vegetation and animal life in the region (see Chapter 8 and Appendix 10 of NGPC, 2011b).

The MEA is ecologically similar to the existing Crow Butte license area and the proposed NTEA and TCEA sites located in Dawes County, NE. Therefore, existing baseline ecological studies, including field observations, agency contacts, and literature searches for those sites, dated from 1982 through 2008, are relevant to the MEA (CBR, 2014, Section 3.5). In addition, CBR conducted field observations, surveys, and mapping for the MEA in 2011 (CBR, 2014, Section 3.5.5). These studies included the area of the MEA and a 2.5-mile (4-km) buffer area around the MEA, although studies of the buffer area were generally limited to aerial surveys (HWA, 2012). The NRC also conducted its own review of the ecology of the MEA using available literature resources and natural resource agency sources (i.e., USFWS and NGPC). The vegetation and animal inventories for the MEA that the licensee documented (CBR, 2014, Section 3.5) coincide with available ecoregion summaries (Chapman et al., 2001). Because of the localized nature of potential impacts that are analyzed in Section 4.4, the area of review for ecological resources is limited to the MEA and the 2.5-mile (4-km) buffer area around the MEA and the portion of the Niobrara River watershed within and immediately south of the MEA.

NGPC, through its Nebraska Natural Legacy Project, has defined Biologically Unique Landscapes as areas of the State with the greatest potential for at-risk species and natural community conservation. The goal of this process is to identify a set of landscapes that offer some of the best opportunities for conserving the full array of biological diversity. These unique landscapes are being inventoried, monitored, and managed in order to maintain their unique legacy. Although the MEA itself does not encompass any "Biologically Unique Landscapes," three such areas are near the MEA: (1) to the north by the Pine Ridge escarpment, (2) to the west by the Panhandle Prairies, and (3) to the south by the Upper Niobrara River (NGPC, 2011b). These three unique settings have the following characteristics (NGPC, 2011b; Rolfsmeier et al., 2014):

(1) The Pine Ridge is a rocky escarpment that rises several hundred feet from the surrounding plains and is composed of sandstone, siltstones, and volcanic ash. Ponderosa pine (*Pinus ponderosa*) woodlands and forest occupy many of the north and east-facing slopes. The Pine Ridge escarpment landscape supports many at-risk species at the edge of their range, including two of Nebraska's three populations of Rocky Mountain bighorn sheep. This feature is located in the northern portion of Dawes County, portions of which are inside the area of review (NGPC, 2016b).

(2) The Panhandle Prairies landscape occupies the plains and rolling hills of the northern panhandle from the Pine Ridge escarpment south to the North Platte River valley. This area supports native prairie inhabited by swift fox, prairie dogs, and grassland birds. It includes the rough breaks and rocky outcrops associated with the Niobrara River in central Sioux County and the North Platte River in Scotts Bluff and Morrill counties, which are outside of the area of review (NGPC, 2016b).

(3) The Upper Niobrara River landscape occupies the river channel and a 2-mile- (3.3-km-) wide buffer on each side of the river from eastern Cherry County westward to the Nebraska-Wyoming border. With the exception of the dam that forms Box Butte Reservoir in Dawes County, the river flows in this reach are fairly natural. The upper river supports a unique assemblage of cold-water fish, including the State-listed blacknose shiner and finescale dace. While the MEA does not encompass any year-round aquatic features, the site does occur within the Niobrara River watershed evaluated as part of this draft EA.

3.4.1 Terrestrial Ecology

3.4.1.1 Vegetation

The Western High Plains Level III ecoregion is located in the rain shadow of the Rocky Mountains. As such, it is characterized by a semiarid to arid climate. Natural vegetation on this smooth to slightly irregular plain is dominated by drought-tolerant shortgrass prairie and large areas of mixed grass prairie (Chapman et al., 2001).

Within the Western High Plains, the northern part of the MEA is in the Pine Ridge Escarpment Level IV ecoregion (Chapman et al., 2001). As described in the ISR GEIS (NRC 2009a), the Pine Ridge escarpment forms the boundary between the Missouri plateau to the north and the High Plains to the south. The region is characterized by dramatic bluffs, escarpments, areas of exposed bedrock, and ponderosa pine woodlands (Chapman et al., 2001). Ponderosa pine, together with mixed-grass prairie, is found on ridge tops, north-facing and east facing slopes, and to a lesser extent on south- and west-facing slopes. The ISR GEIS describes typical vegetation in the woodlands and mixed-grass prairies of the region (NRC, 2009a, Section 3.4.5.1).

The southern part of the MEA is in the Sandy and Silty Tablelands Level IV ecoregion (Chapman et al., 2001). As described in the ISR GEIS (NRC, 2009a, Section 3.4.5.1), this area is characterized by tablelands with areas of moderate relief and consists of mixed-grass prairies. This ecoregion is more arid than the other areas within the Western High Plains. As such, land use is predominantly rangeland, with less extensive agriculture (Chapman et al., 2001).

A study performed in 1973 noted that the area surrounding the MEA encompasses largely herbaceous species capable of rapid colonization (Urbatsch and Eddy 1973). Eight communities comprise the vegetation in the MEA: mixed-grass prairie, degraded rangeland, mixed conifer, cultivated, drainage, range rehabilitation, structure biotope, and deciduous streambank forest (CBR, 2014, Section 3.5.5.3; Rolfsmeier and Steinauer, 2010).

- Mixed-grass prairie comprises about 2,978 acres (1205 ha) or 65 percent of the area of the MEA and is the dominant habitat type throughout the parts of the MEA that would be physically impacted by the proposed action. This habitat type is most common in the northern part of the project area and varies in composition. Species associated with mixed-grass prairie include needle-and-thread grass (*Hesperostipa comata*), june grass (*Koeleria macrantha*), Sandberg bluegrass (*Poa secunda*), and threadleaf sedge (*Carex filifolia*). Abundant nonnative species include cheatgrass (*Bromus tectorum*) and Kentucky bluegrass (*Poa pratensis*). Non-grass plants include white sagebrush (*Artemisia ludoviciana*), fringed sagebrush (*Artemisia frigida*), phlox (*Phlox* sp.), locoweed (*Oxytropis* sp.), lupine (*Lupinus* sp.), pussytoes (*Antennaria* sp.), and yucca (*Yucca glauca*).

- Degraded rangeland comprises about 646 acres (261 ha) or 13.7 percent of the MEA. These areas have been overtaken by nonnative species, predominantly cheatgrass, and have a lower overall biodiversity than mixed-grass prairie. Sections of the southern half of the project area have large patches dominated by cheatgrass and Kentucky bluegrass, and the southernmost portion has large patches dominated by smooth brome (*Bromus inermus*).

- Mixed-conifer forests comprise about 418 acres (169 ha) or 8.3 percent of the MEA and are the most common forested vegetation type within the project area. Mixed-conifer forests are dominated by ponderosa pine and occur along drainages in the northern third of the project area. Chokecherry (*Prunus virginiana*), skunkbush sumac (*Rhus trilobata*), and snowberry (*Symphoricarpos albus*) are common understory species. Both native and nonnative grasses occur, particularly smooth brome in low-lying areas. Pussytoes is commonly observed.

- Cultivated fields of crops such as alfalfa, wheat, oats, corn, barley, and rye comprise about 300 acres (12 ha) or 6.3 percent of the MEA. It is likely that the cultivated fields were occupied by mixed-grass prairie prior to human alteration.

- Drainages cover about 133 acres (54 ha) or 2.9 percent of the project area. Those in the south end are intermittent tributaries to the Niobrara River that are well-drained and usually dry. The vegetation is similar to that in the surrounding grassland, although generally more robust. Other species include meadow death camas (*Zigadenus venenosus*), wild onion (*Allium* spp.), and monkeyflower (*Mimulus* sp.). Drainages to the north are dominated by conifers in the overstory and smooth brome in the understory.

- Range rehabilitation areas comprise about 70 acres (28 ha) or 1.4 percent of the MEA and include previously cultivated fields that are generally heavily grazed and seasonally cut for hay. Vegetation varies; weedy species, including crested wheatgrass (*Agropyron cristatum*) and fringed sagebrush, are more prevalent in areas with cattle disturbance.

- Structure biotopes, or manmade features such as roads and buildings, cover about 68 acres (28 ha) or 1.4 percent of the project area. Nonnative weedy species often dominate such areas and include smooth brome, cheatgrass, white sweetclover (*Melilotus alba*), yellow sweetclover (*Melilotus officinalis*), and mustard species (*Brassicacea* spp.).

- Deciduous streambank forest occurs along ephemeral streams and comprises about 10.0 acres (4 ha) or less than 1 percent of the project area. Eastern cottonwood (*Populus deltoides*), boxelder (*Acer negundo*), and willow (*Salix* spp.) are common in the overstory. Snowberry, Kentucky bluegrass, smallwing sedge (*Carex microptera*), docks and sorrels (*Rumex* spp.), and annual mustards (*Brassicacea* spp.) are common in the understory.

3.4.1.2 Animals

Big Game Mammal Species

Six big game species have the potential to occur near the MEA, including pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), elk (*Cervus elaphus*), bighorn sheep (*Ovis canadensis*), and bison (*Bison bison*) (CBR, 2014, Section 3.5.6.1). The ISR GEIS (NRC, 2009a, Section 3.4.5.1) identified crucial habitats within the Nebraska-South Dakota-Wyoming uranium milling region, including birthing areas and crucial wintering and yearlong areas for large game animals (i.e., antelope, big horn sheep, elk, moose, mule deer, white-tailed deer) and nesting leks for the sage-grouse (*Centrocercus urophasianus*). None of these crucial habitats occur near the MEA (NRC, 2009a, Section 3.4.5.1).

The project area is located in the Box Butte West Antelope Hunt Unit; 48 pronghorn were harvested this unit in 2014 (NGPC, 2015c) and 61 were harvested in 2015 (NGPC, 2016a). Pronghorn are most abundant in short- and mixed-grass habitats. They are relatively common in the project area throughout the year, and their populations in Nebraska are increasing (NGPC, 2010; NGPC, 2011a).

The MEA is located within the Pine Ridge Mule Deer Hunt Unit. The adult mule deer buck harvest for the Pine Ridge Unit was 597 in 2014 (NGPC, 2015c) and 744 in 2015 (NGPC, 2016a). They were observed within the project area during the 2011 CBR fieldwork but not in high numbers (CBR, 2014, Section 3.5.6.1). Mule deer tend to move from uplands during the warmer months to lowlands in the winter. White-tailed deer are also hunted within this same unit. The white-tailed deer buck harvest for the Pine Ridge Unit was 901 in 2014 (NGPC, 2015c) and 964 in 2015 (NGPC, 2016a). They were commonly observed within the project area during the 2011 CBR fieldwork, mainly in the agricultural and riparian areas but also in the higher elevations and forested areas (CBR, 2014, Section 3.5.6.1).

Relatively large numbers of elk occur year-round within the MEA (CBR, 2014, Section 3.5.6.1). During the fall and winter, they occupy many of the agricultural fields and lower elevation upland habitat, then mostly move north to higher elevations in the forested portions of the Pine Ridge escarpment during the warmer times of the year. The MEA is located within the Ash Creek Elk Unit; 20 elk were harvested in this unit in 2014 (NGPC, 2015c) and 19 in 2015 (NGPC, 2016a). The population comprised about 1,000 to 1,200 individuals in 2010 (NGPC, 2011a).

Fort Robinson State Park, which lies 9 miles (14.5 km) from the MEA, is home to reintroduced bighorn sheep and a managed herd of bison. However, it is extremely unlikely that bighorn sheep or bison would occur in the MEA because bison are contained in a compound and appropriate escape terrain for bighorn sheep habitat (i.e., terrain that is suitable for bighorn sheep to use to escape predators, in this case steep slopes) is not present (CBR, 2014, Section 3.5.6.1).

Although never common, black bears at one time occurred in eastern Nebraska, ranged westwards along the Niobrara and Loup rivers, and may have extended into the Pine Ridge area. However, black bears have been considered extinct in Nebraska since the early 1900s, although some sightings of bears have been made. The NGPC reports occasional sightings of individuals since that time that have likely been transient, long-distant dispersals from Colorado or Wyoming (NGPC, 2015a).

Carnivore Mammal Species

Carnivore species observed at the MEA in 2011 include coyotes (*Canis latrans*) and badgers (*Taxidea taxus*). Red fox (*Vulpes vulpes*), bobcat (*Lynx rufus*), mountain lion (*Puma concolor*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and long-tailed weasel (*Mustela frenata*) are also likely present due to the area's grassland, shrub-steppe, and agricultural habitats (CBR, 2014, Section 3.5.6.2).

Small Mammal Species

Small mammal species known to occur or that are potentially present at the MEA include the deer mouse (*Peromyscus maniculatus*), white-footed mouse (*Peromyscus leucopus*), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), meadow jumping mouse (*Zapus hudsonius*), plains pocket gopher (*Geomys bursarius*), least chipmunk (*Tamias minimus*), and meadow vole (*Microtus pennsylvanicus*). Muskrat (*Ondatra zibethicus*) and North American beaver (*Castor canadensis*) occur near the Niobrara River along the southern edge of the project area. Porcupine (*Erethizon dorsatum*) and eastern fox squirrel (*Sciurus niger*) occur in the wooded areas of the MEA. Rabbit species include the white-tailed jackrabbit (*Lepus townsendii*), black-tailed jackrabbit (*Lepus californicus*), eastern cottontail (*Sylvilagus floridanus*), and desert cottontail (*Sylvilagus auduboni*) (CBR, 2014, Section 3.5.6.3).

Bird Species

According to the Nebraska Ornithologists Union, 295 bird species occur in Dawes County and 176 occur in Box Butte County (NOU, 2016). In 2011, 73 bird species were documented in and around the project area, and most are likely to breed locally (CBR, 2014, Section 3.5.7). Many species of perching birds use the MEA throughout the year for breeding, migration, or wintering. All habitats throughout the project area are likely to be used to some degree by various species, including western meadowlark (*Sturnella neglecta*), mourning dove (*Zenaida macroura*), American robin (*Turdus migratorius*), American crow (*Corvus brachyrhynchos*), and lark sparrow (*Chondestes grammacus*) (CBR, 2014).

Game birds occurring in the MEA include wild turkey (*Meleagris gallopavo*), ring-necked pheasant (*Phasianus colchicus*), gray partridge (*Perdix perdix*), and sharp-tailed grouse (*Tympanuchus phasianellus*), and other game birds use the site for migration (CBR, 2014, Section 3.5.7.2).

Seven raptor nests were documented within the MEA in 2011, including red-tailed hawk (*Buteo jamaicensis*), burrowing owl (*Athene cunicularia*), and great horned owl (*Bubo virginianus*), and an additional 19 were documented within the 2.5-mile (4-km) buffer area (CBR, 2014, Section 3.5.7.3). Several additional raptor species were observed in and around the project area during the spring season, including the Cooper's hawk (*Accipiter cooperii*), northern harrier (*Circus cyaneus*), golden eagle (*Aquila chrysaetos*), American kestrel (*Falco sparverius*), and peregrine falcon (*Falco peregrinus*) (CBR, 2014, Section 3.5.7.3).

Although little open water exists within the project area, some waterfowl species may use areas along the Niobrara River and the Box Butte Reservoir, outside the project area, for feeding, nesting, and resting (CBR, 2014, Section 3.5.7.4). There are no waterfowl habitats within the MEA.

3.4.2 Aquatic Ecology

The project area has little to no aquatic habitats. No perennial streams are present. Other small drainages, such as Dooley Spring and Willow Creek, are dry and revegetated, with no distinct stream channels or banks, although small pools may be created by runoff. The licensee found one site that qualified as a wetland based on the methodology described in the "Corps of Engineers Wetlands Delineation Manual" (Environmental Laboratory, 1987), and other relevant guidance (USACE, 1992)—a freshwater emergent wetland located on the western border of the project area (CBR, 2014, Section 3.5.10.3). The prominent drainage near the MEA is the Niobrara River, which is located just south of the MEA and flows into the Box Butte Reservoir.

Formal surveys for reptiles and amphibians have not been completed for the MEA, but the plains spadefoot toad (*Spea bombifrons*), northern leopard frog (*Rana pipiens*), and common snapping turtle (*Chelydra serpentina*) are known to occur in or near the project area (CBR, 2014, Section 3.5.8).

Fish species found in the Niobrara Watershed region are listed in Table 3.4-6 of the ISR GEIS (NRC, 2009a). Sampling of the local fish population at three sites along the Niobrara River in 2011 detected northern pike (*Esox lucius*), white sucker (*Catostomus commersonii*), common carp (*Cyprinus carpio*), largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), bluegill (*Lepomis macrochirus*), pumpkinseed sunfish (*Lepomis gibbosus*), and central stoneroller (*Campostoma anomalum*) (CBR, 2014, Section 3.5.10.1). Crayfish (*Cambarus* sp.) were also commonly found (CBR, 2014, Section 3.5.10.2).

3.4.3 Threatened, Endangered, Proposed, and Candidate Species

3.4.3.1 Federally and State-Listed Species

The Endangered Species Act of 1973, as amended (ESA), was enacted to prevent further decline of endangered and threatened species and restore those species and their critical habitat. Section 7 of the ESA requires Federal agencies to consult with the USFWS or National Marine

Fisheries Service (NMFS) regarding actions that may affect listed species or designated critical habitats. The ESA and its implementing regulations at 50 CFR 402 describe the consultation process that Federal agencies must follow in support of agency actions.

In this section, the NRC identifies the federally listed species and critical habitats that have the potential to occur in the MEA action area. The ESA regulations define “action area” as all areas affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area effectively bounds the analysis of federally listed species and critical habitats because only species and habitats that occur within the action area may be affected by the Federal action. For the purposes of the ESA analysis in this EA, the NRC staff considers the action area to include the approximately 4,622-acre (1,870-ha) MEA, including approximately 592 acres (240 ha) of this proposed licensed area that would be directly disturbed by project activities. The NRC expects all direct and indirect effects of the proposed action to be contained within these areas. The NRC used the USFWS’s Environmental Conservation Online System Information for Planning and Conservation system to identify the potentially present species and habitats. As a result, the NRC staff determined that two federally listed species, the northern long-eared bat (*Myotis septentrionalis*) and whooping crane (*Grus americana*), have the potential to occur in the MEA action area (NRC, 2017a). These species are listed in Table 3-8, and brief life histories follow. The staff did not identify any proposed species, candidate species, or proposed or designated critical habitat in the action area.

The NGPC designated species as endangered or threatened at the State level through the Nebraska Nongame and Endangered Species Conservation Act. This Act requires State agencies to ensure that their actions do not jeopardize the continued existence of endangered and threatened species or result in the destruction or modification of critical habitat. Projects that require State-issued permits, use State funds or are conducted by State agencies require the NGPC to conduct an environmental review for impacts on State-endangered and threatened species. Although the NRC as a Federal agency is not subject to this Act, this EA evaluates the State-listed species that are potentially present in the MEA project area as well as the likely impacts on those species in order to provide a complete assessment of the impacts of the proposed action for the purposes of NEPA. The staff used the NGPC’s Nebraska Conservation and Environmental Review Tool to identify State-listed species with the potential to occur in the MEA project area. The NGPC also maintains a Crucial Habitat Assessment Tool, which identifies habitat for at-risk native species and natural plant communities at a coarse scale, landscape level. As a result of these tools, the NRC staff determined that four State-listed species, the swift fox (*Vulpes velox*), blacknose shiner (*Notropis heterolepis*), finescale dace (*Phoxinus neogaeus*), and northern redbelly dace (*Phoxinus eos*), have the potential to occur in the MEA project area. Additionally, the whooping crane is both federally and State-listed. These species are listed in Table 3-8, and brief life histories follow. The staff did not identify any State-designated crucial habitats in the project area.

Table 3-8 Federally and State-Listed Species with the Potential to Occur in the MEA Action Area

Species	Scientific Name	Potential Occurrence[1]	Status[2]	Source
Mammals				
northern long-eared bat	*Myotis septentrionalis*	Unlikely. The species potentially occurs in northeast Nebraska along the Niobrara River. However, its preferred habitat does not occur within the MEA.	FT, ST	USFWS, 2016a, 2016b; NGPC, 2014, 2015b
swift fox	*Vulpes velox*	Likely. NGPC includes Dawes and Box Butte Counties in the estimated current range of the swift fox. However, a 2011 survey in the area of the MEA did not detect the species.	SE	NRC, 2009a; NGPC, 2013a, 2014; HWA, 2012
Birds				
whooping crane	*Grus americana*	Possible. Although there have been confirmed records of individuals in northwestern Dawes County, Dawes and Box Butte Counties are not part of the species' typical migratory pathway. No USFWS-designated critical habitat occurs in the MEA action area.	FE; SE	NRC, 2009a; USFWS, 2016a, 2016b; NGPC, 2013a
Fish				
blacknose shiner	*Notropis heterolepis*	Possible. Potentially affected downstream. The three State-listed fish are found in the Niobrara River system and may potentially be impacted by a reduction in river flow or impairment of stream quality.	SE	NGPC, 2013a, 2014
finescale dace	*Phoxinus neogaeus*		ST	NRC, 2009a; NGPC, 2013a, 2014
northern redbelly dace	*Phoxinus eos*		ST	NGPC, 2013a, 2014

1 Unlikely = Species are unlikely to occur in the MEA because of a lack of suitable habitat, and there are no reported occurrences in the MEA or in the nearby area; Possible = Little to no suitable habitat is within the MEA but occurrences at the site or within the nearby area have been recorded; Likely = There is sufficient suitable habitat in the MEA and occurrences in the MEA or nearby area have been recorded.

2 FE = federally endangered under ESA; FT = federally threatened under ESA; SE = designated as endangered at the State level by NGPC; ST = designated as threatened at the State level by NGPC.

Northern Long-Eared Bat

The USFWS listed the northern long-eared bat as threatened throughout its range (Volume 80 of the *Federal Register* (FR), page 17974 (80 FR 17974, April 2, 2015)). The USFWS did not designate critical habitat for the species because it found that such habitat is was not determinable at the time of listing. This species occurs in the northern part of Nebraska along the Niobrara River and tributaries and in deciduous forests in the eastern third of the State. During the summer, northern long-eared bats typically roost in cavities, crevices, or hollows or underneath bark in both live and dead trees and snags (typically at least 3 inches (7.6 cm) in diameter at breast height) (USFWS, 2014d). They may also roost in cooler places such as caves and mines. They forage for insects over water, in forest clearings, and under tree canopies in upland and lowland woodlots and tree-lined corridors. In the winter, individuals hibernate in caves and abandoned mine portals. In Nebraska, northern long-eared bats occur in the northern part of the State along the Niobrara River and its tributaries and in deciduous forests in the eastern third of the State. Although the species is found primarily in forested areas, it may also be found throughout Nebraska in opportunistic roosts during movement between hibernation and summer-use areas. Migration is typically only 40 to 50 miles (64 to 97 km).

Northern long-eared bats were not observed during the MEA surveys. The species has been decimated in the northeast, where it was most common; it has always been less common to rare in the western edges of its range (USFWS, 2014e). However, its occurrence in Nebraska is possible through migration from surrounding states where it is known to occur (USFWS, 2015c, 2016f). In 2016–2017, several occurrences of white-nose syndrome, a fungal disease, were recorded in eastern Nebraska (WNS, 2017). The MEA is not located in the white-nose syndrome zone, within which the USFWS has instituted protections to prevent purposeful taking of northern long-eared bat individuals (University of Nebraska, 2017).

<u>Swift Fox</u>

The NGPC has designated the swift fox as State-endangered. The species is not listed at the Federal level under the ESA. The swift fox is the smallest wild canine living in North America (NGPC, 2013b). It typically hunts at night, although it will rest and play outdoors during the day. Swift foxes live in open shortgrass prairies with few shrubs and trees. The species relies on the short grass to watch for predators. The species eats mostly meat, including prairie dogs, ground squirrels, and other small mammals, as well as birds, reptiles, amphibians, fish, and insects. Swift foxes often use prairie dog and badger dens to raise their young rather than digging their own dens. Since prairie dogs are both a source of food and shelter for swift fox, the two species are often closely associated with one another and are often found in the same areas. Swift foxes move to several different dens, including ditches, during the year. However, a female swift fox with young pups will typically remain in one den during the denning season, which in Nebraska is from April through August (NGPC, 2014).

The historic range of the swift fox includes the entire Great Plains region, but today it is limited to the western edge of that range in Nebraska, the swift fox population is believed to be restricted to the southwest corner of the State and the panhandle area, which includes Dawes and Box Butte counties (NGPC, 2013a, 2013b). Data on the actual occurrence of the swift fox in Nebraska are not readily available (Robertson, 2013). A comprehensive study of the animals in Nebraska, the first since the 1980s, is underway, in part in response to concerns over upcoming transportation and wind farm projects, but it will not be completed for several years (Robertson, 2013). CBR commissioned a study in 2011 to document species in the area, but no swift foxes were detected (HWA, 2012). NGPC (2014) observed that although some areas within the MEA could provide habitat for the swift fox, in many places the vegetation is too tall and would preclude the swift fox from denning in those areas.

<u>Whooping Crane</u>

The USFWS listed the whooping crane as endangered wherever found in 1967 on the original endangered species list under the Endangered Species Preservation Act of 1966 prior to the ESA's promulgation. The USFWS designated critical habitat for the species in 1978, and the current designations include an 80-mile (129-km) stretch of the Platte River in central Nebraska. The NGPC have also designated the species as endangered at the State level. The whooping crane is the tallest bird in North America (NGPC, 2013c). Currently, the only wild (naturally occurring) population of whooping cranes lives in Texas and migrates along the Central Flyway to breeding grounds in Canada. The range map depicting habitat use during migration and USFWS-designated critical habitat depicts this pathway as including central Nebraska, which excludes Dawes and Box Butte Counties (NGPC, 2013a). However, the NGPC (2013a) reports confirmed records of the whooping crane in northwestern Dawes County. According to the USFWS, the whooping crane is known or believed to occur in Dawes County (USFWS, 2015b, 2016a, 2016b). Whooping cranes eat both plants and animals found in agricultural fields, wet meadows, marsh habitats, and shallow rivers. The species typically selects sites with wide, open views and areas that are isolated from human disturbance and prefers to roost in shallow braided riverine habitats and wetlands. As stated in Section 3.4.2, there is one small (125 acres (50.5 ha)) wetland site on the western border of the MEA. While migrating through Nebraska, whooping cranes use riverine habitats such as the Niobrara River and a variety of wetland habitats as important stopover and resting spots during both spring and fall migrations (NGPC, 2013c). The Niobrara River is located below the southern boundary of the MEA, although it is within the 2-mile (3.3-km) area of review. Because little suitable habitat occurs within the MEA, the species is not likely to be found there.

Blacknose Shiner

The NGPC has designated the blacknose shiner as State-endangered. The species is not listed at the Federal level under the ESA. The blacknose shiner is a small minnow that eats mainly small invertebrates and some plant material (NRCS, 2009). In Nebraska, the species is found in clear, cool streams. Blacknose shiner are sensitive to decreased water quality, particularly increased turbidity. Although it was once one of the most abundant species in eastern South Dakota and Nebraska, it has only been collected in a few places within the past 20 years, including the Niobrara River east of Box Butte Reservoir. Recent habitat ranges for the species are limited to this portion of the Niobrara drainage system in Dawes County (NGPC, 2013a). The blacknose shiner is found only in clear, well-oxygenated portions of streams that are relatively undisturbed. The closest portion of its range within Dawes County occurs approximately 4 miles (6.4 km) downstream of the MEA (NGPC 2014).

Finescale Dace

The NGPC has designated the finescale dace as State-threatened. The species is not listed at the Federal level under the ESA. The finescale dace ranges from 2 to 5 inches (5.1 to 12.7 cm) in length. It primarily eats small insects and clams but may also eat plankton and algae. It needs small, slow-moving streams with clear water and prefers areas lined with sand or gravel rather than mud, including quiet headwaters, small marshes, and beaver ponds. Although it is considered secure in most of its range, the finescale dace is considered threatened in Nebraska. Its range in Nebraska includes all of the Niobrara River. The species is greatly impacted by any changes to the spring-fed streams it inhabits, such as those occurring as a result of water depletion from groundwater pumping or increased water turbidity from construction projects or other activities that increase silt in the streams (NGPC, 2013d).

Northern Redbelly Dace

The NGPC has designated the northern redbelly dace as State-threatened. The species is not listed at the Federal level under the ESA. The northern redbelly dace is a small fish similar to the finescale dace (NGPC, 2013d). The northern redbelly dace eats tiny plants and animals that float in the water column, as well as small aquatic animals and large quantities of algae. Like the finescale dace, it prefers clear water in order to see its food, although it uses heavy vegetation (algae) for reproduction. Its range and threatened status are the same as that of the finescale dace (NGPC, 2013a, 2013d).

3.4.3.2 Other At-Risk Species

In addition to the federally and State-listed species described above, the USFWS and NGPC identified several other potentially at-risk species that might occur within or adjacent to the MEA. These species, described below, are not protected under Federal or State law but are being actively managed by resource agencies because of their imperiled status or their importance to other species of concern. In Nebraska, such species are identified as Tier I or Tier II species. Tier I species are those that are globally or nationally at risk, including federally and State-listed species, while Tier II contains those species that are at risk within Nebraska although they may be doing well in other parts of their range (NGPC, 2011b). The at-risk species in both tiers are those that, while not afforded the same legal protections as listed species, are considered to be a valuable State resources whose continued existence in Nebraska is desired (NGPC, 2014). NGPC (2014) identified the following Tier I at-risk species as potentially occurring within approximately 5 miles (8 km) of the MEA project area:

- Burrowing owl (*Athene cunicularia*)
- Ferruginous hawk (*Buteo regalis*)
- Long-billed curlew (*Numenius americanus*)
- Plains topminnow (*Fundulus sciadicus*)
- Pearl dace (*Margariscus margarita*)
- Long-legged myotis (*Myotis volans*)
- Fringe-tailed myotis (*Myotis thysanodes pahasapensis*)
- Tawny crescent (*Phyciodes batesii*)

The Tier I burrowing owl, ferruginous hawk, and long-billed curlew are migratory birds that may occur in the area (USFWS, 2013). Under the Migratory Bird Treaty Act (16 U.S.C. 703 et seq.), projects should avoid construction activities in habitats known to be relied upon by these species that would result in the taking of migratory birds, eggs, young, and/or active nests. Most migratory bird nesting activity in Nebraska occurs around April 1 to July 15, although some migratory birds nest at other times (USFWS, 2013). Surveys conducted in 2011 of the MEA found two active burrowing owl nest sites within the MEA and nine in the 2.5-mile (4-km) buffer area (eight of which were associated with prairie dog colonies). One active ferruginous hawk nest was found within the 2.5-mile (4-km) buffer area in 2011, but no nests were found within the MEA (CBR, 2014, Section 3.5.7.3). The 2011 surveys also found active prairie dog colonies along the project border (but not within the MEA) and within 2.5 miles (4 km) of the site (CBR, 2014, Section 3.5.7.3). The curlew is migratory with a summer breeding range that can occur in Dawes and Box Butte counties. The species prefers short growth grasslands and mixed growth prairie grasslands for habitat, which may be affected by the project. The tawny crescent colonies in the area would be expected to be in the area of the Pine Ridge escarpment on wooded ridges and hillsides. While portions of the Pine Ridge escarpment are within the area of review, these areas are not part of the MEA wellfield and satellite facility areas.

The following specific Tier II at-risk species have been recorded within 5 miles (8 km) of the project area (NGPC, 2014):

- Golden eagle (*Aquila chrysaetos*)
- Swainson’s hawk (*Buteo swainsoni*)
- Prairie falcon (*Falco mexicanus*)

Golden eagles and bald eagles (*Haliaeetus leucocephalus*) are also protected by the Bald and Golden Eagle Protection Act (16 U.S.C. 668 et seq.) and may be in the area of the MEA (NGPC, 2014; USFWS, 2013). Bald eagles use mature, forested riparian areas near rivers, streams, lakes, and wetlands and occur along all the major river systems in Nebraska (USFWS, 2013). Like golden eagles, they frequent the open water and forested corridors of Nebraska river systems, such as that south of the MEA, during the winter for feeding, perching, and roosting. A CBR-sponsored survey in winter 2010–2011 did not identify bald eagles within the MEA but did find one adult bald eagle within 2.5 miles (4 km) of the project area (HWA, 2012). Bald eagles are present in the vicinity of the MEA during the winter and use surrounding habitat for feeding and roosting (HWA 2012). Although suitable habitat exists, no regularly inhabited roosts have been identified in the project area. Data from 2013 indicate that a number of active nests exist across Nebraska, although none are in Dawes or Box Butte counties (NGPC, 2013f).

Finally, as noted by the licensee (CBR, 2014), black-tailed prairie dogs (*Cynomys ludovicianus*) are listed as a sensitive species by the U.S. Forest Service (USFS) for the Pine Ridge Ranger District. Unlike other prairie dogs, black-tailed prairie dogs do not hibernate (USFWS, 2011a). These burrowing rodents establish colonies or towns with extensive underground burrow systems, which often serve as habitat for other endangered or at-risk species. Similarly, they are also an important source of food for such species. Some conservation organizations have identified them as a “keystone species” (Rocky Mountain Wild, 2015), which is a species that has a major impact on its ecosystem and is considered essential to maintaining optimum ecosystem function or structure. Because of their importance in terms of providing food and shelter for at-risk or sensitive species, such as the black-footed ferret, swift fox, and a variety of raptors, prairie dogs are considered important because of their association with these other species. Black-tailed prairie dogs are known to occur in the vicinity of the MEA (HWA, 2012). HWA (2012) reports that aerial surveys in 2011 identified two colonies along the project area border (0.63 and 20 acres (0.25 and 8 ha)) and two larger colonies within the 2.5-mile (4-km) buffer area (47 and 151 acres (19 and 61 ha)).

3.5 <u>Climate, Meteorology, and Air Quality</u>

3.5.1 Climate and Meteorology

The area of review for this resource area is a 50-mile (80-km) radius of the MEA. Section 3.4.6.1 of the ISR GEIS (NRC, 2009a) describes the regional climate and meteorology. CBR collected data at the MEA for a baseline monitoring period of August 24, 2010, through August 29, 2011. Monitored data include wind speed and direction, air temperature, relative humidity, solar radiation, and precipitation. CBR also looked at data collected by the Scottsbluff National Weather Service station, less than 50 miles (80.5 km) south of the MEA, from 1996 to 2012. CBR selected this location as most representative of the MEA meteorology (CBR, 2014, Section 3.6.1).

CBR’s analysis indicates that the climate of the area surrounding the MEA is classified as semiarid or steppe, which is characterized by many days of sun, low relative humidity, and sustained winds that result in high levels of evaporation. Temperatures vary greatly between day and night and seasonally, with cold, harsh winters; hot, dry summers; and relatively warm, moist springs and falls. Table 3-9 provides the expected conditions at the MEA based on regional data, which correlate closely to site-specific information taken over a 1-year period (CBR, 2015, Section 2.5.2).

Table 3-9 Expected Site Conditions

Parameter	Expected Value at the MEA
Average temperature	46° F (7.8° C)
Average daily maximum temperature	Near 90° F (32.2° C) in July
Average daily minimum temperature	Near 10° F (-12.2° C) in January
Extreme daily maximum temperature	107° F (41.7° C) in summer
Extreme daily minimum temperature	-30° F (-1.1° C) in winter
Average annual precipitation	15.2 inches (38.6 cm), with the majority in spring and early summer
Annual average wind speed	8–11 mph (13–18 km/hour)
Predominant wind direction	From north-northwest and northwest

Source: CBR, 2014, Section 3.6.2

The region is prone to severe weather events (CBR, 2014, Section 3.6.1). Thunderstorms occur throughout the spring and summer; in a typical year, the region will experience four or five severe thunderstorm events and 40 to 50 thunderstorm days. Additional severe weather events such as hail and damaging winds occur on average five or six times per year in the region. Regionally, tornadoes are possible, but their probability of occurrence is about three times less for Dawes County in comparison with the State of Nebraska, and about two times below the U.S. average (USA.com, 2016). Between 2000 and April 2017, eight tornado touchdowns were reported in Dawes County with no deaths, injuries, or property damage. All but one had winds less than 73 miles per hour (117.5 km per hour) (F0 on the Fujita scale). One tornado, with winds between 73 and 112 miles per hour (117.5 and 180.2 km per hour) (F1 on the Fujita scale), touched down near the Box Butte Reservoir and damaged at least 16 structures (NOAA, 2014, 2017).

Recent improvements in the emissions and the science of climate change have enabled the U.S. Global Change Research Program (GCRP) to estimate regional climate changes in the United States. The GCRP's Third National Climate Assessment (GCRP, 2014) delineates the MEA as located in the Great Plains region of the United States. Projected changes in the climate for the Great Plains region include an increase in the number of hot days and warm nights by mid-century (2041–2070) over the historical period (1971–2000) (GCRP, 2014). Maximum temperatures of about 95° F (35° C) are expected to occur more frequently in both a low greenhouse house gas (GHG) emissions and high GHG emissions scenario, and could increase in frequency by 13 to 22 days by mid-century (GCRP, 2014). As a result of these temperature increases, GCRP projections for the Great Plains region include surface water losses, heat stress, and an increase in insect populations that persist throughout the winter. Only slight changes are projected for precipitation in the vicinity of the MEA. The number of heavy precipitation days is expected to remain about the same, while the number of consecutive dry days is expected to decrease slightly (GCRP, 2014).

3.5.2 Air Quality

Section 3.4.6.2 of the ISR GEIS (NRC, 2009a) describes the general air quality for this region. Ambient air quality monitoring data for criteria pollutants are not available for the MEA or the area of review around it. However, CBR has used State and Federal monitoring sites in the general region to provide representative information on monitored parameters. These include ambient air monitors operated by NDEQ, the U.S. National Park Service, and the South Dakota Department of Environment and Natural Resources between 23 and 110 miles (37 and 177 km) of the MEA that monitor for different parameters, primarily particulate matter (CBR, 2014, Table 3.6-17 and Figure 3.6-32). The data from these monitors indicate that the regions being monitored, including the MEA, are well within the National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) and State Ambient Air Quality Standards (SAAQS) (NAC Title 129, "Department of Environmental Quality," Chapter 4, "Ambient Air Quality Standards") (CBR, 2014, Section 3.6.5.1).

EPA has classified the area containing the MEA as in attainment, meaning that the area either attains the NAAQS or no information is available (EPA, 2016). All counties within a 50-mile (80-km) radius of the MEA, the area of review for this resource area, are in attainment of the NAAQS, and all areas within the State of Nebraska are also in attainment (EPA, 2016). The city of Omaha, which is about 375 miles (603.5 km) from the MEA, previously had a nonattainment designation for lead, but currently is designated as in attainment. Section 3.4.6.2 of the ISR GEIS (NRC, 2009a) states that all of the area within the Nebraska-South Dakota-Wyoming Uranium Milling Region is classified as in attainment. The nearest nonattainment area identified in the EPA data (EPA 2016) is Weld County, Colorado (about 150 miles (241 km) from the town of Marsland), which is in nonattainment for 8-hour ozone.

3.6 <u>Historic and Cultural Resources</u>

The ISR GEIS (NRC, 2009a, Section 3.4.8 and Appendix D) include a discussion of historic and cultural resources at the State level. This draft EA discusses additional historic and cultural information specific to the MEA. Further, NHPA Section 106 requires that Federal agencies take into account the effect of an undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion on the NRHP. As part of this required evaluation, Federal agencies must consult with Tribes to determine whether there are historic properties of cultural and religious significance to Tribes that may be adversely affected by a proposed undertaking. This mandate is reflected in the NRC's Tribal Protocol Manual (NRC, 2014g) and its Tribal Policy Statement (NRC, 2017b). The manual and policy statement are intended to serve as guidance to the NRC staff on effectively consulting and interacting with Native American Tribes concerning activities within the scope of the NRC's jurisdiction.

In accordance with 36 CFR 800.8, "Coordination with the National Environmental Policy Act," the NRC is using the NEPA process to comply with its obligations under Section 106 of the NHPA. The staff conveyed this information to the Advisory Council on Historic Preservation in a letter dated May 3, 2013 (NRC, 2013j).

3.6.1 Federal Undertaking

The amendment of a source and byproduct materials license, such as that CBR proposes for the MEA, is a Federal action that may affect either known or undiscovered historic properties located on or near the MEA. In accordance with NHPA provisions, under 36 CFR 800.4(b)(1), the NRC is required to make a reasonable and good faith effort to identify historic properties in the area of potential effect (APE). The APE is the area that may be directly or indirectly impacted by the construction, operation, aquifer restoration, and decommissioning of the proposed action. For this review, the APE is the entire MEA license boundary area, comprising approximately 4,622 acres (1,870 ha).

3.6.2 Cultural History

Adequate summaries of the cultural background for the area of western Nebraska where the CBR license area and the MEA are located can be found in the ISR GEIS (NRC, 2009a, Section 3.4.8), available CBR project-specific cultural resources reports (Graves et al., 2011, 2012), and elsewhere (Koch, 2000; Louis Berger, 2005). Consequently, given the existence of these other sources, this section provides only a short, general overview of relevant background information to facilitate the later presentation of the NRC's findings.

3.6.2.1 Prehistoric Periods

The prehistoric cultural background is categorized into the following sequential developments, which are generally recognized in terms of archaeology as occurring over a large area of the central plains (Koch, 2000; Bozell, 2004; Graves et al., 2011):

- <u>Paleo-Indian Big Game Hunters (12,000 to 8,000 years before the present (BP))</u>. This cultural tradition began as humans gradually entered the plains following deglaciation of the region, sometime after 14,000 BP. The economy was focused on the hunting of big game animals, notably mammoth and mastodon, and ancient forms of bison. Toward the end of the period, a transition in subsistence modes toward the modern form of bison took place, along with increased reliance on plant foods.

- <u>Archaic Foragers (8,500 to 2,000 BP)</u>. The Plains Archaic period represents a continuation of the change in subsistence patterns that occurred in the latter part of the Paleo-Indian era. The diversity in dietary sources was more pronounced, and settlement patterns became more associated with highly productive food resource areas.

- <u>Plains Woodland (2,000 to 1,000 BP)</u>. The Plains Woodland period is characterized by largely sedentary lifestyles, with a mixed economy based on wild game animals, wild plants, and the beginnings of maize and bean horticulture. The defining settlement pattern of this period consists of earth lodge villages located along the larger drainages. This period marked the appearance of ceramic containers in the region.

- <u>Plains Village (1,000 to 600 BP)</u>. This period continued the trend toward increasing sedentary lifestyles and increasing reliance on domesticated plants. Villages were primarily located along major river systems and larger tributaries. By the end of this period, the basic tribal structure of the later historic period on the plains was in place.

3.6.2.2 Proto-Historic and Post-Contact Tribes (400 Years Before the Present to Present Day)

The post-contact period on the northern plains is that period after initial contacts with Europeans and later Americans (DeMallie, 2001). The earliest documented contact in the region is by Spanish and French explorers in the early 1700s. Western Nebraska was home to "nomadic" people who resided in tepee villages and depended on bison hunting. At various times, these Tribes included the Apache, Crow, Kiowa, Cheyenne, Teton (Sioux), Comanche, and Arapaho. The Lakota Sioux, Northern Cheyenne, and Arapaho resided in northwestern Nebraska, and the Oglala and Sicangu Brule Sioux were concentrated around the Black Hills in northern Sioux Country. By the mid-1800s, the Oglala and Brule bands had extended their range southward to the Platte River region of Nebraska.

The predominant Tribe in the region that includes the project area was formed by linguistically and regionally based groups and several subgroups of what has been termed the "Great Sioux Nation" (Van Vlack et al., 2012). These groups and subgroups include the following:

- Lakota (Lakȟóta, Teton)
  - Northern Lakota (Húŋkpapȟa, Sihásapa)
  - Central Lakota (Mnikȟówožu, Itázipčho, Oóhenuŋpa)
  - Southern Lakota (Oglála, Sičháŋǧu)
- Western Dakota (Yankton-Yanktonai or Dakȟóta)
  - Yankton (Iháŋktȟuŋwaŋ)
  - Yanktonai (Iháŋktȟuŋwaŋna)
- Eastern Dakota (Santee-Sisseton or Dakhóta)
  - Santee (Isáŋyáthi: Bdewákhathuŋwaŋ, Waȟpékhute)
  - Sisseton (Sisíthuŋwaŋ, Waȟpéthuŋwaŋ)

Article 5 of the Fort Laramie Treaty of 1851 defined territories of each participating tribe, including the Sioux Nations of Rosebud, Standing Rock, Pine Ridge (Oglala), Crow Creek, Lower Brule, Cheyenne River, Santee, and Fort Peck, and indicated that the Sioux territory included land in northwestern Nebraska, north of the North Platte River. By the Fort Laramie Treaty of 1868 between the United States and the Oglala, Miniconjou, and Brule bands of Lakota people; Yanktonai Dakota; and Arapaho Nation, land located in the future Dawes County, NE, was included in "unceded" territory that was reserved by the Sioux Nation for the right to hunt and travel, but not for occupation. The 1868 Fort Laramie treaty created the Great Sioux Reservation, essentially all of present-day South Dakota, for the various Sioux groups and subgroups to occupy.

Many Lakota refused to recognize the 1868 Fort Laramie treaty, saying it provided little to the people and pointing out that non-Indians continued to use their land, and the Government did not honor treaty provisions that promised rations, clothing, and schools. These people continued to live in their traditional areas in the unceded lands, followed the buffalo, and maintained their traditional ways of life.

Following the 1868 Fort Laramie treaty, the United States established the Red Cloud Agency in August 1873, just west of the present town of Crawford in Dawes County, NE. Although members of the Oglala Lakota were placed at the agency, members of other Tribes, such as the Northern Cheyenne and Arapaho, were also sent to the agency.

In 1887, Congress passed the General Allotment Act (Dawes Act) to break up communal Indian lands into individual family holdings within the Great Sioux Reservation. On March 2, 1889, Congress passed another act partitioning the former reservation into five smaller reservations, mostly in South Dakota, as follows:

- Standing Rock Reservation, with its agency at Fort Yates

- Cheyenne River Reservation, with its agency on the Missouri River near the mouth of the Cheyenne River (later moved to Eagle Butte following the construction of Oahe Reservoir)

- Lower Brule Reservation, with its agency near Fort Thompson

- Upper Brule or Rosebud Indian Reservation, with its agency near Mission

- Pine Ridge Reservation (Oglala Sioux), with its agency at the town of Pine Ridge near the Nebraska border

The U.S. Indian Claims Commission confirmed on February 15, 1974, that the part of the Nebraska Panhandle area, including Dawes County, was traditionally occupied and used by the ancestors of the modern-day Tribes of the Rosebud, Standing Rock, Pine Ridge (Oglala), Crow Creek, Lower Brule, Cheyenne River, Santee, and Fort Peck Sioux Reservations (33 Ind. Cl. Comm. 151, Docket No. 74-B).

3.6.2.3 Euro-Americans (300 Years Before the Present to Present Day)

As American settlers began emigrating through Nebraska on trails to the western United States in the mid-1800s, increasing conflicts arose in what had previously been Tribal-use lands (Shumway, 1921; Louis Berger, 2005; Buecker, 2003). The establishment of forts on Indian lands and an influx of settlers into the Nebraska Panhandle led to further agitation. The Fort Laramie Treaty of 1851 was signed with the intent of protecting American travelers along the emigrant trails, while preserving the traditional-use lands for the Cheyenne, Sioux, Arapaho, Crow, Assiniboine, Mandan, Hidatsa, and Arikara Nations. Lack of enforcement by the U.S. Government of this treaty resulted in further conflict, eventually leading to the Fort Laramie Treaty of 1868. Continued disagreements between the United States and Tribes led to the construction of Fort Robinson adjacent to the Red Cloud Agency to keep peace. Fort Robinson served a vital role during the Sioux Wars of 1876–1877 and was the place of the Cheyenne Outbreak of September 9, 1878. Fort Robinson was also the setting for the tragic death of the Oglala Lakota leader Crazy Horse on September 5, 1877. In 1878, the Red Cloud Agency moved to the newly created reservation in South Dakota, where it was renamed the Pine Ridge Agency and Reservation. Use of Fort Robinson continued through World War I, and in World War II, it was a training site for soldiers and a camp for German prisoners of war. It ceased use as a military camp in 1948, and today is a Nebraska State park and historic site.

The city of Crawford, located 15.1 miles (24.3 km) north-northwest of the MEA, began about 1866 as a civilian tent camp to support Fort Robinson. The town was formally established and named in 1886; by then, it was the hub of an area of active ranching and farming. Throughout its early history, Crawford and the immediate area included several significant regional transportation routes, as listed below:

- Fort Laramie, WY, to Fort Pierre, SD, Trail (1837 to the 1880s)
- Sidney, NE, to Deadwood, Black Hills, SD, Trail (1874 to 1880)
- Fort Robinson/Red Cloud Agency to Camp Sheridan/Spotted Tail Agency Road (1874 to 1886)
- Fremont, Elkhorn, and Missouri Valley Railroad, then a subsidiary of the Chicago and Northwestern Railroad (reached Crawford in 1886)
- Chicago, Burlington and Quincy Railroad (reached Crawford in 1887)

None of these transportation routes crossed the MEA, although the Sidney-Deadwood trail (Mahnken, 1949; McNair, 2005) and the Chicago, Burlington and Quincy Railroad followed a north-south path just west of the MEA boundary. Construction of the Chicago, Burlington and Quincy Railroad tracks near the MEA was completed in 1888–1889. Two small towns, Marsland and Belmont, appeared at this time to support the construction activities and as places for stations (Hinchley, 2005; Louis Berger, 2005). Marsland, located about 3 miles (4.8 km) west-southwest of the southwest corner of the MEA on the north side of the Niobrara River, began in 1889 as a station location for the railroad. By the early 1940s, the town's population had greatly diminished, and only a few buildings remain today. Belmont is located about 7 miles (11.3 km) north of Marsland and about 3.5 miles (5.6 km) west of the northwestern part of the MEA. It began as a construction camp for the well-known Belmont Tunnel, the only railroad tunnel ever constructed in Nebraska. The tunnel was completed in August 1889 and continued in use until 1982, when the Burlington Northern Railroad constructed a new right-of-way immediately to the west of the tunnel (Louis Berger, 2005). Today, Belmont is an abandoned town with only a few buildings still standing. Marsland, Belmont, and the Belmont Tunnel have been recorded as historic sites; each is at a sufficient distance from the MEA boundary such that there would be no potential impacts from project activities.

Historic period settlement of the MEA APE is characterized by early ranching and homesteading activities. Public land patent records show that lands within the MEA were patented between 1891 and 1917 (Graves et al., 2011).

3.6.3 Identified Historic and Cultural Resources

Information for known or previously recorded historic and cultural properties comes from several sources, including the most recent NRHP list, the Nebraska Historical Markers Program, administered by the NE State Historical Society, and a previous project-specific field inventory of the MEA APE (Graves et al., 2011, 2012) that resulted in the recording of 15 historic resource sites. None of the newly recorded sites is currently evaluated as eligible for listing on the NRHP, although two are recommended as requiring additional evaluation should they be directly impacted by future project development.

3.6.3.1 National Register of Historic Places Properties

As shown in Table 3-10, five historic period sites within 15 miles (24.1 km) of the MEA are listed on the NRHP (Louis Berger, 2005); none of these is closer than 7 miles (11.3 km) to the MEA and so would not likely be impacted by project activities at the MEA. All are in Dawes County. In addition to being listed on the NRHP, the Fort Robinson and the Red Cloud Agency property (west of the city of Crawford and within the boundaries of the Fort Robinson State Park) is also designated a National Historic Landmark by the U.S. Department of the Interior (NPS, 2012). National Historic Landmarks are nationally significant historic places designated by the Secretary of the Interior because they possess exceptional value or quality in illustrating or interpreting the heritage of the United States.

The Agate Fossil Beds National Monument lies along the Niobrara River about 20 miles (32.2 km) west of and upriver from Marsland. Although one historic ranch within the monument boundaries was previously listed on the NRHP (NSHS, 2011a), the entire monument has just been nominated for NRHP listing as the "Agate Springs Fossil Hills Historic and Archaeological District" (Bahr et al., 2012). In conjunction with the NRHP nomination, NPS completed cultural landscape studies for the entire monument (NPS, 2010a), the James H. Cook Homestead Complex (NPS, 2010b), and several historic period campsites occupied by the well-known Oglala Sioux leader Red Cloud and members of his band from 1889 to 1942 (NPS, 2010c). While the proposed NRHP District is at some distance from the CBR MEA, it represents the nearest place where significant comparative analyses have been completed for historic Euro-American and Native American cultural landscapes (NPS, 2010a, 2010b, 2010c), archaeological resources (Bozell, 2004), Native American cultural affiliation (Van Vlack et al., 2012), and Native American places of religious or cultural significance (LeBeau, 2002).

Table 3-10 NRHP-Listed Properties in Proximity to the MEA (All in Dawes County)

NRHP-Listed Properties	Date Listed	Approximate Distance and Direction from the MEA
Army Theater, Fort Robinson State Park	July 7, 1988	13 miles (21 km) NW
Co-Operative Block Building, Crawford, NE	September 12, 1985	11 miles (18 km) NW
Fort Robinson and Red Cloud Agency, also designated a National Historical Landmark, December 19, 1960	October 15, 1966	13 miles (21 km) NW
U.S. Post Office, Crawford, NE	May 11, 1992	11 miles (18 km) NW
Henry Wohlers, Sr. Homestead, southwest of Crawford, NE	October 15, 2004	7 miles (11 km) W

Source: NSHS, 2011a

3.6.3.2 Nebraska Historical Landmarks

The *Nebraska Revised Statutes*, Sections 82-119 through 82-124, authorize NSHS to mark and preserve the historical landmarks of Nebraska. NSHS coordinates this effort through the Nebraska Historical Markers Program. Evaluation criteria for qualification for the Historical Markers Program are found in *Nebraska Revised Statutes*, Section 82-120.

NSHS has placed historical markers at 21 sites and places around the city of Crawford (NSHS, 2011b). All but three of these are related to events, places, and buildings associated with Fort Robinson and the Red Cloud Agency. The remaining three include two locales in Crawford and a “Buttes Country” marker, located 4 miles (6.4 km) east of Crawford that proclaims, in part, “Perhaps no spot in Nebraska is so surrounded by historical and geographical landmarks as this one.” No locales marked by the State program lie in proximity to the MEA.

3.6.3.3 Previous Cultural Resources Surveys

Between November 2010 and February 2011, ARCADIS U.S., Inc. (ARCADIS), conducted an intensive (100-percent coverage) pedestrian cultural resources inventory of 4,500-acres (1,821 ha) of the MEA (Graves et al., 2011). ARCADIS conducted an additional intensive pedestrian cultural resources inventory of another contiguous tract of 160 acres (65 ha), located along the eastern boundary in the northern part of the MEA (Graves et al., 2012). Table 3-11 lists the results of those inventories.

The first ARCADIS field inventory recorded 15 newly discovered historic period sites (25DW357–25DW371) and six historic isolated finds (2368-1004, 1007, 1011, 1013, 1019, and 1023) and further documented two previously recorded historic homesteads (25DWW00-242 and 25DW00-243). All of the sites and isolated finds encountered in the MEA can be associated with historic period ranching and farming activities in the area, dating from the late 1800s to recent times. Resource types included abandoned homesteads, a wooden bridge, secondary debris scatters, isolated livestock features such as cisterns and corrals, and isolated farm machinery. The second field inventory did not result in the discovery of any historic or archaeological sites.

Table 3-11 Historic Cultural Resources Sites and Isolated Finds Recorded during the Field Investigations at the MEA

Site Number	Site Type and Age	NRHP Finding
25DW242	Recently abandoned homestead; historic period, early1900s–recent	Not eligible, but recommended for avoidance and further archival research if to be impacted
25DW243	Abandoned homestead; historic period, late 1800s–mid-1900s	Not eligible, but recommended for avoidance and further archival research if to be impacted
25DW357	Secondary debris scatter; historic period, early to mid-1900s	Not eligible
25DW358	Ranch cistern; historic period,	Not eligible
25DW359	Abandoned homestead; historic period, early to mid-1900s	Not eligible
25 DW360	Abandoned homestead; historic period, early to mid-1900s	Not eligible
25DW361	Abandoned homestead; historic period, early to mid-1900s	Not eligible
25DW362	Abandoned wooden bridge; historic period	Not eligible
25DW363	Secondary debris scatter; historic period, late 1800s to mid-1900s	Not eligible
25DW364	Ranch cistern and debris dump; historic period	Not eligible
25DW365	Abandoned homestead; historic period, early to mid-1900s	Not eligible
25DW366	Abandoned homestead; historic period, early to mid-1900s	Not eligible
25DW367	Abandoned ranch windmill and livestock corral; historic period	Not eligible
25DW368	Abandoned dugout, historic period	Not eligible
25DW369	Secondary debris scatter; historic period, mid- to late 1900s	Not eligible
25DW370	Abandoned single foundation, historic period	Not eligible
25DW371	Sandstone quarry, historic period	Not eligible
2368-1004	John Deere 2-row Lister corn planter and John Deere disc harrow; historic period 1930s	Isolated Find— Not eligible
2368-1007	Small secondary debris scatter; historic period	Isolated Find— Not eligible
2368-1011	International Harvester disc harrow; historic period, ca. 1900–1945	Isolated Find— Not eligible
2368-1013	International Harvester Canada rod weeder; historic period, 1940s	Isolated Find— Not eligible
2368-1019	McCormick-Deering No. 7 mower; historic period, manufactured 1929–1939	Isolated Find— Not eligible
2368-1023	Large farm implement; historic period	Isolated Find— Not eligible

Source: Graves et al., 2011

ARCADIS determined that none of the 17 historic period sites evaluated in the MEA possessed the necessary integrity or potential significance for listing on the NRHP. ARCADIS recommended that two of the historic homesteads (25DWW00-242 and 25DWW00-243) should be avoided. If direct impacts were to occur at either of these two properties, ARCADIS recommended that additional archival research and more intensive documentation be completed before any construction activities. By definition, isolated finds are not considered to have any potential significance for the NRHP. The NE SHPO accepted ARCADIS' first cultural resources report (Graves et al., 2011) and concurred with the NRHP eligibility recommendations on May 19, 2011 (NSHS, 2011c). The NE SHPO concurred with the negative findings of the second ARCADIS inventory report (Graves et al., 2012) on March 27, 2012 (NSHS, 2012). In preparing this draft EA, the NRC staff reviewed ARCADIS' findings and agreed with the recommendations and with the NE SHPO concurrence.

3.6.4 Tribal Consultations for the Marsland Expansion Area

The Federal government and the State of Nebraska recognize the sovereignty of federally recognized Native American Tribes. NEPA encourages Federal agencies to consult with Indian Tribes in the planning process for a proposed Federal action; NHPA Section 106 requires Federal agencies to undertake consultation and coordination with each Tribal government that may have an interest in historic properties within the proposed project area. Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments," issued November 2000, excludes from the requirements of the order, "independent regulatory agencies, as defined in 44 U.S.C. § 3502(5)." However, according to Section 8 of the executive order, "Independent regulatory agencies are encouraged to comply with the provisions of this order." Although the NRC is explicitly exempt from the order, the Commission remains committed to its spirit. The agency has demonstrated a commitment to achieving the order's objectives by implementing a case-by-case approach to interactions with Native American Tribes. The NRC's case-by-case approach allows both the NRC and the Tribes to initiate outreach and communication with one another.

As part of its obligations under Section 106 of the NHPA and the regulations at 36 CFR 800.2(c)(2)(ii)(A), the NRC must provide an Indian Tribe that attaches significance to affected properties "a reasonable opportunity to identify its concerns about historic properties, advise on the identification and evaluation of historic properties and evaluation of historic properties, including those of traditional religious and cultural importance, articulate its views on the undertaking's effects on such properties, and participate in the resolution of adverse effects."

The NRC formally initiated the Section 106 consultation process for the MEA by contacting 21 Tribal governments by letters dated September 5, 2012 (NRC, 2012a). These letters invited the Tribes to participate as consulting parties in the NHPA Section 106 process and requested any known information on any areas on the project site that the Tribes believe have cultural significance. A map of the MEA boundary was enclosed. Following issuance of this letter, the following Tribes were identified as potential consulting Tribes for the MEA under NHPA Section 106:

- Oglala Sioux Tribe
- Standing Rock Sioux Tribe
- Yankton Sioux Tribe
- Rosebud Sioux Tribe
- Cheyenne River Sioux Tribe
- Crow Creek Sioux Tribe
- Lower Brule Sioux Tribe
- Northern Cheyenne Tribe
- Northern Arapaho Tribe
- Eastern Shoshone Tribe
- Santee Sioux Nation

- Ponca Tribe of Nebraska
- Crow Nation
- Three Affiliated Tribes (Mandan, Hidatsa, Arikara)
- Pawnee Nation of Oklahoma
- Assiniboine Sioux, Fort Peck Tribes
- Cheyenne and Arapaho Tribes of Oklahoma
- Kiowa Tribe of Oklahoma
- Apache Tribe of Oklahoma
- Comanche Nation
- Sisseton-Wahpeton Sioux Tribe

The NRC has been consulting with the 21 Tribal governments identified above regarding four CBR project areas: the existing Crow Butte license area, which includes the Crow Butte CPF and associated uranium recovery units; the MEA; the NTEA; and the TCEA. The NRC has been conducting separate Section 106 Tribal consultations for each of these CBR project areas, although there has been considerable overlap in the general consultation process because the regulatory agency, the potentially affected Tribes, and the licensee are the same in each case.

3.6.5 Places of Religious or Cultural Significance[15]

3.6.5.1 Background

Places of religious or cultural significance are resources associated with the cultural practices and beliefs of a living community that are rooted in history and remain important for a group to maintain its cultural heritage. These historic places may not be represented in archaeological or historic contexts. They are often associated with Native American religious or cultural practices and include traditional gathering areas where particular plants or materials were harvested, a sacred mountain or landscape crucial to a Tribe's identity, or burial locations that connect Native Americans with their ancestors. A place of religious or cultural significance to Tribes demonstrates traditional cultural value if its significance to Native American beliefs, values, and customs "has been ethnohistorically documented and if the site can be clearly defined" (Parker and King, 1998).

In the terminology of National Register Bulletin No. 38, "Guidelines for Evaluating and Documenting Traditional Cultural Properties" (Parker and King, 1998), a "traditional cultural property" (TCP) may be a building, site, district, object, or landscape. The significance must stretch beyond the past 50 years, yet it must retain ongoing significance. Although the same aspects of integrity are relevant as for other NRHP-eligible resources (e.g., integrity of location, design, setting, materials, workmanship, feeling, and association), Parker and King (1998) note that the concept of integrity is applied somewhat differently for TCPs than it is for historic buildings or archaeological sites, as quoted below:

---

15 This Draft EA uses the term "places of religious or cultural significance" in place of the more commonly employed term "traditional cultural properties." The latter term is reserved for those places or resources that have been through a more formal identification and evaluation process during consultation, leading to a determination of their potential significance for listing on the NRHP.

> In the case of a TCP, there are two fundamental questions to ask about integrity. First, does the property have an integral relationship to traditional cultural practices or beliefs; and second, is the condition of the property such that the relevant relationships survive?

The Tribes emphasize the interconnectedness between the physical and spiritual worlds. For example, in Lakota cosmology there exist a spiritual realm and an earthly realm. What happens in one realm is reflected in the other; the two worlds are interconnected and inform the other (SRI, 2012). Tribal groups and their descendants, including the historically documented Apache, Arapaho, Arikara, Assiniboine, Cheyenne, Crow, Hidatsa, Kiowa, Mandan, Pawnee, Ponca, Sioux, and Shoshone Tribes, have made their homes in the Northern Plains for more than 12,000 years. Therefore, the area including the CBR project areas may contain landforms, resource areas, and features that are associated with the traditional cultural practices and spiritual beliefs of one or more of the Tribes being consulted under the NHPA Section 106 process.

The range of potential places of religious or cultural significance is varied and includes many property types of religious or traditional use that might be identified during a Tribal consultation process. American Indian researcher and Lakota Tribal member Vine Deloria, Jr., offers the following classification that reflects the wide-ranging variability for such places (Deloria and Stoffle, 1998):

- creation story locations and boundaries
- sacred portals recounting star migrations
- universal center locations
- historic migration destiny locations
- places of prehistoric revelations
- traditional vision quest sites
- plant-animal relationship locations
- mourning and condolence sites
- historic past occupancy sites
- spirit sites
- recent historic event locations
- plant, animal, and mineral gathering sites
- sanctified ground

Cheyenne River Sioux Tribal member Sebastian LeBeau makes a distinction between Lakota "Traditional Cultural Property" and "Traditional Cultural Property Sites" (LeBeau, 2009). In this taxonomy, a "Traditional Cultural Property" is any location in the landscape to which Lakota people attribute cultural significance, such as a prominent landform. In contrast, "Traditional Cultural Property Sites" are distinct places where Lakota people performed a significant cultural activity. An example of the latter would be a specific spot on a given TCP landform where a Lakota person completed a vision quest ceremony. Proper identification, documentation, and evaluation of both types of culturally significant resources at a given project area are best done from the Lakota perspective and through the NHPA Section 106 consultation process (LeBeau, 2009). Continued consultation with the Tribes and an onsite field assessment will help identify places that possess cultural and religious significance to the Tribes. Any identification of sacred or traditional places must be verified in consultation with authorized Tribal representatives.

3.6.5.2 Potential Places of Religious or Cultural Significance

Literature searches and input from some of the consulting Native American Tribes have not identified any previously identified potential places of religious or cultural significance to date within the existing Crow Butte license area or the three potential expansion areas (i.e., the MEA, NTEA, and TCEA). There are some potential places in the general vicinity of Crawford, NE, that are visible from the existing Crow Butte license area, NTEA, and TCEA (SC&A, 2011; NRC, 2014e). None of these prominent features on the landscape is visible from the MEA because of the intervening elevation of the Pine Ridge escarpment.

An ethnographic field study in 2002 by LeBeau (2002) at the Agate Fossil Beds National Monument, approximately 25 miles (40 km) west of the MEA, indicates that there is a potential for Lakota places of religious or cultural significance to exist in this part of western Nebraska. While LeBeau's investigation at Agate Fossil Beds was not a complete survey of the entire monument acreage or a systematic analysis, it did point out some possibility for the existence of places of Lakota spiritual value, offering sites, and sites used for gathering of natural resources to be present in the vicinity of the MEA. This may be the case for non-Lakota Tribes as well.

The NRC mailed a letter to each of the consulting Native American Tribes on October 31, 2012, offering access to all of the CBR project areas, including the existing Crow Butte license area, NTEA, TCEA, and MEA for the purpose of conducting field studies to identify potential places of religious or cultural importance (NRC, 2012b). Two of the consulting Native American Tribes, the Crow Nation and Santee Sioux Nation, conducted field investigations at the existing Crow Butte license area, TCEA, and MEA[16] in late November and early December 2012. The Santee Sioux Nation submitted a TCP report to the NRC on behalf of both Tribes (Santee Sioux Nation, 2013). Tribal field crews completed an intensive on-the-ground survey of the MEA, recording 12 potential places of religious or cultural significance. These results included seven possible camping areas, possible stone arrangement sites, a possible human burial place, a possible dance place, and a possible buffalo jump. Preliminary evaluation by the Crow Nation and Santee Sioux Nation indicated that none of these places was potentially eligible for listing on the NRHP. The report concluded that there were no eligible sites of cultural or religious significance to the Tribes at the existing Crow Butte license area and the MEA and TCEA. In the words of these Tribes, "The spiritual walk through for a Federal undertaking for the NRC, authorized by the Cameco Resources, Inc., who gave the Tribal monitors an opportunity to be totally in charge of what needed to be done to ensure that cultural properties were discovered, were respectively acknowledged, and gave the two Tribes the necessary input and documentation needed to protect and mark buffer zones..." (Santee Sioux Nation, 2013).

The NRC sent a letter to all consulting Native American Tribes on January 3, 2013, to update them on the ongoing consultation activities, including notification that the field studies had been completed (NRC, 2013g). On April 2, 2013, the NRC sent an unredacted copy of the Tribal field survey report (Santee Sioux Nation, 2013) to each of the consulting Native American Tribes (NRC, 2013h). Several other consulting Tribes responded to this report disagreeing with the findings (Cheyenne River Sioux, 2013; NRC, 2013i; Yankton Sioux, 2013; NRC, 2013j; Standing Rock Sioux, 2013; NRC, 2013k).

In the summer of 2013, the NRC sent a cultural resources expert to revisit the 12 places of potential religious or cultural significance the Crow Nation and Santee Sioux Nation field crews

[16] Access to the proposed NTEA was not possible at the time of the Tribal field survey because of site access issues.

identified at the MEA to collect additional documentation (SC&A, 2013a). The NRC prepared a field survey report documenting the results of this evaluation, which confirmed the Tribal determinations that none of the 12 places is potentially eligible for listing on the NRHP. The NRC sent an unredacted copy of this report to the consulting Native American Tribes on May 30, 2014, for their review and comment (NRC, 2014b). The NRC received no comments on the report from any of the consulting Tribes. A redacted copy of this report is available on the NRC's Agencywide Documents Access and Management System (ADAMS) (SC&A, 2013a).

In June 2014, the NRC staff posted documents pertaining to NHPA Section 106 on its Web site and solicited comments, particularly any information that would call into question any of the conclusions stated in the NRC's summary or in the posted documents (NRC, 2014c). These documents included the Santee Sioux and Crow Nations TCP field survey, the report from the summer 2013 field visit, and the draft cultural resources sections of this draft EA. The NRC received no comments.

On October 30, 2014 (NRC, 2014d), the NRC requested the NE SHPO's concurrence with the NRC's finding of no historic properties present for the MEA, based on these surveys and the NRC's draft text for this section of the EA. In a letter dated November 18, 2014 (NSHS, 2014), the NE SHPO concurred with the findings that the proposed project would affect no archaeological, architectural, or historic context property resources.

3.7 Demographics and Socioeconomics

Section 3.4.10 of the ISR GEIS (NRC, 2009a) provides a socioeconomic description for the Nebraska-South Dakota-Wyoming Uranium Milling Region, including communities within the area of review for potential ISR facilities. The analysis in the ISR GEIS extended into Dawes County, but not as far south as Marsland (see ISR GEIS Figure 3.4-21). Data for Nebraska are provided in ISR GEIS Section 3.4.10.4.1.1, Section 3.4.10.4.2.1, Section 3.4.10.5.1, Section 3.4.10.6.1, and Section 3.4.10.7. This draft EA discusses demographics and socioeconomic information specific to the MEA.

3.7.1 Population Distribution

The MEA is located in a rural agricultural area in Dawes County, NE. The area within a 50-mile (80-km) radius of the MEA includes portions of seven counties in northwestern Nebraska, two counties in southwestern South Dakota, and two counties in eastern Wyoming (CBR, 2016). Table 3-12 describes these counties in terms of population; see Figure 3.10-1 in CBR (2016) for relative distances from the MEA.

The cities of Chadron and Crawford in Dawes County, NE, are the largest populated communities closest to the MEA. In 2010, the population of Chadron, located approximately 25 miles (40 km) northeast of the MEA, was recorded at 5,851 residents, reflecting an increase of 3.9 percent from 2000 (USCB, 2000, 2010). However, this has since decreased by 2.2 percent to an estimated population in 2016 of 5,725 residents (USCB, 2017b). Crawford, located 15.1 miles (24.3 km) to the north-northwest of the MEA, had a population of 997 residents in 2010, which was a 9.9-percent decrease from 2000 (USCB, 2000, 2010). Crawford's population continues to decrease by 3.6 percent, with an estimated population in 2016 of 961 (USCB, 2017c). This decline is consistent with the declining population in Dawes County as a whole, as Table 3-12 shows. The Town of Hemingford, located about 15.4 miles (24.8 km) to the south of the MEA in Box Butte County, had a population of 803 residents in 2010, which was a 19-percent decrease from 2000 (CBR, 2016).

Table 3-12 2010 and 2016 Estimated Population of Counties within a 50-Mile (80-km) Radius of the MEA

County	2010 Population	2016 Estimated Population
Dawes County, NE	9,182	8,979
Box Butte County, NE	11,308	11,194
Garden County, NE	2,057	1,930
Morrill County, NE	5,042	4,787
Scotts Bluff County, NE	36,970	36,422
Sheridan County, NE	5,469	5,234
Sioux County, NE	1,311	1,242
Fall River County, SD	7,094	6,849
Oglala Lakota County, SD[17]	13,586	14,415
Goshen County, WY	13,249	13,390
Niobrara County, WY	2,484	2,480

Source: USCB, 2017a

Overall, a review of the census results from 1970 through 2010 (USCB, 1995a, 1995b, 1995c, 2000, 2010) indicate that the populations of the counties within the 50-mile (80-km) radius of the MEA have been declining. This decline is a result of decreases in the rural farming-based economy and limited economic opportunities for the young adult population. Persistent drought conditions have also contributed to the reduction in the agriculture-based economy and have increased the out-migration of rural residents. Because many of the people migrating out of the area are young adults and families, this has resulted in an increasing proportion of the elderly population in the area (UNRI, 2005). The declining population trends of the last two decades are expected to continue into the foreseeable future, based on the lack of changes in land use or economic development activities, as described in Chapter 5.

The 2010 Census (USCB, 2010) found that more than 81.5 percent of the population in each of the counties within the 50-mile (80-km) radius of the proposed project site was white, with the exception of Oglala Lakota County, SD, which is entirely within the Pine Ridge Indian Reservation and is 96 percent American Indian. The southern boundary of the Reservation is approximately 35 miles (56.3 km) northeast of the northern boundary of the MEA. American Indians make up the largest nonwhite classification in the area. This group comprises nearly 4 percent of the population of Dawes County, including about 5 percent in Chadron and about 1 percent in Crawford. More than 70 percent of the population in each county was more than 18 years old in 2010, with the exception of Oglala Lakota County, which had about 39 percent of its population under 18 years old. In Dawes County, about 19 percent of the population was under 18 years old.

3.7.2 Local Socioeconomic Characteristics

In 2016, Dawes County's unemployment rate was 3.1 percent, with a total of 5,077 people employed (BLS, 2017a), a decrease from the 2010 rate of 4.4 percent (BLS, 2013). The unemployment rate in Box Butte County was 3.8 percent in 2016, with a total of 5,463 people employed (BLS, 2017a), a decrease from the 2010 rate of 5.5 percent (BLS, 2013). These are similar to the 2016 unemployment rate for the State of Nebraska of 3.2 percent (BLS, 2017b). In Dawes County, major economic sectors are educational services (17.9 percent of total labor force in 2015), health and social assistance (13.1 percent), retail (13.4 percent), accommodations and food service (10.8 percent), agriculture, forestry, fishing, hunting and mining (10.4 percent), construction (6.3 percent), government (5.2 percent), finance (3.9 percent), manufacturing

17 Shannon County was renamed as Oglala Lakota County in May 2015.

(3.3 percent), and transportation (3.1 percent) (DataUSA, 2017a). In Box Butte County, major economic sectors are transportation (21.2 percent), healthcare and social assistance (14.5 percent), agriculture, forestry, fishing, hunting and mining (8.8 percent), educational services (7.5 percent), manufacturing (7.3 percent), retail (6.9 percent), and construction (6 percent) (DataUSA, 2017b).

In 2015, the median household income in Dawes County was $41,038, which was 77 percent of the State average of $52,997 (UCSB, 2017a). In Box Butte County, per capita personal income was $51,691 in 2015, which was 98 percent of the State average (USCB, 2017a).

In 2015, Dawes County had a total vacancy rate of the combined owner-occupied and rented housing units of 568 units out of a total of 3,684 units, or 15.4 percent. In 2015, Box Butte County had a total vacancy rate of the combined owner-occupied and rented housing units of 740 units out of a total of 4,738 units, or 15.6 percent (NIFA 2017).

3.7.3 Housing and Commercial Uses

CBR identified two housing units within the MEA, one of which is occupied. An additional 25 housing units, seven of which are occupied, are within 2-miles (3.3-km) of the MEA (CBR, 2014, Section 3.1.2.3). The nearest retail and commercial establishments are in Crawford and Hemingford.

3.7.4 Environmental Justice Characteristics

The proposed MEA is located in Dawes County, NE, 15.1 miles (24.3 km) southeast of the city of Crawford and 15.4 miles (24.8 km) northwest of the town of Hemingford (located in Box Butte County). The applicant reported that the MEA contains all or a portion of, or is adjacent to, 23 blocks within Census Tract 9506 in Dawes County. ER Table 3.10-6 (CBR, 2014) provides the 2010 racial makeup of the block groups within these blocks in comparison to Dawes County and Nebraska as a whole. According to the 2010 Census, the combined population of the Census block groups within or adjacent to the MEA was 32 residents. The entire population was white, with one individual identified as Hispanic.

The NRC staff also reviewed the most recent U.S. Census data for the nearest population centers to the MEA. The racial makeup of the city of Crawford, with a total population of 997 residents, is 1 percent Hispanic, 0.9 percent American Indian, and 2.3 percent for two or more races, with smaller percentages of other races. The racial makeup of the town of Hemingford, with a total population of 803 residents, is 4.6 percent Hispanic, 1.2 percent American Indian, and 2.1 percent for two or more races, with smaller percentages of other races. These data indicate that Crawford and Hemingford are similar in terms of percentages of minority population.

Although NRC staff guidance uses Census block groups to analyze environmental justice, because of the extremely small population in Census block groups in and around the MEA, the staff chose to base its environmental justice analysis on data for minority and low-income populations in Crawford, the nearest major population center to the MEA.

Table 3-13 shows 2010 Census data on poverty (low-income) and minority populations for the entire United States, the State of Nebraska, Dawes County, and the city of Crawford. The minority population percentages for Nebraska and Dawes County are approximately one-third of the percentage across the United States. The minority population percentage in the city of

Crawford is approximately one-ninth that of the entire United States. The percentages of low-income populations are about the same for all four areas (slightly larger for Dawes County).

Table 3-13 Poverty and Minority Populations (2009–2013 Estimates)

Geographic Unit	Percentage of Individuals Below Poverty Level	Percentage Identifying as Not White Only
United States	13.8	36.3
Nebraska	14.0	13.9
Dawes County	17.5	10.6
City of Crawford	14.8	4.4

Source: USCB, 2015a

Tables 3-14 and 3-15 show the percentages of minority populations by race for Dawes County and the city of Crawford, respectively. Both Dawes County and the city of Crawford have significantly lower minority populations and percentages than the overall averages across the United States.

Table 3-14 Census Data for Minority Type Populations of Dawes County, Nebraska

Population by Race	Counts	Percentages
American Indian and Alaskan native alone	362	3.9
Asian alone	95	1.0
Black or African American alone	134	1.5
Native Hawaiian or Other Pacific Island alone	46	0.5
Some other race alone	104	1.1
Two or more races	233	2.5
Hispanic or Latino Origin alone	306	3.3
White alone	8,208	89.4

Source: USCB, 2010

Table 3-15 Census Data for Minority Type Populations of the City of Crawford, Nebraska

Population by Race	Counts	Percentages
American Indian and Alaskan native alone	9	0.9
Asian alone	2	0.2
Black or African American alone	1	0.1
Native Hawaiian or Other Pacific alone	7	0.7
Some other race alone	2	0.2
Two or more races	23	2.3
Hispanic or Latino Origin alone	10	1.0
White alone	953	95.6

Source: USCB, 2010

3.8 Transportation

Section 3.4.2 of the ISR GEIS (NRC, 2009a) describes the transportation corridor and traffic counts for roads in the Nebraska-South Dakota-Wyoming Uranium Milling Region. It acknowledges the reliance of NRC-licensed ISR facilities on roads for transportation of goods and personnel.

Figure 3-9 (see also CBR, 2014, Figure 1.4-1) shows the transportation links for the area, including routes between the MEA and the existing Crow Butte license area. Nebraska Highway 2/71 runs to the west of the MEA and converges with U.S. Highway 20 in the city of

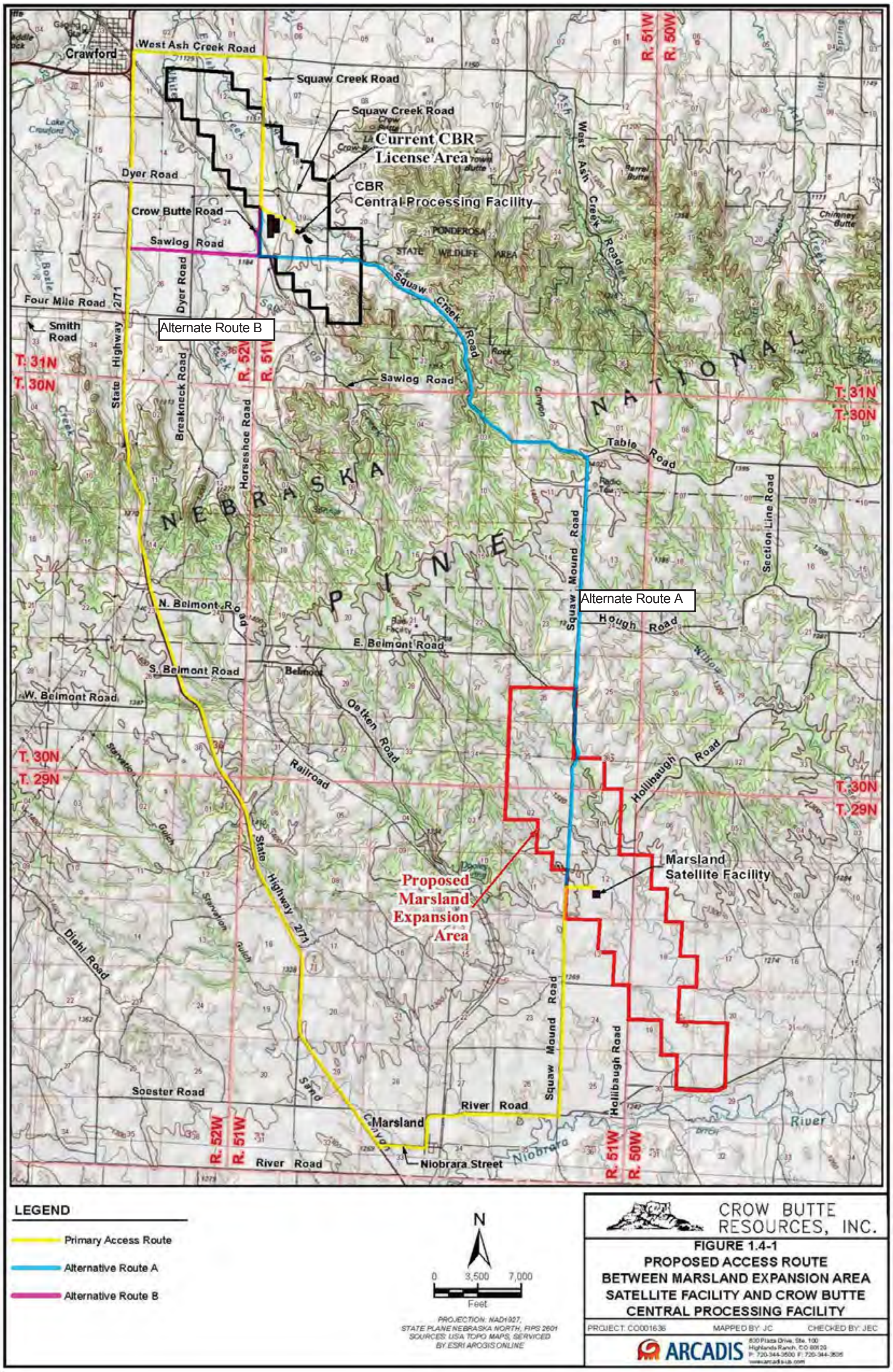


Figure 3-9 Proposed access route between MEA satellite facility and Crow Butte license area (Source: CBR, 2014, Figure 1.4-1)

Crawford northwest of the MEA. The MEA can be reached from Nebraska Highway 2/71 via East Belmont Road to the north, by Squaw Mound Road and Hollibaugh Road to the south, and by Squaw Mound Road to the north. The primary access route from the MEA to the existing Crow Butte license area comprises Squaw Mound Road, River Road, and Niobrara Street to Nebraska Highway 2/71; to West Ash Creek Road; and to Squaw Creek Road. An alternative route (Alternative Route A) also provides access from the north side of the MEA by heading north on Squaw Mound Road and west on Squaw Creek Road. A second alternative route (Alternative Route B) consists of Squaw Mound Road, River Road, and Niobrara Street to Nebraska Highway 2/71 and Sawlog Road (CBR, 2014, Figure 1.4-1). Access to buildings and agricultural lands within the MEA is through secondary and private roads connecting with East Belmont Road, River Road, Hollibaugh Road, and Squaw Mound Road. A Burlington Northern Santa Fe (BNSF) rail line runs to the west of the MEA and to the east of Nebraska Highway 2/71 to Crawford. Although not shown in Figure 3-9, U.S. Route 385 runs from north to south about 12 miles (19.3 km) east of the MEA. The access route to the MEA from U.S. Route 385 is from west on Dunlap Road, to north on Table Center Road, and west on River Road.

Nebraska Highway 2/71 is moderately traveled near Crawford and the existing Crow Butte license area, with traffic decreasing near the MEA (NDOR, 2015a). Traffic is heavier on U.S. Routes 20 and 385, increasing toward Chadron (NDOR, 2015a). Table 3-16 lists the 2014 average daily traffic counts for points along Nebraska Highway 2/71. In 2014, 151 traffic accidents occurred in Dawes County, with none resulting in a fatality and 47 resulting in injuries (NDOR, 2015b) while in 2015, 144 traffic accidents occurred, with three resulting in a fatality and 35 resulting in injuries (NDOR, 2016).

Table 3-16 Annual Average Daily Traffic Counts for the Roadways around the MEA and Existing Crow Butte License Area

Roadway	Trucks	All Vehicles
Nebraska Highway 2/71 at Crawford near West Ash Creek Road	50	605
Nebraska Highway 2/71 just south of Crawford near Sawlog Road	135	1,070
Nebraska Highway 2/71 at East Belmont Road	95	715
Nebraska Highway 2/71 near Marsland	95	725

Source: NDOR, 2015a

3.9 Noise

Section 3.4.7 of the ISR GEIS (NRC, 2009a) describes the existing ambient noise levels for the region. Noise levels for the undeveloped rural areas are estimated at 22 decibels (dB) on calm days to 38 dB on windy days. Ambient noise levels in the Dawes County, NE, communities of Crawford and Chadron were estimated to be in the range of 45 to 78 dB. Higher levels up to 70 A-weighted decibels (dBA) may be experienced near highways.

The MEA and the area surrounding it are primarily rural and undeveloped, with few residences. The existing ambient noise in the area is essentially the same as that for the surrounding rural environment. It comes primarily from intermittent noise from the rail line located about 1 mile (1.6 km) west of the MEA boundary at its closest point. Low levels of traffic noise are also associated with Hollibaugh and River Roads, U.S. Route 20, and Nebraska Highway 2/71. Agricultural equipment contributes to seasonal background noise (CBR, 2014, Section 3.7). Based on the remote location, agricultural uses of the land, and distance to the primary contributors to background noise (the rail line and highway), the NRC expects that ambient noise levels in the MEA would be relatively quiet in comparison with the levels in Crawford and Chadron noted above.

3.10 Visual and Scenic Resources

Section 3.4.9 of the ISR GEIS (NRC, 2009a) describes the visual and scenic resources of the Nebraska-South Dakota-Wyoming Uranium Milling Region. The uranium resources in Dawes County, NE, are in the Great Plains physiographic province, and the existing Crow Butte license area is located near the Pine Ridge Unit of the Nebraska National Forest. The ISR GEIS observes that for the Pine Ridge Unit and the nearby Oglala National Grassland (northwest of Crawford, near the South Dakota border), about 87 percent of the landscape is classified as having low to moderate scenic integrity objective classification, with the remaining 13 percent divided between high and very high.

The MEA is on private land. The land is not managed by any public agency to protect scenic quality, but the MEA may be visible from some public roads. The MEA is located on generally level ground south of the Pine Ridge escarpment, with most of the project area characterized by the low, rolling plains and agricultural land uses found in northwestern Nebraska. Previous and current human activity has modified the landscape to include cropland, roadways, rural residences, and utility corridors, although open land used for grazing is dominant. Under the BLM's Visual Resource Management (VRM) classification system, which provides a way to identify and evaluate scenic values to determine the appropriate levels of management, the MEA was evaluated to have a Class B scenic quality (an area seen from travel routes and areas with low to moderate use). A combination of the scenic quality ranking, sensitivity, and distance zones yielded a VRM Class III Objective for the MEA inventoried lands, meaning that CBR expects the existing character of the landscape will be partially retained and the level of change to the characteristic landscape would be moderate (CBR, 2014, Section 3.9.2.3).

Potential sensitive viewing areas in the area of review include the primary transportation routes through and adjacent to the project area, including East Belmont Road, River Road, Squaw Mound Road, Hollibaugh Road, and some widely scattered rural residences. Another potential sensitive viewing area is the Nebraska National Forest, Pine Ridge Ranger District, located north of the MEA along the Pine Ridge escarpment. Within the Nebraska National Forest is the Pine Ridge National Recreation Area, situated about 7 miles (11.3 km) northeast of the MEA. The recreation area is a 6,600-acre (2671-ha) tract managed by USFS for a semiprimitive backcountry experience. Technical discussions with the Nebraska National Forest, Pine Ridge Ranger District staff indicate that it is unlikely that activities associated with the proposed project at the MEA would be visible from most of the USFS land, including the Pine Ridge National Recreation Area (SC&A, 2012).

3.11 Public and Occupational Health and Safety

Background radiological and chemical characteristics of the site impact public and occupational health safety. The NRC staff considered the pathways by which releases, both radiological and chemical, could transmit to the environment and ultimately to living organisms through ISR activities at the MEA. To provide a baseline for this analysis, the licensee collected data on the background radiological and chemical characteristics through a preconstruction and preoperational environmental monitoring program. The results of this monitoring reflect occurrences of radionuclides and chemicals unrelated to the proposed activities at the MEA that either reflect natural background levels or levels associated with other unrelated activities. CBR performed the monitoring program in accordance with Regulatory Guide (RG) 4.1, "Radiological Environmental Monitoring for Nuclear Power Plants," Revision 2, issued June 2009 (NRC, 2009b), and collected at least 1 year of data on air particulates, radon gas, groundwater (from the non-ore zone, ore zone, and private wells in a 1.2-mile (2-km) radius of the MEA), surface water, vegetation, food, fish, soil, sediment, and direct radiation.

3.11.1 Air Characteristics

CBR monitored for air particulates, radon gas, and direct radiation at locations at or near the proposed satellite facility (MAR-1), close to the nearest occupiable structure (MAR-2), at or near the site boundary (MAR-3 (southeast) and MAR-4 (southwest)), and at a background location (MAR-5). See Figure 3-10 for the locations of these sampling points. The results for the fourth quarter of 2011 through the fourth quarter of 2012 are summarized as follows (CBR, 2014, Section 6.1.1.2):

- Lead-210 measurements were a consistent 2×10^{-14} microcuries per milliliter (µCi/ml) at all monitoring sites for all but the second quarter of 2012, when the level was 1×10^{-14} µCi/ml at all locations (above the detection limit of 2×10^{-15} µCi/ml).

- Radium-226 levels were at or less than the detection limit of 1×10^{-16} µCi/ml, except for the third quarter of 2012, when the level at MAR-2 was 5×10^{-10} µCi/ml.

- Thorium-230 levels were at or less than the detection limit of 1×10^{-16} µCi/ml, except for the first quarter of 2012, when the level at MAR-3 was 2×10^{-16} µCi/ml.

- Uranium levels were below the detection limit of 1×10^{-16} µCi/ml, except for the first quarter of 2012, when MAR-1 and MAR-5 each had a level of 2×10^{-16} µCi/ml, and MAR-2, MAR-3, and MAR-4 each had a level of 3×10^{-16} µCi/ml.

- The average radon concentrations for MAR-1 through MAR-4 ranged from 0.07×10^{-9} µCi/ml to 1.6×10^{-9} µCi/ml (average of 0.5×10^{-9} µCi/ml), as compared to MAR-5 (background) with a range of 0.1×10^{-9} µCi/ml to 1.0×10^{-9} µCi/ml (average of 0.6×10^{-9} µCi/ml) (detection limit 2×10^{-10} µCi/ml).

All levels are well below the effluent limits to air as stated in 10 CFR Part 20, “Standards for Protection against Radiation,” Appendix B, “Annual Limits on Intake and Derived Air Concentrations of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage.”

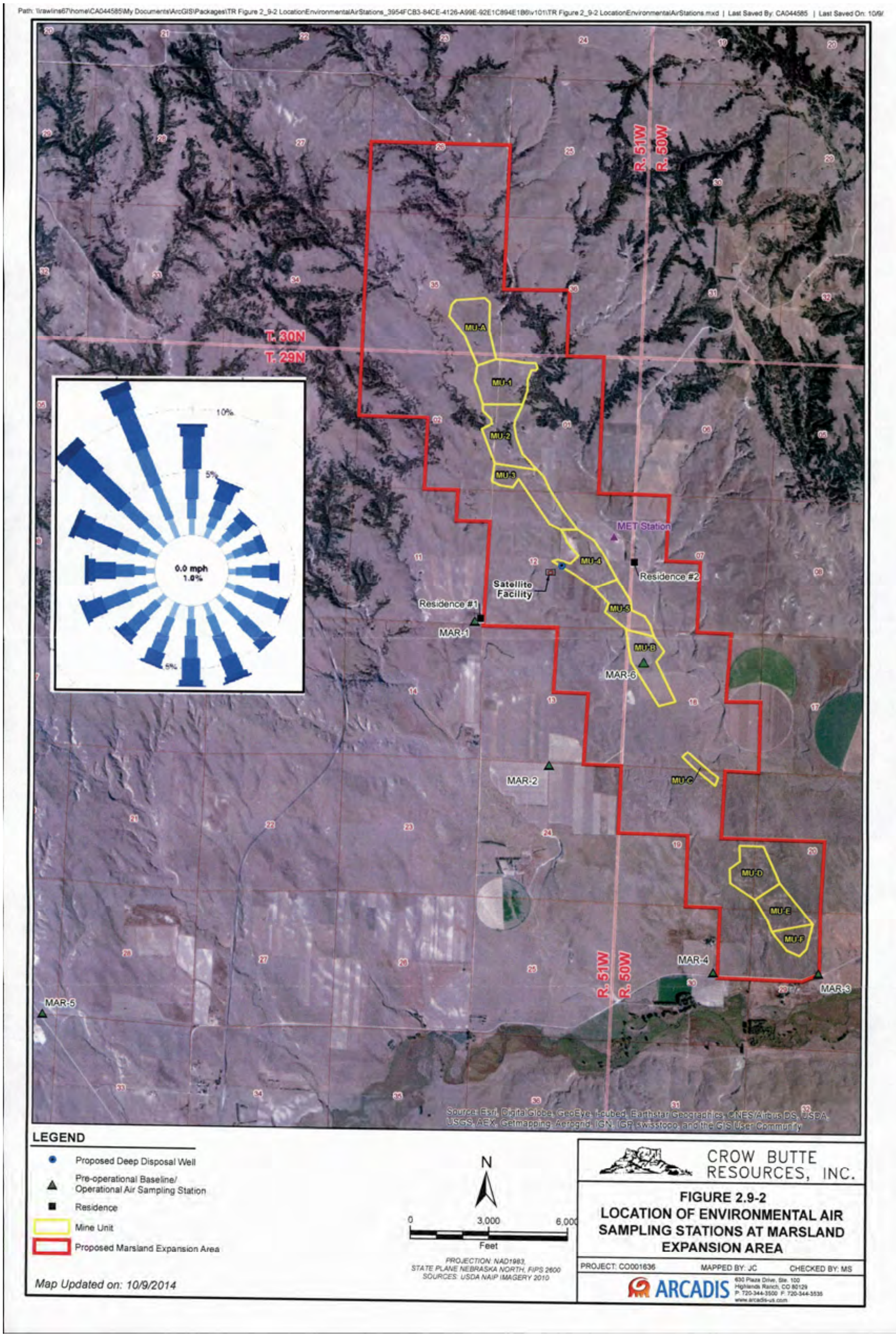


Figure 3-10 Locations of Environmental Air Sampling Stations (Source: CBR, 2015)

3.11.2 Groundwater Characteristics

As described in Section 3.3.2.4, the licensee measured the groundwater quality in private water wells (drawing from the Arikaree and Brule formations) from March 2011 to March 2013 and in CBR monitoring wells from November 2013 to September 2014 for the Arikaree monitor wells, December 2013 to September 2014 for the Brule monitor wells, and November 2011 to August 2012 for the Basal Chadron Sandstone aquifer monitor wells. The 135 private wells CBR monitored included locations within the MEA license boundary, less than 0.6 mile (1 km) from the license boundary, and within 1.2 miles (2 km) of the license boundary.

3.11.2.1 Nonradiological Characteristics

Table 3-17 summarizes the results of the preoperational monitoring program's nonradiological characterization of the groundwater. The nonradiological analytical results are consistent with those that would be expected for background concentrations for the area.

Table 3-17 Groundwater Nonradiological Characteristics

Constituent	Units	Mean (Range) Monitoring Results			
		Active Private Wells	CBR Monitoring Wells		
			Arikaree Formation	Brule Formation	Basal Chadron Sandstone Aquifer
Calcium	mg/L	38.9 (21–73)	36.5 (31–48)	21.7 (4–35)	7.14 (2–19)
Magnesium	mg/L	8.8 (3–13)	9.3 (6–18)	3.84 (<1–10)	1.17 (<1 U–3)
Sodium	mg/L	19.8 (8–49)	16.5 (6–26)	104 (18–408)	394 (298–514)
Potassium	mg/L	4.2 (2–13)	3.6 (1–5)	11.16 (3–38)	20.2 (8–40)
Bicarbonate	mg/L	201.9 (160–480)	186.7 (155–221)	26.2 (<1–205)	357 (140–918)
Sulfate	mg/L	10.2 (3–44)	7.1 (1–12)	26.2 (7–62)	172 (45–388)
Chloride	mg/L	3.5 (2–9)	4.2 (0.5–10)	92.1 (2–502)	259 (137–605)
Conductivity	µmhos/cm	329.9 (241–578)	330.8 (248–398)	669 (289–2,300)	1,835 (1,340–2,740)
TDS 180 C	mg/L	250.2 (202–400)	254.4 (220–300)	440 (200–1,280)	1,076 (791–1,400)
TDS Calculated	mg/L	270.7 (166–870)	244.4 (210–270)	439 (220–1,410)	1,063 (770–1,450)
pH	n/a	8.1 (7.64–8.5)	8.4 (8.3–8.5)	8.9 (8.1–10.8)	8.81 (8.29–9.72)
Cations	meq/L	3.6 (2.75–6.29)	3.4 (2.76–3.99)	6.14 (1.92–20.32)	18.2 (13.5–23.8)
Anions	meq/L	3.7 (2.94–6.71)	3.5 (2.76–4.09)	6.42 (3.07–21.67)	17.4 (13.6–24.6)

Source: CBR, 2015

3.11.2.2 Radiological Characteristics

Table 3-18 summarizes the results of the preoperational monitoring program radiological characterization of the groundwater. The radiological analytical results were at levels that would be expected for background concentrations of the area.

Table 3-18 Groundwater Radiological Characteristics

Constituent	Units	Mean (Range) Monitoring Results			
			CBR Monitoring Wells		
		Active Private Wells	Arikaree Formation	Brule Formation	Basal Chadron Sandstone Aquifer
Radium-226, Dissolved	µCi/ml	$2.3x10^{-10}$ ($<1.3x10^{-10}$–$9x10^{-9}$)	$1.22x10^{-10}$ ($<2x10^{-10}$–$4x10^{-10}$)	$2.25x10^{-10}$ ($<2x10^{-10}$–$1x10^{-9}$)	$1.91x10^{-8}$ ($2x10^{-10}$–$3.48x10^{-7}$)
Radium-226, Suspended	µCi/ml	$8.5x10^{-11}$ ($3x10^{-11}$–$2x10^{-10}$)	$1.28x10^{-10}$ ($<2x10^{-10}$–$6x10^{-10}$)	$1.27x10^{-10}$ ($<2x10^{-10}$–$9x10^{-10}$)	$1.86x10^{-10}$ ($<1x10^{-10}$–$9x10^{-10}$)
Uranium Activity, Dissolved	µCi/ml	$2.14x10^{-9}$ ($3.8x10^{-10}$–$3.9x10^{-9}$)	$4.23x10^{-9}$ ($2.6x10^{-9}$–$5.9x10^{-9}$)	$3.17x10^{-9}$ ($<2x10^{-10}$–$9x10^{-9}$)	$3.47x10^{-10}$ ($<2x10^{-10}$–9.5)
Uranium Activity, Suspended	µCi/ml	$1x10^{-10}$ ($<2x10^{-10}$–$6.5x10^{-10}$)	$3.44x10^{-10}$ ($<2x10^{-10}$–$6x10^{-10}$)	$1.9x10^{-10}$ ($<2x10^{-10}$–$5x10^{-10}$)	$1x10^{-10}$ ($<2x10^{-10}$–$6x10^{-10}$)
Uranium, Suspended	mg/L	0.0002 (<0.0003 U–0.001)	0.0003 (<0.0003–0.0017)	0.0002 (<0.0003 U–0.0007)	0.0011 (<0.0003 U–0.0295)
Uranium, Dissolved	mg/L	0.0071 (0.0028–0.0282)	0.0062 (0.0038–00087)	0.007 (0.0003–0.0282)	0.0068 (<0.0003 U–0.0771)

Source: CBR, 2015

3.11.3 Surface Water Characteristics

The MEA has only ephemeral drainages, and the lack of water flow in those drainages has prevented the collection of surface water samples until sufficient flow is available (CBR, 2015). However, CBR collected water samples from the Niobrara River, which is just south of the MEA boundary, from September 2013 through August 2014. CBR chose two Niobrara River sampling points: one (N-1) upstream (west) of the MEA license boundary, and one (N-2) downstream (east) of the license boundary. Table 3-19 shows the Niobrara River surface water radiological characteristics, which indicate that background radiation levels were low. As described in Section 3.3.1.2, based on its sampling, NDEQ has rated the Niobrara River in the vicinity of the MEA as Supported Beneficial Use for aquatic life, agricultural water supply, and aesthetics, but as Impaired for recreational use. Box Butte Reservoir is rated as Supported Beneficial Use for recreation, agricultural water supply, and aesthetics, but as Impaired for aquatic life and pH (CBR, 2015).

3.11.4 Baseline Vegetation, Food, and Fish Monitoring

Figure 3-11 shows the three locations where CBR collected vegetation samples: West, Middle, and East. The factors CBR used to select the vegetation sampling locations within the MEA were the three dominate wind directions, the grazing area availability, and private landowner access.

Table 3-19 Niobrara River Surface Water Radiological Characteristics

Constituent	Units	Concentration Minimum	Concentration Maximum	Nondetect Frequency	Nondetect Value Minimum	Nondetect Value Maximum
Upgradient Sampling Point N-1						
Dissolved Radiological Analytes						
Lead-210	µCi/ml	$<1x10^{-9}$	$2x10^{-9}$	8/12	$<1x10^{-9}$	$<1x10^{-9}$
Polonium-210	µCi/ml	$<1x10^{-9}$	$<1x10^{-9}$	12/12	$<1x10^{-9}$	$<1x10^{-9}$
Radium-226	µCi/ml	$<2x10^{-10}$	$5x10^{-10}$	11/12	$<2x10^{-10}$	$<2x10^{-10}$
Thorium-230	µCi/ml	$<2x10^{-10}$	$<2x10^{-10}$	112/12	$<2x10^{-10}$	$<2x10^{-10}$
Uranium Activity	µCi/ml	$8.8x10^{-9}$	$2.4x10^{-9}$	0/12	N/A	N/A
Uranium	mg/L	0.0035	0.013	0/24	N/A	N/A
Suspended Radiological Analytes						
Lead-210	µCi/ml	$<1x10^{-9}$	$1.1x10^{-9}$	11/12	$<1x10^{-9}$	$<1x10^{-9}$
Polonium-210	µCi/ml	$<1x10^{-9}$	$<1x10^{-9}$	12/12	$<1x10^{-9}$	$<1x10^{-9}$
Radium-226	µCi/ml	$<2x10^{-10}$	$3x10^{-10}$	10/12	$<2x10^{-10}$	$<2x10^{-10}$
Thorium-230	µCi/ml	$<2x10^{-10}$	$<2x10^{-10}$	12/12	$<2x10^{-10}$	$<2x10^{-10}$
Uranium Activity	µCi/ml	$<2x10^{-10}$	$<2x10^{-10}$	12/12	$<2x10^{-10}$	$<2x10^{-10}$
Uranium	mg/L	<0.0003	0.0051	11/12	<0.0003	<0.0003
Downgradient Sampling Point N-2						
Dissolved Radiological Analytes						
Lead-210	µCi/ml	$<1x10^{-9}$	$2.1x10^{-9}$	9/12	$<1x10^{-9}$	$<1x10^{-9}$
Polonium-210	µCi/ml	$<1x10^{-9}$	$3x10^{-9}$	11/12	$<1x10^{-9}$	$<1x10^{-9}$
Radium-226	µCi/ml	$<2x10^{-10}$	$5x10^{-10}$	8/12	$<2x10^{-10}$	$<2x10^{-10}$
Thorium-230	µCi/ml	$<2x10^{-10}$	$<2x10^{-10}$	12/12	$<2x10^{-10}$	$<2x10^{-10}$
Uranium Activity	µCi/ml	$1.2x10^{-9}$	$6.8x10^{-9}$	0/12	N/A	N/A
Uranium	mg/L	0.0018	0.01	0/12	N/A	N/A
Suspended Radiological Analytes						
Lead-210	µCi/ml	$<1x10^{-9}$	$1.6x10^{-9}$	11/12	$<1x10^{-9}$	$<1x10^{-9}$
Polonium-210	µCi/ml	$<1x10^{-9}$	$<1x10^{-9}$	12/12	$<1x10^{-9}$	$<1x10^{-9}$
Radium-226	µCi/ml	$<2x10^{-10}$	$4x10^{-10}$	11/12	$<2x10^{-10}$	$<2x10^{-10}$
Thorium-230	µCi/ml	$<2x10^{-10}$	$<2x10^{-10}$	12/12	$<2x10^{-10}$	$<2x10^{-10}$
Uranium Activity	µCi/ml	$<2x10^{-10}$	$8x10^{-10}$	10/12	$<2x10^{-10}$	$<2x10^{-10}$
Uranium	mg/L	<0.0003	0.0012	10/12	<0.0003	<0.0003

Source: CBR, 2015

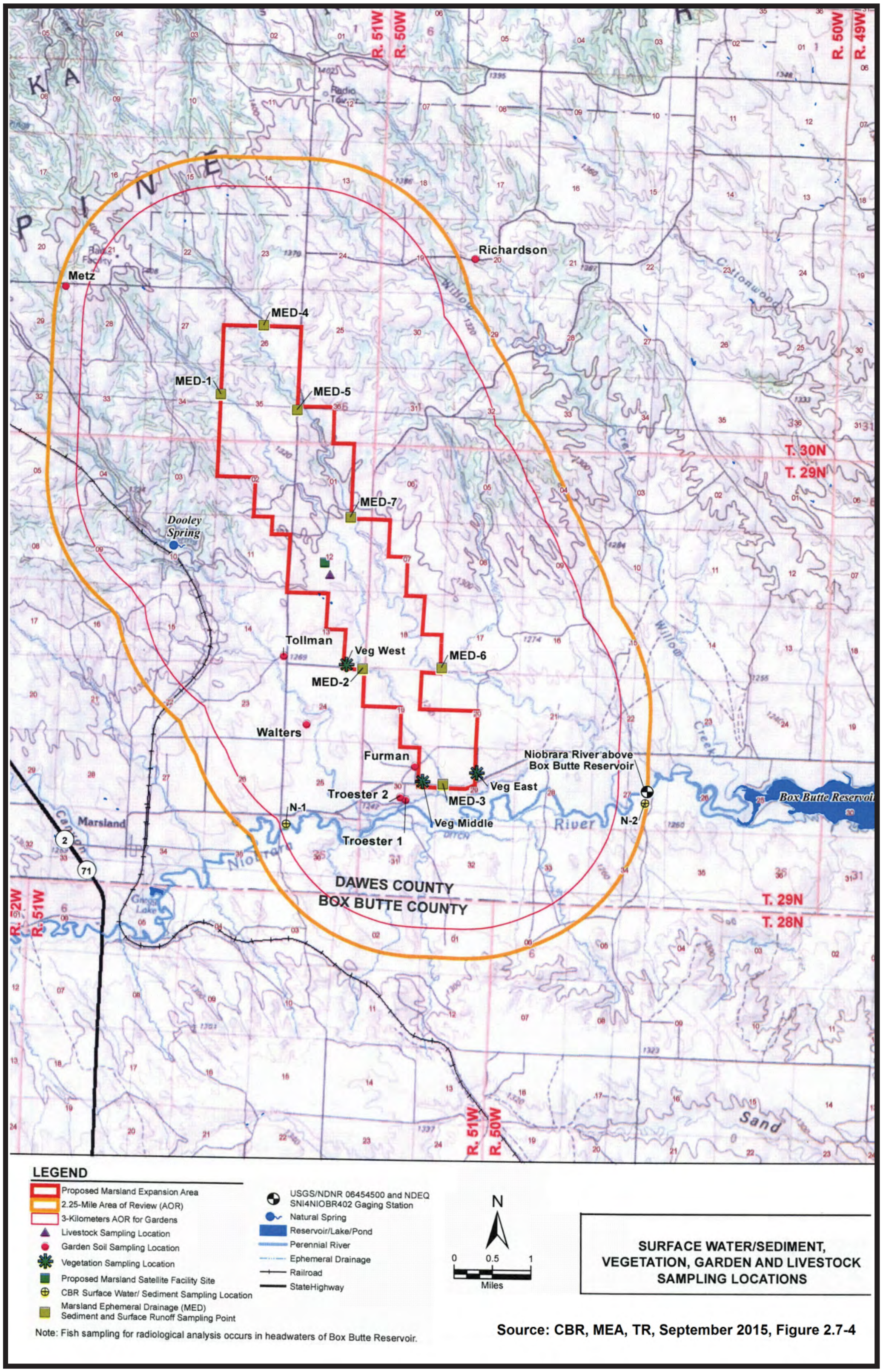


Figure 3-11 Surface water/sediment, vegetation, garden soil, and livestock sampling locations (Source: CBR, 2015)

CBR collected three samples (one from each location) three times during the grazing season and analyzed them for natural uranium, radium-226, thorium-230, lead-210, and polonium-210. Table 3-20 shows the results from the vegetation sampling.

Table 3-20 Vegetation Radiological Characteristics

Constituent	Units	Marsland West			Marsland Middle			Marsland East		
		6/26/13	7/19/13	9/13/13	6/26/13	7/19/13	9/13/13	6/26/13	7/19/13	9/13/13
Lead-210		4.6x10^{-5}	1.0x10^{-4}	1.5x10^{-4}	1.2x10^{-4}	1.1x10^{-5}	9.8x10^{-5}	2.5x10^{-5}	2.7x10^{-5}	7.5x10^{-5}
Polonium-210		4.6x10^{-6}	2.9x10^{-5}	5.9x10^{-5}	2.4x10^{-5}	2.1x10^{-6}	3.5x10^{-5}	2.7x10^{-6}	3.4x10^{-6}	1.4x10^{-5}
Radium-226	µCi/kg	1.1x10^{-6}	2.7x10^{-6}	4.7x10^{-6}	9.1x10^{-6}	4.0x10^{-7}	2.8x10^{-6}	1.8x10^{-6}	2.4x10^{-8}	2.6x10^{-6}
Thorium-230		4.6x10^{-6}	3.6x10^{-6}	9.3x10^{-6}	7.4x10^{-6}	9.3x10^{-7}	6.2x10^{-6}	1.6x10^{-6}	2.3x10^{-6}	3.1x10^{-6}
Uranium		4.2x10^{-4}	6.3x10^{-6}	5.0x10^{-5}	2.9x10^{-5}	1.6x10^{-6}	1.3x10^{-4}	6.8x10^{-7}	1.4x10^{-6}	1.1x10^{-4}
Uranium	mg/kg	0.63	0.0093	0.080	0.043	0.0023	0.20	0.0010	0.0021	0.16

Source: CBR, 2015

Because the quantity of vegetables that would have to be sampled to meet lower limits of detection is very large, and in many instances would decimate a private garden, the licensee used an alternative approach to estimating baseline radionuclide concentrations in vegetables. Rather than sampling the vegetables themselves, CBR sampled the vegetable garden soil and followed the methods and parameters in NUREG/CR-5512, "Residual Radioactive Contamination from Decommissioning: Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent," issued October 1992 (NRC, 1992a), to calculate the radionuclide concentrations in root and leafy vegetables and fruits based on the soil radionuclide concentrations. A similar alternative approach had been used by Powertech at the Dewey-Burdock site (Powertech, 2011), and the NRC staff had determined it to be acceptable (NRC, 2014h).

As Figure 3-11 shows, the licensee selected seven garden or crop locations and took soil, rather than vegetable, samples. Table 3-21 shows the results of this radiological characterization of crops.

Table 3-21 Crops Radiological Characteristics

Constituent	Units	Root Vegetables	Leafy Vegetables	Fruits
Lead-210		26.24	38.74	24.95
Polonium-210		Not detected	Not detected	Not detected
Radium-226	pCi/kg	13.85	22.06	12.82
Thorium-230		6.01	7.69	5.4
Uranium		13.35	17.13	11.87

Source: CBR, 2015

With the cooperation of a local landowner in March of 2014, CBR collected three animal tissue samples from locally raised beef cattle at the time of slaughter. In accordance with RG 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills," (NRC, 1980b), CBR analyzed the samples for natural uranium, radium-226, thorium-230, lead-210, and polonium-210. Table 3-22 presents the radiological characterization of the beef samples.

Table 3-22 Livestock (Beef) Radiological Characteristics

Constituent	Units	Sample 1	Sample 2	Sample 3	Mean
Lead-210	μCi/kg	8.8×10^{-6}	5.0×10^{-6}	6.1×10^{-6}	6.6×10^{-6}
Polonium-210		$<1.0\times10^{-6}$	$<1.0\times10^{-6}$	$<1.0\times10^{-6}$	NA
Radium-226		1.2×10^{-6}	2.0×10^{-7}	$<1.5\times10^{-7}$	5.2×10^{-7}
Thorium-230		$<2.0\times10^{-7}$	$<2.0\times10^{-7}$	1.0×10^{-6}	4.0×10^{-7}
Uranium		9.0×10^{-7}	2.0×10^{-7}	$<2.0\times10^{-7}$	4.0×10^{-7}

Source: CBR, 2015

The licensee did not collect preoperational samples of game animals because of the following factors (CBR, 2015):

- Hunting access is limited by private landowners.
- There are a limited number of game animals in the licensed area.
- Because of the migratory nature of game animals, it would be difficult to attribute any radionuclide concentration origins to the site.

Fish sampling within the MEA license boundary was not feasible because no streams or water impoundments are located within the MEA, and the two drainages that cross the MEA are typically dry. Instead, CBR collected samples of northern pike from the Niobrara River at the inlet to the Box Butte Reservoir on May 25 and September 26, 2014. Table 3-23 summarizes the radiological characteristics of the fish samples.

Table 3-23 Fish (Northern Pike) Radiological Characteristics

Constituent	Units	5/25/14	9/26/14
Lead-210	μCi/kg	2.8×10^{-5}	$<1.0\times10^{-6}$
Polonium-210		8.1×10^{-6}	$<1.0\times10^{-6}$
Radium-226		4.1×10^{-6}	8.0×10^{-7}
Thorium-230		8.0×10^{-7}	4.0×10^{-7}
Uranium		2.1×10^{-6}	1.5×10^{-6}
Uranium	mg/kg	0.0031	0.0023

Source: CBR, 2015

The Nebraska Department of Health and Human Services and other Nebraska agencies have issued fish consumption advisories to limit the consumption of northern pike in the reservoir because of elevated mercury concentrations (NDEQ, 2012a).

3.11.5 Soil Characteristics

Based on the guidance in RG 4.14 (NRC, 1980b), CBR collected soil samples at 984.3-foot (300-meter) intervals to a distance of 4,921.3 feet (1,500 meters) in each of eight directions from the centerpoint of the proposed MEA satellite facility. CBR also collected samples at the same intervals from the centerpoint of each proposed mine unit. Surface samples were collected to a depth of 2 inches (5 cm) and 5.9 inches (15 cm), once before construction and again for any disturbed locations. The samples were analyzed for radium-226; 10 percent were sampled for natural uranium, thorium-240, and lead-210. CBR took soil samples to 2 inches at air monitoring stations and analyzed them for natural uranium, radium-226, thorium-230, and lead-210. (CBR, 2015, Section 2.9.6). Similarly, CBR took subsurface samples at the centerpoint of the proposed MEA satellite facility and at a distance of 2,461 feet (750 meters) in each of four directions and other locations as noted in the TR (CBR, 2015). Subsurface soil profile samples were collected to a depth of 3.3 feet (1 meter). Table 3-24 shows the results of the soil sampling.

Table 3-24 Soil Radiological Characteristics

Constituent	Units	Surface Soil		Subsurface Soil		Background[a]	
		Mean	Range	Mean	Range	Mean	Range
Lead-210	pCi/g	1.4	(1.1–2)	1.3	(1–1.5)	Not Reported	
Radium-226		0.7	(0.2–1.2)	0.7	(0.2–1.3)	0.7	(0.2–1.2)
Thorium-230		0.4	(0.3–0.6)	0.6	(0.5–0.8)	Not Reported	
Uranium		0.5	(0.4–1.6)	0.5	(0.5–0.5)	0.6	(0.3–1.7)

a Background levels are derived from monitoring results to represent occurrences of radionuclides and chemicals unrelated to the proposed activities at the MEA that either reflect natural background levels or levels associated with other unrelated activities.

pCi = picocurie; g = gram

Source: CBR, 2015

3.11.6 Sediment Characteristics

CBR collected Niobrara River sediment samples on October 25, 2013 and May 2, 2014 from upgradient (N-1) and downgradient (N-2) sampling points (see Figure 3-11). Table 3-25 shows the analytical results for lead-210, radium-226, thorium-230, and natural uranium for both sampling points.

Table 3-25 Niobrara River Sediment Radiological Characteristics

Constituent	Units	Upgradient Sampling Point N-1		Downgradient Sampling Point N-2	
		10/25/13	5/2/14	10/25/13	5/2/14
Lead-210	µCi/kg	$1x10^{-6}$	$1.3x10^{-6}$	$3x10^{-7}$	$5x10^{-7}$
Radium-226		$6x10^{-7}$	$7x10^{-7}$	$4x10^{-7}$	$5x10^{-7}$
Thorium-230		$2x10^{-7}$	$2x10^{-7}$	$2x10^{-7}$	$2x10^{-7}$
Uranium		$3x10^{-7}$	$6x10^{-7}$	$2x10^{-7}$	$3x10^{-7}$

Source: CBR, 2015

Table 3-26 presents the results from CBR's sampling of ephemeral drainage sediments at the MEA. As shown in Figure 3-11, two major ephemeral drainages cross the MEA license area from north to south. CBR identified seven upgradient and downgradient sampling points on these drainages, denoted in Figure 3-11 as MED-1 to MED-7, to measure radiological concentrations in the sediment.

Table 3-26 Ephemeral Drainage Sediment Radiological Characteristics

Constituent	Units	Mean	Range
Lead-210	µCi/kg	$1.3x10^{-6}$	$(3.0x10^{-7}–2.1x10^{-6})$
Radium-226		$6.3x10^{-7}$	$(2.0x10^{-7}–1.2x10^{-6})$
Thorium-230		$3.1x10^{-7}$	$(1.5x10^{-7}–5.0x10^{-7})$
Uranium		$1.3x10^{-6}$	$(2.0x10^{-7}–7.2x10^{-6})$

Source: CBR, 2015

3.11.7 Baseline Direct Radiation Monitoring

CBR collected a total of 81 direct gamma measurements as part of the baseline radiological site investigation. The direct gamma measurements ranged between 11.8 microroentgen (μR)/hour and 14.2 μR/hour, with a mean of 13.2 μR/hour (CBR, 2015, Appendix BB, Table 17). In addition, Table 3-27 presents the net results of gamma measurements conducted at the air particulate monitoring stations (MAR-1 through MAR-5; see Section 3.11.1) for the fourth quarter of 2011 through the fourth quarter 2012.

Table 3-27 Quarterly Net Gamma Exposure Results (mrem)

Location	Q4-2011	Q1-2012	Q2-2012	Q3-2012	Q4-2012	Mean
MAR-1	6.7	6.5	9.6	9.9	11.9	8.9
MAR-2	6.7	7.5	Badge Lost	10.4	9.5	8.5
MAR-3	6.5	5.1	4.6	8.7	7.2	6.4
MAR-4	5.0	14.5	10.5	10.4	10.0	10.1
MAR-5	5.9	6.2	7.7	4.5	6.8	6.2

Source: CBR, 2015

Table 3-27 shows that the background quarterly net gamma exposure (MAR-5) ranged from 4.5 to 7.7 millirem (mrem) with an average of 6.2 mrem, while the MEA exposures (MAR-1 to MAR-4) ranged from 4.6 to 14.5 mrem with an average of 8.5 mrem.

4 ENVIRONMENTAL IMPACTS

In the ISR GEIS (NRC, 2009a), the NRC assessed the potential environmental impacts from the construction, operation, aquifer restoration, and decommissioning of an uranium in situ recovery (or ISR) facility located in one of four specified geographic regions of the western United States. As part of this assessment, the NRC determined which potential impacts would be similar for all ISR facilities and which would result in potential impacts unique to a particular facility and, therefore, would require further site-specific information to determine potential impacts. The NRC staff used the potential impacts outlined in the ISR GEIS as a starting point in assessing potential impacts for the MEA, then performed a site-specific review and data analysis to further consider the likelihood and significance of the potential environmental impacts.

The NRC staff reviewed the license amendment application, including the TR and ER and their revisions, requests for additional information, and other supplemental information (see Section 1.4), and evaluated the potential environmental impacts from the proposed action on the resource areas analyzed in detail in this draft EA (described in Chapter 3). The staff applied the guidelines outlined in NUREG-1748 (NRC, 2003a) in its evaluation. In accordance with this guidance, the staff evaluated the direct, indirect, short-term, and long-term effects that each resource may encounter from the proposed action. The staff qualified the effects in terms of SMALL, MODERATE, or LARGE:

- SMALL—Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
- MODERATE—Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
- LARGE—Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The staff also evaluated the potential cumulative impacts of the project with respect to whether the impacts would be significant, taking into consideration past and ongoing actions and possible future actions occurring in the area of review for a specific resource area.

As stated in Section 1.4.1, the determination as to the magnitude of the potential impact takes into account the enforcement of regulatory requirements or other requirements that would be stipulated in a license, should the NRC issue the requested license amendment. The analysis also takes into account the implementation of best management practices (BMPs) that the licensee has identified as essential parts of its proposed project.

In accordance with 122 NAC and NAC Title 135, “Rules and Regulations for Mineral Exploration Holes,” the State of Nebraska requires surface reclamation at the MEA. Specifically, 135 NAC requires that “any mineral exploration hole activities affecting land resources of the State shall ensure restoration to a condition consistent with the land use existing prior to the exploration.” Throughout Chapter 4, reference is made to surface reclamation and related activities such as revegetation and recontouring. These measures are important because they can minimize the potential impacts associated with many resource areas; namely, land use, geology and soils, water resources, air quality, and ecological resources.

Because surface reclamation activities are required by regulation, the NRC took into account the implementation of these measures when determining whether potential impacts on resource areas are SMALL, MODERATE, or LARGE.

4.1 Land Use Impacts

As noted in Section 4.2.1 of the ISR GEIS (NRC, 2009a), much of the total permitted area of ISR facilities would be expected to remain undisturbed since surface operations (wellfields and processing facilities) would affect only a small portion of the permitted area. The greatest disturbance of the land and subsurface would be expected to take place in the wellfields. The ISR GEIS notes that while the permitted areas of an ISR facility can be very large, such as 2,800 acres (1,134 ha) for the existing Crow Butte license area, the Crow Butte CPF at a commercial-scale facility may occupy only 2.5 to 15 acres (1 to 7 ha), and satellite plants may be even smaller. The ISR GEIS bounds the total permit area of a new ISR site to 2,471 to 17,297 acres (1,000 to 7,000 ha) and the total (disturbed land) surface area of a new ISR site, including multiple wellfields, a CPF, and satellite plants within the overall permit area, to 120 to 1,860 acres (50 to 750 ha). The MEA is within this estimate, as it would contain a licensed area of approximately 4,622 acres (1,870 ha) (CBR, 2014, Section 2.2), with an estimated 1,754 acres (710 ha) that could be affected over the life of the MEA project (CBR, 2014, Section 4.1.1). Of the 1,754 acres, currently planned facilities at the MEA would disturb approximately 13 percent, or 592 acres (240 ha), primarily for the 11 planned mine units but also for access roads, the satellite building and associated structures, and the DDWs. The MEA would not contain a CPF. The remaining 1,162 acres (470 ha) would potentially be disturbed by future site operations not yet planned, including roadways, exploration drilling, new and expanded mine units, wellhouses, and underground piping.

The ISR GEIS (NRC, 2009a, Sections 4.2.1 and Section 4.4.1), considers potential land use impacts from construction, operation, restoration, and decommissioning. Impacts to land use are projected by the ISR GEIS to be SMALL during construction, operation, and restoration because of the small area of land to be disturbed as compared to similar land surrounding a proposed ISR facility in the region, and compensation to landowners who lose access or use of their land. Impacts during decommissioning could be SMALL to MODERATE in the short term, decreasing to SMALL as restoration and decommissioning is completed and the land is restored to previous conditions and use.

4.1.1 Construction

Construction activities at the MEA, including site preparation, would include facility site grading, topsoil salvage, building erection, foundation installation, contouring for control of surface runoff, trenching, and construction of the access roads and DDWs. Drilling of individual wells and pipeline installation would also occur during construction of individual mine units (CBR, 2014, Section 4.1.1). Construction activities would not result in significant amounts of subsoil and geologic materials being removed or significant changes to the topography. CBR would implement sediment and topsoil management during construction (both initial construction of access roads and the satellite facility and other initial activities, and for individual mine units as they are opened over the lifetime of the project) in accordance with NDEQ requirements (CBR, 2014, Section 5.1.1.1). During final decommissioning, CBR would reclaim all disturbed areas and recreate approximate original contours. Thus, the changes in surface configuration would only be temporary, beginning with construction and continuing during operations and aquifer restoration, and returning to their original state as a result of decommissioning.

ISR construction activities would result in potential impacts to land use at the MEA from (1) changes and disturbances of existing land uses; (2) restricted access, including to livestock grazing and recreational areas; and (3) alterations to ecological, cultural, and historic resources. Construction of the MEA would temporarily restrict access to and prevent land from being used for other purposes, as discussed below. Sections 4.4 and 4.6 discuss potential impacts to ecological resources and cultural and historic resources, respectively.

Although potential land use impacts would be most intense during construction, they would be temporary and reversible. Only a relatively small fraction of the permitted site area would be temporarily impacted by land disturbance and access restrictions. In addition, postconstruction actions, such as recontouring and restoring surface cover, would minimize the temporary losses. According to CBR, postconstruction operations in the existing Crow Butte license area have shown that CBR can successfully restore the land surface following mining operations and that surface reclamation activities, including contouring and revegetation, have been performed routinely following initial wellfield construction (CBR 2014, Section 4.1.2).

During construction, property owners of land located within the immediate wellfield and facility boundaries would lose access and free use of areas that would be under development, which are currently used for agricultural purposes (CBR 2014, Sections 4.1.2 and 7.2.7.4). The exclusion of agricultural activities from these areas would not have a significant potential impact on local agricultural production given the small size of land that would be taken out of production. Surface lease and mineral royalty payments to the landowners are intended to offset these access restrictions. As discussed in Section 3.1, recreational uses are not prevalent at the MEA, although access to some areas potentially used for hunting would be lost during the project period.

As Table 4-1 shows, land uses that would be temporarily lost from MEA development would be grazing and some agricultural cultivation. About 59 percent (347.6 acres or 141 ha) of the 591.9 acres (240 ha) planned for disturbance would be mixed-grass prairie; 24 percent (143.6 acres or 58 ha), degraded rangeland; and 12 percent (71.9 acres or 29 ha), cultivated land. About 68 percent (795.1 acres or 322 ha) of the additional 1,162 acres (470 ha) that may be disturbed would be mixed-grass prairie; 16 percent (189.0 acres or 76 ha), mixed conifer; 7 percent (84.4 acres or 34 ha), degraded rangeland; and 5 percent (56.7 acres or 1 ha), cultivated land.

Areas of potentially disturbed land listed in Table 4-1 are small in comparison to areas with corresponding uses in the vicinity (CBR, 2014, Table 3.1-2). For example, the estimated total potential disturbance of 128.6 acres (52 ha) of cultivated land represents less than 5 percent of cropland (2,924 acres (1,183 ha)) within the 2.25-mile (3.6-km) area of review, while potential disturbance of 228 acres of degraded rangeland would represent less than 1 percent of the rangeland in the area of review.

Considering the relatively small size of the area that would be impacted by construction, the surface disturbance and exclusion of agricultural activities would not significantly impact local or regional agricultural production or other land uses. The limited potential impacts would be temporary and reversible. CBR would be required to minimize impacts and to return the land through postmining surface reclamation to a condition suitable for original, preconstruction uses (primarily grazing and cultivation). CBR also would compensate landowners affected by access restrictions. Therefore, the NRC staff concludes that the potential impacts to land use from construction activities at the MEA would be SMALL.

Table 4-1 Estimated Acres Disturbed by MEA Development

	Type of Habitat Cover								
Disturbed Area	Cultivated	Mixed--Grass Prairie	Range Rehabilitation	Structure Biotype	Degraded Rangeland	Drainage	Deciduous Streambank Forest	Mixed Conifer	Total
Initial Acres[a] Disturbed by MEA Satellite Facility, 11 Mine Units, Deep Disposal Well and Access Routes									
Mine Units (11)	71.7	343.7	6.9	8.9	143.6	7.2	0	5.6	587.6
SAT		1.8							1.8
Access Route to SAT		1.6				0.1			1.7
DDWs (6)[b]	0.20	0.52				0.07			0.79
INITIAL DISTURBED ACRES	**71.9**	**347.6**	**6.9**	**8.9**	**143.6**	**7.4**	**0**	**5.6**	**591.9**
Long-Term Acres[a] Disturbed by Additional Site Operations									
All Additional Long-Term Activities[c]	56.7	795.1	0.2	8.0	84.4	23.9	4.7	189.0	1,162.0
TOTAL DISTURBED ACRES	**128.6**	**1,142.7**	**7.1**	**16.9**	**228.0**	**31.3**	**4.7**	**194.6**	**1,753.9**

a Convert acres to hectares by multiplying values in table (acres) by 1.6.
b The estimated disturbance area for each of six DDWs (~0.5 acre (0.2 ha) for a total of 3 acres (1 ha)) overlaps areas to be disturbed by mine unit development; this overlapped acreage of the DDWs within the mine units is not included in the estimated DDW disturbance acres since the disturbed acreage has already been addressed.
c Multiple new activities such as roadways, exploration/delineation drilling, new and expanded mine units, wellhouses, and underground piping.
SAT = satellite facility
Source: CBR, 2014, Table 4.1-1

4.1.2 Operations

The NRC staff expects the types of potential land use impacts for operational activities at the MEA to be similar to potential construction impacts with regard to access restrictions. As noted above, access restrictions would be in place over the operational life cycle of the ISR facility. Property owners of land located within the immediate wellfield and satellite facility boundaries would not have access to or use of these areas. These areas are presently used for agricultural purposes. As noted in Table 4-1, CBR estimates that the project would initially affect approximately 491 acres (199 ha) of rangeland[18] and 71.9 acres (29 ha) of cropland. Assuming a value of $89.73 per acre per year for livestock and a value of $121.70 per acre per year for nonlivestock agricultural products (NASS, 2014), initial planned construction and operation would result in lost livestock production of about $44,060 per year and lost crop production of about $8,750 per year. Assuming that additional long-term activities would disturb another 879.5 acres (356 ha) of rangeland and 56.7 acres (23 ha) of cropland (see Table 4-1), by the end of the life of the project, a total of 1,370.5 acres (555 ha) of livestock range and 128.6 acres (52 ha) of cropland could potentially be affected, for an annual loss of approximately $122,975 per year of livestock production and approximately $15,650 per year of crop production. The small annual value of this potential impact would not significantly affect local or regional agricultural production. These

18 347.6 acres (141 ha) of mixed-grass prairie plus 143.6 acres (58 ha) of degraded rangeland = 491 acres (199 ha).

limited potential impacts would be temporary and reversible, and the land would be returned to its former use through surface reclamation after ISR operations are complete. In addition, CBR would compensate landowners through surface leases and mineral royalties, as applicable.

Additional land disturbances during project operation would include well drilling and pipe laying activities as individual mine units are brought into production, but the primary infrastructure (i.e., satellite building and support facilities, main access roads) would be in place. As active operation is moved from one wellfield to another, potential impacts would also shift as each wellfield worked through the cycle of construction, operation, and restoration. Expected land disturbances from these activities are already accounted for in the acreage estimates given in Table 4-1. The NRC requires licensees to conduct environmental monitoring to identify impacts to soil in addition to other environmental media. At the end of the project, CBR would conduct surveys as part of decommissioning to ensure potentially impacted areas are appropriately characterized and remediated (NRC, 2009a, Section 4.2.1.2).

These assessments are consistent with the discussion in the ISR GEIS. Because access restriction and land disturbance impacts would be expected to be similar to or less than those expected for construction, the NRC staff concludes that the overall potential impacts to land use from operational activities would be SMALL.

4.1.3 Aquifer Restoration

Once a mine unit has completed uranium recovery operations, CBR would conduct groundwater restoration activities at that mine unit, in conformance with NRC and NDEQ requirements. Aquifer restoration uses the same infrastructure as the operation phase. Therefore, for the reasons discussed in Section 4.1.2 above, and consistent with the analysis in the ISR GEIS (NRC, 2009a), the NRC staff concludes potential land use impacts at the MEA from aquifer restoration activities would be SMALL.

4.1.4 Decommissioning

Under the separate outdoor area decommissioning provisions in 10 CFR 40.42, a mine unit would undergo decommissioning and surface reclamation after the NRC approves groundwater restoration of that mine unit. Once all operations at the individual wellfields had ceased, the remaining MEA facilities (e.g., access roads, satellite facility) would undergo final, sitewide decommissioning, in accordance with an NRC-approved decommissioning plan. In general, as described in ER Section 5.1 (CBR, 2014), surface reclamation would return the land surface to preoperational condition. The goal of CBR’s surface reclamation plan would be to return disturbed lands to production compatible with a postoperation land use of equal or better quality than the preconstruction condition (CBR, 2014, Section 5.1). For the MEA, this means that the reclaimed lands should be able to support livestock grazing and provide wildlife habitat. CBR would seek to limit soil erosion and sedimentation and reestablish natural drainage patterns by blending affected areas with adjacent undisturbed lands to recreate their original slope and topography.

Consistent with the analysis in the ISR GEIS (NRC, 2009a, Section 4.2.1.4), the NRC staff expects potential land use impacts during decommissioning to be similar to those for construction (SMALL), temporarily increasing as heavy equipment is used for land reclamation and dismantling of wellfield materials, pipelines, and the satellite facilities. Most of these potential impacts would occur on previously disturbed land and would result in only small additional potential impacts to land use (within the acreages given in Table 4-1). As a result of decommissioning activities, the land would be restored to its original condition and use. Therefore, the NRC staff concludes that the overall potential impacts to land use from decommissioning would be SMALL.

4.2 Geology and Soils

4.2.1 Impacts to Geology

Based on the NRC's evaluation in the ISR GEIS (NRC, 2009a, Sections 4.2.3 and Section 4.4.3), ISR activities would have little potential impact on geological resources, with the exception that extraction operations would remove uranium in the geologic formation through dissolution by the lixiviant solution and pumped to the surface for further processing. Furthermore, the proposed action would not affect the basic geology of the MEA, and the inherent geologic hazards in the area do not pose a significant danger or public safety hazard. Potential impacts related to natural geologic hazards are not likely to occur as a result of minor topographic alterations from ISR activities. The MEA has no landslide areas, and, because no subsurface rock volume would be removed during construction and operation associated with the proposed action, the project would not initiate landslides, mudslides, debris flows, slumps, or other forms of mass movement.

Because of the low seismic activity in the region of the MEA, the potential for associated damage to project facilities is low. The sandstone host rock containing the uranium is naturally filled with water. Because the ISR process simply recirculates water at pressures slightly below normal within these sandstones, it is highly unlikely that the proposed action could initiate any seismic activity.

The MEA has no unique and specific geologic features that the ISR GEIS (NRC, 2009a) does not addressed generically. Because formations in the area of review are considered highly fossiliferous (Section 3.2.1.3), the risk of disturbing vertebrate fossils during construction activities could be moderate to high. Potential impacts on vertebrate fossils would be greatest in areas where bedrock layers are exposed during land-clearing activities. Such activities would be limited to construction activities at the MEA and are not anticipated at a large scale. Although potential impacts on fossils could be moderate to high in some areas, in view of the relatively small area of disturbance, the NRC concludes that overall impacts on paleontological resources would be SMALL.

As discussed above, the NRC staff concludes that overall potential impacts to geological resources from the MEA would be SMALL. Furthermore, although there may be significant impacts to paleontological resources on a local scale, overall potential impacts to the resource would be SMALL.

4.2.2 Impacts to Soils

The clearing of vegetation, excavating, leveling, stockpiling, compacting, and redistributing soils are all activities associated with the MEA that could lead to potential impacts to soils. Potential impacts include loss of soil, sedimentation of the soil, compaction, increase in salinity, changes in productivity, and soil contamination. These disturbances would continue until the area was revegetated as part of reclamation that would occur following the decommissioning of the mine units and final, sitewide decommissioning. Because of the nature of the soil (shallow to deep silt loams and loamy, very fine sands), wind and water erosion are of most concern (CBR, 2014, Section 3.3.1.6).

Hazards for soil erosion as a result of wind at the MEA are generally high to moderately high because the soils present have one or more major constituents that can easily be picked up and spread by wind. However, CBR notes that almost all MEA soils likely to be disturbed by project activities are also considered to have high soil resiliency (i.e., inherent ability to recover degradation) and high potential for successful restoration (CBR, 2015, Section 2.6.1.6). CBR would control wind erosion by removing vegetation only where necessary, avoiding clearing and grading on erosive areas, surfacing roads with locally obtained gravel, and conducting timely reclamation (CBR, 2014, Section 4.3.1.1).

Because various soils within the MEA meet the criteria for severe water erosion hazard, water erosion is also possible at the MEA, especially in disturbed areas where the removal of vegetation has exposed the soil and excavation has broken down soils to increase the likelihood of runoff and gully formation. CBR would reduce soil loss by avoiding highly erosive areas such as badlands and steep drainages. CBR would locate roads in areas where cuts and fills would not be required, surface roads with gravel, install drainage controls, and reseed and install water bars across the reclaimed areas (CBR, 2014, Section 4.3.1.1).

To assess the potential impacts of flooding or erosion on MEA operations, CBR conducted flood and erosion studies (CBR, 2014, Appendices K-1 and K-2). The studies examined peak discharge rates and velocities associated with a 100-year storm and with storms with shorter return frequencies to determine whether the potential for erosion or flooding at the MEA would warrant special design features or other measures to be implemented. The studies focused on catchment and watershed delineation, hydrologic characteristics, and the identification of areas most prone to flooding and subsequent erosion. CBR prepared an erosion risk potential map and evaluated the potential placement of the proposed wellfields, the satellite facility, and DDWs. Based on these studies, the erosion risk for mine units (MUs) A and 1 would be either low or very low, while the erosion risk at MUs C, D, and E would be very low. MU 5 would have multiple locations of moderate erosion risk. MU 2, MU 3, MU 4, and MU B would have locations of potential moderate and high erosion risk, but this level of risk would apply to only 2 to 7 percent of the area within these units.

CBR acknowledges that additional hydrologic and erosion analysis may be required during specific phases of site grading and engineering design to supplement the current studies. For instance, specific phases requiring additional analysis may include the final design of the mine unit (locations of buildings, wells, and piping), DDWs, or the satellite facility building and associated structures (CBR, 2015, Section 3.1.4.5).

CBR would use ditches, diversions, culverts and other BMPs to control surface water flow within the MEA. CBR intends to develop and implement an erosion and sediment control plan during construction, operation, and reclamation activities to reduce soil losses within the license area and to protect surface and subsurface assets.

NDEQ follows permitting regulations for the control of stormwater discharges related to construction, as detailed in NAC Title 119, “Rules and Regulations Pertaining to the Issuance of Permits Under the National Pollutant Discharge Elimination System” (CBR 2014, Section 4.4.1). Every 5 years, NDEQ issues a General NPDES Storm water Discharge Permit for construction sites. Individuals and companies can apply for authorization to discharge construction-related stormwater under this permit. CBR is currently authorized under NDEQ’s General NPDES Discharge permit but would have to be reauthorized every 5 years.

CBR would use the results of the flood and erosion studies to support current and future planning of the project design and layout. For example, CBR would use the results of these studies to identify areas that may require special design features or measures to reduce impacts (e.g., berms around areas of mine units, strategically located drainage channels, culverts on roadways).

Using the results of erosion and flood analyses, CBR would construct facilities outside of flood-prone boundaries in order to avoid potential impacts to facilities from flooding and potential impacts to major ephemeral drainages and the Niobrara River in the event of any potential spills or leaks.

CBR's BMPs include the following (CBR, 2015, Section 3.1.4.6):

- Surface structures/wells would be located outside of the 100-year flood zone boundaries when possible. Any facilities that would have to be built within the 100-year flood zone boundaries would be protected from flood damage by the use of control measures such as diversion/collection ditches, channels, storm drains, slope drains, and/or berms.

- Pipelines would be buried below the frost line, and pipeline valve stations would be located outside of the 100-year flood zone in order to avoid damage from potential surface flooding.

- Efforts would be made to avoid placement of production, injection and monitor wells in potential flood prone areas (using results of erosion and flood risk analyses), but if it is necessary to place such wells in these areas, surface water control measures (e.g., diversion or erosion control structures) would be used. Wellheads in these areas can be built so that the casing extends above grade and is mounted on a concrete pad. Aboveground protective housing can be used to protect the well casing in the event of flooding. CBR currently uses an anchored metal or plastic protective housing (similar to a 55-gallon drum with the ends cut out), which affords protection in the event of flooding. As applicable, wellheads would be sealed in order to withstand brief periods of submergence.

- All construction tasks would be conducted in compliance with applicable stormwater general permit requirements under the National Pollution Discharge Elimination System (NPDES).

CBR would design and implement effective risk management strategies (discussed below) to minimize the potential impacts of flooding and the resulting transport of contaminated soils (CBR, 2014, Section 1.3.2.13). CBR routinely implements administrative and engineering controls and conducts construction activities under General NPDES Permit NER160000.

The stormwater pollution prevention plan (SWPPP) requirements NDEQ issued for the existing Crow Butte license area are expected to be the same for the MEA. These requirements assume that all precipitation falling on active mine units is contaminated, and the requirements include provisions to prevent contaminated water and sediment from entering surface water. For example, CBR would be required to develop a pollution control strategy for preventing the discharge of pollutants through the use of storm water diversion, containment structures, roof coverings, preventive maintenance, good housekeeping, pollutant source minimization, spill prevention practices, site inspections, and maintaining current documentation.

A number of activities, however, have the potential to cause adverse impacts to soils, including earth-moving activities associated with the construction of surface facilities, access roads, wellfields, and pipelines. Some erosion and productivity problems resulting from the MEA may cause a long-term declining trend in soil resources. Potential long-term impacts to soils include productivity and stability, which could occur as a result of large-scale surface grading and leveling. Reduction in soil fertility levels and reduced productivity would affect diversity of reestablished vegetative communities. Such activities could also reduce moisture infiltration, potentially creating soil drought conditions. Vegetation could undergo physiological drought reactions. CBR would address these potential impacts through the BMPs and measures described in ER Section 4.3.1.1 (CBR, 2014). BMPs for stormwater management and erosion control are based on EPA guidance (EPA, 2014).

If there were a spill or leak of hazardous materials at the MEA, impacts to soils could occur. To address this possibility, CBR has developed and implemented the Safety, Health, and Environment Quality Management System (SHEQMS) to ensure that all levels of workers and crew follow due diligence in addressing environmental, health, and safety issues. The SHEQMS describes how the operations of the facility would comply with CBR's Safety, Health, and Environmental Quality Policy and regulatory requirements (CBR, 2015, Section 5.2.1). In the eight-volume SHEQMS, the most relevant to mitigating unintended releases of hazardous material are the Environmental Manual (Volume 6), Emergency Manual (Volume 8), and Standard Operating Procedures Manual (Volume 3).

In addition to the SHEQMS, CBR has complementary plans in place, including a spill prevention, control, and countermeasure (SPCC) plan to follow if such a situation occurred. The plan includes procedures for accidental discharge reporting, spill response, and cleanup measures (CBR, 2015, Section 7.1.3.2). CBR is also committed to following BMPs to control erosion, minimize disturbance, and facilitate reclamation as described in the MEA TR, Section 7.1.3.2 (CBR, 2015).

The SWPPP would also require that CBR develop a spill response plan that identifies personnel responsible for implementing the SWPPP and an employee education program that ensures the SWPP would be effectively implemented.

CBR would include soils in decommissioning surveys, and any soils exceeding NRC release limits at 10 CFR Part 40, Appendix A, Criterion 6 would be removed and disposed of as 11e.(2) byproduct wastes (CBR, 2017, Section 4.3.2). Implementation of CBR's spill prevention plan and BMPs would minimize this volume of soil waste.

Based on CBR's comprehensive SHEQMS program, implementation of BMPs proposed by CBR in its application, CBR's operational and contingency plans, CBR's approach to the facility design to minimize the potential effects of erosion, and NDEQ permit requirements, the NRC staff concludes that overall potential impacts to soils from the MEA would be SMALL.

4.2.3 No-Action Alternative

If the NRC does not grant the amendment to the license, no new development activities would take place at the MEA. Wells and other structures that may have been constructed for the purpose of obtaining data about the groundwater and uranium deposits (i.e., during preconstruction activities) in the area would be plugged and the surrounding area restored. Activities at the existing Crow Butte license area would continue to take place in accordance with its license. Therefore, the NRC expects the potential impacts on geology associated with these closure activities at the MEA to be SMALL.

4.3 <u>Water Resources</u>

Potential environmental impacts on water resources may occur during all phases of the uranium recovery lifecycle, which includes construction, operation, aquifer restoration, and decommissioning. This assessment is divided into two sections: (1) impacts to surface waters (Section 4.3.1) and (2) impacts to groundwater resources (Section 4.3.2). Impacts to surface waters can result from road and wellfield construction, channel filling, road travel, soil erosion, surface water runoff, spills or leaks, and wellfield operations (NRC, 2009a, Sections 4.2.4 and 4.4.4). Impacts to groundwater resources can result from spills or leaks (fuels, lubricants, and discharges of wellfield fluids from pipeline or wellhead leaks), horizontal and vertical excursions of lixiviant from the production zone (Basal Chadron Sandstone aquifer), water quality degradation and water chemistry impacts on the Basal Chadron Sandstone aquifer and surrounding aquifers, and consumptive water use (e.g., production bleed).

4.3.1 Surface Water Impacts

Under the proposed action, soil disturbances from road construction, vehicular traffic, and wellfield construction, operations, and decommissioning could result in soil erosion and sediment transport during periods of ephemeral surface water flow. In addition, spills or leaks of fuels and lubricants, and discharges of wellfield fluids from pipeline or wellhead leaks could affect surface water quality. This section details the potential environmental impacts on surface water quality and quantity from the construction, operation, aquifer restoration, and decommissioning phases of the proposed action.

4.3.1.1 Surface Water Quality

<u>Construction</u>

As noted in the ISR GEIS (NRC, 2009a, Sections 4.2.4 and 4.4.4), potential impacts to surface waters from construction would involve road crossings, increased sedimentation, erosion, runoff, and spills or leaks of fuels and lubricants from construction equipment. The accumulation of sediment or the erosion of existing soils can lead to potential releases of pollutants to surface water. The likelihood of significant sediment or erosion problems is greatest during construction activities. Potential additional wellfield development may increase the sediment load into the Niobrara River. Precipitation and the resulting runoff may also transport small amounts of sediments into the drainage features.

As described in Section 4.2.2 of this draft EA, CBR would implement administrative and engineering controls and conduct construction activities at the MEA, as required by General NPDES Permit NER160000 (CBR, 2014, Section 1.3.2.14). Under that permit, CBR's is required to implement procedures that control runoff and the deposition of sediment in surface water features during construction activities. These procedures are contained in the SHEQMS Environmental Manual (Volume 6) and require active engineering measures (such as berms) and administrative measures (such as work activity sequencing) to control runoff and sedimentation of surface water features. Each year, CBR must submit a construction plan for the coming year and must obtain NDEQ authorization before proceeding. CBR must remediate spills of petroleum products or hazardous chemicals into surface waters or related habitats in accordance with the General NPDES Permit NER160000 requirements and report the event to NDEQ.

The NDEQ NPDES regulatory program contained in NAC Title 119 requires that procedural and engineering controls be implemented so that runoff will not pose a potential source of pollution.

The design and engineering controls for the proposed MEA facilities would collect any potentially contaminated stormwater runoff or snowmelt (e.g., any tankage diking, or curbing outside the satellite building) and dispose of it in an onsite DDW (CBR, 2014, Section 1.3.2.11).

In addition to the requirements outlined in the SHEQMS, CBR would also be required to follow procedures in the SWPPP and SPCC plans designed to prevent, control, and mitigate any spills should they occur. Engineering and procedural controls contained in the SWPPP, in combination with the design of the project facilities, would ensure that stormwater runoff is not a potential source of pollution (CBR, 2014, Section 1.3.2.11).

CBR would mitigate potential impacts to surface water using methods described in ER Section 5.4.2 (CBR, 2014, Section 5.4.2) to prevent erosion and the accumulation of sediment through runoff and by compliance with General NPDES Permit NER160000 and NDEQ regulations.

Based on CBR's comprehensive SHEQMS program, SWPPP and SPCC plan requirements, implementation of BMPs proposed by CBR in its application, development of operational and contingency plans, and the NDEQ permit requirements, the NRC staff concludes that overall potential construction impacts to surface water quality at the MEA would be SMALL.

Operation

The only surface water present within the MEA is water that collects in natural drainage swales or low-lying depressions after large precipitation events. Several proposed access roads are the only features that would have a direct potential impact on these drainage features (CBR, 2016a, Section 4.5.3). To alleviate these potential impacts, CBR intends to install culverts below each road crossing to maintain flow. Although potential ponding and increased sediment deposition could occur immediately upstream of these features, and additional erosion and scarring could occur immediately downstream, these processes would be very localized and would not lead to any pervasive long-term impacts on the functional integrity of the drainage system within the MEA.

CBR's flood and erosion analyses described in Section 4.2.2, indicates that the MEA generally carries a low potential for erosion (and therefore a low potential for sediment delivery to the Niobrara River). However, some small, localized areas within the MEA carry a moderate to high erosion potential. As described in Section 4.2.2, if wells cannot be placed outside of areas within the wellfield deemed to carry moderate to high erosion risks, CBR would implement measures (e.g., berms) to minimize the potential for flooding and erosion. CBR would further define these measures during final engineering and before any construction. As a result of these measures, sediment delivery to the Niobrara River would be insignificant.

CBR identified one wetland site within the MEA that has formed in a low-lying depression with ephemeral water created by runoff and precipitation. This wetland is located outside of the area proposed for disturbance. Therefore, no direct impacts to wetlands are anticipated. Also, for the reasons described above and in Section 4.2.2, the potential for sedimentation of wetlands within and near the MEA is insignificant.

As required by General NPDES Permit NER160000, CBR would also have in place an SWPPP that provides detailed descriptions of the sediment and erosion controls, in addition to descriptions of potential pollutant sources, spill prevention and control measures, and outfall controls (CBR, 2015, Section 7.1.3.2). CBR would implement a wide range of BMPs, such as avoiding construction in erosive or steep areas, removing vegetation only where necessary, resurfacing roads with locally obtained gravel, initiating timely and effective reclamation, diverting runoff to avoid disturbed areas, conducting inspection and repair, and other measures (CBR, 2015, Section 7.1.3.2).

Potential impacts to surface water can result from spills of barren lixiviant or wastewater leaks reaching surface streams via drainage swales (NRC, 2009a, Section 4.4.4.1.2, page 4.4-10). At the existing Crow Butte license area, CBR has never had a spill that exceeded the threshold criteria for a reportable spill under the requirements of 10 CFR Part 20. However, CBR has had several leaks of lower magnitude (in terms of volume or contaminant concentration or both) that required reporting to State regulators. CBR has investigated and mitigated the impacts immediately following the release or spill as warranted (NRC, 2014).

CBR would place the piping underground from the satellite facility to and within the wellfield. The only pipes that would typically not be buried below the frost line would be at the wellheads and in the wellhouses in the wellfields (CBR, 2014, Section 3.12.2.5). CBR would place pipeline valve stations outside of the 100-year flood zone to avoid damage due to potential surface flooding (CBR, 2014, Section 1.3.2.14). Typically, CBR would construct the pipe of high-density polyethylene (HDPE) HDPE with butt-welded joints or equivalent, pressure test all pipelines before placing into operation, and monitor trunkline flows and manifold pressures for spill detection and process control (CBR, 2014, Section 3.12.2.5).

Breaks in the buried lines would be unlikely because the lines would be below the frost line (thereby protecting them from vehicular traffic), and comprised of HPDE. Although pipe leaks and breaks would be possible, the potential releases would be small because CBR would leak test the piping before placing the piping into service, and continuously monitor the flows through the wellfield piping and manifold pressure gauges in the wellhouses by control room operators using visual and audible alarms.

CBR would be required to maintain a list of the spills or leaks that occur at the MEA and to demonstrate compliance with the regulations. NRC and NDEQ would confirm the spill and leak history during their review of the decommissioning plan to ensure reclamation. Because CBR would operate within the conditions of its permits, including flow monitoring and spill response procedures, concrete curbing, and berms to contain spills and facilitate clean up, potential impacts from any unintended discharges would be controlled. In order to minimize potential impacts from spills, CBR would implement its SPCC Plan. The plan includes procedures for reporting accidental discharges, spill response, and cleanup measures. CBR would ensure that the satellite building was constructed with secondary containment, and that a regular program of inspections and preventive maintenance was in place (CBR, 2014, Section 4.4.2.2). Potential impacts, should they occur, would be mitigated through proper planning, timely response, compliance with permit conditions, and BMPs, as described in Section 4.2.2. CBR's routine water quality monitoring program would also identify any potential impacts that may occur so that they could be addressed. Based on permitting requirements, NRC's license conditions, CBR's spill mitigation and response plans and BMPs, the NRC staff concludes that the potential impacts from accidental spills on surface waters during operations would be SMALL.

In summary, activities related to the operation of the wellfield are conducted under NDEQ permitting regulations for the control of construction stormwater discharges. NDEQ NPDES permitting would require CBR to implement procedures that control runoff and the deposition of sediment in surface water features during operational activities. Given the applicable permitting and reporting requirements, the NRC staff concludes that potential impacts to surface water quality from MEA operations would be SMALL.

Aquifer Restoration

Activities occurring during aquifer restoration that could impact surface waters include the management of produced water, stormwater runoff and accidental spills, and management of brine reject from the reverse osmosis system (Section 2.3.5). An important difference between potential impacts during operation and restoration is that CBR would no longer be pumping lixivant through the wellfield piping. CBR would, however, implement the spill and leak monitoring program, and control stormwater quality under a SWPPP, in the same manner as during operations.

Based on CBR's comprehensive SHEQMS program, implementation of BMPs, development of a SWPPP and operational and contingency plans, and compliance with NRC and NDEQ permit requirements, the NRC staff concludes that the potential impact on surface water quality during the ISR aquifer restoration phase at the MEA would be SMALL.

Decommissioning

Wellfield decommissioning would occur sequentially during the operational lifetime of the MEA. Once a mine unit was depleted of uranium and groundwater restoration was completed and accepted by the NRC, CBR would schedule the wellfield for decommissioning. CBR would remove the buried piping and utilities and plug and abandon the wells using accepted practices identified as part of the NDEQ UIC program.

Surface reclamation activities, both within individual wellfields during wellfield decommissioning and in other areas during overall sitewide decommissioning before license termination would include replacing excavated soils, removal and disposal of contaminated soils, recontouring affected areas, and reestablishing original drainage and revegetation. CBR completed surface and subsurface reclamation of a significant portion of MU 1 at the existing CBR license area following NDEQ and NRC approval of groundwater restoration. The area in MU 1 has been successfully recontoured, and revegetation has been completed in accordance with regulatory requirements (CBR, 2014, Section 4.1.2).

During decommissioning of the MEA, the NRC anticipates temporary impacts to surface waters from sediment loading associated with the removal of piping, linear crossings, and other facility infrastructure. Activities to clean up, recontour, and reclaim the land surface during decommissioning would involve revegetation and slope stabilization that would mitigate potential long-term impacts on surface waters. CBR would control stormwater runoff by implementing an SWPPP during decommissioning activities. Based on these considerations, the NRC staff concludes that impacts to surface water quality from decommissioning would be SMALL.

4.3.1.2 Surface Water Quantity

Construction

As described in Section 3.3.1, stream drainages within the MEA are ephemeral in nature and flow only in response to precipitation events and snowmelt. CBR would mitigate or reclaim any changes to ephemeral drainages that may impact stream flow from grading and changes in topography and natural drainage patterns after completion of any new construction. Due to land disturbance, there may be changes to the amount of surface water runoff relative to recharge. During construction, however, CBR would control stormwater runoff by implementing a SWPPP, applying BMPs and following the General NPDES Permit NER160000 requirements.

Changes in the surface configuration caused by construction and installation of operating facilities affecting surface water runoff would be temporary during the operating period. CBR would mitigate these changes by topsoil removal and storage along with the relocation of subsoil materials used for construction purposes (CBR, 2014, Section 5.1.1.2). During decommissioning, CBR would restore the original land surface to be consistent with the pre- and post-mining land use. Affected areas would be blended with adjacent topography to approximate original contours. CBR would re-establish drainage patterns by returning the earthen materials moved during construction to their approximate original locations (CBR, 2014, Section 5.1.1.2).

Drainage channels that CBR modified during construction, such as road crossings, would be re-established by removing fill materials and culverts and reshaping to as close to pre-operational conditions as practical (CBR, 2014, Section 5.1.1.2). CBR would re-contour disturbed surface drainage areas by grading and contouring to allow for controlled surface water runoff and eliminate depressions where water could accumulate (CBR, 2014, Section 5.1.1.2). CBR would recontour previously planted agricultural fields to approximate pre-existing contours and ripped to depths of 12 to 18 inches (30.5 to 45.7 cm) to relieve compaction and enhance natural recharge (CBR, 2014, Section 4.5.2).

Based on CBR's commitment to follow the procedures outlined in the SWPPP, implementation of BMPs, development of operational and contingency plans, and the General NPDES Permit NER160000 requirements, the NRC staff concludes that overall potential construction impacts to surface water quantity at the MEA would be SMALL.

Operations

The Niobrara River is a perennial stream located approximately 0.24 mile (0.4 km) southeast of the southern boundary of the MEA (CBR, 2014, Figure 1.3-1). The MEA would have very little impact on streamflow because no water would be drawn from or discharged to the river, and the planned groundwater injection and extraction associated with ISR activities would be too deep and hydraulically isolated (see Section 3.3.2.5) to adversely affect groundwater recharge to the stream. CBR would control potential changes to surface water runoff due to surface disturbance by implementing a SWPPP.

Based on CBR not discharging to or extracting from surface water, and their commitment to follow the procedures outlined in the SWPPP, implementation of BMPs, development of operational and contingency plans, and following the General NPDES Permit NER160000 requirements, the NRC staff concludes that overall potential impacts to surface water quantity during plant operations at the MEA would be SMALL.

Aquifer Restoration

Similar to both the construction and operation phases, during aquifer restoration CBR would not withdraw from or discharge water to the Niobrara River. Based on CBR's lack of physical interaction with the Niobrara River, hydraulic isolation of the Basal Chadron Sandstone aquifer from the river, CBR's commitment to follow the procedures outlined in the SWPPP, implementation of BMPs, development of operational and contingency plans, and following the General NPDES Permit NER160000 requirements, the NRC staff concludes that overall potential impacts to surface water quantity during aquifer restoration at the MEA would be SMALL.

Decommissioning

As described above, during decommissioning CBR would restore the original land surface to be consistent with the pre- and post-mining land use. Since the disturbances created by ISR mining are relatively minor and would not require extensive removal of soil and geologic materials the existing topography would only be interrupted in small, localized areas, and recontouring to the original approximate topography would be readily achievable during final surface reclamation. Because the disturbances associated with these activities during decommissioning would be short lived and over relatively localized areas, the NRC staff concludes that overall potential impacts to surface water quantity during decommissioning at the MEA would be SMALL.

4.3.2 Groundwater Impacts

Under the proposed action, potential environmental impacts on groundwater at the MEA may occur throughout the project lifecycle; such impacts would primarily occur during operations and aquifer restoration activities. ISR activities can impact aquifers overlying the ore-bearing Basal Chadron Sandstone aquifer. This section details the potential environmental impacts on groundwater quantity and quality from the proposed action; that is, construction, operation, aquifer restoration, and decommissioning.

4.3.2.1 Groundwater Quantity

Construction

Activities at the MEA could involve construction of as many as 11 mine units. CBR would construct the mine units in sequence, with each unit taking an average of about 6 months to construct. Consumptive use of groundwater is defined as the volume of water removed from an aquifer that is not returned to the same aquifer, and potential impacts to groundwater quantity during construction of the mine units are primarily from the consumptive use of groundwater. As noted in the ISR GEIS, the volume of water consumed during construction (for dust control, drilling support, and cement mixing) would be generally small and temporary relative to the water supply available (NRC, 2009a, Section 4.4.4.2.1). This is also expected to be the case at the MEA.

In 2011, CBR performed an aquifer pumping test at the MEA that involved pumping groundwater from the Basal Chadron Sandstone aquifer for 100 hours at about 27 gpm (102 Lpm). This test resulted in a consumptive use of about 162,000 gallons (613,236 L) of water. CBR would also perform additional aquifer pumping tests to provide coverage in the southern portion of the MEA (CBR, 2015, Section 2.6.1.3) and to identify hydrologic boundaries. The pumping rates for the future tests most likely would be very similar to the 2011 test, although the durations would probably be shorter because of the more localized areas being tested. The small amount of drawdown and rapid recovery during the 2011 aquifer pumping test indicates that the consumptive use of water during the test had minimal impact on the resource. The consumptive use volumes of groundwater required for the future aquifer pumping tests and subsequent drawdowns and recoveries are expected to be similar to the 2011 test, and therefore would have minimal impacts.

Because of the limited nature of intrusive drilling activities and limited consumptive use during well development and aquifer testing, the NRC staff concludes that potential construction impacts on groundwater quantity would be SMALL.

Operation

During uranium production, more water would be pumped from the Basal Chadron Sandstone aquifer than would be returned (i.e., production bleed). This is referred to as consumptive use. Consumptive use of the Basal Chadron Sandstone aquifer groundwater effectively maintains inward and downward hydraulic gradients into the production zone, thereby making excursions less likely to occur.

To more completely appreciate the potential impacts from consumptive use, it is important to understand how water is stored in unconfined versus confined aquifers (i.e., Basal Chadron Sandstone aquifer). In a water table (i.e., unconfined) aquifer, the amount of water that can be delivered from storage is derived from the amount of water present in the open pores (i.e., porosity) interspersed between the grains of the aquifer matrix (e.g., sand). Therefore, water pumped from the unconfined aquifer will drain the aquifer, as exhibited by a decrease in the water level. The drainable porosity of an unconfined aquifer is defined as specific yield and ranges between 0.1 and 0.3 (Lohman, 1972). If the water level decreases at a rate that is faster than it can be replenished by natural recharge, the water is considered "mined" from the aquifer.

In a confined aquifer, however, not only is the water stored within the open pore space (i.e., porosity), but there is some additional storage created because of compaction of the water within the aquifer caused by the combined weight of the overlying rocks and water. This weight slightly compresses the water in the aquifer and pressurizes the aquifer. If water is pumped from the confined aquifer, the pressure will be reduced and water will be released from two sources. First, the water entering the well will expand back to an unpressurized volume, and second, as pressure is released in the aquifer, the particle grains will realign and move closer together, thereby reducing the porosity. If the confined aquifer is pumped until the potentiometric surface falls below the top of the aquifer, the aquifer will become unconfined and, as described above, the water will derive solely from the draining of the porosity. Because neither the water nor the aquifer matrix is very compressible, the amount of water required to drop the potentiometric surface in a confined aquifer by 1 foot (0.3 meter) would be far less than that required to lower the water table by 1 foot once the aquifer became unconfined and the pores started to drain. Storativity describes the volume of water that a confined aquifer releases from storage per unit drop in hydraulic head. Because the storage in a confined aquifer is derived from the expansion of water and compression of the aquifer matrix, it is far smaller than specific yield, with typical storativity values of a confined aquifer ranging from 5×10^{-5} to 5×10^{-3} (Todd 1980). As discussed in EA Section 3.3.2.3, the mean storativity of the Basal Chadron Sandstone aquifer obtained during the 2011 aquifer pumping test was $2.56\text{x}10^{-4}$ (ranging from $1.7\text{x}10^{-3}$ to $8.32\text{x}10^{-5}$).

From a practical standpoint, whether an aquifer is confined is very important to the uranium recovery operations. In accordance with License Condition 10.7 (NRC, 2014f), CBR is required to control the lateral movement of lixiviant by maintaining an inward hydraulic gradient within the perimeter monitoring well ring. This inward gradient would be created by adjusting the wellfield production flow to a rate that is slightly greater than the injection flow. As described above, the volume of water required to create this inward gradient by lowering the potentiometric surface of a confined aquifer is much smaller than that required to decrease the water table by the same amount in an unconfined aquifer.

CBR would implement operating procedures at the MEA to minimize the consumptive use of water requiring disposal via DDW including (1) designing wellfields to maximize the ability to continuously minimize the amount of production bleed through continuous and effective wellfield balancing; (2) minimizing the consumptive use of process water by injecting all of the ISR fluids except for the small production and restoration bleed streams necessary to maintain an inward hydraulic gradient in each wellfield configuration; and if necessary, (3) using two stages of reverse osmosis to treat restoration fluids and reduce the total required wastewater disposal capacity (CBR 2015, Section 3.1.7).

Annual estimates of consumptive use at the MEA range from 21 gpm (79.5 Lpm), when mining would be initiated, to about 338 gpm (1,279.5 Lpm), when multiple mine units would be either in production or restoration (CBR, 2016, Appendix GG, Attachment A).

To assess whether the potentiometric surface of the Basal Chadron Sandstone aquifer would remain above the top of the Basal Chadron Sandstone aquifer (i.e., confined) throughout the operational period, CBR applied a groundwater model to predict the drawdown of the potentiometric surface caused by the simultaneous pumping at the MEA and TCEA as well as at the existing Crow Butte license area (CBR, 2016, Appendix GG). The height of the pre-pumping potentiometric surface above the top of the Basal Chadron Sandstone aquifer ranges from 380 to 500 feet (115.8 to 152.4 meters) over the license area (CBR, 2016, Appendix GG, Figure 21). Therefore, if the cumulative drawdown from the consumptive use is less than 380 feet (115.8 meters) over the license area, the Basal Chadron Sandstone aquifer would remain confined.

The CBR model input parameters included transmissivity, storativity, and projected consumptive use rates for each of the mine units within the existing Crow Butte license area and proposed expansion areas, except for NTEA. Transmissivity is defined by the aquifer thickness multiplied by the permeability (i.e., hydraulic conductivity). The transmissivity multiplied by the hydraulic gradient and cross-sectional area determines the volume of water flowing through an aquifer or aquitard. CBR's model drawdown projections should be considered conservative because they do not include the impact of groundwater recharge on the Basal Chadron Sandstone aquifer over a large radius of influence.

Although CBR did not include the proposed NTEA in the analysis because it is too uncertain when or whether this facility may become operational, sufficient information could be derived from the analysis to draw reasonable conclusions had it been included. The model computed drawdown impacts over the period 2011 through 2052, corresponding to the approximate historical groundwater monitoring period at the MEA, future ISR facility operations, and the expected aquifer recovery period after all pumping has ceased. The anticipated consumptive use average yearly rates for MEA, TCEA, and the existing Crow Butte license area are provided as Attachment A (CBR, 2016, Appendix GG).

To match historical drawdowns during the model calibration process, CBR assigned a lateral "no-flow" boundary to the easternmost extent of the Basal Chadron Sandstone aquifer (see Figure 3-8). A "no-flow" boundary literally means that no groundwater flows across the boundary. The modeling assumed that this lateral no-flow boundary, which trends northwest to southeast parallel to the main mineralized trend at the MEA and existing Crow Butte license area, is located approximately 2 to 3 miles (3.2 to 4.8 km) east of the easternmost MEA permit boundary. Dickinson (1990) provides an isopach (i.e., thickness) map of the Basal Chadron Sandstone aquifer that supports this assumption, in that the Basal Chadron Sandstone aquifer is not present east of the "no-flow' boundary.

CBR computed cumulative drawdown impacts from multiple ISR facilities by summing the drawdown impacts of individual facilities using the principal of superposition. This simply means that the drawdown effects from the individual facilities are additive. For example, if pumping at the

MEA results in a drawdown of 50 feet (15.2 meters) at a specified point, and the drawdown at that same point from pumping at the TCEA and the currently licensed facility are 10 feet (3 meters) and 5 feet (1.5 meters), respectively, then the total drawdown at that point would be 65 feet (19.8 meters). If this same drawdown analysis is extended into a two-dimensional plane, then areal drawdown maps can be constructed as shown in the figures provided in CBR (2016, Appendix GG).

CBR computed drawdown impacts resulting from MEA operations over an assumed period from 2020 to 2042, the expected duration of the MEA ISR operation. The model also simulated a 10-year aquifer recovery period from 2042 to 2052. The results of the modeling indicate that maximum cumulative drawdown at the MEA would occur in 2028 and would be less than 111 feet (33.8 meters), of the available 380 to 500 feet (115.8 to 152.4 meters) of drawdown, over the period of combined ISR operations (2011 to 2052). This year (2028) corresponds to the second highest expected consumptive use rate at the MEA (310 gpm (1,175 Lpm)) and to the last year of consumptive water use at the existing Crow Butte license area. Therefore, at the time of maximum cumulative drawdown, more than 320 feet (97.5 meters) of available drawdown would remain within the MEA wellfields and greater than 270 feet (82.3 meters) would remain within the MEA permit boundary.

CBR did not consider consumptive use in the model for the proposed NTEA because of the uncertain start up time and other significant operational unknowns. A maximum bound on the potential drawdown that would be associated with the proposed NTEA operations, however, can be estimated from the drawdown predictions provided in CBR (2016, Appendix GG Figure 19). In that figure, the maximum drawdown created by pumping at the existing Crow Butte license area and at the proposed TCEA would be about 29 and 13 feet (8.8 and 4 meters), respectively. Because the proposed NTEA is between 2 and 6 miles (3.2 and 9.6 Km) farther from the MEA than either the TCEA or the existing Crow Butte license area, it is very unlikely that the drawdown caused by pumping at NTEA would exceed 29 feet (8.8 meters) at the MEA. Therefore, it can be reasonably expected that the Basal Chadron Sandstone aquifer would remain saturated even if uranium production at the NTEA occurred.

CBR would confirm the model projections during ISR operation to ensure that the Basal Chadron Sandstone aquifer remained saturated, and if necessary, a corrective action plan would be developed and submitted to NRC for review and approval (CBR 2016, Section 7.2.5.4). To achieve this goal, CBR would install additional monitoring wells to collect water-level data that would not be impacted by groundwater withdrawals during water-quality sampling.

The model also projected the recovery times for the potentiometric surface once pumping at the existing Crow Butte license area and expansion areas had ceased. The potentiometric surface recovers to 95 percent of its preoperation levels within 10 years (CBR, 2016, Appendix GG, Figure 19).

With respect to categorizing potential impacts, the NRC staff concludes that the lowering of the potentiometric surface of the Basal Chadron Sandstone aquifer would be noticeable and would therefore result in a MODERATE impact. The resource would not be destabilized and result in a LARGE impact, however, unless the potentiometric surface falls below the top of the aquifer and the withdrawal rates exceed the ability of the natural recharge to replenish the aquifer causing the mining of the groundwater. Furthermore, the lowering of the potentiometric surface below the top of the aquifer does not necessarily destabilize the resource, as long as withdrawal rates are lower than the sustainable yield of the aquifer. As described above, there are operational incentives for maintaining confinement of the aquifer.

Based on expected consumptive use rates and available drawdown above the top of the Basal Chadron Sandstone aquifer, the NRC finds that the potential short-term impact from consumptive groundwater use during operations at the MEA to be MODERATE. As discussed in Section 3.3.3.2, there were no wells identified within the 2.25-mile (3.62-km) area of review that draw water from the Basal Chadron Sandstone aquifer. Although it is conceivable that the decrease in the potentiometric surface could potentially impact future local water users by requiring that the water be pumped from greater depths, the resource would not be destabilized (i.e., potentiometric surface) and water levels would eventually recover after aquifer restoration is complete. Thus, the NRC staff concludes that the overall potential long-term impact from consumptive groundwater use would be SMALL.

Aquifer Restoration

The ISR GEIS explains that potential environmental impacts on groundwater resources during aquifer restoration are related to the consumptive use of groundwater and waste management practices, including discharge to evaporation ponds (which are not proposed for the MEA and would require a license amendment) and deep disposal of brine. In addition, aquifer restoration directly affects groundwater quality in the vicinity of the wellfield being restored (NRC, 2009a, Section 4.2.4.2.3).

The consumptive use of groundwater during aquifer restoration is generally greater than during ISR operations (NRC, 2009a, Section 4.2.4.2.3). This is particularly true during the sweep phase, when a greater amount of groundwater is generally withdrawn from the production aquifer. During the sweep phase, groundwater is not reinjected into the production aquifer and all withdrawals are considered consumptive. As discussed in Section 4.3.2.2, CBR applied a groundwater model to estimate the potential environmental impacts from consumptive use. The height of the potentiometric surface above the top of the Basal Chadron Sandstone aquifer at the time of maximum drawdown (i.e., in 2028) is projected to be greater than 320 feet (97.5 meters) within the MEA wellfields and greater than 270 feet (82.3 meters) within the MEA permit boundary during ISR operations (2011–2042). Therefore, it can be reasonably expected that the Basal Chadron Sandstone aquifer would remain saturated.

Based on the analysis of consumptive use during operations described above, the NRC staff reached the same conclusions about potential impacts caused by the consumptive use of groundwater during aquifer restoration as it did for those potential impacts during construction (Section 4.3.2.1). Aquifer restoration would not desaturate the Basal Chadron Sandstone aquifer or destabilize the resource. Therefore, the potential short-term impact from consumptive groundwater use during aquifer restoration would be MODERATE. Water levels would eventually recover after aquifer restoration was complete; thus, the NRC staff concludes that the overall potential long-term impact from consumptive groundwater use during aquifer restoration would be SMALL.

Decommissioning

The potential environmental impacts on groundwater quantity during decommissioning ISR facilities are primarily associated with the consumptive use of groundwater, which would include water used for dust suppression, revegetation, and reclaiming disturbed areas. Based on groundwater consumptive use during the decommissioning activities being significantly less than that during ISR operation and groundwater restoration activities, the NRC staff concludes that the potential environmental impacts on groundwater quantity from decommissioning would be SMALL.

4.3.2.2 Groundwater Quality

<u>Construction</u>

Potential impacts to groundwater quality during construction of the mine units are primarily from the loss of drilling fluids and muds to the formations during well drilling and associated mud pits, and spills of fuels and lubricants from construction equipment.

CBR estimates that the MEA would produce approximately 211 gallons (800 liters) of waste oil per year (CBR, 2014, Section 1.3.2.12) from construction activities. Waste oil would be disposed of by a licensed waste oil recycler. CBR has management procedures in place in the SHEQMS Environmental Manual (Volume 6) to control and manage these types of wastes. The NRC would also require CBR to have standard operating procedures in place that specify emergency procedures for potential accidental leaks and spills (License Condition 10.3 (NRC, 2014f)). Therefore, not only is the potential volume of stored fuels and lubricants within the MEA small, but leaks or spills would result in an immediate cleanup response to prevent soil contamination and infiltration to the surficial aquifer.

According to the site water-level data, the depth to the water table in the Brule aquifer ranges from 50 to 150 feet (15.2 to 45.7 meters) bgs (CBR, 2014, Section 3.4.1.2). Therefore, small amounts of leakage from the mud pits or spills during drilling activities could result in a small amount of infiltration, which would have a minimal effect on the water quality of the surficial aquifers. High-viscosity drilling muds would be used to keep the borehole open and prevent fluid loss to the formation being penetrated during drilling and casing advancement. Since the drilling fluids are designed to stay within the borehole during drilling and are removed to the extent practicable after the borehole is completed, the amount of drilling fluids that could be introduced into the lower aquifers during the drilling, installation, and development of monitoring wells would be minor. Following well construction, CBR would initially develop wells by pumping or air lifting groundwater from the monitoring wells to remove residual drilling muds and fine-grained sediments and ensure a good hydraulic connection with the aquifer open to the well screen (CBR, 2014, Section 1.3.2.5). A good hydraulic connection is required to obtain representative water quality data during later groundwater sampling. Before obtaining baseline samples from monitoring or restoration wells, CBR would further develop the well by pumping the well or swabbing until the pH and conductivity have stabilized to ensure that the water entering the well is representative of the aquifer formation water.

CBR would place drilling fluids and mud into mud pits to control the spread of the fluids to minimize soil contamination in the area and to enhance evaporation. Closure of the mud pit would involve removing all subsoil and then adding topsoil. CBR would capture all well development water in water trucks for transport and injection into DDWs (CBR, 2014, Section 1.3.2.5). Alternatively, CBR may transport these fluids to the CPF evaporation ponds at the existing Crow Butte license area if there are fluid separation equipment issues at the MEA (CBR, 2014, Section 1.3.2.5).

The disposal wells at the existing Crow Butte license area that would receive well development water during construction are completed at an approximate depth of 3,500 to 4,000 feet (1,067 to 1,219 meters) through about 1,800 feet (548 meters) of low permeability shale (Pierre and Graneros shale), and into the Morrison and Sundance formations. The TDS levels observed during the drilling and testing of deep disposal well #1 at the existing Crow Butte license area in the Morrison and Sundance formations were approximately 24,000 and 40,000 mg/L, respectively. The EPA secondary drinking water standard for TDS is 500 mg/L.

Liquid discharges to the deep disposal wells at the existing Crow Butte license area are expected to have little to no potential impact on water resources because they are isolated from any underground source of drinking water by hundreds of feet of low permeability shale (Pierre and Graneros shale), monitored and alarmed to quickly detect and respond to above ground pipeline failures, double-cased into the Pierre Shale formation with continuous flow and pressure monitoring, located inside the monitoring rings in the overlying aquifers, subject to mechanical integrity testing every 2 years, and are held to monitoring requirements requiring monthly testing for Resource Conservation Recovery Act metals to ensure that hazardous wastes are not injected.

Under License Condition 10.5 (NRC, 2014f), CBR field tests all injection, production, and monitoring wells using pressure-packer tests to demonstrate the mechanical integrity of the well casing before the well can be placed into service. CBR would have to perform the same mechanical integrity testing in accordance with NRC License Condition 10.5 at the MEA. NDEQ has also approved these procedures and CBR has included them in the SHEQMS Standard Operating Procedures Manual (Volume 3). CBR intends to use these same procedures at MEA (CBR, 2014, Section 3.1.2.7). Water produced during integrity testing would be discharged to the MEA wastewater system for injection into the DDWs (CBR, 2014, Section 1.3.2.5).

Because of the limited nature of intrusive drilling activities, CBR's comprehensive SHEQMS program, development of operational and contingency plans, NRC license conditions and NDEQ permit requirements, and the implementation of BMPs to protect groundwater quality, the NRC staff concludes that potential construction impacts on groundwater quality would be SMALL.

<u>Operations</u>

During operations, injection of the lixiviant into the wellfield would result in a temporary degradation of water quality in the exempted aquifer, compared to the pre-mining conditions. Excursions represent a potential effect on the adjacent groundwater as a result of operations. There would also be the potential for water-quality degradation from spills of fuels, libricants, and process-related fluids.

Excursions

Excursion of lixiviant-fortified groundwater beyond the expected confines (horizontal or vertical) of a wellfield could occur due to an improper balance between injection and recovery rates. CBR would control the potential for horizontal excursions (i.e., within the Basal Chadron Sandstone aquifer) through the wellfield bleed rate. If the bleed rate is not properly maintained, lixiviant-fortified groundwater would migrate to, and be intercepted by, a monitoring well.

As shown in Figure 2-3, CBR would place monitoring wells in the overlying aquifer and in perimeter rings surrounding all mine units to detect vertical and horizontal excursions. License Condition 10.4 in the current NRC license (NRC, 2014f) and NDEQ Class III UIC Permit for the existing Crow Butte LA require that Basal Chadron Sandstone aquifer monitoring wells be located no more than 300 feet (91.4 meters) from the nearest mineral production wells and no more than 400 feet (121.9 meters) from each other (NDEQ, 1990, Section B.1). The perimeter ring of monitoring wells would provide early detection of any unwanted horizontal flow (horizontal excursion) of fluids from the ore body. These requirements would also apply to the MEA. The NDEQ Class III UIC Permit for the current license requires the placement of shallow monitoring wells in the first continuous and water-bearing sandstone unit overlying the production zone at a density of one well per 4 acres (1 well per 1.6 hectares), which would allow for the early detection of unwanted vertical flow of fluids (vertical excursion) from the ore body (i.e., Basal Chadron Sandstone aquifer) (NDEQ, 1990, Section B.2).

Under License Condition 11.5 (NRC, 2014f), CBR would be required to perform excursion monitoring at the MEA, including biweekly monitoring of wells in the perimeter ring and overlying aquifer. The program would consist of monitoring a minimum of three excursion status parameters (alkalinity, conductivity, and chloride) and comparing the levels to upper control limits that would be established for the monitoring wells in each mine unit during baseline sampling before uranium recovery. Should the levels monitored during the excursion monitoring program exceed the upper control limit thresholds in License Condition 11.4 (NRC, 2014f), CBR would be required to notify the NRC and begin corrective actions to ensure that the production fluids do not migrate from the production aquifer.

At the existing Crow Butte license area, there have been several confirmed horizontal excursions in the Basal Chadron Sandstone aquifer. In the event of an excursion, CBR implements corrective actions, which typically involve adjusting the flow rates on nearby injection and production wells to recover the migrating lixiviant. Because the excursions were all confined to the exempt portion of the aquifer, they did not threaten the water quality of an underground source of drinking water. CBR would implement similar mitigation measures at MEA for controlling excursions.

The water quality of the water-bearing units below the Basal Chadron Sandstone aquifer would not be impacted because the Pierre Shale provides hydraulic isolation from the Basal Chadron Sandstone aquifer (CBR, 2014, Section 6.2.2.1). Groundwater in these underlying units also already have naturally elevated levels of TDS (above secondary drinking water standards) (CBR, 2015, Seciton 4.2.1.8).

Based on excursion monitoring requirements, operating pressures held below fracture initiation thresholds, and required reporting and mitigation measures, the NRC staff concludes that the potential long-term impacts on groundwater quality from excursions would be SMALL.

Spills and Leaks

As discussed in Section 3.3.3.2, CBR identified one irrigation well that is located within the license area and area of review but outside of the MEA itself. To assess whether the irrigation well that is located within the MEA would potentially capture contaminants derived from a hypothetical shallow casing leak, CBR developed a groundwater model (CBR, 2016, Appendix AA-2). Over a 100-day growing season, it was assumed that this well pumped an average of about 400 gpm (1,480 Lpm). After calibrating the model to field-measured data, the zone of capture was determined after 30 years of seasonal operation. Based on the results of this analysis, MEA wellfields would not be located within the 30-year capture zone of the irrigation well, and a shallow casing leak within the MEA wellfields would not impact the irrigation well at any time in the future under similar operating conditions.

As noted in the ISR GEIS (NRC, 2009a, Sections 4.2.4.2.2.1 and 4.4.4.2.2), groundwater quality could potentially be impacted during MEA operation as a result of an accident, such as pipe leakage or failure, or an uncontrolled release of process liquids because of a wellfield accident. In such a case, potential contamination of the shallow aquifer, as well as surrounding soil, could occur. Such contamination could result from a slow leak or a sudden failure (e.g., trunk line failure, injection casing rupture, or wellhead rupture), a shallow excursion, or an overflow as a result of excess production or restoration flow. In addition, accidental releases from a spill of lixiviant or other chemicals from a wellfield building or associated piping could impact groundwater. In order to prevent these types of releases, the MEA would use piping constructed of either polyvinyl chloride (PVC), high-density polyethylene (HDPE) with butt-welded joints, or an equivalent. CBR would ensure that all piping was leak tested before production flow and following repairs or maintenance (CBR, 2014, Section 4.4.3.3). In the event of an accident, CBR would adhere to the SPCC Plan developed for the site (CBR, 2015, Section 7.1.3.2). NRC License Condition 10.3 (NRC, 2014f) would also require CBR to write standard operating procedures describing emergency procedures for potential accident and unusual occurrences including pipe breaks and spills.

Under 122 NAC, Chapter 19, Section 002.02, CBR is required to ensure formation pressures stay below those that could initiate fracturing within the ore zone or overlying confining units and potentially allow the migration of injection fluids into an underground source of drinking water (CBR, 2015, Section 2.7.2.4). Although normal operating injection pressures would be too low to initiate fracturing, they would be sufficiently high to allow faulty well casings or valves to leak. To detect potential well casing or value failures, CBR would be required to conduct mechanical integrity testing (MIT) every five years in accordance with License Condition 10.5 (NRC, 2014f) to ensure that the well would not leak. CBR would conduct this MIT after installation, after the well is serviced, whenever a well is suspected of having damage, or at intervals of once every 5 years (CBR, 2015, Section 2.7.2.4). Should a well fail an MIT, CBR would repair or abandon the well to prevent the potential release of production fluids (CBR, 2014, Section 1.3.2.5). NRC license conditions 10.5 and 11.1 (NRC, 2014f) require CBR to notify the NRC of all MIT failures and maintain documentation of corrective actions that were implemented. Through its UIC program, NDEQ also has oversight of MIT of wells that are used for ISR and has reporting requirements for MIT failures.

Based on the required well MIT and implementation of the leak detection and spill correction program that would mitigate potential impacts (i.e., through early detection and cleanup), the NRC staff concludes that the potential long-term impacts on groundwater quality from spills and leaks would be SMALL.

Deep Disposal Wells

CBR estimates that up to six DDWs may be needed to address wastewater generation over the life of the project (CBR, 2014, Section 3.12.2.2). The wells would be permitted under NDEQ regulations in 122 NAC and operated under a Class I UIC Permit. The injection interval would consist of the lower Dakota, Morrison, and Sundance formations and has been identified as the DDW Injection Zone at the MEA.

The first two disposal wells would be completed at approximate depths of 3,500 to 4,000 feet (1,067 to 1,219 meters) through about 1,800 feet (548 meters) of low permeability shale (Pierre and Graneros shale). This separating aquitard protects against vertical migration of injected fluids to the overlying Brule and Chadron formations.

The TDS levels observed during the drilling and testing of deep disposal well #1 at the Morrison and Sundance formations at the existing Crow Butte license area were approximately 24,000 and 40,000 mg/L, respectively. The EPA secondary drinking water standard for TDS is 500 mg/L.

The DDWs would receive wastewater from the wastewater tanks located at the satellite facility via an underground pipeline constructed of either PVC or HDPE. CBR addressed the details of these systems in the Class I UIC Permit application submitted to NDEQ in April 2013 as part of the required permitting process (ARCADIS, 2012). CBR has successfully operated a Class I DDW for approximately 19 years at the existing Crow Butte license area without any significant spills or releases (CBR, 2014, Section 4.4.3.3).

Liquid discharges to the deep disposal wells are expected to have little to no potential impact on water resources because they would be isolated from any underground source of drinking water by hundreds of feet of low permeability shale (Pierre and Graneros shale).

The DDWs would be monitored and alarmed to quickly detect and respond to above-ground pipeline failures, double-cased into the Pierre Shale formation with continuous flow and pressure monitoring, located inside the monitoring rings in the overlying aquifers, subject to mechanical integrity testing every 2 years, and would be held to monitoring requirements requiring monthly testing for Resource Conservation and Recovery Act metals to ensure that hazardous wastes were not injected.

Based on the required well mechanical integrity testing, implementation of the leak detection system, and hydraulic isolation of the injection zone from the overlying aquifers, the NRC staff concludes that the potential long-term impacts on groundwater quality from disposal into the DDWs would be SMALL.

In summary, the NRC staff concludes that the potential long-term impacts on groundwater quality from excursions, leaks, spills, and disposal into the DDWs during operations would be SMALL. This conclusion is based on the required periodic monitoring, well mechanical integrity testing, implementation of the leak detection and spill correction program that would mitigate potential impacts (i.e., through early detection and cleanup), and hydraulic isolation of the DDW injection intervals from the overlying aquifers.

Groundwater Restoration

CBR would mitigate impacts to groundwater quality in the production zone (Basal Chadron Sandstone aquifer) by undertaking the groundwater restoration activities described in ER Section 5.4.1.4 (CBR, 2016a) after uranium recovery was completed.

The purpose of aquifer restoration at the MEA would be to return the groundwater quality in the production zone to compliance with the groundwater protection standards in 10 CFR Part 40, Appendix A, Criterion 5B(5). These standards, described in License Condition 10.6 (NRC, 2014f), require that the concentration of a hazardous constituent must not exceed (1) the Commission-approved background concentration of that constituent in groundwater, (2) the respective value in the table in paragraph 5C of the regulation if the constituent is listed in the table and if the background value of the constituent is below the value listed, or (3) an alternate concentration limit the Commission establishes. Since the objective of aquifer restoration would be to return the Basal Chadron Sandstone aquifer groundwater to meet groundwater protection standards, the NRC staff concludes that any adverse environmental impacts on the Basal Chadron Sandstone aquifer groundwater quality from aquifer restoration would be SMALL. Furthermore, once groundwater is restored in the exempted region of the Basal Chadron Sandstone aquifer to approved groundwater protection standards, the future impact on groundwater quality in the nonexempt portions of the Basal Chadron Sandstone aquifer would be negligible.

CBR would use a network of buried pipelines during ISR operation and restoration for transporting fluids between the pump house and the satellite facility. Although the liquids carried in these pipes during restoration would have lower levels of hazardous constituents than those used during the operation phase, the failure of pipeline fittings or valves, or failures of well mechanical integrity, could result in leaks or spills of these fluids, which could impact water quality in shallow aquifers. The monitoring and impact reduction activities for groundwater aquifers during project operation described in Section 4.3.2.2 would also limit the estimated impacts on groundwater aquifers during aquifer restoration. Based on these considerations, the NRC staff determined that the potential adverse impact on shallow aquifers during aquifer restoration would be SMALL.

Decommissioning

The potential environmental impacts on groundwater quality during decommissioning at the MEA would be similar to those impacts from the construction phase (see Section 4.3.2.1), and would be primarily associated with potential spills of fuels and lubricants, and well abandonment (NRC, 2009a, Section 4.2.4.2.4). Spills of fuels and lubricants during decommissioning activities could impact the water quality of shallow aquifers. CBR's implementation of BMPs during decommissioning (see Section 4.3.2.1), execution of spill prevention and control plans (EPA, 2014), and the requirements stipulated in License Condition 10.3 (NRC, 2014f) that emergency procedures be taken in the event of pipe breaks or spills, or both, would reduce the likelihood and magnitude of such spills and facilitate cleanup. Based on CBR's commitment to implement these BMPs and spill prevention and control procedures, the NRC staff concludes that the environmental impacts on the groundwater resources in shallow aquifers from decommissioning would be SMALL.

After ISR operations are complete, all monitoring, injection, production, and exploration wells and boreholes from previous activities, would be plugged and abandoned in accordance with the Nebraska UIC program requirements (NDEQ, 1990, Sections A and E). CBR would fill the wells with cement or clay, or both, and then cut off below plow depth to ensure that groundwater does not flow through the abandoned wells. Since these procedures primarily involve adding inert clay and cement to the system, designed to ensure that abandoned wells are properly isolated from the overlying aquifers, the NRC staff concludes that potential environmental impacts from well plugging and abandonment would be SMALL.

4.3.3 No-Action Alternative

If the NRC does not grant the amendment to the license, no new development activities would take place at the MEA. Wells and other structures that may have been constructed for the purpose of obtaining data about the groundwater and uranium deposits (i.e., during preconstruction activities) in the area would be plugged and the surrounding area restored. Activities at the existing Crow Butte license area would continue to take place in accordance with its license. Therefore, the NRC expects potential impacts on water resources associated with these closure activities at the MEA to be SMALL.

4.4 Ecological Resources

4.4.1 Impacts to Vegetation and Animals

4.4.1.1 Vegetation Impacts

In the ISR GEIS, the NRC (2009a, Section 4.2.5.1) determined that ISR facilities primarily affect terrestrial vegetation through the removal of vegetation during construction (associated reduction in wildlife habitat and forage productivity and an increased risk of soil erosion and weed invasion), the modification of existing vegetative communities through the loss of sensitive plants, and the potential spread of invasive species and noxious weed populations. Specific to the proposed action, vegetation removal and soil handling from the construction of wellfields, pipelines, access roads, and the satellite facility would have both direct and indirect impacts. Direct impacts include the short-term loss of vegetation. Indirect impacts include the increased potential for nonnative species invasion (particularly near roads), exposure of soils to accelerated erosion, shifts in species composition or density, reduction of wildlife habitat, and changes in visual aesthetics. Currently, the MEA has a relatively high level of noxious weeds and other unwanted invasive, nonnative species in areas adjacent to roads and to a lesser degree in areas located farther from roads (CBR, 2014, Section 4.5.2).

However, because for ISR facilities the percentage of vegetation removed or land disturbance relative to the size of the permit area is small, the NRC (2009a, Section 4.2.5.1) in the ISR GEIS that such activity would result in a SMALL potential impact in relation to the total permit area and surrounding plant communities. In the case of the MEA, CBR has estimated that 38 percent (1,754 acres (710 ha)) of the total permit area acreage (4,622 acres (1,870 ha)) would be disturbed because of site development and operation. Initially, the construction of the satellite facility, Mine Unit 1, and supporting roadways would result in short-term disturbance to the surface of approximately 78 acres (32 ha). The satellite facility (satellite building and associated facilities) would disturb about 1.8 acres (0.73 ha) (CBR, 2014, Section 4.5.2).

The amount of potential impact to each plant community is summarized as follows:

- The greatest potential impact is anticipated for mixed-grass prairie (1,143 acres (463 ha)) and degraded rangeland (228 acres (92 ha)), which occupy 78 percent of the total acreage with the potential for disturbance (1,754 acres (710 ha)), as described in Section 4.3.1.1.

- Small amounts of forested habitat would be disturbed. As is evident in ER Figure 3.5-1 (CBR, 2014), these forested areas are located in the northern third of the MEA, primarily in one band stretching diagonally from west to east. ER Figure 1.1-7 (CBR, 2014) shows that the first mine unit (MU-A) would begin just to the west of this band. As shown in Table 4-1, initial planned activities would disturb 5.6 acres (2 ha) of mixed conifer, and potential long-term activities would disturb 189 acres (76 ha) of mixed conifer and 4.7 acres (2 ha) of deciduous streambank forest habitat. Although this amounts to a relatively small proportion of the permit area (4 percent) and potential disturbed acreage (11 percent), it represents about 47 percent of the total of each type of these habitats in the MEA (194.6 acres (79 ha) of the 418.4 acres (169 ha) of mixed conifer and 4.7 acres (2 ha) of the 10.0 acres (4 ha) of deciduous streambank forest; see ER Table 3.5-2 (CBR, 2014)). Forest habitat is important for many species in the area, including those considered to be at risk (see Sections 4.4.1 and 4.4.2).

- No habitat classified as a wetland would experience any direct impacts. As stated in Section 3.4.2, only one site within the MEA is classified as a wetland: a freshwater emergent wetland located on the western border of the project area. While no direct impacts are expected to any wetlands within the MEA (CBR 2014, Section 3.5.10.3), CBR must comply with the Clean Water Act should there be any changes in activities within the MEA that would potentially impact wetlands, and CBR would need to obtain applicable permits from the U.S. Army Corps of Engineers prior to performing work in wetland areas.

Vegetation and subsequent habitat loss associated with the proposed action would be temporary because reclamation activities would be required and approved by NDEQ and NAC (under NAC 122 and 135) (NRC, 2009a, Section 4.2.5.1). Site activities would primarily affect mixed grass prairie and degraded rangeland plant communities, which are known to rapidly colonize due the presence of annual and perennial herbaceous species. As noted in the ISR GEIS (NRC, 2009a, Section 4.2.5.1), many plant species can return within the first growing season. However, although timely reseeding of disturbed areas can minimize these impacts, wooded areas (such as the forested areas in the northern portion of the MEA) would take longer to reestablish. Although potential impacts would still be temporary in these areas, effects would last longer than impacts in other habitat types given the pace of natural succession. Forest succession requires the transition from herbaceous communities to more specialized woody species. Competition for resources by the climax community requires time and proper environmental conditions of light and soil moisture. As a result, potential impacts to forested habitat would be MODERATE given that almost half of the forest habitat in the MEA would be potentially impacted and because this habitat would take longer to recover to its original state.

Reclamation activities would take place in accordance with a decommissioning plan approved by the NRC and NDEQ. Reclamation of the site is intended to return the site to its natural preoperational conditions, as discussed in Section 4.1.

In summary, the proposed project would yield temporary impacts to vegetation within the project area. Affected vegetation communities would be reclaimed during the proposed project in compliance with Nebraska regulations in 122 NAC and 135 NAC. Although forested areas make up a small portion of the permitted area (4 percent of the permit area), about half of those habitats in the MEA would be impacted. Reclamation of the entire project footprint would make all of these impacts temporary, although some may take longer to fully recover. Based on foregoing analysis, the NRC staff concludes that although the project has the potential for temporary MODERATE impacts to forested areas because of the length of time needed for forested areas to recover, reclamation measures and natural succession would reduce these impacts to SMALL over the long term. Potential short-term and long-term impacts to other types of vegetation would be SMALL, and the overall potential impact of the proposed project on vegetation would be SMALL.

4.4.1.2 Mammals and Birds

The NRC (2009a) determined in the ISR GEIS that ISR facilities primarily affect terrestrial wildlife through (1) habitat loss or alteration and incremental habitat fragmentation, (2) displacement of wildlife from the project area, and (3) direct and indirect mortalities from project construction and operation. These impacts would also apply to the proposed activities at the MEA, as discussed below. These potential impacts would be SMALL, since, over time, habitat loss would be minimized as disturbed areas are reseeded following completion of construction, and displaced species may recolonize adjacent, undisturbed areas or return to the project area after suitable habitats are reestablished. In addition, when project activities end, particularly the construction period, the traffic hazards posed to wildlife would be abated, thereby eliminating construction- and traffic-related mortality.

<u>Big Game Mammal Species</u>

The proposed project would involve the loss and alteration of habitat used by big game mammals, including 1,143 acres (463 ha) of mixed-grass prairie, 31.3 acres (13 ha) of drainage, 194.6 acres (79 ha) of mixed conifer, 4.7 acres (2 ha) of deciduous streambank forest, and 7.1 acres (3 ha) of range rehabilitation habitat (CBR, 2014, Section 4.5.5). In addition to the direct removal of habitat, drilling and traffic would also affect wildlife use of areas adjacent to those directly disturbed, effectively reducing big game habitat further as the animals avoid the wider area. In general, the NRC (2009a, Section 4.2.5.1) determined in the ISR GEIS that most wildlife would disperse from the project area as construction activities approach. Although this habitat loss would cause the potential displacement of big game mammals, these larger mammals are highly mobile. Being highly mobile species, they may recolonize in adjacent, undisturbed areas or return to their previously occupied habitats after construction ends and suitable habitats are reestablished. The amount of habitat loss that would occur at the MEA can be considered inconsequential compared to the amount of habitat available throughout Nebraska, South Dakota, and Wyoming, as described in the ISR GEIS (NRC, 2009a, Sections 3.2.5, 3.3.5, and 3.4.5). In addition, habitat loss would be temporary as reclamation activities would be required and approved by NDEQ (NRC, 2009a, Section 4.4.5.1).

For big game mammals, the risk of mortality related to increased human activities would primarily be associated with increased vehicle traffic. Factors that would minimize vehicle-related mortality include posted speed limits; generally open land and low, rolling plains that allow long-distance sight-lines for vehicle drivers and wildlife alike; and prevalence of unpaved roads that would promote lower vehicular speeds. As noted in the ISR GEIS (NRC, 2009a, Section 4.2.5.2), although some mortalities would occur, these should not impact overall big game populations because of the relatively low volume of traffic required for construction and operational activities. Big game mortalities would also be offset by the elimination of hunting within the restricted areas of the MEA. Therefore, the NRC staff concludes that the potential impacts on big game mammal species from the MEA would be SMALL.

<u>Carnivore and Small Mammal Species</u>

As noted in the ISR GEIS (NRC, 2009a, Section 4.2.5.1), habitat loss would impact carnivore and small mammal species. Some species, such as squirrels and fox, are highly adaptable to human activities and would adjust. Other species that are relatively sensitive to human activity, such as bobcats and mountain lions, would seek alternative areas away from human activities. Small animal species tend to be opportunistic and may recolonize the reclaimed habitats rapidly. Based on information in Section 4.1 and Table 4-1, about 62 percent of the MEA would remain undisturbed and available for small mammal habitation. Although smaller mammals are not as mobile as big game mammals, because only a small portion of the MEA would be disturbed, there would be sufficient undisturbed habitat within and surrounding the MEA. While there are no census data regarding the prevalence of carnivores and small mammals in the MEA boundary, NRC staff review of the licensee’s ecological studies (HWA, 2012) suggest that sufficient populations of common small mammals exist so that site activities would not cause populations of small mammals and their predators to destabilize. Therefore, the NRC staff concludes that the potential impacts on carnivore and small mammal species from the MEA would be SMALL.

<u>Bird Species</u>

Impacts to birds would include a loss of suitable nesting sites and foraging areas. Birds may also experience loss of habitat in addition to the disturbed areas if they avoid the project area because of noise or human activity. Species such as mourning doves that are more tolerant of human activity are least likely to be affected, while more sensitive specialist species, such as grasshopper sparrows, may be more affected. Construction activities that occur during the nesting season could directly affect the mortality of eggs or nestlings because of nest abandonment and reproductive failure. Regarding the greater sage-grouse, no lek nesting areas are known to occur in Nebraska (NRC, 2009a, Figure 3.4-17; USFWS, 2016e). Because of the lack of a historical presence of leks in the area and the adaptability of other birds, potential impacts to non-raptor birds would be SMALL.

As described in Section 3.4.1.2, seven raptor nests were documented within the MEA in 2011, including red-tailed hawk (*Buteo jamaicensis*), burrowing owl (*Athene cunicularia*), and great horned owl (*Bubo virginianus*), and an additional 19 nests were documented within the 2.5-mile (4-km) ecological study area surveyed by the licensee. Raptors breeding on the site may be impacted by construction activities or uranium recovery operations and may be temporarily impacted depending on the time of year construction activities occur. In addition, power lines can pose a threat to raptors, in that the birds that land on the cross-arms could potentially be electrocuted. Power lines are present at the MEA, as shown in ER Figure 3.4-6 (CBR, 2014). As described in Section 4.9.1, the electric distribution lines would connect wellhouses to existing electric lines as part of the proposed project. The NRC (2009a) determined in the ISR GEIS that wellfield operations would require the construction of power distribution lines but that the conductors of any new power lines would be configured to assure adequate spacing between the shield wire (i.e., ground wire). The ISR GEIS notes that construction of the distribution lines would be expected to follow the guidance of the Avian Power Line Interaction Committee (APLIC, 2006) that should minimize direct impacts to birds that encounter the lines. The Nebraska Public Power District, which serves Dawes County, is a member of the Avian Power Line Interaction Committee and uses standard poles when establishing new power lines (APLIC, 2012).

In addition, the NRC (2009a) notes in the ISR GEIS that construction activities would be required to comply with the Migratory Bird Treaty Act. Golden eagles and bald eagles are afforded additional protection under the Bald and Golden Eagle Protection Act. In addition, several raptor species are considered at-risk or sensitive by NGPC and/or Nebraska National Forest-Pine Ridge Ranger District, and the licensee would be required to comply with the State's Nongame and Endangered Species Conservation Act. Because of these statutory protections, NRC staff concludes that the potential impacts to raptors would be SMALL.

4.4.1.3 Reptiles and Amphibians

As stated in Section 3.4.2, the plains spadefoot toad (*Spea bombifrons*), northern leopard frog (*Rana pipiens*), and common snapping turtle (*Chelydra serpentina*) are known to occur in or near the project area. Based on Table 4-1 of this draft EA and Table 3.5-2 in the ER (CBR, 2014), about 24 percent of drainage areas (31.3 acres (13 ha) of 132.5 total acres (54 ha)) and 47 percent of deciduous streambank forest area (4.7 acres (2 ha) of 10.0 total acres (4 ha)) would be disturbed at the MEA. However, the MEA has only ephemeral drainages, and the lack of water flow limits the value and usefulness of those drainages to these species. As stated in the ER, reptiles and amphibians would primarily be impacted by (1) direct mortality during the construction period, (2) ongoing mortality from increased vehicle traffic, (3) loss of habitats, and (4) changes in water quality in aquatic habitats (CBR, 2014, Section 4.5.9).

Construction activities would predominantly affect terrestrial habitats that are of little significance to toads, frogs, and turtles. In addition, once construction is completed, direct mortality from human activities would be reduced. While there would be traffic related to construction and subsequent activities, they are not likely to result in noticeable population-level changes to any amphibian or reptile species because of the relatively small increases in traffic, as discussed in Section 4.8. Once areas are reclaimed, reptiles and amphibians are expected to recover in the previously disturbed areas. Because of reclamation measures and the temporary nature of construction activities, and because the onsite drainages are not sufficient to be generally useful to these species, NRC staff concludes that the potential impacts to reptiles and amphibians would be SMALL.

4.4.1.4 Fish and Macroinvertebrates

In the ISR GEIS, the NRC (2009a, Section 4.2.5.1) finds that ISR construction activities primarily affect aquatic resources through (1) short-term physical disturbances to stream channels, (2) short-term increases in suspended sediments from in-stream activities and erosion from adjacent disturbed lands, (3) increases in downstream sedimentation, during construction, from in-stream activities and erosion from adjacent disturbed lands, (4) potential fuel spills from equipment and refueling operations during construction, and (5) short-term reductions in habitat and potential loss of individuals from water appropriations, if needed. During operations, aquatic animals would potentially be impacted by spills around well heads and leaks from pipelines (NRC, 2009a, Section 4.2.5.2).

As described in Section 4.4.1.3, about 31.3 acres (13 ha) (24 percent) of drainage areas and 4.7 acres (2 ha) (47 percent) of deciduous streambank forest area would be disturbed at the MEA. Runoff during construction could temporarily increase sediment loads, temporarily affecting sensitive fish and invertebrates inhabiting the downstream area. However, the MEA has only ephemeral drainages, and the lack of water flow in those drainages prevents the occurrence of aquatic species. Only opportunistic invertebrates with brief aquatic-based life history requirements (i.e., emergent flies) can occupy the onsite drainage systems. It is possible for fish and macroinvertebrates in the Niobrara River to be affected by reductions in water quality as a result of upstream activities, such as from runoff from construction activities carrying sediment into surface waters downstream of the MEA. However, most of the MEA is located on generally level ground with low, rolling plains, as stated in Section 3.10, and therefore has low erosion potential. As described in Section 4.3.1, CBR is required to meet EPA stormwater BMPs (EPA, 2014) and other impact reduction measures for the limited areas of moderate to high erosion potential. Section 4.4.2 further discusses potential project impacts to the State-listed sensitive fish that occur within Niobrara River. The ISR GEIS notes that BMPs commonly used and required for sedimentation control (see NRC, 2009a, Section 4.2.5.1) would help limit impacts, and that sediment levels would quickly taper off both over time and distance and would not be expected to permanently alter existing habitats.

Accordingly, the NRC staff concludes that the potential impacts on fish and macroinvertebrates from the MEA would be SMALL.

4.4.2 Protected Species and Habitats

ISR facilities can impact threatened and endangered species primarily through habitat loss, alteration, or fragmentation; wildlife displacement; and direct and indirect mortalities (NRC, 2009a, Section 4.2.5.1). Whether such impacts would occur and their extent would depend on the presence of such species and on any measures undertaken to protect these species. Section 3.4.3 discusses the likelihood that threatened, endangered, and sensitive species are present in the project area.

The NRC staff contacted USFWS by letter dated February 8, 2013, requesting USFWS assistance in identifying the presence of endangered or threatened species or critical habitat at the MEA and in the vicinity (NRC, 2013d). USFWS replied by letter dated March 7, 2013 (USFWS, 2013), with technical assistance to assist in the planning process to avoid or minimize adverse impacts to Federal trust fish and wildlife resources the proposed project might cause.

USFWS also noted species of concern or State-listed species under the Nebraska Nongame and Endangered Species Conservation Act and recommended consultation with NGPC. Therefore, by letter dated February 5, 2014 (NRC, 2014a), the NRC staff contacted NGPC to determine whether the proposed project may affect any additional State-listed species. NGPC conducted a site visit in December 2013 to facilitate its review of the project by confirming the information provided about the site setting and planned activities and replied by letter dated May 15, 2014 (NGPC, 2014) that provided the requested information. In the letter, NGPC stated that it appeared unlikely that the project would adversely impact State-listed endangered or threatened species.

Tables 4-2 and 4-3 summarize the potential impacts to federally and State-listed species, respectively, that have the potential to occur in the MEA project area. For federally listed species, the NRC staff uses language prescribed by the ESA to make its conclusions.

In accordance with the "Endangered Species Act Consultation Handbook" (USFWS and NMFS, 1998), the NRC staff uses the following definitions to characterize effects to federally listed species:

- Not likely to adversely affect—is the appropriate conclusion when effects on listed species are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.

- No effect—is the appropriate conclusion when the action agency determines its proposed action will not affect a listed species or designated critical habitat.

Effects to State-listed species are characterized as SMALL, MODERATE, or LARGE in accordance with the NRC's regulations that implement NEPA.

Table 4-2 Impacts to Federally Listed Species

Species	Scientific Name	Impact	Federal Status
northern long-eared bat	*Myotis septentrionalis*	Not likely to adversely affect.	Threatened
whooping crane	*Grus americana*	Not likely to adversely affect.	Endangered

Table 4-3 Impacts to State-Listed Species

Species	Scientific Name	Impact	State Status
swift fox	*Vulpes velox*	SMALL	Endangered
blacknose shiner	*Notropis heterolepis*	SMALL	Threatened
finescale dace	*Phoxinus neogaeus*	SMALL	Endangered
northern redbelly dace	*Phoxinus eos*	SMALL	Endangered

4.4.2.1 Northern Long-Eared Bat

In Section 3.4.3, the NRC staff determined that although northern long-eared bats have not been observed during MEA surveys, individuals could occasionally occur in the MEA action area during migration. As stated in Section 4.4.1.1, initial planned activities would disturb 5.6 acres (2 ha) of mixed conifer, and potential long-term activities would disturb 189 acres (76 ha) of mixed conifer and 4.7 acres (2 ha) of deciduous streambank forest habitat. However, given the relative lack of forested areas in, and surrounding, the MEA, and lack of observation of bats in the action area, any impacts to forested areas in the MEA would not significantly affect northern long-eared bat. Regarding possible noise impacts to the northern long-eared bat, noise impacts (see Section 4.9) would be confined to the immediate area around activities occurring in the MEA, and the northern long-eared bat would avoid such areas. Because no long-eared bats have been observed in the action area, lack of significant areas of suitable habitat, and minor and short-term noise impacts, the NRC staff concludes that the MEA project is not likely to adversely affect this species.

4.4.2.2 Whooping Crane

While there has been at least one record of whooping cranes occurring in Dawes County (see Section 3.4.3.1), there have been no recorded sightings in the action area, and the action area generally lacks suitable habitat (i.e., wetlands). The species is most likely to occur in the area during migration periods, which in Nebraska are approximately from March 23 through May 15 and from September 16 through November 16. With the relative lack of suitable habitat in the form of wetlands in the MEA and the rare occurrence of whooping crane sightings, the NRC staff concludes that the MEA project is not likely to adversely affect this species.

4.4.2.3 Swift Fox

As discussed in Section 3.4.3, the swift fox is believed to exist in Dawes and Box Butte Counties, and the MEA contains suitable habitat, particularly the mixed-grass prairie habitat that would undergo the most disturbance. NGPC conducted a site visit on December 10, 2013, to evaluate site habitat conditions. NGPC found that, although there are some areas within the MEA that could provide habitat, in many places the vegetation is too tall and therefore precludes the swift fox from denning in those areas (NGPC, 2014). Nevertheless, NGPC (2014) noted CBR’s commitment to locate project development activities outside of swift fox habitat to the extent possible and conduct surveys as necessary. Before beginning construction activities in suitable swift fox habitat, CBR would have qualified biologists perform surveys for swift fox dens and would implement avoidance measures for any dens located. These actions would be taken according to a protocol provided by CBR (CBR, 2014, Section 4.5.11). If project development activities cannot meet specific protocol requirements, such as designated distances from swift fox dens, CBR would consult with NDEQ and NGPC regarding alternate actions and would not conduct work before resolving such issues with NDEQ and NGPC. Because of the lack of suitable habitat and the precautions to be taken by CBR to avoid impacts to the swift fox, the NRC staff concludes that impacts would be SMALL.

4.4.2.4 Fish (Blacknose Shiner, Northern Redbelly Dace, Finescale Dace)

As discussed in Section 3.4.3, the three State-listed fish species that potentially occur downstream of the MEA may experience indirect effects as a result of changes in water quality in the Niobrara River associated with upstream activities. Such changes would most likely result from increased sediment loads and resulting decrease in water clarity from construction runoff at the MEA. As stated in Section 3.10, most of the MEA is located on generally level ground with low, rolling plains and, therefore, the erosion potential is low. CBR would implement BMPs for the limited area of moderate to high erosion potential if wells could not be placed outside of these areas (see Section 4.3.1). Because of the low erosion potential, the NRC staff concludes that impacts would be SMALL.

4.4.2.5 Other Species of Concern

Section 3.4.3.2 discussed other at-risk species potentially in the project area, including the ferruginous hawk, black-tailed prairie dog, and burrowing owl (which tend to be found in prairie dog colonies). However, there are no known prairie dog colony sites within the MEA; therefore, the NRC staff concludes that impacts to the black-tailed prairie dog would be SMALL. Burrowing owls are most often found associated with prairie dog colonies; however, given the absence of prairie dog colonies in the MEA, the NRC staff concludes that impacts to burrowing owls would be SMALL. Ferruginous hawk nests have periodically been found in the MEA, but CBR would conduct raptor surveys before the start of construction; therefore, the NRC staff concludes that impacts to this species would be SMALL.

The long-billed curlew is potentially present within the MEA. It is not listed as a species of concern, but is considered a species under threat requiring protection. urveys for sensitive species would be conducted before the start of construction. If species were observed, mitigation measures would preclude any direct impact to the species; therefore, the NRC staff concludes that impacts to this species would be SMALL.

Because the portions of the Pine Ridge escarpment that might support tawny crescent colonies would not be in the MEA wellfield and satellite facility areas, encountering the species is not anticipated; therefore, the NRC staff concludes that impacts to this species would be SMALL.

The plains topminnow and pearl dace would be protected by the same sediment control measures that would minimize impacts to other fish, as discussed in Section 4.4.2.4. In addition, the MEA topography does not lend itself to significant erosion potential, and surface water flow is ephemeral (i.e., short-lived or periodic). Because of these reasons, the NRC staff concludes that impacts to these species would be SMALL.

The golden eagle, bald eagle, Swainson's hawk, and prairie falcon are all likely to occur in the MEA. The considerations discussed in Section 4.4.1.2 with regard to raptors would also apply to these species. There are no particular characteristics of these species that would make them particularly vulnerable to impacts from the proposed ISR activities. Given that CBR would conduct nest searches before the start of construction and enact mitigation measures for powerline mortality, the NRC staff concludes that the potential impacts to these raptor species would be SMALL.

4.4.3 No-Action Alternative

If the NRC does not grant the amendment to the license, no new development activities would take place at the MEA. Wells and other structures that may have been constructed for the purpose of obtaining data about the groundwater and uranium deposits (i.e., during preconstruction activities) in the area would be plugged and the surrounding area restored. Small numbers of construction vehicles and workers would travel to the site for these activities. Activities at the existing Crow Butte license area would continue to take place in accordance with its license. Therefore, the NRC staff concludes that potential impacts on ecological resources associated with these closure activities at the MEA would be SMALL.

4.5 Climate, Meteorology, and Air Quality

This section of the draft EA discusses potential impacts to air quality and GHG emissions from the proposed MEA. Section 3.5 described local and regional characteristics of meteorology and climatology. The NRC staff determined that the proposed action would not affect meteorology or climatology; therefore, they are not included in this impact analysis. However, the analysis for public health and safety impacts uses these characteristics as input parameters in evaluating the effects of atmospheric dispersion for gaseous releases (see Section 4.11 below).

4.5.1 Air Quality

As noted in the ISR GEIS (NRC, 2009a, Section 4.2.6), in general, ISR facilities are not major nonradiological air emissions sources. Impacts on air quality from an ISR facility are expected to be SMALL if gaseous emissions are within regulatory limits and requirements, air quality in the project's region is in compliance with air quality standards, and the facility is not classified as a major source that would require Title V permitting, as defined by 40 CFR Part 70, "State Operating Permit Programs," and 129 NAC. This analysis from the ISR GEIS applies to the MEA and is addressed here. Section 4.11.2 discusses radiological emissions related to MEA.

The ISR GEIS (NRC, 2009a, Section 4.2.6) anticipates the following nonradiological gaseous emissions associated with construction, operation, aquifer restoration, reclamation, and decommissioning activities that are consistent with proposed activities at the MEA:

- fugitive dust and combustion emissions (diesel emissions from construction equipment and surface vehicles required for site preparation, reclamation, and decommissioning of surface facilities; onsite traffic for operations and maintenance; employee traffic to and from the site; heavy truck traffic delivering supplies and transferring IX resin)

- release of pressurized vapor from wellfield pipelines, vented at relief valves, during operations

- release of gaseous effluents during resin transfer (liquefied gases used in the lixiviant that come out of solution and gases from the underground environment that are mobilized; see Section 4.11.2.1 regarding the release of naturally occurring radon gas)

- gaseous emissions from equipment for plugging and abandoning wells

Fugitive dust (particulate matter less than 10 micrometers in diameter (PM_{10})) would be generated from site construction; well-site preparation; facility operation; and restoration, reclamation, and decommissioning activities. During site construction and well-site preparation, construction equipment, worker travel, and wind over unpaved roadways would generate fugitive dust. Air emissions from construction operations would be short term and highly variable because of the required amount of equipment. In the ISR GEIS (NRC, 2009a, Section 4.2.6.1), the NRC estimated fugitive dust emissions during site construction to be less than 2 percent of the NAAQS for particulate matter less than 2.5 micrometers in diameter and less than 1 percent for PM_{10}.

Based on CBR's most recent estimates of fugitive dust from vehicles associated with MEA activities in a typical year (CBR, 2014, Section 4.6), the expected levels are below levels requiring an NDEQ air permit and are not anticipated to affect local ambient air quality. In addition, CBR has indicated that it would minimize such emissions through the enforcement of low speed limits on the site, revegetating exposed surfaces, and applying water for dust control within site boundaries, as needed. In the past, CBR has donated road surfacing materials to Dawes County for use on unpaved county roads near residences adversely impacted by fugitive dust from site-related traffic; the licensee would continue such measures as appropriate (CBR, 2014, Section 5.5).

Based on NRC experience with the licensing of other ISR projects, drilling rigs and pumps would be also be contributors to emissions. The amount of other pollutants generated by these sources and vehicles at the project site are expected to be minor and would not affect local ambient air quality because of the small number of sources and expected trips, as well as the more-stringent Federal air pollution standards for engines and fuel. Only a small number of vehicles would be traveling at the MEA, mostly limited to 2 daily trips for each commuting employee (19 employees and contractors), 10 daily trips associated with employees traveling between the MEA and the existing Crow Butte license area, and 9 daily truck trips transporting resin and other materials (CBR, 2014d).

The ISR GEIS (NRC, 2009a, Section 4.2.6.2) considers that the nonradiological emissions from wellfield pipelines and resin transfer would be rapidly dispersed in the atmosphere and would be small, primarily because of the low volume of effluent produced. Emissions from well plugging and abandonment would be expected to be limited in duration and result in small, short-term effects (NRC, 2009a, Section 4.2.6.3). Emission levels could increase for particulate matter during decommissioning, as buildings are dismantled and surfaces are regraded, but they would decrease as decommissioning proceeds (NRC, 2009a, Section 4.2.6.4).

As noted in Section 3.5, the area encompassing the MEA is well within the NAAQS and SAAQS and is in attainment for air quality. Based on the information provided, the NRC staff does not anticipate that these standards would be exceeded at any time during the life of the project. Therefore, the NRC staff concludes that the potential impacts to air quality would be SMALL.

4.5.2 Greenhouse Gas Emissions and Global Climate Change

4.5.2.1 Marsland Expansion's Contribution to Atmospheric Greenhouse Gas Levels

In CLI-09-21 (NRC, 2009c), the Commission provided guidance to the staff on addressing GHG issues in environmental reviews. That guidance directed the staff to "…include consideration of carbon dioxide and other greenhouse gas emissions in its environmental reviews for major licensing actions under the National Environmental Policy Act."

Construction and operation of the MEA would contribute to GHG emissions. During the construction phase, GHG emissions would result from construction equipment used for wellfield development and vehicle traffic. During operations, onsite vehicle traffic related to operation and maintenance, employee commuter vehicles, and truck shipments delivering supplies to the site and removing products from the site, as described in Section 4.5, would generate GHG emissions. The small number of drilling rigs and pumps, infrequency of truck shipments, and the small projection of employment are expected to result in minimal GHG emissions from vehicles and engines used on site. Construction-equipment emissions would be localized and temporary. GHG emissions from the MEA are expected to be below the EPA's threshold of 27,558 tons (25,000 metric tons) per year of carbon dioxide equivalent, which requires facilities to report GHG emissions to EPA annually in accordance with 40 CFR Part 98, "Mandatory Greenhouse Gas Reporting." This expectation is based on estimates made for other ISR projects located in the region (NRC, 2014i, 2011). Decommissioning emissions would be comparable to those during construction. Given that GHG emissions during construction, operation, and decommissioning would be localized and infrequent, and well below the GHG-reporting threshold, the NRC staff concludes that GHG impacts associated with the MEA would be SMALL.

4.5.2.2 Potential Effect of Climate Change on the Marsland Expansion Area

As discussed in Section 3.5.1 of this EA, climate change impacts include an increase in temperatures and resultant surface water loss, with minimal change to precipitation patterns. Much of the activity associated with the ISR process that would be used for uranium recovery at the MEA occurs below ground. Climate change impacts to temperature and surface water availability are unlikely to impact activities at the MEA because the proposed action would use groundwater for these activities. Groundwater availability is not projected to change in the Great Plains region. Because there is little overlap between climate change projections and the environmental impacts of the MEA activities, the environmental impacts to specific resources should not be altered because of climate change, and therefore the NRC staff concludes that climate change impacts would be SMALL.

4.5.3 No-Action Alternative

If the NRC does not grant the amendment to the license, no new development activities would take place at the MEA. Wells and other structures that may have been constructed for the purpose of obtaining data about the groundwater and uranium deposits (i.e., during preconstruction activities) in the area would be plugged and the surrounding area restored. Small numbers of construction vehicles and workers would travel to the site for these activities. Activities at the existing Crow Butte license area would continue to take place in accordance with its license. Therefore, the NRC expects potential impacts on air quality associated with these closure activities at the MEA to be SMALL.

4.6 Historic and Cultural Resources Impacts

Section 3.6 discusses how the NRC fulfilled its responsibilities under Section 106 of the NHPA for CBR's license amendment. At present, a Class III archaeological survey, TCP surveys completed by the Crow and Santee Sioux Nations and the NRC's cultural resources expert, a literature review, and overall Tribal consultations have resulted in the recording of 15 historic resource sites. None of the newly recorded sites is currently evaluated as eligible for listing on the NRHP, although two are recommended as requiring additional evaluation should they be directly impacted by future project development (Graves et al., 2011). In response to information the NRC provided by letter dated November 18, 2014 (NRC 2014f), the NE SHPO concurred with the NRC's finding that the MEA would not impact archaeological, architectural, or historic context property resources (NSHS, 2014).

4.6.1 Historic and Archaeological Resources

When the NRC first issued SUA-1534 in 1989, the license included an administrative condition calling for (1) additional cultural resources surveys should any previously unsurveyed land be used for future developmental activity, (2) cessation of work and immediate notification to the NRC should a discovery of previously unknown cultural artifacts take place during project disturbance activity, and (3) providing the NRC with documentation of the licensee's interaction with NSHS before any development activity takes place in the immediate vicinity of any known potentially eligible sites. If the license is amended to incorporate the MEA, this administrative condition would remain in place.

The MEA has been subjected to intensive cultural resources field surveys by ARCADIS for archaeological and historical sites, resulting in the recording of 17 historic sites (15 newly recorded and 2 previously recorded) and 6 isolated finds (Graves et al., 2011, 2012), which are never evaluated per NRHP criteria. None of the historic sites was evaluated as being either eligible or potentially eligible for listing on the NRHP, although the NE SHPO recommended one historic farmstead (25DW297) for further archival work should the site actually be disturbed by future uranium recovery development. This farm complex is currently occupied and would not be impacted by any proposed project activities, although construction and operation of nearby wells would create a visual intrusion. This potential visual impact would be temporary, and the visual resource would return to its original condition after reclamation and decommissioning of nearby mine units. If future project activities were to directly impact this property, additional research would be conducted to supplement the current cultural resource documentation and reach a final evaluation on NRHP eligibility. In 2011 and 2012, the NE SHPO concurred with the recommendations included in the ARCADIS archaeological and historical sites reports (NSHS, 2011c, 2012).

CBR has practiced avoidance for all archaeological and historic sites within the existing Crow Butte license area (SC&A, 2012). CBR also would apply this practice of avoidance at the MEA for all project phases (i.e., construction, operation, aquifer restoration, and decommissioning). Activities associated with restoration of the groundwater in uranium recovery units would occur at existing wells within established wellfields, and there would be little or no potential for impacts to known cultural resource sites. While general earth-disturbing activities would be associated with decommissioning the wellfields and other facilities, CBR would continue to avoid all known cultural resource sites during those activities (CBR, 2004).

In summary, the entire MEA has been surveyed for historic and archaeological resources, and none of the recorded resources is currently considered to be eligible for listing on the NRHP. Regardless of their NRHP eligibility status, CBR intends to avoid direct impacts to these sites during all project activities (CBR, 2014, Section 4.8). Therefore, the NRC staff concludes that potential impacts to known and recorded historic and archaeological resources located within the APE (i.e., within the boundaries of the MEA) would be SMALL.

4.6.2 Places of Religious or Cultural Significance

Two of the consulting Native American Tribes surveyed the entire MEA for potential places of religious or cultural significance (Santee Sioux Nation, 2013), resulting in the identification of 12 possible places. These two Tribes completed a TCP survey report, which indicated that none of the identified places is eligible for listing on the NRHP; however, the report recommended that CBR observe a buffer zone with a radius of either 100 or 200 feet (30 or 61 meters) during project construction and operation activities and use Tribal monitors if there are future project impacts in the immediate vicinity of the identified places (Santee Sioux Nation, 2013). Following the Tribal field survey, the NRC acquired additional information about each of the identified places through a field documentation effort. This additional field documentation and evaluation of these places confirmed that none of the places the Tribes identified is considered eligible for listing on the NRHP (SC&A, 2013a, 2013b). The NRC provided this further documentation of the Tribal places to the consulting Native American Tribes for their review and comment. The NRC received no comments.

It is possible that culturally important medicinal herbs may be found within the MEA. Comparison of the plant species list provided in Appendix H-1 to the MEA ER (CBR, 2014) and the list of plants used as medicinal herbs in contemporary times by the Oglala Sioux (Morgan and Weedon,

1990) yields a list of nine plant species used today by the Oglala (Table 4-4). Although each of the plants included in Table 4-4 may potentially occur at the MEA, these plants are known to be found over a wide range in the Northern Plains.

Table 4-4 Summary of MEA Plant Species that Have Been Identified as Being Used by the Oglala Sioux in Contemporary Times

Common Name	Scientific Name	Lakota Name	Lakota Use
Curly-top gumweed	*Grindelia squarrosa* (Pursh) Dun.	*pteiciyuha unma*	Remedy for colic, kidney problems, and other ailments
Purple coneflower	*Echinacea angustifolia* DC.	*icahpe hu*	A commonly used medicinal plant with a wide range of uses
Sweet clover	*Melilotus officinalis* (L.) Lam. and *Melilotus alba* Dest.	*wacanga iyececa*	Two species of sweet clover are hung in the house for its aromatic odor and burned as an aromatic for pleasure, purification, or curing
White sage	*Artemisia ludoviciana* Nutt.	*pejihota ape blaskaska*	Consistently used at religious ceremonies, for medicinal purposes, and for remedies associated with women’s menstruation
Fringed sagebrush	*Artemisia frigida* Willd.	*pejihota wastemna*	Same as for white sage
Field mint	*Mentha arvensis* L.	*ceyaka*	Used to make a traditional beverage and as a remedy for colds and upset stomach
Common sunflower	*Helianthus annuus* L.	*wahcazizi*	Used to make a tea and as a remedy for pulmonary troubles, upset stomach, and diarrhea
Prairie wild rose	*Rosa arkansana* Porter	*unjinintka*	Roots of plant used for stomach ailments
Red false mallow	*Sphaeralcea coccinea* (Pursh) Rydb.	*heyoka tapejuta*	Used as a healing salve for sores and wounds, but may not be used any longer

Source: Adapted from Morgan and Weedon, 1990; CBR, 2014, Appendix H-1

Two of the plants identified as a culturally important Oglala Sioux medicinal herb, peyote and sweet flag, are not native to the Northern Plains. The closest known location of sweet flag and peyote are along Bordeaux Creek, near Chadron, NE, in the Pine Ridge area of northwestern Nebraska, about 25 miles from the MEA, where it is believed to have been introduced in historic times by Lakota people (Morgan and Weedon, 1990).

As with the historic and archaeological resources that are potentially eligible for listing on the NRHP, CBR intends to avoid direct impacts to all identified Tribal locations during all project activities (CBR, 2014, Section 4.8), even though none of these potential cultural properties is recommended for NRHP eligibility. Using available information, the staff concludes that the potential impacts of amending the CBR license to include development of the MEA on known places of Tribal religious and cultural significance would be SMALL.

Based on the findings that no historic properties exist at the MEA and that no places of potential Tribal religious or cultural significance would be impacted, the NRC staff concludes that the MEA would not have adverse effects on significant historic and cultural resources.

4.6.3 No-Action Alternative

If the NRC does not grant the amendment to the license, no new development activities would take place at the MEA. Wells and other structures that may have been constructed for the purpose of obtaining data about the groundwater and uranium deposits (i.e., during preconstruction activities) in the area would be plugged and the surrounding area restored. Small numbers of construction vehicles and workers would travel to the site for these activities. Activities at the existing Crow Butte license area would continue to take place in accordance with its license. Therefore, the NRC staff concludes that potential impacts on historic and cultural resources associated with these closure activities at the MEA would be SMALL.

4.7 Demographics and Socioeconomics

4.7.1 Socioeconomic Impacts

Impacts associated with the existing Crow Butte license area to the community infrastructure in the city of Crawford or in Dawes County, NE, can give an indication of those that would be expected from the MEA. Operation at expansion areas such as the MEA would enable activities at the existing Crow Butte license area to continue as its reserves are depleted. The NRC recently reviewed socioeconomic impacts as part of its EA for renewing CBR's license for its existing Crow Butte license area (NRC, 2014e). The staff found that there are beneficial small to moderate overall socioeconomic impacts from the operation of the existing Crow Butte license area, primarily in the form of monetary benefits that accrue to the community as a result of tax revenues, jobs, and local purchases.

As of September 2017, CBR employed a workforce of approximately 32 employees, a decrease from the January 2014 workforce level of approximately 68 employees and two contractors with 14 employees, with short-term contractors and employees for specific projects or during the summer (CBR, 2014, Section 4.10.2.1; NRC 2017c). The majority of these employees were hired from the surrounding communities. Given total employment in Dawes County in 2016 of 5,077 workers (see Section 3.7.2), which is down from 5,545 workers in 2010 (BEA, 2015), CBR accounted for less than 1 percent of all employment in Dawes County and about 4 percent of the total payroll for the county. The average wage for CBR employees was approximately $58,821 in 2009, which is higher than the Dawes County median household income of $41,038 in 2015 (see Section 3.7.2). Entry-level workers for CBR earned a minimum of $16.15 per hour, or $33,600 per year in 2009, not including overtime, bonuses, or benefits (CBR, 2014, Section 4.10.2.1, page 4-30). While the wages shown above are not from the same year, it shows that CBR employees earn incomes higher than other residents of Dawes County.

The MEA project would require an additional 10 to 12 full-time CBR employees, 4 to 7 full-time contractor employees, and 10 to 15 part-time CBR employees and short-term contractors for construction activities (CBR, 2014, Section 4.10.2.2). CBR employees would serve at the satellite facility and in wellfield operator and maintenance positions. Contractor employees would provide construction services and serve as drilling rig operators. These positions would increase payroll by approximately $400,000 to $480,000 per year. CBR expects to hire the majority of these workers from the current labor force in Dawes County, which had an annual unemployment rate in 2016 of 3.1 percent (see Section 3.7.2).

Because CBR expects to fill positions from within the existing labor force, the proposed project is not anticipated to require bringing additional workers into the area. Therefore, the NRC does not anticipate any change in the local population, housing unit vacancy rates, or in demand on local services, from implementation of the proposed project.

Likewise, the NRC does not expect any increases in levels of domestic water usage in Dawes County, nor the water requirements of MEA construction and operation to affect municipal water systems. Electricity, water, propane and other fuel, sanitary water, and wastewater treatment for construction and operation would be provided by the utilities that currently provide these services to the existing Crow Butte license area. As a result, activities at the MEA may increase the total quantities of these inputs related to CBR activities. However, this would be for a limited period of time because the MEA would begin operations at the same time as active uranium recovery operations in the existing Crow Butte license area are winding down, and CBR has been following the same practice proposed for the MEA of conducting aquifer restoration activities as each individual uranium recovery unit ceases operations. Although consumptive water use would increase during aquifer restoration, the additional water would be pumped from within the MEA from the Basal Chadron Sandstone aquifer and would not impact the amount of water available to other users. Because the scope of production at the MEA would be similar to that at the existing Crow Butte license area, CBR anticipates that fuel and utility requirements would likewise be similar (CBR, 2014, Section 4.10.2.2).

As noted above, CBR currently has a beneficial economic impact on the local Dawes County economy, and development of the MEA would continue this beneficial impact. The amount of impact on Dawes County tax revenue is predicated on the level of production occurring, given that the tax rate applied by the county is influenced by market conditions for uranium. For example, tax revenues attributable from activities at the existing Crow Butte license area were about $1,372,000 in 2010, based on a production rate of 800,000 pounds (360,000 kg) of uranium per year (CBR, 2014, Table 4.10-2). The additional production from the MEA would be approximately 553,000 pounds (251,000 kg) per year, resulting in an incremental contribution to taxes of about $950,000 per year. CBR's purchasing procedures emphasize obtaining all possible supplies and services in the local area, resulting in payments to Nebraska businesses, the vast majority in the city of Crawford and Dawes County, in 2010 of $4,330,900. Local purchases for the MEA are estimated to be at least $1 million per year, and the NRC staff's EA for the most recent CBR license renewal noted that those local purchases amounted to about $5 million in 2006 (NRC, 2014e). In addition, mineral royalty payments accrue to local landowners, and CBR paid production royalties of $532,000 to landowners in 2010; CBR would make additional royalty payments to MEA landowners, most of whom are residents of Dawes County (CBR, 2014, Section 4.10.3).

Given these factors, the NRC staff concludes that the potential direct socioeconomic impacts resulting from this project would be SMALL and primarily beneficial because of the small increase in the number of people employed and associated tax revenue, regardless of the mining production rate.

4.7.2 Environmental Justice

As required by Title VI of the Civil Rights Act of 1964, Federal agencies must consider whether their actions may cause disproportionately negative impacts on minority or low-income populations. Executive Order 12898 (59 FR 7629, February 16, 1994), "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires similar analysis. In response to Executive Order 12898, the NRC issued a "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions" (69 FR 52040, August 24, 2004), which states that the NRC "is committed to the general goals set forth in Executive Order 12898, and strives to meet those goals as part of its NEPA review process." The NRC staff performed its environmental justice analyses using guidance in Appendix C to NUREG-1748.

NUREG-1748, Appendix C, "Environmental Justice Procedures," states that an environmental justice analysis is not required for an EA and is usually not performed for an EA. For this EA, the NRC staff completed an environmental justice analysis because the staff was aware of the interest in this licensing action among several federally recognized Tribes within 100 miles (161 km) of the MEA.

NRC addresses environmental justice matters for license reviews through (i) identifying minority and low-income populations that may be affected by the proposed licensing of the MEA, and (ii) examining any potential human health or environmental effects on these populations to determine whether these effects may be disproportionately high and adverse. In 1997, CEQ provided the following guidance relevant to determining when an agency's actions may disproportionately affect certain populations (CEQ, 1997):

- <u>Disproportionately High and Adverse Human Health Effects</u>—Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as defined by NEPA) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group.

- <u>Disproportionately High and Adverse Environmental Effects</u>—A disproportionately high environmental impact that is significant (as defined by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as defined by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian tribes are considered.

The following environmental justice analysis assesses whether licensing the MEA might cause disproportionately high and adverse human health or environmental effects on minority and low-income populations. In assessing the effects, the NRC used the following CEQ (1997) definitions of minority individuals, minority populations, and low-income populations:

- <u>Minority individuals</u>—Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races meaning individuals who identified themselves on a Census form as being a member of two or more races, for example, Hispanic and Asian.

- <u>Minority populations</u>—Minority populations are identified when (i) the minority population of an affected area exceeds 50 percent or (ii) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

- Low-income population—Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series PB60, on Income and Poverty.

Because the MEA is located in a rural area outside city limits, the area of assessment (review area) used for the environmental justice analysis is a 4-mile (6.4-km) radius (NRC, 2003a) around the MEA. NRC staff guidance also recommends using Census Block Groups (CBGs) for the environmental justice analysis (NRC, 2003a). In this case, given the extremely small population in CBGs in and around the MEA (as discussed in Section 3.7.4), the staff chose to base its environmental justice analysis on 2010 census data for minority and low income populations in Crawford, which is the nearest major population center to the MEA.

In 2010, the total population for the city of Crawford was 997 people (USCB, 2010). As shown in Table 3-13, minority populations accounted for less than 5 percent of this total population. The population characteristics of the review area (in this case, the city of Crawford) are compared with State of Nebraska and Dawes County population characteristics to determine whether there are significant concentrations of minority or low-income populations in the review area relative to the State and county.

The NRC staff considers environmental justice in greater detail when the percentage of minority or low-income population in the impacted area exceeds the corresponding populations in the county or State by more than 20 percentage points, or when the minority or low-income population in the impacted area exceeds 50 percent (NRC, 2003a). According to the Census data presented in Table 3-13, the percentages of minority and low-income populations of 4.4 and 14.8 percent, respectively, in the vicinity of the MEA (as represented by the city of Crawford) do not significantly exceed the corresponding percentages in either Dawes County (10.6 and 17.5 percent, respectively) or the State of Nebraska (13.9 and 14.0 percent, respectively). Also, the low-income or minority populations within the affected area do not exceed 50 percent. Therefore, the NRC staff concludes that granting a license amendment to construct and operate the MEA would not result in disproportionately high or adverse impacts to minority or low-income populations.

As noted in Section 3.7.1, the population of Oglala Lakota County, SD, which is entirely with the Pine Ridge Indian Reservation, is 96 percent American Indian. In addition, about 54 percent of the Oglala Lakota County population is below the poverty level, compared with about 14 percent for the State of South Dakota (USCB, 2011). The southern boundary of Oglala Lakota County (and the Pine Ridge Indian Reservation) is approximately 35 miles (56.3 km) northeast of the northern boundary of the MEA. Based on the NRC staff's impact determinations in this draft EA and the distance between the Pine Ridge Indian Reservation and the MEA, the NRC staff concludes that there would be no significant impacts to the Pine Ridge Indian Reservation and, therefore, granting a license amendment to construct and operate the MEA would not result in disproportionately high or adverse impacts on minority or low-income residents on the Pine Ridge Indian Reservation.

If the NRC approves CBR's license amendment application for the MEA, there would be potential beneficial impacts related to environmental justice. Beneficial economic impact on minority groups is possible because the project could generate additional employment opportunities with compensation that compares favorably with other employment opportunities in the area.

Based on the above analysis, the NRC staff concludes that there would not be disproportionately high or adverse impacts on minority and low-income populations if the MEA is licensed.

Therefore, the NRC staff concludes that overall impacts to environmental justice from the licensing of the MEA would be SMALL.

4.7.3 No-Action Alternative

If the NRC does not grant the amendment to the license, no new development activities would take place at the MEA. Wells and other structures that may have been constructed for the purpose of obtaining data about the groundwater and uranium deposits (i.e., during preconstruction activities) in the area would be plugged and the surrounding area restored. Small numbers of construction vehicles and workers would travel to the site for these activities. Activities at the existing Crow Butte license area would continue to take place in accordance with its license. Therefore, the NRC staff concludes that potential impacts on socioeconomics and environmental justice associated with these closure activities at the MEA to be SMALL.

4.8 Transportation

This section presents nonradiological and radiological impacts associated with transportation activities. Section 4.5 analyzed air quality impacts from increased transportation and Section 4.9 analyzes noise impacts from traffic.

4.8.1 Nonradiological Transportation Impacts

As noted in the ISR GEIS (NRC, 2009a, Section 4.2.2), truck and automobile use is associated with all phases of the ISR facility life cycle. At the MEA, construction, operation, aquifer restoration, and decommissioning activities are expected to add commuting and delivery vehicles on the roadways leading to the MEA from the nearby population centers, primarily Crawford, NE, but potentially also Hemingford and Chadron, NE. Although the ISR GEIS (NRC, 2009a, Section 4.2.2.1) found the construction phase to pose the highest potential impacts in terms of employee commuting, construction equipment, and transportation of materials for construction, it also notes that ISR facilities in general are not large-scale or time-consuming construction projects, and the potential impacts would have a short duration. These expectations are consistent with the activities proposed for the MEA.

Surface transportation routes from the MEA to nearby population centers (Crawford) and the existing Crow Butte license area include the roadways shown in ER Figure 1.4-1 (CBR, 2014):

- to Crawford
  - about 23 miles (37 km) (7.1 miles (11.4 km) on unpaved roads, including about 0.43 mile (0.7 km) on a gravel access road to be constructed)
- to existing Crow Butte license area and Crow Butte CPF (see Section 3.8 for details)
  - primary access route (30 miles (48.3 km), including 11.6 miles (18.7 km) on unpaved roads)
  - alternative Route A (14 miles (22.5 km), all unpaved roads)
  - alternative Route B (24.7 miles (39.8 km), including 9.9 miles (15.9 km) on unpaved roads)

CBR states that the alternative routes would only be used in case of emergency or closure of the primary access route (expected to be less than 1 percent of the time) and prefers Alternative Route B over Alternative Route A (CBR, 2014, Section 4.2.2.3). These route preferences minimize the use of unpaved roads. The MEA would have no impact on the current operations of the BNSF rail line, which runs in a northwesterly direction beyond the western boundary of the MEA.

Most MEA employees are expected to live in Dawes County (CBR, 2014, Section 4.10.2.2). Those traveling from the city of Crawford would use Nebraska Highway 2/71, which intersects with Dodge Road/ Nebraska Highway 2 about 8.5 miles (13.7 km) to the south of the MEA. Workers may also travel from the village of Hemingford, 11.9 miles (19.2 km) east of the MEA. Chadron, the county seat and another potential source of employees, is located about 23 miles (37 km) to the northeast of Crawford along U.S. Route 20, at the intersection with U.S. Route 385. MEA activities would also involve daily truck and employee traffic to the CPF at the existing Crow Butte license area, located just southeast of Crawford. Based on CBR's designation of primary and secondary routes (CBR, 2014, Figure 4.1-1), the NRC staff expects Nebraska Highway 2/71 to be used for commuting by a large portion of the workforce for the MEA and for the transportation of the uranium-loaded resin to the Crow Butte CPF.

As stated in Section 4.7.1, 10 to 15 part-time CBR employees and short-term contractor employees would work at the site 7 days per week during construction, and 10 to 12 CBR employees and 4 to 7 contractor employees would work at the site 7 days per week during operations. In addition to these commuters, Table 4-5 summarizes the levels of truck traffic associated with the transport of materials during operations.

Table 4-5 Transportation of Materials during Operations

Material	Frequency
Fuel and process chemicals (including carbon dioxide, oxygen, soda ash, propane, and motor vehicle fuel)	Average of one truck per working day
Wellfield construction materials	Once per month
Low-level radioactive waste or unusable equipment contaminated with 11e.(2) byproduct[a]	Averaging two per year
Uranium-laden resin[a]	One 4,000-gallon-capacity tanker truck per day (from the MEA satellite facility to the CPF at the existing Crow Butte license area)
Barren, eluted resin[a]	One load per day (returning tanker truck from the Crow Butte CPF to the MEA)

a 11e.(2) byproduct material; uranium-laden resin; and barren, eluted resin are handled as Low Specific Activity material; complying with all DOT and NRC regulations.

Table 2.8-1 of the ISR GEIS (NRC, 2009a, Section 2.8) provides estimates for the magnitude of vehicle trips for all purposes from all phases of the ISR life cycle. The NRC staff (NRC, 2009a, Section 4.4.2) found that these are low in magnitude compared with local traffic volumes in the Nebraska-South Dakota-Wyoming Uranium Milling Region and are therefore not expected to significantly change the amount of traffic or accident rates. The ISR GEIS did note that commuting traffic during periods of peak employment (during construction) would have greater potential impacts when roads with the lowest levels of current traffic are traveled, and that this would be more pronounced in the Nebraska-South Dakota-Wyoming Uranium Milling Region since the region has relatively lower traffic counts. However, the vehicle estimates given above for the MEA are all significantly less than or the same as those given in ISR GEIS Table 2.8-1 and used in the ISR GEIS analysis. In particular, CBR expects many fewer trips associated with employee commuting. Although the MEA is in a rural area of Nebraska with low traffic, the additional traffic volumes expected are relatively small compared to the existing traffic volumes on these roadways, given in Section 3.8. Therefore, they are not expected to significantly contribute to the congestion or accident rates on these roadways.

In addition to employee commuting, transportation impacts during operation are also associated with the transport of IX resin, waste, and supplies (NRC, 2009a, Section 4.2.2.2). Section 2.8 of the ISR GEIS (NRC, 2009a) describes the transportation of hazardous and radioactive materials associated with expansion areas and the frequency of such shipments, which are equal to or more than those expected for the MEA. The ISR GEIS (NRC, 2009a, Section 4.2.2.2) considers this estimated magnitude of operational truck transportation as unlikely to generate significant environmental impacts above those associated with construction.

The additional traffic from MEA activities may result in the degradation of public road surfaces, particularly local gravel roads maintained by Dawes County. CBR would support the maintenance through its tax payments and by working with the county to address any impacts on county roads from CBR operations, such as providing materials for road maintenance (CBR, 2014, Section 5.2).

Potential impacts from the transport of hazardous chemical supplies are considered to be low given the relatively low frequency of such shipments; the low risk of high-consequence accidents, given the precautions taken with such materials; and the low likelihood of an accident in a populated area, given the remote location of ISR facilities such as the MEA. CBR is required to follow the packaging and shipping requirements contained in the DOT Hazardous Materials Regulations in 49 CFR Part 173, "Shippers—General Requirements for Shipments and Packagings," for hazardous materials.

The ISR GEIS (NRC, 2009a, Sections 4.2.2.3 and 4.2.2.4) considers the potential impacts to transportation related to aquifer restoration and decommissioning to be similar to or less than those of construction and operation. There is no basis for reaching a different conclusion for the MEA.

Based on the above analysis, the NRC staff concludes that potential nonradiological transportation impacts during construction, operation, aquifer restoration, and decommissioning would be SMALL.

4.8.2 Radiological Transportation Impacts

As discussed in Section 2.3.2, during ISR operations CBR would transport the IX resin loaded with uranium from the MEA to the CPF at the existing Crow Butte license area, where the uranium would be removed from the resin and processed into yellowcake. This yellowcake would be shipped offsite from the Crow Butte CPF for processing into fuel. The activities at the MEA would extend the operation of the Crow Butte CPF, resulting in a continuation of truck shipments from the CPF at the existing Crow Butte license area after uranium recovery ceases at the existing facility.

In the ISR GEIS, the NRC analyzed the accident risks associated with 1,300,000 lbs (589,670 kg) annually, resulting in an annual accident risk of up to 0.01 latent cancer fatality[19] (NRC, 2009a, Section 4.2.2.2). When adjusted for the licensed maximum amount of yellowcake produced each year from MEA operations (i.e., 2 million lbs, or 907,185 kg), the accident risk specific to MEA operations would be up to 0.015 latent cancer fatality per year.

The potential radiological impacts of IX resins from ISR sites such as the MEA are expected to be lower than those from the transport of yellowcake because (1) IX resins are less concentrated and therefore contain less uranium per shipment than a yellowcake shipment, (2) the uranium in IX resins is chemically bound to the resins and less likely to spread and easier to remediate in the event of a spill, and (3) IX resins typically are not shipped as far as yellowcake. The distance from the MEA to the existing Crow Butte license area for processing is about 30 miles (48.3 km), using the primary access route. The potential impacts from solid waste shipments to disposal facilities would not be significant because of the low levels of radioactivity associated with the waste and compliance with packaging and transportation regulations. The potential impacts of any groundwater shipments (which would be 11e.(2) byproduct material), which would be related to an extended shutdown of the MEA, to the ponds at the existing CBR license area would also not be significant, given their small number and lower concentrations of radioactivity.

Licensee compliance with existing transportation regulations and safety controls increase confidence that shipments of hazardous and radioactive material can be made safely. CBR is required to follow the packaging requirements contained in the NRC regulations in 10 CFR Part 71, “Packaging and Transportation of Radioactive Material,” and shipping requirements contained in the DOT regulations in 49 CFR Part 173 for radioactive materials. In addition, Nebraska has promulgated transportation regulations in NAC Title 180, “Control of Radiation,” Chapter 13, “Transportation of Radioactive Material,” implementing the Nebraska Radiation Control Act (Neb. Stat. Rev. §§ 71-3501 to 71-3520) that require compliance with DOT regulations for transporting radioactive materials and sets forth requirements for issuance of a general license for the packaging. CBR has procedures in place in its SHEQMS Emergency Manual (Volume 8) to rapidly respond to accidents (CBR, 2014, Section 4.12.3). These procedures incorporate the NRC’s recommendations from its analysis of accidents at uranium ISR facilities in NUREG/CR-6733, “A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licenses,” issued September 2001 (CNRWA, 2001).

Therefore, based on the characteristics of the materials that would be transported, the low number of shipments, the regulatory requirements, and the procedures CBR has in place, the NRC staff concludes that the potential radiological transportation impacts related to the MEA would be SMALL.

---

[19] Latent cancer fatality is a measure of the calculated number of excess cancer deaths expected in a population as a result of exposure to radiation. Latent cancers can occur from one to many years after the exposure takes place.

4.8.3 No-Action Alternative

If the NRC does not grant the amendment to the license, no new development activities would take place at the MEA. Wells and other structures that may have been constructed for the purpose of obtaining data about the groundwater and uranium deposits (i.e., during preconstruction activities) in the area would be plugged and the surrounding area restored. Small numbers of construction vehicles and workers would travel to the site for these activities. Activities at the existing Crow Butte license area would continue to take place in accordance with its license. Therefore, the NRC concludes that potential impacts on transportation associated with these closure activities at the MEA would be SMALL.

4.9 Noise

In general, the average noise level in a residential area at night is 40 dBA, in a residential area during the day is 50 dBA, in a rural area during the day is 40 dBA, and in a typical construction site is 80 dBA. A normal conversation at 5 feet (1.5 meters) is 60 dBA. EPA identified a 24-hour exposure level of 70 dBA as the level of environmental noise that would prevent any measurable hearing loss over a lifetime, and levels of 55 dBA outdoors and 45 dBA indoors as those that would prevent activity interference and annoyance (EPA, 1974).

4.9.1 Construction

As noted in the ISR GEIS (NRC, 2009a, Section 4.2.7.1), potential noise impacts from ISR activities are expected to be greatest during construction because of the use of heavy equipment, especially for new facilities developed in rural, previously undeveloped areas such as that of the MEA that would likely have a lower baseline noise level. Increased vehicle travel and operation of construction equipment at the site (primarily related to operation of drilling rigs during wellfield development) would result in a slight increase in noise impacts to residents who live close to the MEA. Average noise levels at 50 feet (15 meters) from representative construction heavy equipment range from 71 to 109 dBA. In general, the ISR GEIS found that noise from line sources, such as highways, is reduced by about 3 dB per doubling of distance, and for point sources, such as construction equipment, would reduce by about 6 dB per doubling of distance. For example, while noise levels associated with a typical water well drill rig may exceed 100 dBA within 7 feet (2 meters) of the compressor, they quickly drop to less than 90 dBA within 20 feet (6 meters).

Construction activities at the MEA would typically occur over an 8-hour workday, 5 days per week (CBR, 2014, Section 4.7.1). The increased noise levels would be intermittent and temporary in duration, occurring only during the day during the limited period of construction. The one occupied residence is located approximately 656 feet (200 meters) from the proposed wellfield in Mine Unit 4; potential construction noise impacts at this location would be MODERATE, at about 61 dB for a 100-dBA noise 656 feet away.[20] This impact, however, would not be generated during nighttime hours and would be temporary and intermittent (CBR, 2014, Sections 3.7 and 4.7.1). Noise impacts from construction equipment to residences and other sensitive receptors about 1,000 feet (300 meters) or more from the facility would be about 55 dBA. The increase in traffic levels during construction may also add to existing noise levels, but since this increase in traffic would be small, the increase to noise also would be small and intermittent. Therefore, the NRC

---

[20] One calculator to use for determining sound level at various distances is available at http://www.sengpielaudio.com/calculator-distance.htm.

staff concludes that potential overall impacts from noise associated with construction activities at the MEA would be SMALL.

4.9.2 Operation

As noted in the ISR GEIS (NRC, 2009a, Section 4.2.7.1), operation activities at ISR facilities generally do not create important sources of noise for offsite receptors, except for heavy truck traffic associated with deliveries and shipments of resin and solid wastes. This and employee commuting traffic would add to existing noise associated with roadways. In the wellfields, the only noise sources during operation would be the groundwater pumps and occasional truck traffic required to perform maintenance and inspections. Truck and employee commuting traffic associated with MEA operation is expected to be less than during construction, as noted in Section 4.8; therefore, the potential noise impacts would also be less than those associated with construction. At the satellite facility, operational noises would be typical of an industrial facility, audible above undisturbed background levels but still less than during construction. Potential impacts are expected to be small to receptors located more than about 1,000 feet (300 meters) from the source (NRC, 2009a, Section 4.2.7.2). Therefore, the NRC staff concludes that potential impacts from noise associated with operational activities at the MEA would be SMALL.

4.9.3 Aquifer Restoration and Decommissioning

Given the relatively small amount of vehicle traffic to be added to existing levels from MEA operation to accomplish aquifer restoration and decommissioning, as discussed in Section 4.8, and the small number of occupied structures in the area of the MEA, as discussed in Section 3.7.3, and their distances from the wellfields and satellite facility (all greater than 1,000 feet (300 meters), except for the one residence noted above), the NRC staff concludes that the potential noise impacts from MEA operation would be SMALL.

The ISR GEIS (NRC, 2009a, Sections 4.2.7.3 and 4.2.7.4) considers the potential noise impacts related to aquifer restoration and decommissioning to be similar to or less than those of construction and operation. Therefore, the NRC staff concludes that potential noise impacts from restoration and decommissioning would be SMALL.

4.9.4 No-Action Alternative

If the NRC does not grant the amendment to the license, no new development activities would take place at the MEA. Wells and other structures that may have been constructed for the purpose of obtaining data about the groundwater and uranium deposits (i.e., during preconstruction activities) in the area would be plugged and the surrounding area restored. Small numbers of construction vehicles and workers would travel to the site for these activities. Activities at the existing Crow Butte license area would continue to take place in accordance with its license. Therefore, the NRC staff concludes that potential impacts from noise associated with these closure activities at the MEA would be SMALL.

4.10 Visual and Scenic Resources

As noted in the ISR GEIS (NRC, 2009a, Section 4.2.9.1), most potential visual and scenic impacts associated with drilling and other land-disturbing construction activities would be temporary in duration; roads and structures would be present for a longer duration but eventually removed and the land reclaimed. Impacts of operation, aquifer restoration, and decommissioning would be the same or less than those associated with construction. The greatest potential for visual impacts would be for new facilities operating in rural, previously undeveloped areas or within view of sensitive regions. Given the distances of existing and potential uranium ISR facilities from these areas, the ISR GEIS (NRC, 2009a, Section 4.4.9.2) anticipates that potential visual and scenic impacts introduced by ISR facilities would be small.

MEA activities would involve the construction of visible surface structures; namely, wellhead covers, wellhouses, electrical distribution lines, and one satellite facility. Construction of wellhouses and ancillary facilities and well-drilling would affect the visual character of the landscape. These activities would typically occur 8 to 12 hours per day during the regular work week, and equipment and infrastructure would remain at other times. Workers would use both existing and new roads to access each wellhouse and the satellite facility. CBR would reclaim areas of temporary disturbance to preconstruction conditions after facility installation is complete (CBR, 2014, Section 5.1).

Although the added structures and associated access roads and electric distribution lines would continue to impact the visual quality of the MEA until final reclamation, they are not such that they would change the rural nature of the existing landscape. These visible structures are relatively small in scale and spread widely throughout the entire license area. In addition, CBR plans to construct these features such that they would blend into the landscape. For example, wellhead covers would have a relative low profile and small size (3 feet (0.9 meter) high by 2 feet (0.6 meter) in diameter) and a harmonizing color to help them blend in with the landscape (CBR, 2014, Section 4.9.1). Each of the 10 to 12 wellhouses at the MEA would consist of a small shed and a vehicle turnaround area. Electric distribution lines would connect wellhouses to existing electric distribution lines. The wooden distribution poles would be approximately 20 feet (6 meters) high and harmonize in color with the landscape. The electric distribution line poles connecting wellhouses with existing lines would be distributed in a higher density than on adjacent lands. The satellite building would have a footprint of approximately 100 feet by 130 feet (30.5 meters by 39.6 meters). As explained in the ER (CBR, 2014, Section 5.6), CBR would use existing vegetation and topographic features to screen wells, facilities, and roads from view. It would use nonreflective paint in colors that harmonize with the surrounding landscape. It would avoid straight, line-of-sight road construction and instead align roads with the contours of the topography. Clearings would be made to look natural by rounding comers and feathering the vegetation interface. CBR would also remove construction debris immediately.

As discussed in Section 3.10, the objective of the VRM Class III designation is to partially retain the existing character of the landscape with a moderate level of change to the characteristic landscape. The MEA project would modify the existing rural landscape to include a noticeable but minor industrial component. Those in sensitive viewing areas would be able to see the line and textural contrasts of the wellhouses, satellite facility, and associated access roads and distribution lines, but the contrasts would be low to moderate. Thus, CBR's plan for developing the MEA would meet the VRM Class III objectives.

Taking into account the small scale of structures to be constructed, actions to blend structures into the landscape and contour the topography, and meeting VRM Class III objectives, the NRC staff concludes that potential impacts from the MEA for visual and scenic resources would be SMALL.

No-Action Alternative

If the NRC does not grant the amendment to the license, no new development activities would take place at the MEA. Wells and other structures that may have been constructed for the purpose of obtaining data about the groundwater and uranium deposits (i.e., during preconstruction activities) in the area would be plugged and the surrounding area restored. Small numbers of construction vehicles and workers would travel to the site for these activities. Activities at the existing Crow Butte license area would continue to take place in accordance with its license. Therefore, the NRC staff concludes that potential impacts on visual and scenic resources associated with these closure activities at the MEA would be SMALL.

4.11 Public and Occupational Health and Safety

4.11.1 Nonradiological Effects

The ISR GEIS (NRC, 2009a, Sections 4.2.11.2.3 and 4.2.11.2.4, Appendix E) notes that only small risks would be expected in the use and handling of hazardous chemicals used during normal operations at ISR facilities. The ISR GEIS also provides an analysis of accidental chemical releases that can produce more serious consequences. The ISR GEIS concludes that "offsite impacts would be SMALL, while impacts to workers involved in response and cleanup could receive MODERATE impacts that would be mitigated by establishing procedures and training requirements." Releases of hazardous chemicals of sufficient magnitude to adversely impact public and occupational health and safety are generally considered unlikely, although possible, given commonly applied safety practices and the history of safe use of these chemicals at NRC-regulated ISR facilities.

CBR would design the chemical storage and handling facilities at the MEA in accordance with applicable codes and standards. MEA operation would, by design, involve a self-contained uranium recovery circuit, which limits spills and leaks during operation. If spills and leaks occur, the licensee would be required to comply with the following Federal regulations to limit the potential impacts to workers and the public:

- 40 CFR Part 68, "Chemical Accident Prevention Provisions." This regulation lists regulated toxic substances and threshold quantities for accidental release prevention.

- 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals." This regulation lists highly hazardous chemicals, including toxic and reactive materials that have the potential for a catastrophic event at or above the threshold quantity.

- 40 CFR Part 355, "Emergency Planning and Notification." This regulation lists extremely hazardous substances and their threshold planning quantities for the development and implementation of emergency response procedures. The regulation also provides a list of reportable quantity values for reporting releases.

- 40 CFR 302.4, "Designation, Reportable Quantities, and Notification—Designation of Hazardous Substances." This regulation lists hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act, compiled from the Clean Water Act and Clean Air Act.

Section 2.3.1 describes the potential for lixiviant excursion at the MEA, which is considered to be a potential release of process chemicals that may impact the environment. CBR has successfully controlled excursions in the existing Crow Butte license area, which were recovered through overproduction in the immediate vicinity (CBR, 2014, Section 3.11.1.2) and has therefore demonstrated that they could be controlled in the MEA. As described in Section 4.3.2.2, CBR would be required to monitor for lixiviant excursions and take corrective action should they occur.

The potential nonradiological impacts from decommissioning would be similar to those identified for construction. During decommissioning, nonradiological impacts would be temporary as the site is returned to unrestricted use. CBR would employ appropriate dust suppression practices to minimize impacts from vehicle and construction equipment. Decommissioning activities at the MEA would be completed under NRC and NDEQ permitting requirements, and any potential impacts would be localized and mitigated through compliance with these requirements. While spills of fuels and lubricants during decommissioning activities could potentially result in nonradiological impacts, CBR's implementation of BMPs, such as those identified in Section 4.12.1 of the ER (CBR, 2014), would reduce the likelihood and magnitude of such spills and facilitate corrective action.

The NRC staff concludes that potential nonradiological impacts to public and occupational health from activities at the MEA would be SMALL because environmental releases would be below regulatory limits and because of Federal and State regulatory requirements that control the safe handling, storage, and disposal of chemical and hazardous materials that could pose a threat to human health.

4.11.2 Radiological Effects

As noted in the ISR GEIS (NRC, 2009a, Section 4.2.11.2.1), the 2007 CBR application for renewal of the license for the existing Crow Butte license area reported that quarterly and biannual measurements of downwind concentrations of radon at the facility boundary from 1991 to early 2007 were below 2.0 picocuries (pCi)/L, with a majority of measurements below 1 pCi/L. The ISR GEIS also reports that the highest, potentially anomalous, results were 3.7 pCi/L in the second half of 2003, well below the NRC effluent limit for radon of 10 pCi/L given in 10 CFR Part 20, Appendix B.

Potential radiological impacts from the MEA on public and occupational health and safety are determined by analyzing the types of emissions from MEA operations, the potential emission pathways present, and an overall evaluation of the potential radiological hazards associated with the emission pathways. Since the project is an ISR facility, most of the particulate emission sources normally associated with a conventional mill would not be present. The only source of radioactive emissions would be radon released into the atmosphere through plant ventilation systems or from the wellfields; no elution or drying into yellowcake would occur at the MEA. This radon release could result in radiation exposure through inhalation and ingestion of radon decay products (i.e., radon progeny). CBR would monitor radon continuously at six sampling locations in or near the MEA during operations. Gamma radiation would be monitored using environmental dosimeters (CBR 2017a).

As explained in the ISR GEIS (NRC, 2009a, Section 4.2.11.2.1), radionuclides in the form of radon gas can be released to the environment from ISR wellfields and processing facilities during operations. However, historical measurements reported in the ISR GEIS resulted in public doses well below the NRC public dose limit of 1 mSv per year (100 mrem per year) specified in 10 CFR Part 20 and the 40 CFR Part 190 annual limit of 0.25 mSv per year (25 mrem per year), and maximum doses to workers were about 15 percent of the annual dose limit for workers. Worker doses from ISR facilities are expected to all be similar because the activities are similar from location to location.

4.11.2.1 Exposure from Air Pathways

Exposures from air pathways to the environment are expected to come in the form of radon gas, which has the potential to be released via a vent from the main plant or from the wellfields during operation (CBR, 2014, Section 4.12.2). Radon is present in the ore body and dissolves in the lixiviant as it travels through the ore body to a production well. When the solution is brought to the surface and processed in the plant, radon gas may be released. Radon is present in the process solution that passes through the IX columns and holding tanks. Most of this radon would remain in solution and be returned underground. Radon gas would be vented into the exhaust manifold and discharged via the main radon exhaust stack. Minor releases would occur when resin is transferred from the columns. Unplanned emissions from the site are possible as a result of accidents and engineered structure failure (see Section 4.11.3 below).

Radiation exposure occurs through one of three pathways: inhalation, ingestion, or external exposure. The total effective dose equivalent is calculated for employees at the MEA and surrounding area residents. CBR compiled the joint frequency data[21] from a site-specific meteorological station, which it used to define the atmospheric conditions in the project area.

CBR used MILDOS-AREA to calculate radon release, as did the NRC in its confirmatory analysis. MILDOS-AREA uses a radon venting rate of 1 percent of the radon in the uranium extraction circuit each day from the wellfield header houses (25 percent) and at the satellite building (75 percent) (CBR, 2014, Section 4.12.2.1 and Appendix M). The analyses also considered the radon emissions from other nearby ISR projects. The NRC MILDOS-AREA results differed somewhat from those CBR presented (CBR, 2015) because the analyses used different assumptions. The most important difference is that the NRC obtained the radon releases for the nearby ISR projects from the application documentation for the license renewal of the existing Crow Butte license area and amendments for the NTEA and TCEA (CBR 2014d, CBR 2007, CBR 2010), while CBR used the data from the MEA TR (CBR, 2015, Appendix M).

The results of the NRC's MILDOS-AREA evaluation of radon dose rates are summarized below:

- All dose rates to the public at the property boundaries, the cities and towns within a 50-mile (80-km) radius of the MEA, and at the nearest eight residences and two unoccupied structures were below the 100 mrem per year limit for the public specified in 10 CFR Part 20, and in the State's regulations at 180 NAC, Chapter 4, "Standards for Protection Against Radiation."

- The highest cumulative boundary dose rate was 66.1 mrem (0.661 mSv) per year at the south property boundary.

- The highest cumulative dose rate at an occupied residence was 21 mrem (0.21 mSv) per year, and 10 mrem (0.10 mSv) per year at the nearest unoccupied structure.

- The highest cumulative dose rate from all existing and proposed ISR facilities at cities and towns within a 50-mile (80-km) radius of the MEA (i.e., existing Crow Butte license area and MEA, NTEA, and TCEA) was 3.6 mrem (0.036 mSv) per year at Crawford,

---

21 "Joint frequency data" are a way to present meteorological data for each of the six meteorological stability classes, A to F. It shows the frequency that the wind of a given speed blows from each of the 16 directions.

2.1 mrem (0.021 mSv) per year at Hemingford, and 2.6 mrem (0.026 mSv) per year at Marsland.

- The maximum 2,000 hours per year occupational dose rate was 42.6 mrem (0.426 mSv) per year, which is within the 5,000 mrem (50 mSv) per year limit specified in 10 CFR Part 20 and 180 NAC, Chapter 4.

- The total population effective dose rate was 9.3 person-rem (0.093 person-Sv) per year, and the total population bronchial dose rate was 395 person-rem (3.95 person-Sv) per year. The bronchial dose rate was the largest of the organ dose rates presented in the MILDOS-AREA output.

In comparison, the average dose from background radiation in Nebraska is 419.5 mrem (4.195 mSv) per year (29.3 mrem (0.293 mSv) from cosmic radiation, 29.2 mrem (0.292 mSv) from terrestrial radiation, and 361 mrem (3.61 mSv) from radon) (SC&A, 2005), higher than the doses calculated for the MEA. For the above reasons, NRC staff concludes that potential impacts on human health as a result of radiological exposures from the MEA via air pathways would be SMALL.

4.11.2.2 Exposure from Water Pathways

CBR would control and monitor the solutions used in the wellfield to ensure that migration does not occur, and would monitor the overlying aquifers as well (CBR, 2014, Section 4.12.2.2). CBR would place wastewater tanks used to manage project wastewater in the satellite building on a curbed concrete pad to prevent any liquids from entering the environment. Chemical storage tanks located outside the satellite building would also be located within spill containment dikes to control any spills or releases from the tanks. The wastewater collected in the wastewater tanks would discharge to DDWs. These wells would be completed such that they are isolated from any underground source of drinking water. They would be constructed in accordance with NDEQ-issued UIC permits in compliance with 122 NAC. Since there would be no routine discharges of process water from the MEA, there would be no definable water-related pathways.

For the above reasons, the NRC staff concludes that potential impacts to public and occupational health from water pathways on the MEA and the surrounding environment would be SMALL.

4.11.3 Accidents

Based on the NRC's annual inspections of licensed ISR facilities, the NRC's Web site reports that these sites have experienced few safety violations, all of which have been relatively minor (NRC, 2012c). Nevertheless, the ISR GEIS (NRC, 2009a, Section 4.2.11.2.2) describes and evaluates numerous accident scenarios that may result in impacts to public health and safety and identifies mitigation measures for each accident scenario. Since the MEA would only contain the wellfield and a satellite facility, with no yellowcake processing or drying operations, not all of the accidents evaluated in the ISR GEIS are applicable. For the accidents that are applicable to the MEA (e.g., radon release to the air in an enclosed area without adequate ventilation, such as from a pipe or valve failure at the IX columns; spills of hazardous chemicals used as part of ISR operations), the ISR GEIS (NRC, 2009a, Section 4.2.11.2.2) states that the consequences of those accidents to workers and the public are generally low. Licensees are required to implement radiological monitoring and safety programs that comply with 10 CFR Part 20 requirements to protect the health and safety of workers and the public. Federal regulations pertaining to the storage and use of chemicals that must be followed include 40 CFR Part 68, 29 CFR 1910.119, 29 CFR 1910.120, “Hazardous Waste Operations and Emergency Response,” 40 CFR Part 355, and 40 CFR 302.4 (see Section 4.11.1). The NRC would further analyze accidents with regard to the MEA in the safety evaluation report.

At the request of the NRC, the Center for Nuclear Waste Regulatory Analyses (CNWRA) analyzed the consequences of tornados and seismic events occurring at ISR facilities (CNWRA, 2001). In the report, CNWRA noted that structures at ISL facilities are not designed to withstand tornado winds. CNWRA showed that the only radiological material release from a tornado event that could incur any significant consequences would be the dispersal of dry yellowcake powder and a spill of dry localized thickener (i.e., yellowcake that has yet to be dried). Because no yellowcake processing or drying would occur at the MEA, these releases would not occur. In addition to radiological consequences, nonradiological consequences from a tornado could result from the reaction of chemicals that could be released from storage tanks. As noted in the CNWRA report (CNWRA, 2001), it is important that chemical storage tanks be located far enough apart to prevent chemical reactions resulting from the release of chemicals. CBR has committed to assessing the location and construction of chemical storage tanks and associated containment features (such as berms) in order to reduce the risk of chemical reactions resulting from the release of chemicals from storage tanks. In addition, a number of regulations dictate how chemicals are stored and handled, and industry follows accepted codes and standards (CBR, 2017). Based on the infrequent occurrence of tornadoes, the absence of yellowcake, and the design features, the NRC staff concludes that significant impacts would not occur.

The above description of consequences and design measures taken for minimizing the possibility and associated environmental impacts would conservatively apply to the impacts associated with a seismic event, as a seismic event could potentially lead to the same type of releases if the event is powerful enough. However, a seismic event in the region would not likely lead to any releases. As presented in Section 3.2.4, Table 3-5 shows that most of the earthquakes are in the magnitude range from 2.5 to 3.5 on the Richter scale, with only three events at or above magnitude 4.0. In general, earthquakes below 4.0 do not cause damage, and earthquakes around 3.0 are the smallest that can be felt. Table 3-5 also indicates that there was not a single event recorded within less than 15 miles (24.1 km) of the proposed facility in the 120 years of recording history.

At the MEA, CBR conducted flood studies to determine the potential flooding hazard from concentrated channel flow at 10-, 25-, 50-, and 100-year storm return periods to determine whether the MEA would require special design considerations or need to implement additional mitigation measures. The areal extent of the estimated floodplain compares well with the Federal Emergency Management Agency floodplain. The flood studies conclude that the 100-year flood plain parallels the two major drainages that cross the MEA from the northwest to the southeast. The westernmost drainage way and associated 100-year floodplain passes through Mine Units 2, 3, 4, and 5. The eastern drainage is located east of the mine units. Flooding, however, is considered a low-risk event because, as presented in Section 4.2.2, CBR would use the results of the flood studies to avoid placing project facilities, such as roads, processing equipment, storage tanks, or wells, within the flood zone (CBR, 2015).

CBR’s Emergency Manual (SHEQMS Volume 8) maintains procedures for dealing with emergencies, such as fires, tornados, and seismic events (CBR, 2015). Procedures address personnel notification of severe weather, evacuation procedures, security plans, medical emergencies, damage assessment and reporting, and mitigation and cleanup of spills.

In view of the low probability of occurrence of events that could cause radiological releases, the low potential population doses, and design and administrative measures to minimize and address the possibility and consequences of chemical reactions, the NRC staff concludes that the potential occupational and public health and safety impacts from accidents would be SMALL.

4.11.4 No-Action Alternative

If the NRC does not grant the amendment to the license, no new development activities would take place at the MEA. Wells and other structures that may have been constructed for the purpose of obtaining data about the groundwater and uranium deposits (i.e., during preconstruction activities) in the area would be plugged and the surrounding area restored. Small numbers of construction vehicles and workers would travel to the site for these activities. Activities at the existing Crow Butte license area would continue to take place in accordance with its license. Therefore, the NRC concludes that potential impacts on public and occupational health associated with these closure activities at the MEA would be SMALL.

4.12 Hazardous Materials and Waste Management

4.12.1 Hazardous Materials

For all onsite hazardous materials that exceed the threshold planning quantity, CBR is required by the Emergency Planning and Community Right-to-Know Act of 1986 to provide inventories and location information to State and local emergency responders for use in case of emergency. Wellfield development would require the use of hazardous materials, such as cement and commercial drilling mud products for well completions, corrosion inhibitors, glycol, anti-freeze, new and used lube oils, paints, gasoline, and diesel fuel for equipment operation and infrastructure construction. Drilling contractors are expected to stage their equipment at an alternate location and bring to the field locations only those materials needed for the specific operation being completed. Therefore, CBR does not anticipate that the volume of any single material on hand at any one time would exceed the threshold planning quantity of 10,000 lbs (about 4,500 kg) for hazardous materials, as required by Title III of the Superfund Amendments and Reauthorization Act (SARA). CBR does not expect that any extremely hazardous substances, as defined in SARA, would be used during operations (CBR, 2014, Section 4.12.3.1).

Hazardous chemicals could pose a threat to the public and wildlife in the event that a spill or release was prolonged and a nearby drinking-water source was contaminated. CBR is required to have standard operating procedures related to worker and public health and safety in place, including, but not limited to, a hazard communication program, an SPCC Plan, an SWPPP, and wellfield and radiological monitoring. These plans and protocols are intended to reduce the opportunity for hazardous material releases and the risk of human contact. CBR does not propose to use materials or chemicals considered to be extremely hazardous, as defined in 40 CFR Part 355. The NDEQ permit to recover uranium and the CBR operational plan would include a detailed listing of all monitoring requirements.

As discussed in Section 4.11.3 of this draft EA, to minimize potential impacts involving hazardous chemicals in the event of a tornado or earthquake, CBR would locate its chemical storage tanks and containment features to prevent the possibility that any chemicals released from a failed tank would come in contact with incompatible substances that could cause a dangerous chemical reaction (CBR, 2014).

The NRC staff concludes that potential impacts from the presence of hazardous materials at the MEA would be SMALL because of the regulatory requirements that control the safe handling, storage, and disposal of hazardous materials, the absence of extremely hazardous materials at the site, and the low volume of hazardous materials needed on site at any one time.

4.12.2 Waste Management

Solid wastes generated at the site would include both radiologically contaminated (i.e., 11e.(2) byproduct waste) and noncontaminated wastes. As discussed in Section 2.3.5, CBR regularly collects and disposes onsite noncontaminated solid waste into an NDEQ-permitted sanitary landfill. Activities at the MEA would generate about 50 gallons (189 liters) of waste petroleum products and chemicals annually (CBR, 2015, Section 4.2.1.3). CBR would isolate radioactive solid wastes with contamination levels requiring disposal at an NRC-licensed facility in drums or other suitable containers before offsite disposal. NRC License Condition 10.1.7 (NRC, 2014f) requires CBR to maintain a location within the restricted area boundary to store contaminated materials before their disposal. CBR expects that the proposed uranium recovery operations would generate about 60 cubic yards (45.9 m^3) of 11e.(2) byproduct waste annually. This waste would be disposed of under CBR's current contractual agreement with Denison Mines USA for disposal of 11e.(2) byproduct materials generated by uranium recovery operations at the company's White Mesa Mill site near Blanding, UT (CBR, 2014, Section 4.13.2.3). License Condition 9.9 requires CBR to notify the NRC if it decides to contract with a new disposal facility (NRC, 2014f).

The majority of MEA wastewater requiring disposal would be the process bleed through the first four or five years of operations (25–65 gpm) (see Section 2.3.3), which would then rise to include the reverse osmosis bleed associated with aquifer restoration throughthe remainder of the MEA operational period (an additional 150–225 gpm) (see Section 2.3.5 above) (CBR, 2015). Other liquid wastewater (well development water (see Section 2.3.5), laundry water, and plant washdown water) would be generated intermittently, with a maximum average of 1–2 gpm over the life of the project (CBR, 2014, Section 3.12.2.2). Impacts associated with disposal of wastewater in the DDWs are presented in Section 4.3.2 and, for the reasons discussed in that section, would be SMALL.

4.12.3 No-Action Alternative

If the NRC does not grant the amendment to the license, no new development activities would take place at the MEA. Wells and other structures that may have been constructed for the purpose of obtaining data about the groundwater and uranium deposits (i.e., during preconstruction activities) in the area would be plugged and the surrounding area restored. Small numbers of construction vehicles and workers would travel to the site for these activities. Activities at the existing Crow Butte license area would continue to take place in accordance with its license. Therefore, the NRC concludes that potential impacts related to hazardous materials and waste management associated with these closure activities at the MEA would be SMALL.

5 CUMULATIVE IMPACTS

CEQ regulations implementing NEPA define cumulative effects as “the impact on the environment which results from the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions” (40 CFR 1508.7, “Cumulative Impact”). Unless otherwise stated for a specific resource area, the NRC staff considered cumulative impacts within a 50-mile (80-km) radius of the proposed MEA. This geographical range encompasses the proposed action, all reasonably foreseeable actions in the area, and a reasonable buffer surrounding these areas. The timeframe considered for cumulative impacts is 35 years, starting in 2012, the year the NRC received the application to amend the current license to include the MEA. This timeframe covers the continued operation of the existing Crow Butte license area, as well as construction, operation, and restoration of the other two proposed CBR ISR expansion areas, in addition to the MEA.

A review of the ISR GEIS (NRC, 2009a, Section 5.4) guided the NRC staff to identify potential past, present, and future actions to be considered and establish the scope for each resource area.

For the purposes of this analysis, past actions are those actions that occurred between the time of original licensing of the existing Crow Butte license area in 1989 and submittal of the MEA application in May 2012. CEQ guidance states that “agencies…look for present effects of past actions that are…relevant and useful because they have a significant cause-and-effect relationship with the direct and indirect effects of the proposal for agency action and its alternatives” (CEQ, 2005). No past actions before the licensing of the existing Crow Butte license area in 1989 have any “significant cause-and-effect relationship” with the MEA. No specific past actions have been identified for inclusion in this cumulative impact analysis that have caused moderate or large changes to any of the resource areas presented in this analysis since 1989 (actions related to the existing Crow Butte license area are considered “present actions”).

Present actions are those that have occurred since the submittal of the MEA application. Activities at the existing Crow Butte license area are considered a present action. The MEA is approximately 6 miles (9.7 km) southeast of the existing Crow Butte license area. No nuclear materials facilities (i.e., fuel cycle facilities and uranium recovery facilities) other than the existing Crow Butte license area are located in Nebraska, or within a 50-mile (80-km) radius of the MEA (NRC, 2012d; CBR, 2014, Section 3.1.2.5). No other nonuranium resource recovery operations are ongoing in the region, other than construction sand and gravel sites in Dawes, Box Butte, and Sheridan counties (USGS, 2013). No active oil or gas wells are present in the region (NOGCC, 2013). Non-Federal present actions include ongoing minor county road repair and maintenance projects (SC&A, 2013c). A cell phone tower was constructed on the Pine Ridge escarpment between the existing Crow Butte license area and the MEA. The cell phone tower is not likely to have a significant cumulative impact to the resource areas in this geographic range, as the tower was erected on previously disturbed land and occupies a relatively small footprint compared to the overall geographic range of this assessment. Other present regional actions include the continued use of lands for agricultural purposes.

Future actions are considered to be those that are reasonably foreseeable through the 35-year timeframe. Reasonably foreseeable actions related to nuclear facilities other than the MEA include the proposed NTEA and TCEA. The locations of these reasonably foreseeable future actions are shown in Figure 2-3. The proposed NTEA would be located approximately 13 miles (21 km) northwest of the MEA and 2 miles (3.3 km) to the northwest of the existing Crow Butte license area (nearest boundary to nearest boundary) and encompasses approximately 2,110 acres (854 ha). The proposed TCEA would be located approximately 10 miles (16 km) northwest of the MEA and 4 miles (6.4 km) west of the existing Crow Butte license area (nearest boundary to nearest boundary).

Other facilities (such as the Dewey-Burdock facility near Edgemont, SD, in Custer and Fall River counties, SD) exist within the Nebraska-South Dakota-Wyoming Uranium Milling Region[22] but are all more than 50 miles (80 km) from the MEA. The Dawes County Department of Roads has stated that no major projects are planned for the foreseeable future (SC&A, 2013c).

CBR possesses an NDEQ mineral exploration permit for the entire panhandle region of Nebraska that allows it to perform exploratory drilling at the existing Crow Butte license area and the proposed expansion areas. From 1979 to 1983, exploration boreholes were plugged using Nebraska Oil and Gas Conservation Commission standards. Beginning in November 1983, NDEQ assumed jurisdiction over mineral exploration activities. During 1979 and 1980, exploration holes were plugged with cement grout. Beginning in 1981 and continuing through the present, all exploration holes were plugged with an NDEQ-approved abandonment material, which is a nontoxic, high-grade bentonite with small amounts of non-fermenting organic polymer and soda ash (Ferret, 1988). NDEQ also specifies the timeframe and conditions for properly plugging and abandoning the exploratory holes, which would reduce the potential for impacts. CBR has drilled approximately 2,000 exploratory holes at the MEA; 1,000 exploratory holes at the NTEA and about 1,500 exploratory holes at the TCEA, all of which have been plugged and abandoned as required by the NDEQ permit. For these reasons, exploratory drill holes are not expected to contribute to past, present, or future cumulative impacts within any resource area (NRC, 2014e).

Figure 5-1 shows the timeframes CBR stated in its license application for the planned construction, production, and aquifer restoration and reclamation phases at the proposed CBR ISR expansion areas. This schedule is expected to change, although the licensee has not provided an update. While the start and end years would change, the duration of activities is not expected to change. Thus, the conclusions in this draft EA about cumulative impacts would not be affected by the change in schedule for these activities.

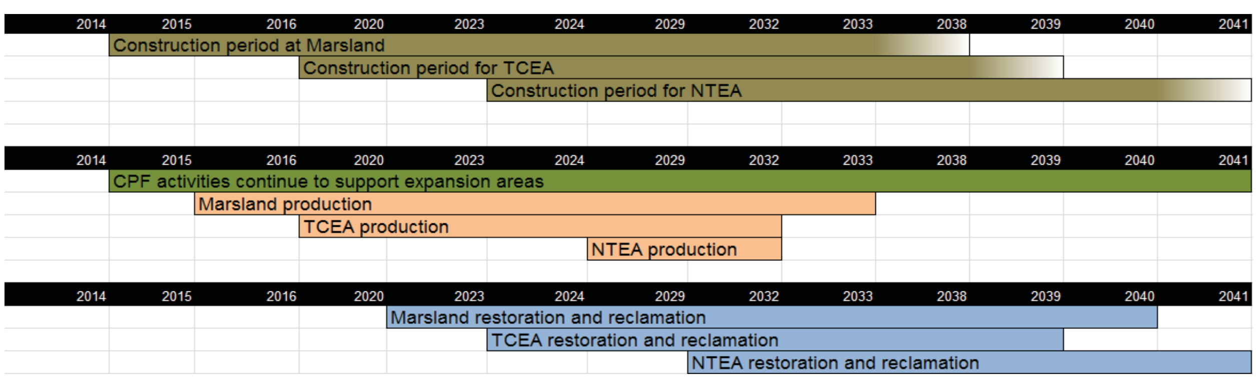


Figure 5-1 Proposed timeline of construction, production, restoration and reclamation (top to bottom) at proposed CBR ISR expansion areas (based on CBR, 2014)

22 This region, defined within the ISR GEIS (NRC, 2009a, Section 1.4.3) and discussed in Section 3.1, is not to be confused with the area of review considered for this cumulative impact analysis.

The NRC staff analyzed the cumulative impacts for the existing Crow Butte license area and the NTEA and TCEA (should they be constructed, operated, and decommissioned) as shown in Figure 5-1. For analytical purposes, to ensure the analysis is conservative (i.e., tends to overestimate potential impacts), the NRC staff assumed that the existing Crow Butte license area, the NTEA, and the TCEA would operate simultaneously to maximize impacts when evaluating cumulative impacts, although it is likely that uranium extraction would occur at only one expansion area at a time and that uranium recovery at the existing Crow Butte license area will end before operations begin at the NTEA or TCEA. Initial construction activities at each expansion facility would include construction of an IX process and the first wellfield. Subsequent construction activities would include additional wellfields over the operational lifetime of each project. In the MEA ER (CBR, 2014, Section 1.1.3.2), CBR estimated that construction activities and operation at the MEA would occur over a 20-year period. Aquifer restoration and wellfield decommissioning at the MEA would begin about 5 years after operation begins, concurrent with operations, with restoration ending after about 20 years. Final sitewide decommissioning activities and reclamation would be completed about 25 years after operations commence. CBR originally planned initial construction of the NTEA project in 2023, with production from 2024 to 2032, and groundwater restoration activities from 2029 through 2039. Final site decommissioning and reclamation was to be completed in 2041 (CBR, 2014, Section 1.1.3.4). CBR's application for the MEA indicated that initial construction at the TCEA was planned to be completed in 2016, with production from 2016 to 2032, restoration from 2023 to 2038, and final site decommissioning and reclamation completed in 2039 (CBR, 2014, Section 1.1.3.3). However, since licensing activities for the NTEA and TCEA are on hold, these schedules are unlikely.

Based on the above information, the NRC staff analyzed whether significant cumulative impacts could result from the incremental impact of the proposed action (amendment to authorize activities at the MEA) when added to the impacts from the existing Crow Butte license area and the other two proposed CBR expansion areas.

5.1 Cumulative Impacts for Land Use

For purposes of analyzing cumulative impacts on land use, the NRC staff used the area within a 20-mile (32-km) radius of the MEA as the review area. As discussed in Section 4.1, activities at the MEA would potentially impact up to about 1,754 acres (710 ha) of land (Table 4-1). Impacts would potentially affect prairie, degraded rangeland, and cultivated land. CBR would recontour and revegetate disturbed areas to return the lands to its prior state and uses. As stated in Section 4.1, for all phases of activities (i.e., construction, operation, aquifer restoration, and decommissioning), the NRC staff determined that potential impacts would be SMALL. Preconstruction activities would only impact small areas of land where construction would take place or where environmental monitoring would occur. Given the small land area that would be impacted, the NRC staff concludes that the potential cumulative impacts on land use resulting from preconstruction would not be significant.

Pasturelands are the predominant land use within a 20-mile (32-km) radius of the MEA. As discussed in Section 3.1, the MEA comprises 80 percent rangeland, which is consistent with the surrounding area. The rest of the geographic range for cumulative impacts is made up primarily of cropland. Forestlands are present but below 20 percent of the overall total land use. Some habitat lands, residential areas, and water areas are within the geographic range, but these make up a very small percentage. Habitat lands provide recreational opportunities. No significant changes in land use have occurred since the original licensing of the existing Crow Butte license area.

Other than the existing Crow Butte license area and its proposed expansion areas (including the MEA), there are no other significant current or proposed industrial activities within the 50-mile (80-km) area of review. The existing Crow Butte license area comprises about 3,000 acres (1,214 ha), of which 2,100 acres (850 ha) are disturbed. If the proposed CBR expansion areas are licensed, approximately 8,300 additional acres (3359 ha) of pastureland and cropland (including the MEA) would be used for ISR activities. The amount of land used by the existing Crow Butte license area and proposed CBR expansion areas (including the MEA) make up a small percentage of the total pastureland and cropland in the region and would not impact overall availability of this land in the region except to specific landowners, who would temporarily lose use of their land. After decommissioning, the reclaimed land would be released for unrestricted use and could be returned to its original uses, which are primarily pasturelands and croplands.

Because of the small percentage of pastureland and cropland disturbed relative to the available land area for these uses, the lack of other existing or proposed industrial development in the region, and the stagnant nature of economic development that would otherwise promote changes in land use, the NRC staff concludes that when the incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts to land use would not be significant.

5.2 Cumulative Impacts for Geology and Soils

The MEA is located in a region where the geology has been relatively undisturbed because of the lack of industrial development. Contamination of the soil has not been an issue in the region because most of the land area is rangeland and cropland. Any current level of soil contamination would likely be the result of the use of agricultural chemicals, such as fertilizer, pesticides, and herbicides. Although this has not been quantified, the NRC staff does not expect conditions to be any different because of the proposed action, as most of the land is rangeland and would not require application of such chemicals. Activities related to ISR activities at the MEA, the existing Crow Butte license area, and the NTEA and TCEA would not contribute to these types of agriculture impacts, except for possible sporadic use of herbicides to control weeds in the developed MEA area.

As discussed in Section 4.2, impacts to soils for the MEA would be greatest during construction and lowest during operation, since greatest soil disturbance occurs when clearing vegetation, and excavating, leveling, stockpiling, compacting, and redistributing soils (preconstruction impacts to soils would also be less than construction). Construction activities associated with the other two proposed CBR expansion areas that may have potential impacts to soils include the construction of a small-scale building to perform IX, installation of an area for trucks to transport materials to the existing Crow Butte license area, and drilling wells and installing piping for wellfields. There is a potential for erosion from disturbance of existing soils during these construction activities. The magnitude of these impacts at the other proposed CBR expansion areas (TCEA and NTEA) is expected to be similar to those of the MEA. The disturbance of soils at the three proposed CBR expansion areas would be less than was experienced at the existing Crow Butte license area because a CPF would not be constructed at those sites. During construction, CBR would implement various measures to reduce erosion, keeping effects localized to the immediate vicinity of each proposed expansion area. Section 4.2.2 discusses these measures. Because the expansion areas are situated far apart from one another, construction activities are not expected to have a significant cumulative impact on soils.

Impacts to soils from operations would primarily occur because of spills. CBR would have procedures in place at the MEA and the other proposed expansion areas, similar to those already in place at the existing Crow Butte license area, to prevent accidental discharges, as described in Section 4.2.2. CBR's spill response and cleanup measures would minimize the impact of any spills that do occur by keeping them localized and contained within the immediate vicinity of the site. Therefore, operations are not expected to have a significant cumulative impact on soils.

Decommissioning activities that may impact soils include well abandonment, cleanup of structures and soils, and permanent revegetation. At each site considered in this analysis, these activities would be temporary and localized, and the purpose of these activities is to restore the area to its previous condition. In particular, revegetation would reduce erosion potential and would have a positive impact on soils. For these reasons, decommissioning is not expected to have a significant cumulative impact on soils.

Based on the above analysis, the NRC staff concludes that when the incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts to geology and soils would not be significant.

5.3 Cumulative Impacts for Water Resources

The NRC staff evaluated cumulative impacts on surface and groundwater resources within a 50-mile (80-km) radius of the MEA. This area encompasses three major watersheds, Hat Creek, the Niobrara River, and the White River, that would potentially be impacted by past, present, and reasonably foreseeable future actions.

5.3.1 Surface Water

As described in Section 3.3.1, the MEA lies within the Niobrara River watershed. There are numerous small and two major ephemeral drainages present within and adjacent to the MEA, but there is no evidence of standing surface water in the vicinity of MEA and only limited, intermittent flow in the drainages after large precipitation events. Other major activities that are conducted within a 50-mile (80-km) radius of the MEA are related to the active uranium recovery at the existing Crow Butte license area and proposed uranium recovery activities at the NTEA and TCEA. However, these facilities are north of the Pine Ridge escarpment, which creates a surface water divide between the Niobrara and the Hat Creek-White River watersheds. This hydrologic separation between these watersheds makes it highly unlikely that the other ongoing or proposed uranium recovery activities would contribute to cumulative surface water impacts during any of the project phases (including preconstruction).

The NRC staff concludes that when the potential incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts to surface water resources would not be significant.

5.3.2 Groundwater

The major activities located within a 50-mile (80-km) radius of the MEA include the ongoing uranium recovery at the existing Crow Butte license area and the proposed uranium recovery at the NTEA and TCEA. As discussed in Section 3.3.2, the Pine Ridge escarpment forms a groundwater divide between the MEA and the NTEA and TCEA for the Brule aquifer and overlying units. This hydraulic barrier would eliminate the potential for cumulative impacts of spills, leaks, and excursions within the aquifers overlying the Basal Chadron Sandstone aquifer. Although the Pine Ridge escarpment does not create a hydraulic divide for groundwater flow within the Basal Chadron Sandstone aquifer, it would take more than 1,000 years for any constituents released into the Basal Chadron Sandstone aquifer at the MEA to travel the more than 6 miles (9.6 km) in order to reach the existing Crow Butte license area, which is nearest to the MEA. Dilution and attenuation over these distances and timeframes would exclude cumulative impacts on groundwater quality. Therefore, the only potential for cumulative impacts would be those associated with consumptive use.

Potential cumulative consumptive use impacts would be greatest during aquifer restoration (as opposed to preconstruction, construction, operations, or decommissioning) and would be related to whether the consumptive use of groundwater at multiple mines results in the cumulative decrease in the potentiometric surface of the Basal Chadron Sandstone aquifer. As described in Section 4.3.2.2, CBR applied a groundwater model to evaluate potential cumulative impacts caused by the consumptive use of groundwater at the MEA, TCEA, and existing Crow Butte license area. Drawdown impacts were computed over the period 2011 through 2052, corresponding to the approximate historical groundwater monitoring period at the MEA, future ISR facility operations, and the aquifer recovery period. The maximum cumulative consumptive use of groundwater is anticipated to be 338 gpm (1,279.5 Lpm). The potentiometric surface of the Basal Chadron Sandstone aquifer in the immediate vicinity of the MEA could potentially be decreased by a maximum of 111 feet (33.8 meters) by the consumptive withdrawal of water from the basal Chadron sandstone (CBR, 2014, Section 4.14.3.6). Consumptive water use volumes within similar ranges at the other proposed expansion areas would result in comparable drawdowns at similar distances (CBR, 2016, Appendix GG, Figure 20). Although cumulative drawdowns within intersecting zones of influence could result in appreciable drawdowns, the Basal Chadron Sandstone aquifer would remain confined (i.e., saturated thickness would not decrease).

Potential impacts on groundwater resulting from interaction between ISR activities at the existing Crow Butte license area with the proposed expansion areas are not likely to be significant because the greatest consumptive use would occur during aquifer restoration, which is anticipated to be completed at the existing Crow Butte license area before restoration activities are initiated at the proposed expansion areas. Furthermore, although the potentiometric surface of the Basal Chadron Sandstone aquifer would decrease because of the pumping, the aquifer would remain fully saturated. Also, after uranium production and aquifer restoration are finished and groundwater withdrawals end, groundwater levels would naturally recover with time.

Based on the foregoing analysis, the potential impact of the proposed project on the existing and future use and quantity of water for local and surrounding residential, municipal, and recreational purposes would be minimal.

For the reasons discussed above, the NRC staff concludes that when the incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts to groundwater resources would not be significant.

5.4 Cumulative Impacts for Ecological Resources

The ISR GEIS (NRC, 2009a, Section 3.3.5.1) describes the ecoregions comprising the 50-mile (80-km) area of review around the MEA. As described in Section 3.4, the MEA is in the Western High Plains ecoregion (a Level III ecoregion). The northern part of the MEA is located in the Pine Ridge escarpment Level IV ecoregion, while the southern part is in the Sandy and Silty Tablelands Level IV ecoregion. The existing Crow Butte license area and proposed TCEA and NTEA lie to the north and west, respectively, of the MEA within the Pine Ridge escarpment

Level IV ecoregion and the Northwestern Great Plains Level III ecoregion, and within that Level III ecoregion, the Semiarid Pierre Shale Plains Level IV ecoregion.

As discussed in Section 4.4, ecological resources include vegetation, wetlands, and wildlife. The potential impacts from an ISR facility, as described in Section 4.4, on vegetation and wetlands primarily would be during construction on the site, from (1) the removal of vegetation (and associated reduction of habitat and forage), (2) modification of existing vegetative communities as a result of site operations and maintenance, (3) loss of sensitive plants and habitats, and (4) potential spread of invasive species and noxious weed populations (NRC, 2009a, Section 4.2.5.1). Preconstruction activities would have small, additional impacts to those from construction. Preconstruction and construction would only incur localized effects that would not extend beyond the immediate area in which the facilities are located. The potential impacts on these resources associated with activities at the MEA, described in Section 4.4, would be similar to those for the NTEA and TCEA.

Potential impacts on ecological resources during preconstruction and construction of the MEA, TCEA, and NTEA would include disturbance of wildlife and loss of habitat. As noted above, no additional construction is expected at the existing Crow Butte license area. At the NTEA and TCEA, disturbance and loss of habitat would be expected to be consistent with that described for the MEA in Section 4.4.1.2. Initial construction of the expansion areas would be staggered, and subsequent wellfield construction would be unlikely to occur simultaneously. Within and around each proposed expansion area, the vegetation and habitat are relatively homogeneous; therefore, displaced wildlife would be able to find new habitat without leaving the vicinity. The loss of vegetation from construction would not be significant compared with available habitat in the surrounding ecoregions that can support the displaced wildlife. Also, the distance between the proposed expansion areas is such that wildlife displacement at one site would not affect wildlife at the others. For the reasons discussed above, the NRC staff does not expect construction activities to have a significant potential cumulative impact on ecological resources.

At the MEA, the existing Crow Butte license area, and proposed expansion areas, potential impacts to ecological resources during operations would be limited to vehicle noise and potential vehicle collision with wildlife. Wildlife disturbance from vehicle noise would be temporary and transient, and the noise would dissipate quickly as vehicles moved away. Significant cumulative impacts would not be expected based on the distance between the existing Crow Butte license area and the other two proposed expansion areas. As discussed in Section 4.4, vehicle collisions with big game mammals would be infrequent at the MEA, and the NRC staff expects that the frequency of collisions at the existing Crow Butte license area and other proposed expansion areas would be similar. Therefore, the NRC staff does not expect operations to have potential significant cumulative impacts on ecological resources.

The potential impacts to ecological resources from decommissioning the MEA, existing Crow Butte license area, and proposed expansion areas would be similar to those from construction activities. For the reasons discussed above for construction, the NRC staff does not expect significant cumulative impacts on ecological resources from decommissioning. Also, any potential impacts associated with decommissioning would be temporary, as the purpose of decommissioning is to return the land to conditions suitable for its original use. Required reclamation activities, such as recontouring the land and revegetation as described at the beginning of Chapter 4, as well as natural succession, would reduce the potential long-term ecological impacts once the MEA, existing Crow Butte license area, and the NTEA and TCEA are decommissioned and restored.

A list of threatened and endangered species within the geographic range is provided in Section 3.4.3. Although some threatened or endangered species may be present at the MEA, the existing Crow Butte license area, and other proposed expansion areas, the NRC staff has determined, for the existing Crow Butte license area and the MEA, that activities are not likely to adversely affect such species. With respect to the proposed TCEA and NTEA, the NRC staff would expect to make similar findings because of the proximity of these areas to the MEA and the similar vegetation and habitat.

Based on the above analysis, the NRC staff concludes that when the incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts to ecological resources would not be significant.

5.5 Cumulative Impacts for Air Quality

All counties within a 50-mile (80-km) radius of the MEA facility, the area of review for this resource area, are in attainment of the NAAQS (EPA, 2016). Initial construction of the NTEA and TCEA would potentially have impacts to air quality from increased dust and emissions from construction vehicles and an incremental increase in traffic. Subsequent wellfield construction would have similar types of impacts but to a lesser extent. Initial construction activities at the other two proposed expansion areas would be staggered, and subsequent construction of additional wellfields during the operational lifetimes of the expansion areas would also be unlikely to occur simultaneously. Further, construction impacts to air quality would be temporary, and CBR would employ appropriate dust suppression practices. Finally, dust created from vehicle traffic on unpaved roads would dissipate quickly and would remain localized. Therefore, the NRC staff does not expect construction activities to have a significant cumulative impact to air quality.

Other than wellfield construction during operations, discussed above, operations of the existing Crow Butte license area and the other two proposed expansion areas would not produce measurable particulate emissions. CBR would employ dust suppression practices, and any dust produced would dissipate quickly and remain localized. Therefore, the NRC staff does not expect operations to have a significant cumulative impact on air quality.

Decommissioning activities at the existing Crow Butte license area, NTEA, and TCEA would require vehicles and other equipment as well as cause some soil disturbance, resulting in the release of dust and emissions. The NRC staff expects that these impacts would be of smaller magnitude than those from construction and likely would not occur simultaneously. Additionally, CBR would employ dust suppression practices, and any dust produced would dissipate quickly and remain localized. Therefore, the NRC staff does not expect decommissioning to have a significant cumulative impact on air quality.

Based on the above analysis, the NRC staff concludes that when the incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts to air quality would not be significant.

5.6 Cumulative Impacts for Historic and Cultural Resources

Cumulative impacts for historic and cultural resources would result from environmental effects from the proposed action and from similar effects from other nearby actions in the past, present, and foreseeable future. The area of review for potential cumulative impacts to historic cultural resources is the geographic area within which the proposed action may exert some influence. The NRC staff assessed the potential for cumulative impacts to both historic and archaeological resources and religious and cultural resources of potential significance to Native American Tribes. There are few public lands within a reasonable distance of the MEA where comparable historic and cultural resources data have been reported for use in evaluating potential cumulative impacts. Contacts with cultural resources specialists at the Fort Robinson State Park Museum, U.S. Department of Agriculture, USFS, and Nebraska National Forests and Grasslands support this conclusion (SC&A, 2012).

The NRC developed an assessment of cumulative impacts for the historic and cultural resources in the MEA in consultation with Native American Tribes and public involvement in accordance with the requirements of NHPA Section 106 (NRC, 2014). The NRC mailed consulting tribes copies of the NRC's Section 106 review findings and supporting documentation, which included a cumulative impacts assessment for historic and cultural resources. Additionally, the NRC made these documents available on public Web site on June 30, 2014. The public comment period closed on July 30, 2014; no comments were received.

5.6.1 Historic and Archaeological Resources

The best comparative data for historic and archaeological information come from the existing Crow Butte license area and proposed expansion areas (i.e., MEA, NTEA, and TCEA). For the purpose of the present analysis, CBR completed intensive (Class III) field inventories for such resources for the existing Crow Butte license area and for each of the proposed expansion areas (see Section 3.6.3 for MEA data), as summarized below:

- Existing Crow Butte License Area—CBR conducted intensive field surveys for historic and archaeological sites within the existing Crow Butte license area in two phases. The University of Nebraska conducted identification and assessment of cultural resources in the CBR research and development portion of the existing Crow Butte license area in 1982. NSHS surveyed the remainder of the existing Crow Butte license area (the commercial study area) during 1987. The results of the two surveys were presented in a single report (Bozell and Pepperl, 1987).

  The 1982 and 1987 CBR area surveys of the existing Crow Butte license area recorded 21 prehistoric and historic period archaeological sites. Cultural affiliation of the recorded sites included eight with Native American components, 12 historic period locations, and a buried bone deposit of undetermined cultural association. Investigators from the University of Nebraska and NSHS found that 15 of the newly recorded sites, including four Native American and nine historic period locales, contained limited scientifically important cultural remains or were determined not to be of significant historic value based on archival research. The investigators evaluated these sites as not eligible for nomination and potential listing on the NRHP. The remaining six sites included three Native American and three historic period locales and were evaluated as potentially eligible for the NRHP, requiring further field assessment for a full evaluation of eligibility. Four of these sites (25DW114, 25DW192, 25DW194, and 25DW198) were evaluated as having potential importance for the recovery of archaeological data, and sites 25DW112 and 25DW00-25 have possible architectural values. Additional evaluation of site 25DW198 in 2003 resulted in a determination that the site was not eligible for listing on the NRHP (Späth and Walth, 2003).

- NTEA—The proposed NTEA license area includes a total of 2,680 acres (1,085 ha), although only 1,190 acres (482 ha) are included in the potential development area. In 2004, ARCADIS conducted an intensive pedestrian cultural resources inventory of the proposed development area (Späth, 2007a). The NTEA field inventory recorded three historical sites (25DW296, 25DW297, and 25DW298) and three isolated artifacts (25DW299, 25DW300, and 25DW301). The historic sites include an abandoned farm complex, an occupied farm complex with a nearby schoolhouse foundation, and a small historic refuse disposal area. The isolated artifacts include an early historic period metal trade point and two prehistoric period chert artifacts (a core and a projectile point fragment). Based on the field survey findings, none of the resource sites was recommended as potentially eligible for listing on the NRHP, although one historic property, 45DW297, was recommend for further archival work should the site be disturbed by future uranium recovery development. The NE SHPO accepted the cultural resources report and concurred with the NRHP eligibility recommendations in 2006 (CBR, 2007, Appendix C).

- TCEA—ARCADIS conducted an historic and cultural resources field inventory at the TCEA in January 2006 (Späth, 2007b). The TCEA historic and cultural resources inventory included a 100-percent pedestrian coverage of a 2,100-acre (850-ha) tract, although only 1,643 acres (665 ha) of this total are included within the proposed TCEA license amendment boundary.

  The field inventory recorded 11 historic period sites, along with two isolated prehistoric period artifacts and one historic period artifact within the proposed TCEA project area. These 11 historic sites included three artifact scatters, two farm complexes, two rural residences, two collapsed buildings, a windmill and water tank, and an isolated piece of farm machinery. Isolated artifacts included an historic fraternal medallion and two prehistoric chert flakes. The sites and isolated artifacts were recorded and given designations 45DW302–315 in the Nebraska Statewide inventory system. Furthermore, ARCADIS concluded that none of the recorded sites and isolated artifacts was associated with important historical events or persons or was likely to contribute useful information about historic lifeways beyond the data collected during the field recording. Consequently, CBR recommended that none of the recorded properties within the TCEA was potentially eligible for the NRHP. The NE SHPO concurred with this recommendation on December 17, 2007 (Späth, 2007b).

Table 5-1 summarizes the total number of acres that have been surveyed for historic and archaeological resources in the existing Crow Butte license area and ISR expansion areas, along with the numbers of historic and prehistoric sites and isolated finds that have been recorded. In all, some 9,050 acres (3,662 ha) have received intensive pedestrian cultural resources inventories.

This combined surveyed acreage amounts to approximately 58 percent of the total acreage included in the license renewal application for the existing Crow Butte license area, plus the total numbers of acres in the license amendment applications for the NTEA, TCEA, and MEA. Because of these surveys, a total of 66 cultural resource sites and isolated finds has been recorded, for an overall density of 4.53 resources/mi^2. Considering only the recorded historic and archaeological sites, the overall density drops to 3.61 resources/mi^2. Of the total 50 cultural resources sites recorded, 42 (84 percent) are associated with historic-period Euro-American rural settlement of these areas.

Table 5-1 Comparison of Historic and Archaeological Resources Data for CBR Sites

Data Category	Existing Crow Butte License Area	NTEA	TCEA	MEA	Totals
Total License Area (acres)	3,300	2,680	1,643	4,621	12,244
Cultural Resource Inventory (acres)	1,100[a] (445 ha)	1,190 (482 ha)	2,100 (850 ha)	4,660[c] (1,886 ha)	9,050 (3,662 ha)
Number of Resource Sites and Isolated Finds Recorded	21[b]	6	14	23	64
Historic Resource Sites	12	3	11	17	42
Prehistoric Resource Sites	8	0	0	0	8
Historic Isolated Finds	0	1	1	6	9
Prehistoric Isolated Finds	0	2	2	0	4
Site Density (per mi^2)	12.21	1.61	3.05	2.06	3.61
Isolated Find Density (per mi^2,)	0	1.61	1.22	0.69	1.57
Total Cultural Resources Density (per mi^2.)	12.21	3.23	4.27	2.75	4.53

a This acreage is estimated based on the surface area developed as stated in the application for renewal of the license for the existing Crow Butte license area (CBR, 2014).
b One of the recorded cultural sites at the existing Crow Butte license area is of unknown age and cultural affiliation.
c Although the two cultural resources inventories at the MEA covered a combined total of 4,660 acres (1,886 ha), 4,622 acres (1,870 ha) of the area covered by these inventories are included within the MEA.
Sources: Bozell and Pepperl, 1987; Späth, 2007a; 2007b; Graves et al., 2011; 2012

Of the total number of cultural resources sites recorded, five (10 percent) have been recommended as potentially eligible for listing on the NRHP. Isolated finds, by their designation, are not considered eligible for potential listing on the NRHP. All of the potentially eligible sites are located at the existing Crow Butte license area. One historic site at the NTEA and two historic sites at the MEA were not recommended as potentially eligible for the NRHP based on the field inventories, but it was suggested that additional evaluation should be undertaken if the sites become directly impacted by future construction activities (Graves et al., 2011). As noted above, the CBR management approach to cultural resources involves avoidance of all sites during preconstruction, construction, operation, aquifer restoration, decommissioning, and reclamation activities, regardless of their evaluations for potential listing on the NRHP (CBR, 2014, Section 4.8).

Based on available historic and archaeological resources information from the CBR application for the existing Crow Butte license area and the data related to the proposed license amendments for the NTEA, TCEA, and MEA, the NRC staff concludes that overall cumulative impacts to such resources are not expected to be significant because of the low density of sites found within this geographic setting and their lack of eligibility for nomination and potential for listing on the NRHP. Therefore, the NRC staff concludes that when the incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, the potential for adverse cumulative impacts for historic and archaeological resources resulting from the MEA would not be significant.

5.6.2 Places of Religious or Cultural Significance

From previous Tribal consultations, beginning with the 2011 Tribal information-gathering meeting, and from subsequent literature reviews, the NRC staff identified several potential places of religious and cultural significance in the general vicinity of the existing Crow Butte license area

(SC&A, 2011; NRC, 2014e). The MEA is separated from known historical events associated with Fort Robinson and the Red Cloud Agency both by distance and by the Pine Ridge escarpment. None of the buttes with potential cultural significance located near Crawford, NE, is visible from the MEA. Contacts with the nearby Fort Robinson State Park, State of Nebraska Ponderosa Wildlife Management Unit, and the Pine Ridge District of the Nebraska National Forest did not yield specific information for any potential places of religious and cultural significance located close to or within the MEA boundary (SC&A, 2012).

Little comparative information for known or potential places of religious or cultural significance is available for the region surrounding the MEA. The University of Montana and National Park Service completed two studies of places of religious and cultural significance for the Agate Fossil Beds National Monument (LeBeau, 2002; NPS, 2010a, 2010c), situated about 25 miles (40 km) west of the MEA. At present, these studies are the closest such efforts to any of the CBR project areas. The studies found a potential for places of Native American religious and cultural significance to occur within the boundaries of the Agate Fossil Beds National Monument, especially some associated with the Post-Contact Native American Tribal era.

As discussed in Section 3.6.5.2, two of the consulting Tribes, the Crow Nation and the Santee Sioux Nation, conducted field surveys of the proposed CBR ISR expansion areas in November and December 2012 to locate potential places of Tribal religious or cultural significance. This field effort identified 13 potential places, including 12 at the MEA and 1 at the TCEA. The Santee Sioux Nation submitted a report to the NRC on behalf of both Tribes (Santee Sioux Nation, 2013). The report concluded that none of the 13 places identified was potentially eligible for NRHP listing but offered recommendations for a buffer zone around places to avoid impacts during future project activities. This recommendation was confirmed by additional field documentation and evaluation of the 13 Tribal places in July 2013 (SC&A, 2013a).

Based on available information, the NRC staff concludes that when the potential incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts to potential places of Tribal religious or cultural significance would not be significant during preconstruction activities and all phases of the proposed action, given the low density of sites found within this geographic setting and their lack of eligibility for nomination and potential listing on the NRHP.

5.7 Cumulative Impacts for Demographics and Socioeconomics

5.7.1 Socioeconomics

As discussed in Section 4.7.1, the NRC staff considers the direct socioeconomic impacts resulting from the MEA to be SMALL and primarily beneficial because of the small increase in the workforce and associated tax revenue. In addition, the existing Crow Butte license area provides a beneficial socioeconomic impact in the form of continued employment and tax revenues.

As presented in Section 4.7.1, the MEA would require an additional 10 to 12 full-time employees, 4 to 7 full-time contractor employees, and 10 to 15 part-time employees and short-term contractors for construction activities (CBR, 2014, Section 4.10.2.2). As of January 2014, the existing Crow Butte license area has approximately 68 company employees and two contractors with 14 employees, plus short-term contractors and employees as needed. If the facilities were to operate as projected in Figure 5-1, then it can be assumed that activities at the proposed NTEA and TCEA would have similar employment needs as estimated for the MEA and less if the three expansion areas did not operate concurrently.

Preconstruction activities at the MEA would not have a noticeable incremental impact on socioeconomics because of the minor amount of materials and contractors needed to complete the preconstruction activities. The NRC staff, therefore, has determined that preconstruction activities would not have significant impacts.

Construction, operation, and decommissioning of the NTEA and TCEA would provide a potential measurable beneficial socioeconomic impact because of additional tax revenue CBR would pay. The NRC staff contacted the Dawes County Treasury office in October 2014, which indicated that the county received approximately $9 million dollars in certified taxes in 2013. Of this amount, approximately 7.5 percent ($675,000) came from CBR. As stated in the introduction of Chapter 5, it is unlikely that CBR would operate more than one of the three ISR expansion areas simultaneously given the constant variations in market price of uranium; however, if the facilities were to operate as projected in Figure 5-1 the tax revenue the county received from CBR is estimated to increase from 7.5 percent to approximately 23 percent of its revenue. The NRC staff concludes that this increase would have a potential significant impact. Since most employment and related economic activity would come from within Dawes County, the NRC staff determined that potential socioeconomic impacts to neighboring counties would be expected to not be significant.

Regarding impacts to utility infrastructure, because no additional population is expected, no increases in levels of domestic water usage in Dawes County are expected, and the water requirements of MEA construction and operations would not affect municipal water systems. The utilities that currently provide electricity, water, propane, and other fuel, sanitary water, and wastewater treatment to the existing Crow Butte license area would provide these services for MEA construction and operations. While the demand by CBR for these services may increase somewhat as MEA construction and operational activities proceeded, the need for utility services at the existing Crow Butte license area would decline as uranium recovery at the existing Crow Butte license area ends. If the NTEA and TCEA operate simultaneously with the MEA, the NRC staff expects that utility demands would still be small such that there would be no impacts to services to other regional customers.

Based on the above analysis, the NRC staff concludes that when the potential incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, there would be no significant negative cumulative impacts to socioeconomics. Cumulative beneficial impacts to Dawes County tax revenue and employment could be significant if all expansion areas operate simultaneously.

5.7.2 Environmental Justice

As discussed in Section 4.7.2, the NRC staff considers environmental justice in greater detail when the percentage of minority or low-income population in the impacted area exceeds the corresponding populations in the county or State by more than 20 percentage points or when the minority or low-income population in the impacted area exceeds 50 percent (NRC, 2003a, Appendix C). The environmental justice analysis for the proposed action found that minority populations make up 4.4 percent of the demographic in the environmental justice area of review, and low-income populations make up 14.8 percent of the demographic within that area. These percentages fall below the 20 percent and 50 percent thresholds identified above that would prompt the NRC to more heavily scrutinize impacts disproportionately affecting minority and low-income populations. Therefore, the NRC staff concluded that there would be no disproportionately high and adverse impacts to minority or low-income populations from the licensing of the MEA.

As shown in Table 3-13, Dawes County and the State of Nebraska do not, as a whole, contain populations at or above the 20 percent threshold for either minorities or low-income populations. The MEA and the proposed NTEA and TCEA are all within 10 miles (16.1 km) of the existing Crow Butte license area and are all situated in rural areas of Dawes County. The city of Crawford is the nearest population center to the existing Crow Butte license area and the three expansion areas. Because the environmental justice analyses for the NTEA and TCEA would be based on similar data, the staff concludes that the environmental justice reviews for the NTEA and TCEA would also find that the thresholds for further environmental justice analysis would not be met. Therefore, there is no basis to conclude that the NTEA or TCEA will have disproportionately high or adverse impacts to minority or low-income populations.

The NRC staff concludes that when the potential incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts to environmental justice would not be significant.

5.8 Cumulative Impacts for Transportation

As described in Section 4.8, construction of the MEA would not require construction of new public roads or improvements to existing roads, although CBR would construct new access roads. The same is expected for the NTEA and TCEA (CBR, 2007, 2010). As stated in Section 4.8, Dawes County has no plans for road improvements or construction (SC&A, 2013c).

Preconstruction activities at the MEA would consist of traffic associated with baseline monitoring and delineation drilling. The number of trips associated with preconstruction activities therefore would be a small fraction of the total number of trips associated with construction. Given the small number of trips associated with preconstruction, even when including possible preconstruction activities at the NTEA and TCEA, NRC staff concludes that the impacts associated with preconstruction would not be significant.

Potential impacts on transportation from construction activities at the MEA, NTEA, and TCEA would occur from an increase in traffic from construction vehicles and delivery of construction equipment and supplies. Because of their distance, construction activities at the NTEA and TCEA would not impact the same roads in the immediate area. In addition, increases in traffic from construction would be temporary, and the MEA, existing Crow Butte license area, TCEA, and NTEA all are in a rural area of Nebraska with low traffic (Table 3-16 shows that Nebraska Highway 2/71 traffic volume ranges from about 520 to 995 vehicles per day, depending on the location). Based on the analysis in Section 4.8, construction activities at the MEA would add about 15 to 20 vehicles to the daily traffic volume. The small increase (no more than 4 percent) in traffic resulting from construction would not affect the capacity of local roads. Traffic increases related to construction activities at the TCEA and NTEA would impact different segments of Highway 2/71 and other roads that would not be used for transportation to the MEA. Therefore, the NRC staff does not expect construction activities to have a significant potential cumulative impact on transportation.

During operation of the MEA, employee commuters would involve up to about 20 vehicles in addition to the approximately three trucks transporting supplies and eluded resin (see Table 4-5) on a daily basis. This increase in traffic on Nebraska Highway 2/71 would have the same impact as that during construction. Traffic increases related to operations at the TCEA and NTEA would impact different segments of Highway 2/71 and other roads that would not be used for transportation to the MEA. Therefore, the NRC staff does not expect operations at the proposed ISR expansion areas to have a significant potential cumulative impact on transportation.

Existing roads are used for yellowcake shipments from the existing Crow Butte license area. During operation of the MEA, NTEA, and TCEA, potential impacts on transportation would occur from increased truck traffic to transport extracted uranium from these expansion areas to the Crow Butte CPF. The transport of yellowcake from the CPF at the existing Crow Butte license area to nuclear fuel manufacturers would increase by one or two shipments per month, as stated in Section 4.8. These shipments would travel on existing roads. Because the existing Crow Butte license area and the proposed CBR ISR expansion areas are in a rural area of Nebraska with low traffic, and because production levels of yellowcake would remain about the same as currently produced, the NRC does not expect the small increase in traffic resulting from the transport of extracted uranium to have a significant potential cumulative impact on transportation. Even if the MEA, existing Crow Butte license area, TCEA, and NTEA operated simultaneously, impacts to traffic volume would not have a significant cumulative impact.

In regard to radiological risks associated with yellowcake, as stated in Section 4.8, CBR would comply with packaging and shipping requirements contained in DOT hazardous materials regulations, including those related to transportation security. CBR has also committed to comply with the NRC's recommendations from its analysis of accidents at uranium ISR facilities in NUREG/CR-6733 (CNRWA, 2001) in its emergency manual to rapidly respond to accidents (CBR, 2014, Section 4.12.3). The increase from two shipments per month to three or four shipments per month would negligibly increase any radiological risk associated with this material.

Potential impacts to transportation from decommissioning would occur from increased traffic during the removal of contaminated materials and equipment, the performance of additional site surveys, and revegetation. Transportation associated with decommissioning activities would occur after operations ceased at a particular wellfield or site; therefore, any increase in transportation due to decommissioning would be partially offset by a reduction of vehicles needed for operation activities. The NRC staff concludes that the increases in traffic from removal activities and survey work would not likely have a potential cumulative impact on transportation because these activities would be temporary and would not occur at the proposed CBR expansion areas simultaneously, thereby localizing the impacts. In addition, the staff has determined that a small increase in traffic would not have a significant potential cumulative impact on the capacity of local roads.

As indicated in Section 4.8, operations at the MEA would not impact the BNSF railroad operations. Because the railroad does not cross into the boundary of the existing Crow Butte license area or the other two proposed expansion areas, operations at those sites also would not affect railroad operations.

Based on the above analysis, the NRC staff concludes that when the potential incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts to transportation would not be significant.

5.9 Cumulative Impacts for Noise

Cumulative impacts from noise were assessed within a 20-mile (32-km) radius of the MEA. Potential noise impacts at the MEA, the existing Crow Butte license area, and the other two proposed expansion areas would occur from operation of vehicles and equipment. Because noise from vehicles and equipment dissipates quickly with distance, impacts at each site would be localized; and the distance between the sites would also provide a noise buffer. Therefore, the NRC staff does not expect significant cumulative impacts from noise, including from preconstruction activities. Based on this analysis, the NRC staff concludes that when the incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts to noise would not be significant.

5.10 Cumulative Impacts for Visual and Scenic Resources

The NRC staff assessed cumulative impacts for visual and scenic resources within a 2-mile (3.3-km) area of the MEA borders. Beyond this distance, any changes to the landscape would be in the background distance zone with respect to the BLM-defined VRM classification system and would be either unobtrusive or imperceptible to viewers (BLM, 1984, 1986).

The potential impacts on visual and scenic resources because of the proposed activities at the MEA are described in Section 4.10 and were found to be SMALL. Impacts associated with preconstruction activities would not be different than those incurred during construction, operation, aquifer restoration, or decommissioning. The existing Crow Butte license area, the NTEA, and the TCEA are all outside the 2-mile (3.3-km) geographic range, and no other past, present, or reasonably foreseeable actions are found within that range. Therefore, the NRC staff concludes that when the potential incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts to visual and scenic resources would not be significant.

5.11 Cumulative Impacts for Public and Occupational Health and Safety

As discussed in Section 4.11, there is a potential for nonradiological and radiological impacts to public and occupational health and safety during the life of an ISR facility.

5.11.1 Nonradiological Impacts

As noted in Section 4.11, CBR expects that the risk of impacts associated with the use and handling of hazardous chemicals during normal operations at ISR facilities would be small. The ISR GEIS (NRC, 2009a, Section 4.2.11.2.4 and Appendix E) also provides an analysis of accidental chemical releases that could produce serious consequences. Section 4.11.1 lists non-NRC regulations that have established procedures and training requirements. Although potential impacts to workers involved in response and cleanup could be moderate, adherence to the provisions in these regulations for monitoring and cleanup of spills would ensure that potential offsite impacts would be SMALL. The consideration of preconstruction activities at the MEA would not add any activities that would introduce different hazardous chemicals that would not be used during operations.

Preconstruction activities would require only small quantities of hazardous materials and few vehicle trips that would lead to dust generation. The proposed NTEA and TCEA would be constructed in similar fashion to the MEA, in accordance with State and Federal permits to minimize the potential for nonradiological impacts to public and occupational health. During construction, CBR would employ appropriate dust suppression practices to minimize impacts from vehicle and construction equipment to ensure that State ambient air quality standard were not exceeded. Any potential impacts would be localized and mitigated through procedures outlined in the required permits. For these reasons, the NRC staff does not expect cumulative nonradiological impacts to public and occupational health from construction to be significant.

During operations and aquifer restoration, potential cumulative nonradiological impacts to public and occupational health could result from fugitive dust and emissions from vehicles, leaks and spills of hazardous and nonhazardous chemicals, evaporation pond leakage, potential lixiviant excursions, and waste. Nonradiological impacts from operations and aquifer restoration at the MEA would be SMALL because of CBR's compliance with appropriate State and Federal regulations. CBR would employ the same controls at the existing Crow Butte license area, NTEA, and TCEA to minimize vehicle emissions as at the MEA. The existing Crow Butte license area, NTEA, and TCEA would be required to adhere to the same standards for processing and storing hazardous and nonhazardous chemicals as required at the MEA. Furthermore, CBR would follow the same environmental monitoring procedures at the existing Crow Butte license area, NTEA, and TCEA as at the MEA to detect and mitigate evaporation pond leakage and would adhere to Federal and State statutes that regulate the discharge of stormwater runoff and process-related water. CBR would conduct MIT at the existing Crow Butte license area, NTEA, and TCEA to detect and minimize nonradiological impacts from lixiviant excursion. For these reasons, the NRC staff does not expect cumulative nonradiological impacts to public and occupational health from operation and aquifer restoration to be significant.

The potential nonradiological impacts from decommissioning would be similar to those identified for construction. During decommissioning of the existing Crow Butte license area, NTEA, and TCEA, CBR would employ the same controls as at the MEA to limit dust and minimize impacts from vehicle and construction equipment. Decommissioning of the proposed expansion areas would be completed in accordance with NRC and NDEQ regulations, and any potential impacts would be localized and mitigated through compliance with these requirements. CBR's implementation of BMPs would reduce the likelihood and magnitude of potential leaks and spills and facilitate corrective action. CBR would further minimize nonradiological impacts from decommissioning at the existing Crow Butte license area, NTEA, and TCEA by restoring groundwater to groundwater protection standards, thereby reducing the potential for nonradiological releases into groundwater. For these reasons, the NRC staff does not expect cumulative nonradiological impacts to public and occupational health from decommissioning to be significant.

Based on the above analysis, the NRC staff concludes that when the incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative nonradiological impacts to public and occupational health would not be significant.

5.11.2 Radiological Impacts

Preconstruction at the existing Crow Butte license area, NTEA, and TCEA, and initial construction and subsequent wellfield development from these facilities may result in radon exposure from air or water pathways, as well as population dose. Radiological impacts associated with wellfield development from the existing Crow Butte license area, NTEA, and TCEA would be expected to be similar to impacts from the MEA, which the NRC staff found to be SMALL. These exposures would original mostly from leaks and spills, which would be primarily nonradiological because the wells will not have not started operation and are not yet pumping water with radiological properties. Construction would be staggered; therefore, spills and leaks would not occur simultaneously, reducing the cumulative impact. Further, radiological doses to members of the public would be required to fall below the 10 CFR Part 20 annual limits for dose to the public at all of these facilities. CBR would perform total effective dose equivalent studies and analysis during wellfield development at these facilities to monitor doses and would comply with Federal regulations to stay under the limits. Therefore, the NRC staff does not expect cumulative radiological impacts to public and occupational health from construction to be significant.

Operations and aquifer restoration of the existing Crow Butte license area, NTEA, and TCEA may result in radon exposure from air or water pathways. No radiological impacts associated with yellowcake production at the NTEA or TCEA would occur because the expansion areas would not have a central processing plant. However, even assuming that release doses at the expansion areas would be similar to those for the existing Crow Butte license area, the cumulative dose assuming the MEA, existing Crow Butte license area, NTEA, and TCEA are in operation would still fall below the 10 CFR Part 20 dose limits. Additionally, it is unlikely that all of these facilities would be in operation simultaneously and the pathways of air and water are such that doses would not all carry to the same location. Also, as discussed above, CBR would perform total effective dose equivalent studies and analysis during operations to monitor dose limits and comply with Federal regulations to stay under those limits. Therefore, the NRC staff does not expect cumulative radiological impacts to public and occupational health from operations and aquifer restoration to be significant.

The potential radiological impacts from decommissioning would be similar to those identified for construction. During decommissioning of the existing Crow Butte license area, NTEA, and TCEA, radiological impacts would result from leaks or spills associated with decommissioning activities as the sites are returned to unrestricted use. For reasons similar to those discussed above, the NRC staff does not expect cumulative radiological impacts to public and occupational health from decommissioning to be significant.

The NRC staff concludes that when the incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative radiological impacts to public and occupational health would not be significant.

5.12 Cumulative Impacts for Hazardous Materials and Waste Management

5.12.1 Hazardous Materials

As described in Section 4.12.1, the use of hazardous materials at the MEA would have SMALL impacts because of the regulatory requirements that control the safe handling, storage, and disposal of hazardous materials; the lack of the need for extremely hazardous materials; the low volume of hazardous materials needed on site at any one time; and the low probability of natural phenomena that could result in releases, such as tornadoes and earthquakes. This same level of impact would be expected at the existing Crow Butte license area, NTEA, and TCEA because of the similarity in operations (leading to the lack of need of extremely hazardous materials and the small quantities of hazardous materials used at each facility). In addition, the regional proximity of the existing Crow Butte license area, NTEA, and TCEA to the MEA would mean that the probability of occurrence of tornados and earthquakes at these proposed facilities would also be low. In regard to preconstruction at the MEA, NTEA, and TCEA, very small quantities of hazardous materials would be expected to be used, even on a cumulative basis.

The NRC staff concludes that when the incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, the cumulative impacts would not be significant because of the similarity of activities and small use of hazardous materials.

5.12.2 Waste Management

5.12.2.1 Liquid Wastes

Liquid wastes would be generated at MEA, TCEA, and NTEA during preconstruction, construction, uranium recovery operations, aquifer restoration, and decommissioning. The primary sources of liquid waste would be well development water, process bleed to maintain inward gradients, and concentrated brine produced during aquifer restoration. DDWs, which are currently used at the existing Crow Butte license area, would be the primary liquid waste disposal method for liquid wastes at the MEA, TCEA, and NTEA (CBR, 2014, Sections 1.1.3.3 and 1.1.3.4). The hydrogeology of the TCEA and NTEA are expected to be similar to the MEA (CBR, 2014, Section 3.4.3.2). CBR would obtain permits for the wells under NDEQ regulations at 122 NAC and operated under a Class I UIC Permit. The DDW's would most likely be open to the Lower Dakota, Morrison, and Sundance formations, as applicable. Although injection of the water would increase pressures within these units, the Morrison Formation has demonstrated the capacity to accept large volumes of an injected waste stream over an extended period at the existing Crow Butte license area (CBR, 2014, Section 4.14.3.6). The DDWs at the MEA would be separated from those at the existing Crow Butte license area, the NTEA, and the TCEA by at least 6 miles (9.7 km).

Although there may be some overlap in pressure responses within the Lower Dakota, Morrison, or Sundance formations (or all three), the subsurface geologic characteristics beneath the proposed expansion areas would prevent disposal fluids injected into the deep disposal wells injection zones from impacting the overlying fresh-water aquifers. Between the lowermost drinking water source aquifer and the deep disposal well injection are more than 2,500 feet (762 meters) of sediments primarily consisting of low permeability shale. This separating aquitard protects against vertical migration of injected fluids to the drinking water source aquifers. Shales above and below the deep disposal well injection zone would encase the disposal fluids within the receiving formations and CBR has identified no structural elements with the potential to disrupt the natural vertical containment.

CBR would monitor the quality of injected water in the Morrison and Sundance formations on a daily or weekly basis, depending on the parameter, and report the results to the NDEQ on a monthly basis. Therefore, water quality in the deep injection formations would not be adversely impacted beyond that permitted from operation of deep disposal wells at multiple mines.

The NRC staff concludes that the vertical hydraulic separation of the DDW injection zone from overlying aquifers and low permeability of the confining units, in conjunction with compliance monitoring, would not result in significant impacts to natural resources. Therefore, the NRC staff concludes that when the potential incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts from liquid wastes would not be significant.

5.12.2.2 Solid Wastes

The NRC determined that impacts from solid-waste generation at the MEA, as described in Section 4.12.2, would be SMALL. Preconstruction activities would generate small amounts of solid sanitary and hazardous wastes primarily related to the installation and operation of wells. These same preconstruction activities would occur at the NTEA and TCEA. CBR would dispose of the sanitary wastes in an NDEQ-permitted sanitary landfill and disposed of the hazardous wastes at an appropriate permitted facility. As presented in Section 4.12.2, activities at the MEA would generate about 50 gallons (189 liters) of waste petroleum products and chemicals annually throughout the facility lifetime. It can be assumed that this same level of waste generation would occur at the NTEA and TCEA because of the similarity in activities, with a larger volume (about 350 gallons (1,325 liters) (NRC, 2014d, Section 2.2.3.3)) generated at the existing Crow Butte license area. CBR would send these petroleum and chemical wastes to recycling or disposal facilities. While it can be expected that decommissioning activities would generate a higher volume of these wastes, recycling would minimize the need for disposal, and no disposal volume limitations are known to exist.

Section 11e.(2) byproduct solid wastes generated would occur from the existing Crow Butte license area, TCEA, and NTEA in addition to the MEA. This waste would be disposed of under CBR's current contractual agreement with Denison Mines USA for disposal of 11e.(2) byproduct materials generated by uranium recovery operations at Denison's White Mesa Mill site near Blanding, UT (CBR, 2014, Section 4.13.2.3). Should the Denison Mines USA disposal option become unavailable, other disposal sites could accept the byproduct wastes, such as Pathfinder Mines in Shirley Basin, WY; Energy Solutions LLC in Clive, UT; and Waste Control Specialists in Andrews, TX.

The NRC staff concludes that when the potential incremental impacts from amending the CBR license to include the MEA are added to other past, present, and reasonably foreseeable future actions, cumulative impacts from solid wastes would not be significant because of the small amount to be generated and the availability of disposal options.

6 MONITORING AND MITIGATION

As discussed in Section 8.1 of the ISR GEIS (NRC, 2009), monitoring programs are developed for ISR facilities to verify compliance with standards for the protection of worker health and safety in operational areas and for protection of the public and environment beyond the facility boundary. Monitoring programs provide data on operational and environmental conditions so prompt corrective actions can be implemented when adverse conditions are detected. These programs help limit potential environmental impacts at ISR facilities and the surrounding areas.

In accordance with 10 CFR Part 40, Appendix A, Criterion 7, licensees are required to have a preoperational monitoring program to establish facility baseline conditions. After establishing the baseline program, ISR facility operators are required to conduct an operational monitoring program to measure or evaluate compliance with standards and to evaluate the potential environmental impact of an operating ISR facility. RG 4.14 (NRC, 1980b) provides guidance for implementing monitoring programs at uranium mills (which includes ISR facilities) that are acceptable to the NRC staff.

6.1 Preoperational Baseline Monitoring

CBR is conducting preoperational baseline environmental monitoring to support the license application. Baseline environmental monitoring is used to establish the current site conditions before the commencement of operations so that impacts of operations on environmental parameters can be assessed and to establish groundwater cleanup goals. Preoperational monitoring consists of air particulate and radon gas monitoring; ore zone and non-ore zone groundwater monitoring; surface water monitoring; vegetation, food, and fish monitoring; sediment sampling in ephemeral drainages in the MEA and Niobrara River; and soil sampling (CBR, 2014, Section 6.1).

Figure 3-10 shows air sampling locations. CBR is conducting preoperational air sampling of lead-210, radium-226, thorium-230, and natural uranium. ER Section 6.1.1.2 (CBR, 2014) contains some of the results of this monitoring. In addition, CBR is sampling radon gas at least once per month. Air monitoring is being performed in accordance with RG 4.14 (NRC, 1980).

For groundwater, CBR is monitoring private water supply wells with the monitoring wells in the MEA as part of the preoperational monitoring program. Consistent with RG 4.14, CBR monitored a total of 134 active and inactive private wells located within 1.24 miles (2 km) of the MEA license boundary. ER Section 6.1.2.1 and Appendix A to the ER (CBR, 2014) contain the results from this monitoring. Parameters monitored include suspended and dissolved natural uranium concentrations, suspended and dissolved radium-226, lead-210, polonium-210, thorium-230, sodium, and sulfate. For CBR monitoring wells in the MEA, CBR took water level measurements in the Arikaree Group and Brule Formation, and Basal Sandstone of the Chadron Formation, with results summarized in ER Section 6.1.2.2 (CBR, 2014). In addition to monitoring water levels, CBR performed several sampling events to monitor for major ions, physical properties such as conductivity, pH, and TDS, dissolved metals, and radionuclides (natural uranium, thorium-230, radium-226, polonium-210, and lead-210) (CBR, 2014, Sections 6.1.2.3 and 6.1.2.4).

Surface water samples have not been collected in the MEA because of the ephemeral nature of surface water features in the site. Preoperational surface water monitoring has therefore been limited to the Niobrara River and the Box Butte Reservoir. ER Section 6.1.3 (CBR, 2014) summarizes the results of this monitoring. CBR would, however, sample surface water from the ephemeral drainages if water flow becomes available at any time during preoperations at any of the sampling points (CBR, 2017, Section 2.9.7.2).

CBR conducted preoperational sampling of vegetation (TR Table 2.9-32), meat (TR Appendix DD), and fish (TR Appendix X) (CBR, 2015; 2017). TR Appendix W-2 provides results for sediment (CBR, 2015; 2017). CBR will collect additional preoperational crop samples as recommended in RG 4.14 (NRC, 1980b) and add the results to TR Appendix Q (CBR, 2017). CBR analyzed garden soil samples in lieu of collecting garden vegetation for analysis because the sample size to meet lower limit of detection standards in RG 4.14 would be too large. Results from the garden soil samples are provided in TR Table 2.9-36 (CBR, 2017). CBR analyzed livestock samples with results shown in TR Table 2.9-33 (CBR, 2017).

CBR used a radial grid pattern to establish preoperational soil sampling locations, and collected soil samples at the air monitoring stations. The purpose of the soil sampling was to determine background natural uranium and radium-226 in the soils. CBR followed the guidance in NUREG/CR-5849 (NRC, 1992b). Results of this sampling can be found in TR Appendix BB (CBR, 2015). CBR will perform additional soil sampling at 6-inch (15-cm) depths as required by NUREG-1569 Criterion 2.9.3(2) (NRC, 2003) and TR Appendix BB would be updated accordingly (CBR, 2017).

6.2 <u>Operational Monitoring</u>

6.2.1 Groundwater and Surface Water

As described in the MEA ER (CBR, 2014, Section 6.1), CBR would implement a groundwater monitoring program to assess and mitigate potential impacts from commercial operations to individuals at and near the facility and to the environment. In accordance with License Condition 10.4 (NRC, 2014f), CBR would install monitoring wells no more than 300 feet (91 meters) from the wellfield boundary and no more than 400 feet (122 meters) apart, unless NDEQ imposes more conservative spacing requirements. Before uranium recovery begins at each individual wellfield (mine unit), CBR would sample selected injection, recovery, and monitoring wells to establish baseline water quality in order to define the required background groundwater protection standards in 10 CFR Part 40, Appendix A, Criterion 5B(5) for the ore zone aquifer and surrounding aquifers (License Condition 11.3 (NRC, 2014f)).

Under License Condition 11.4 (NRC, 2014f), CBR would be required to determine baseline concentrations of excursion detection parameters, including chloride, conductivity, and total alkalinity before injection of lixiviant into the mine unit. The shallow and perimeter monitoring wells would be sampled and tested at least biweekly during operations to detect excursions of lixiviant either horizontally or vertically outside of the production zone, in accordance with License Condition 11.5 (NRC, 2014f). If excursion indicators are detected (e.g., changes in chloride concentrations, conductivity, and total alkalinity), CBR would be required under License Condition 11.5 to notify the NRC within 24 hours of confirming an excursion and take corrective action, including additional sampling followed by adjusting production or injection rates as needed. CBR would also be required under License Condition 10.6 (NRC, 2014f) to monitor water quality during restoration, including stabilization monitoring at the end of restoration activities, to determine when groundwater protection standards have been achieved.

CBR would also monitor all active, operational, and accessible private wells located within the MEA and in a 1.2-mile (2-km) radius around the MEA, and Brule and ore zone wells within the MEA to identify any potential impacts to water resources of the area. CBR would monitor the wells quarterly for dissolved and suspended natural uranium, radium-226, thorium-230, lead-210, and polonium-210 during operations (CBR, 2017).

CBR would collect surface water samples at 7 locations along the two ephemeral drainages, subject to sufficient flow (CBR, 2017). Because drainages are ephemeral, CBR would collect onsite surface water samples quarterly if possible and analyze for dissolved and suspended natural uranium, radium-226, thorium-230, lead-210, and polonium-210 (CBR, 2017).

6.2.2 Air Quality Monitoring

CBR would conduct air particulate monitoring as part of the environmental monitoring program at the MEA (CBR, 2014; 2017). CBR would obtain quarterly composites of weekly airborne particulate samples from air-monitoring locations and analyze them for natural uranium, radium-226, lead-210, and thorium-230 (CBR, 2015, Table 5.7-1). CBR would analyze the samples in accordance with the guidance for air measurements in RG 4.14 (NRC, 1980b). Air sampling locations would be located along the MEA southern boundary, in the sector having the highest predicted concentration of airborne particulate, at or close to the nearest residence, and at a background location (CBR, 2015, Table 5.7-1).

CBR would monitor radon gas effluent released to the environment from the satellite facility at the air monitoring locations used for baseline determination of radon concentrations (CBR, 2015, Table 5.7-1). In accordance with RG 8.37, "ALARA Levels for Effluents from Materials Facilities," issued July 1993 (NRC, 1993), CBR would estimate the magnitude of these releases and use these estimates in demonstrating compliance with the annual radiation dose limit. Environmental monitoring and estimated releases of radon from process operations would be reported in the semiannual reports, in accordance with 10 CFR 40.65, "Effluent Monitoring Reporting Requirements," and License Condition 12.1 of SUA-1534 (CBR, 2014, Section 6.2.1.2; NRC, 2014f).

CBR would continuously monitor environmental gamma radiation levels at the air monitoring stations during operations. Gamma radiation would be monitored using environmental dosimeters obtained from a National Voluntary Laboratory Accreditation Program-certified vendor. Dosimeters would be exchanged quarterly (CBR, 2014, Section 6.2.1.7).

6.2.3 Environmental Monitoring

Each year, as required by License Condition 11.13 (NRC, 2014f) and consistent with in RG 4.14 (NRC, 1980b), CBR would collect 6 surface and subsurface soil samples annually and analyze them for natural uranium, radium-226, and lead-210. CBR would annually obtain 7 sediment samples along each of the two ephemeral drainages in the MEA and analyze them for natural uranium, radium-226, thorium-230, and polonium-210. Because of the sporadic nature of wind-blown dust in Marsland, CBR would use sediment samples as a surrogate to track the wind transport and dispersion of contaminants. If increasing concentrations were identified, CBR would further evaluate dose implications and the need for additional sampling and potential mitigation measures (CBR, 2015; 2017).

CBR concluded from computer modeling that the predicted dose to an individual from all pathways would be less than 5 percent of the applicable radiation protection standard (5 mrem per year), as described in RG 4.14. However, CBR would sample vegetation from gardens for natural uranium, thorium-230, radium-226, lead-210, and polonium-210 during the first year of operations for comparison to the baseline data. If the results, supported by annual computer modeling, confirmed that this is not a significant pathway, CBR would propose to NRC to modify the operational monitoring plan to remove the sampling of vegetation or forage from the operational monitoring program, consistent with the guidance in RG 4.14 (NRC, 1980b). CBR would collect vegetation samples three times during the grazing season from grazing areas near the site in different sectors that would have the highest predicted air particulate concentrations during operations (CBR 2017).

CBR would collect three crop samples annually at the time of harvest. CBR commits to collecting livestock samples annually, consistent with the guidance in RG 4.14. Crop and livestock samples would be analyzed for natural uranium, thorium-230, radium-226, lead-210, and polonium-210. If the results from preoperational monitoring of crops confirmed that this is not a significant pathway, then CBR would propose to NRC to modify the operational monitoring program, consistent with the guidance in RG 4.14 (CBR, 2017). If the results from operational monitoring of livestock confirmed that this is not a significant pathway, then CBR would propose to NRC to modify the operational monitoring program, consistent with the guidance in RG 4.14 (CBR, 2017).

For the reasons provided in Section 3.11.4, consumption of big game mammals is not a significant pathway of exposure to man; therefore, CBR would not conduct sampling of big game mammals. CBR would continue to annually conduct computer modeling of the radiological dose from ingestion pathways that would include the consumption of big game (CBR, 2017).

CBR would collect fish samples from Box Butte Reservoir and analyze them for radium-226 and lead-210 on a semiannual basis.

6.3 Mitigation Measures

CBR has committed to using mitigation measures identified in the MEA ER (CBR, 2014). These mitigation measures would reduce the related potential environmental impacts. For the purposes of NEPA, and consistent with CEQ guidance (CEQ, 2011), the NRC staff discloses measures that could potentially reduce or avoid environmental impacts related to the proposed action. The NRC staff discusses mitigation measures that CBR would employ in the impacts analyses in Chapter 4. An example of a mitigation measure in Chapter 4 is the use of BMPs to manage surface water flow (see Section 4.2.2).

7 CONSULTATIONS

The NRC staff consulted with other agencies regarding the proposed action in accordance with NUREG-1748 (NRC, 2003a). These consultations were intended to (1) ensure that the requirements of Section 7 of the Endangered Species Act and Section 106 of the NHPA were met and (2) provide the designated State liaison agencies the opportunity to comment on the proposed action.

The NRC staff contacted USFWS by letter dated February 8, 2013, requesting USFWS assistance in identifying the presence of endangered or threatened species or critical habitat at the MEA and in the vicinity (NRC, 2013d). USFWS replied by letter dated March 7, 2013 (USFWS, 2013), with technical assistance to assist in the planning process to avoid or minimize adverse impacts to Federal trust fish and wildlife resources the proposed project might cause. USFWS also noted species of concern or State-listed species under the Nebraska Nongame and Endangered Species Conservation Act and recommended consultation with NGPC. Therefore, by letter dated February 5, 2014 (NRC, 2014a), the NRC staff contacted NGPC to determine whether the proposed project may affect any additional State-listed species. NGPC replied by letter dated May 15, 2014 (NGPC, 2014), providing the requested information and describing a visit made to the site in December 2013. NGPC also stated that it appeared unlikely that the project would adversely impact State-listed endangered or threatened species.

In addition, by letter dated February 8, 2013, the NRC asked NDEQ for information about resources potentially affected by CBR's license amendment (NRC, 2013l). The NRC did not receive a response from NDEQ.

The NRC staff contacted NDNR by letter dated February 8, 2013, requesting information about resources potentially affected by CBR's license amendment application (NRC, 2013m, 2013n). NDNR responded on March 14, 2013, with its review of the project for potential impacts to surface water rights, registered groundwater wells, and floodplain management (NDNR, 2013). NDNR determined that there are no appropriations of surface water rights that apply to the proposed location, but there are 21 registered wells within the proposed project area. NDNR advised that the licensee should take special care should to locate and avoid impacting these wells in any significant way. CBR would need to register new wells proposed as part of the MEA project and update the status of any existing wells, including with the appropriate NDNR district. A portion of the proposed project is located within the regulated floodplain, so development there would require special permitting and need to follow certain construction requirements.

By letter dated February 8, 2013, the NRC initiated NHPA Section 106 consultation with the NE SHPO (NRC, 2013e). On October 30, 2014 (NRC, 2014d), the NRC requested the NE SHPO's concurrence with the NRC's finding of no historic properties present for the MEA, based on surveys conducted and the NRC's draft text for this draft EA. In a letter dated November 18, 2014 (NSHS, 2014), the NE SHPO concurred with the findings that no archaeological, architectural, or historic context property resources would be affected by the proposed project.

The NRC invited 20 Native American Tribes to be consulting parties under NHPA Section 106 by letters sent to each Tribe dated September 5, 2012 (NRC, 2012a). The consultation process with the Tribes is captured in Sections 3.6.4 and 4.6.

Finally, the NRC contacted the Advisory Council on Historic Preservation by letter on May 3, 2013 (NRC, 2013j), to inform the council that the NRC is using the NEPA process to comply with

Section 106 of the NHPA requirements and describe consultation efforts to date. The staff also provided a redacted version of the report for the TCP survey the Tribes conducted in fall 2012.

8 CONCLUSION

The NRC staff has assessed the potential environmental impacts associated with the request from CBR to amend NRC Source Materials License SUA-1534 for the existing Crow Butte license area, located in Crawford, NE, to allow ISR activities at the MEA, and has documented the results in this draft EA. The staff performed the assessment in accordance with the requirements in 10 CFR Part 51. In conducting the assessment, the staff considered information in the license amendment application (ER and TR); information in the responses to the staff's requests for additional information; communications with CBR, NE SHPO, NDEQ, and others as indicated in Chapter 5; information from NRC staff site visits; consultation with Native American Tribes and the public; and the NRC staff's independent analysis.

Approval of the proposed action would not result in significant potential impacts to the current land use at the MEA, and restoration is planned to return the site to its original condition as activities are completed. Minimal new construction, including roads, at the MEA is anticipated. Traffic is also not expected to increase significantly from current conditions. Water resources, discussed in detail in Sections 3.3 and 4.3, would not be significantly impacted from the activities at the MEA. Section 106 of the NHPA was complied with and the proposed action would not significantly impact historic and cultural resources or minority populations. Permitting ISR activities at the MEA would have a positive potential impact on socioeconomics. There would be no significant impacts to the public pertaining to radiological and nonradiological health associated with permitting ISR activities at the MEA. The staff performed a cumulative impacts analysis and concluded that there would not be significant cumulative impacts for any resource areas.

Based on its review of the proposed action, in accordance with the requirements in 10 CFR Part 51, the NRC staff has preliminarily determined that amendment of SUA-1534 to authorize construction and operation of the MEA, located near Marsland, NE, would not have significant direct or cumulative impacts on the resource areas summarized in the above paragraph and discussed in Chapters 3 and 4, and would not significantly affect the quality of the human environment. Therefore, the NRC has determined that pursuant to 10 CFR 51.31, "Determinations Based on Environmental Assessment," preparation of an environmental impact statement (EIS) is not required for the proposed action and a Finding of No Significant Impact (FONSI) is appropriate. The staff has not identified any mitigation measures (see Section 1.4.1) that should be implemented beyond those proposed.

Pursuant to 10 CFR 51.33, "Draft Finding of No Significant Impact; Distribution," the NRC staff is making this draft EA and draft FONSI available for public review and comment. Comments on the draft EA and draft FONSI will be accepted through January 29, 2018. Based on the comments submitted, the NRC staff may determine that a final FONSI is appropriate or instead find that preparation of an EIS is warranted should significant potential impacts resulting from the proposed action be identified. The NRC staff's final determination will be published in the *Federal Register*.

9 LIST OF PREPARERS

This section documents all individuals who were involved with the preparation of this draft EA. Contributors include staff from the NRC and its consultant, SC&A, Inc.

NRC

Nathan Goodman, Project Manager
Jean Trefethen, Project Manager, Technical Reviewer
Jessie Muir-Quintero, Technical Reviewer

SC&A

Dr. Abe Zeitoun, Project Manager, Ecology, and Technical Reviewer
Milton Gorden, Task Manager and Senior Technical Reviewer
David Back, Geology and Soil Resources and Water Resources
Deborah Schneider, Land Use, Senior Technical Reviewer
Stephen Marschke, Monitoring and Health Effects
Dr. Paul Nickens, Historic and Cultural Resources and Visual Resources
Andrew Shroads, Air Quality and Noise
Joanne Stover, Technical Editor

10 REFERENCES

10 CFR Part 20 *U.S. Code of Federal Regulations*, "Standards for Protection against Radiation," Part 20, Chapter I, Title 10, "Energy."

10 CFR Part 40 *U.S. Code of Federal Regulations*, "Domestic Licensing of Source Material," Part 40, Chapter I, Title 10, "Energy."

10 CFR Part 51 *U.S. Code of Federal Regulations*, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," Part 51, Chapter I, Title 10, "Energy."

10 CFR Part 71 *U.S. Code of Federal Regulations*, "Packaging and Transportation of Radioactive Material," Part 71, Chapter I, Title 10, "Energy."

29 CFR Part 1910 *U.S. Code of Federal Regulations*, "Occupational Safety and Health Standards," Part 1910, Chapter XVII, Title 29, "Labor."

33 Ind. Cl. Comm. 151, Docket No. 74-BIndian Claims Commission, Volume 33, page 151, Docket No. 74-B, Sioux Nation v United States, 1974.

36 CFR Part 800 *U.S. Code of Federal Regulations*, "Protection of Historic Properties," Part 800, Chapter VIII, Title 36, "Parks, Forests, and Public Property."

40 CFR Part 50 *U.S. Code of Federal Regulations*, "National Primary and Secondary Ambient Air Quality Standards," Part 50, Chapter I, Title 40, "Protection of Environment."

40 CFR Part 68 *U.S. Code of Federal Regulations*, "Chemical Accident Prevention Provisions," Part 70, Chapter I, Title 40, "Protection of Environment."

40 CFR Part 70 *U.S. Code of Federal Regulations*, "State Operating Permit Programs," Part 70, Chapter I, Title 40, "Protection of Environment."

40 CFR Part 98 U.S. *Code of Federal Regulations*, "Mandatory Greenhouse Gas Reporting," Part 98, Subchapter C, Chapter 1, Title 40, "Protection of Environment."

40 CFR Part 302 *U.S. Code of Federal Regulations*, "Reportable Quantities, and Notification–Designation of Hazardous Substances," Part 70, Chapter I, Title 40, "Protection of Environment."

40 CFR Part 355 *U.S. Code of Federal Regulations*, "Emergency Planning and Notification," Part 355, Chapter I, Title 40, "Protection of Environment."

40 CFR Part 1508 *U.S. Code of Federal Regulations*, "Terminology and Index," Part 1508, Chapter V, Title 40, "Protection of Environment."

49 CFR Part 173 *U.S. Code of Federal Regulations*, "Shippers—General Requirements for Shipments and Packagings," Part 173, Chapter I, Title 49, "Transportation."

118 NAC — *Nebraska Administrative Code*, Title 118, "Groundwater Quality Standards and Use Classification," Nebraska Department of Environmental Quality, available via http://www.sos.ne.gov/rules-and-regs/regsearch/Rules/Environmental_Quality_Dept_of/Title-118.pdf

119 NAC — *Nebraska Administrative Code*, Title 119, "Rules and Regulations Pertaining to the Issuance of Permits Under the National Pollutant Discharge Elimination System," Nebraska Department of Environmental Quality, available via http://www.sos.ne.gov/rules-and-regs/regsearch/Rules/index.cgi?l=Environmental_Quality_Dept_of.

122 NAC — *Nebraska Administrative Code*, Title 122, "Rules and Regulations for Underground Injection and Mineral Production Wells," Nebraska Department of Environmental Quality, available via http://www.sos.ne.gov/rules-and-regs/regsearch/Rules/index.cgi?l=Environmental_Quality_Dept_of.

129 NAC — *Nebraska Administrative Code*, Title 129, "Department of Environmental Quality," Nebraska Department of Environmental Quality, available via http://www.sos.ne.gov/rules-and-regs/regsearch/Rules/index.cgi?l=Environmental_Quality_Dept_of.

135 NAC — *Nebraska Administrative Code*, Title 135, "Rules and Regulations for Mineral Exploration Holes," Nebraska Department of Environmental Quality, available via http://www.sos.ne.gov/rules-and-regs/regsearch/Rules/index.cgi?l=Environmental_Quality_Dept_of.

180 NAC — *Nebraska Administrative Code*, Title 180, "Control of Radiation," Nebraska Health and Human Services System, available via http://www.sos.ne.gov/rules-and-regs/regsearch/Rules/index.cgi?l=Health_and_Human_Services_System.

Alexander et al. 2010 — Alexander, J.S., R.B. Zelt, and N.J. Schaepe, "Hydrogeomorphic Segments and Hydraulic Microhabitats of the Niobrara River, Nebraska—With Special Emphasis on the Niobrara National Scenic River," U.S. Geological Survey Scientific Investigations Report 2010-5141, Reston, VA, 2010.

APLIC 2006 — Avian Power Line Interaction Committee, "Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006," Edison Electric Institute, Avian Power Line Interaction Committee, and California Energy Commission, 2006. Available at http://www.aplic.org/uploads/files/2643/SuggestedPractices2006%28LR-2%29.pdf.

APLIC 2012 — Avian Power Line Interaction Committee, "Reducing Avian Collisions with Power Lines: The State of the Art in 2012." Edison Electric Institute and APLIC. Washington, D.C. Available at http://www.aplic.org/uploads/files/11218/Reducing_Avian_Collisions_2012watermarkLR.pdf.

Aqui-Ver 2011 Aqui-Ver, Inc., "Marsland Regional Hydrologic Testing Report—Test #8, Crow Butte Project, Marsland Expansion Area," 2011.

ARCADIS 2012 ARCADIS U.S., Inc., "Crow Butte Resources, Inc., Aquifer Exemption Petition, Marsland Expansion Area," July 2012. ADAMS Accession No. ML13302B482.

Arendt et al. 1980 Arendt, J.W., T.R. Butz, P.M. Prinz, and D.E. Borman, "Hydrochemical and Stream Sediment Reconnaissance Basic Data for Alliance NTMS Quadrangle, Nebraska, South Dakota," Oak Ridge Gaseous Diffusion Plant Report No. K/UR-141, 1980.

Atomic Energy Act of 1954, as amended, accessed May 14, 2016. ADAMS Accession No. ML13274A489.

Ayers 2007 Jerry F., Ayers Conservation and Survey Division, School of Natural Resources, Institute of Agriculture and Natural Resources, University of Nebraska–Lincoln, "Projection Completion Report: Box Butte County—Niobrara River Numerical Groundwater Flow Model Nebraska Department of Natural Resources Task Orders #5 and #6," Lincoln, NE, 2007.

Bahr et al., 2012 Bahr, Vermeer, and Haecker, Architects, Ltd., "National Register of Historic Places Registration Form: Agate Springs Fossil Hills Historic and Archaeological District," Lincoln, NE, March 2012.

BEA 2015 Bureau of Economic Analysis, "CA25N Total Full-Time and Part-Time Employment by NAICS Industry 1/County," last updated November 19, 2015, accessed May 12, 2016, at http://www.bea.gov/iTable/iTable.cfm?reqid=70&step=1&isuri=1&acrdn=7#reqid=70&step=1&isuri=1 (select Local Area Personal Income and Employment; Total Full-Time and Part-Time Employment by Industry (CA25, CA25N); NAICS (2001 forward); County; Nebraska; Dawes, NE; 2010 and 2014).

BLM 1984 Bureau of Land Management, "Visual Resource Management," Manual 8400, April 5, 1984, ADAMS Accession No. ML12237A194.

BLM 1986 Bureau of Land Management, "Visual Resource Inventory," Manual H–8410–1, January 17, 1986, ADAMS Accession No. ML12237A196.

BLM Bureau of Land Management, "Assessment and Mitigation of Potential Impacts to Paleontological Resources – Guidelines for Assessment and Mitigation of Potential Impacts to Paleontological Resources," Instructional Memorandum No. 2009-011, Attachment 1, 2009, 19 pages.

BLS 2013 U.S. Bureau of Labor Statistics, "Labor Force Data by County, 2010 Annual Averages," accessed March 15, 2013, ftp://ftp.bls.gov/pub/special.requests/la/laucnty10.txt.

BLS 2017a U.S. Bureau of Labor Statistics, "Labor Force Data by County, 2016 Annual Averages," accessed July 28, 2017 at https://www.bls.gov/lau/laucnty16.txt.

BLS 2017b U.S. Bureau of Labor Statistics, "Unemployment Rates for States, 2016 Annual Averages," accessed July 28, 2017 at https://www.bls.gov/lau/lastrk16.htm.

Bozell 2004 Bozell, John R., “An Archaeological Overview and Assessment of Agate Fossil Beds National Monument, Sioux County, Nebraska,” U.S. National Park Service, Midwest Archaeological Center, Lincoln, NE, 2004. Available for review at the U.S. National Park Service Agate Fossil Beds National Monument.

Bozell and Pepperl 1987 Bozell, John, and Robert Pepperl, “A Cultural Resources Study of the Crow Butte Uranium Prospect, Dawes County, Nebraska,” Nebraska State Historical Society, Lincoln, NE, 1987, ADAMS Accession No. ML111170476.

Buecker 2003 Buecker, T.R., *Fort Robinson and the American West, 1874–1899*, University of Oklahoma Press, Norman, OK, 2003.

Cady and Scherer 1946 Cady, R.C. and O.J. Scherer, “Geology and Groundwater Resources of Box Butte County, Nebraska,” U.S. Geological Survey Water-Supply Paper 969, U.S. Department of the Interior, Washington, DC, 1946.

CBR 2004 Crow Butte Resources, Inc., “Wellfield Decommissioning Plan for Crow Butte Uranium Project,” Environmental Restoration Group, Inc., Albuquerque, NM, June 2004, ADAMS Accession No. ML041980328.

CBR 2007 Crow Butte Resources, Inc., “Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area, Environmental Report—Volume 1,” May 2007. ADAMS Accession Nos. ML071870302, ML071760344, and ML071870307.

CBR 2010 Crow Butte Resources, Inc., “Application for Amendment of USNRC Source Materials License SUA-1534, Three Crow Expansion Area, Crawford, Nebraska, Environmental Report, Volume I,” August 2010. ADAMS Accession Nos. ML102220278, ML 102220280, ML102220281.

CBR 2012a Josh Leftwich, Cameco Resources, letter to Keith McConnell, U.S. Nuclear Regulatory Commission, May 16, 2012, ADAMS Accession No. ML12160A512.

CBR 2014 Crow Butte Resources, Inc., Compiled Environmental Report for the Crow Butte License Renewal Application for SUA-1534, CBR-011, compiled as of November 2014. ADAMS Accession No. ML17325B322.

CBR 2015 Crow Butte Resources, Inc., “Application for Amendment of USNRC Source Materials License SUA-1534 Marsland Expansion Area, Technical Report,” Response to Requests for Additional Information, Combined Revisions May 2012 through September 2015, September 2015. ADAMS Accession No. ML15328A422 (package).

CBR 2016 Crow Butte Resources, Inc., “Response to Open Issues—Marsland Expansion Area Technical Report, Teleconference on April 6, 2016, Source Materials License SUA-1534, CAC NO. J00683,” May 20, 2016. ADAMS Accession Nos. ML16155A267 and ML16155A268.

CBR 2017 Crow Butte Resources, Inc., "Response to Open Issues – Marsland Expansion Area Technical Report, Teleconference on June 14, 2016, Source Materials License SUA-1534, CAC NO. J00683," June 27, 2017. ADAMS Accession No. ML17193A314.

CEQ 1997 Council on Environmental Quality, "Environmental Justice: Guidance Under the National Environmental Policy Act," Washington, DC: Executive Office of the President, December 10, 1997. Available at http://www.energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/G-CEQ-EJGuidance.pdf.

CEQ 2005 Council on Environmental Quality, "Guidance on the Consideration of Past Actions in Cumulative Effects Analysis," Memorandum from James L. Connaughton to Heads of Federal Agencies, June 24, 2005. Available at http://energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/G-CEQ-PastActsCumulEffects.pdf.

CEQ 2011 Council on Environmental Quality, "Appropriate Use of Mitigation and Monitoring and Clarifying the Appropriate Use of Mitigated Findings of No Significant Impact," Memorandum from Nancy H. Sutley to Heads of Federal Departments and Agencies, January 14. Accessed July 24, 2017 at https://energy.gov/sites/prod/files/2017/06/f35/NEPA-CEQ_Mitigation_and_Monitoring_Guidance_14Jan2011.pdf.

Chapman et al. 2001 Chapman, Shannen S., James M. Omernik, Jerry A. Freeouf, Donald G. Huggins, James R. McCauley, Craig C. Freeman, Gerry Steinauer, Robert T. Angelo, and Richard L. Schlepp, Richard L., "Ecoregions of Nebraska and Kansas" [color poster with map, descriptive text, summary tables, and photographs], U.S. Geological Survey, Reston, Virginia, 2001, accessed February 6, 2015 at http://www.epa.gov/wed/pages/ecoregions/ksne_eco.htm.

Cheyenne River Sioux 2013 Cheyenne River Sioux Tribe, Letter from Steve Vance to Nathan Goodman, NRC, "Proposed Crow Butte License Renewal, North Trend, Marsland, Three Crow TCP Survey by Santee and Crow Tribes," May 1, 2013, ADAMS Accession No. ML13123A087.

Clean Air Act of 1963, as amended, accessed May 13, 2016, at http://www.epw.senate.gov/envlaws/cleanair.pdf.

Clean Water Act, Federal Water Pollution Control Act Amendments of 1972, accessed May 16, 2016, at https://www.gpo.gov/fdsys/pkg/STATUTE-86/pdf/STATUTE-86-Pg816.pdf.

CNRWA 2001 Center for Nuclear Waste Regulatory Analyses, "A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licenses," NUREG/CR-6733, September 2001.

Collings and Knode 1984 Collings, S.P. and R.H. Knode, "Geology and Discovery of the Crow Butte Uranium Deposit," Proceeding of the Practical Hydromet '83, 7th Annual Symposium on Uranium and Precious Metals. Littleton, CO: American Institute of Mining, Metallurgical, and Petroleum Engineering, 1984.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, accessed May13, 2016, at http://www.epw.senate.gov/cercla.pdf.

Cooper and Jacob 1946 Cooper, H.H., and C.E. Jacob, "A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well Field History," *Am. Geophys. Union Trans*., 27(1946):526–534.

DataUSA 2017a Dawes County, NE, [webpage], accessed on July 28, 2017 at https://datausa.io/profile/geo/dawes-county-ne/.

DataUSA 2017b Box Butte County, NE, [webpage], accessed on July 28, 2017 at https://datausa.io/profile/geo/box-butte-county-ne/.

DeGraw 1969 DeGraw, H.M., "Subsurface Relations of the Cretaceous and Tertiary in Western Nebraska," University of Nebraska, M.S. Thesis, 1969.

DeGraw 1971 DeGraw, H.M., "The pre-Oligicene surface in western Nebraska—Its relation to structure and subsequent topographies," in Stout, T.M., H.M. DeGraw, L.G. Tanner, K.O. Stanley, and W.J. Wayne, *Guidebook to the Late Pliocene and Early Pleistocene of Nebraska*, The University of Nebraska Conservation and Survey Division, Lincoln, and Nebraska Geological Survey, pp. 13–21, 1971.

Deloria and Stoffle 1998 Deloria, Vine, Jr., and Richard W. Stoffle, "Native American Sacred Sites and the Department of Defense," Bureau of Applied Research in Anthropology, University of Arizona, Tucson, AZ, 1998.

DeMallie 2001 DeMallie, Raymond, ed., *The Handbook of North American Indians: The Plains, Volume 13*, Smithsonian Institution Press, Washington DC, 2001.

Dickinson 1990 Dickinson, K.A., "Distribution of the basal clastic unit of the Oligocene Chadron Formation in the Alliance 2-degree quadrangle, northwestern Nebraska," U.S. Geological Survey, Open File Report OF-90-416, Washington, DC, 1990. Available at https://pubs.er.usgs.gov/publication/ofr90416.

EIA 2013 U.S. Energy Information Administration, "Nuclear and Uranium. Uranium Marketing Annual Report, Data for 2012," accessed November 28, 2017 at http://www.eia.gov/uranium/marketing/.

Emergency Planning and Community Right-to-Know Act of 1986, accessed May 13, 2016, at https://www.gpo.gov/fdsys/pkg/USCODE-2011-title42/html/USCODE-2011-title42-chap116.htm.

Endangered Species Act of 1973, as amended, accessed May 13, 2016, at http://www.fws.gov/endangered/esa-library/pdf/ESAall.pdf.

EPA 1974 U.S. Environmental Protection Agency, Office of Noise Abatement and Control, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," EPA 550/9-74-004, March 1974, accessed November 13, 2012, at http://www.nonoise.org/library/levels74/levels74.htm, summary at http://www.epa.gov/history/topics/noise/01.html.

EPA 1989 U.S. Environmental Protection Agency, "Requirements for Hazardous Waste Landfill Design, Construction, and Closure," Seminar Publication, EPA/625/4-89/022, August 1989. Available via search at https://www.epa.gov/nscep#searchApp.

EPA 2012 U.S. Environmental Protection Agency, "What Are Wetlands" [webpage], accessed February 9, 2015, at http://water.epa.gov/type/wetlands/what.cfm, last updated October 9, 2012.

EPA 2014 U.S. Environmental Protection Agency, "Construction Site Stormwater Runoff Control." [Web Page]. Accessed September 4, 2014, at: http://water.epa.gov/polwaste/npdes/swbmp/Construction-Site-Stormwater-Run-Off-Control.cfm. Last updated July 14, 2014. .

EPA 2016 U.S. Environmental Protection Agency, "The Green Book Nonattainment Areas for Criteria Pollutants," as of April 22, 2016, accessed May 14, 2016, at https://www3.epa.gov/airquality/greenbook/multipol.html. (See nonattainment county map: https://www3.epa.gov/airquality/greenbook/mapnpoll.html; Nebraska nonattainment areas: https://www3.epa.gov/airquality/greenbook/anayo_ne.html; Wyoming nonattainment areas: https://www3.epa.gov/airquality/greenbook/anayo_wy.html; Note: South Dakota is not included because no areas within South Dakota have ever been classified as nonattainment.)

Environmental Laboratory, 1987 Environmental Laboratory, "Corps of Engineers Wetlands Delineation Manual," Technical Report Y-87-1, U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi, January 1987, http://el.erdc.usace.army.mil/elpubs/pdf/wlman87.pdf.

Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments," November 2000.

Ferret 1987 Ferret Exploration Company of Nebraska, "Crow Butte Project Water Quality Report," July 29, 1987. ADAMS Accession No. ML080940310.

Ferret 1988 Ferret Exploration Company of Nebraska, "Crow Butte Uranium Project Dawes County, Nebraska Application and Supporting Environmental Report for State of Nebraska Underground Injection Control Program Commercial Permit Submitted to: Nebraska Department of Environmental-Control, Lincoln, Nebraska."

Gaul et al. 2004 Gaul, S., J. Schellpeper, and A. Bleed, "Report on Hydrologically Connected Groundwater and Surface Water in the Upper Niobrara-White Natural Resource District," Nebraska Department of Natural Resources, October, 2004.

GCRP 2014 U.S. Global Change Research Program, "Climate Change Impacts in the United States: The Third National Climate Assessment," J.M. Melillo, T.C. Richmond, and G.W. Yohe (editors). U.S. Government Publishing Office, Washington, D.C. Accession No. ML14129A233.

Gjelsteen and Collings 1988 Gjelsteen, T.W., and S.P. Collings, "Relationship Between Groundwater Flow and Uranium Mineralization in the Chadron Formation, Northwest Nebraska," in *Wyoming Geological Association Guidebook, 39th Annual Field Conference*, pp. 271–284, 1988.

Gosselin et al. 1996 Gosselin, D.C., J. Headrick, X-H. Chen, and S.E. Summerside, "Regional Analysis of Rural Domestic Well-water Quality—Hat Creek-White River Drainage Basin; from Domestic Water-well Quality in Rural Nebraska," Nebraska Department of Health, 1996.

Graves et al. 2011 Graves, Adam, Natalie Graves, Maureen Boyle, and Ashley Howder, "Cameco Resources Marsland Expansion Area Uranium Project Class III Cultural Resource Investigation, Dawes County, Nebraska," ARCADIS U.S., Inc., Buffalo, WY, 2011, ADAMS Accession No. ML12165A503.

Graves et al. 2012 Graves, Adam, Natalie Graves, Maureen Boyle, and Ashley Howder, "Cameco Resources Marsland Expansion Area Uranium Project Addition Cultural Resource Inventory, Dawes County, Nebraska," ARCADIS U.S., Inc., Buffalo, WY, 2012, ADAMS Accession No. ML12165A502.

Hinchley 2005 Hinchley, Opal, "Marsland, Dawes County," Virtual Nebraska—Our Towns, University of Nebraska, Lincoln, NE, 2005, http://www.casde.unl.edu/history/counties/dawes/marsland/.

Hoganson et al. 1998 Hoganson, J.W., E.C. Murphy, and N.F. Forsman, "Lithostratigraphy, paleontology, and biochronology of the Chadron, Brule, and Arikaree Formations in North Dakota," in Terry, D.O., Jr., H.E. LaGarry, and R.M Hunt, eds., *Depositional Environments, Lithostratigraphy, and Biostratigraphy of the White River and Arikaree Groups (Late Eocene to Early Miocene, North America).* Geological Society of America Special Paper #325, pp. 185–196, 1998.

HWA 2012 Hayden-Wing Associates, LLC, "Ecological Resources Summary: Technical Report for Cameco Resources—2011 Proposed Marsland Expansion Area Uranium Project Dawes County, Nebraska," February 2012.

Koch 2000 Koch, Amy, "High Plains Archaeology," Nebraska State Historical Society, Explore Nebraska Archaeology, No. 5, Lincoln, NE, 2000.

LaGarry 1998 LaGarry, H.E., "Lithostratigraphic revision and redescription of the Brule Formation, White River Group, western Nebraska," in Terry, D.O., Jr., H.E. LaGarry, and R.M. Hunt, eds., *Depositional Environments, Lithostratigraphy, and Biostratigraphy of the White River and Arikaree Groups (Late Eocene to Early Miocene, North America).* Geological Society of America Special Paper #325, pp. 63–91, 1998.

LeBeau 2002 LeBeau, Sebastian C., "Wico'cajeyate: Traditional Cultural Property Evaluation, Agate Fossil Beds National Monument, Nebraska." Gettysburg, SD, January 2002.

LeBeau 2009 LeBeau, Sebastian C., "Reconstructing Lakota Ritual in the Landscape: The Identification and Typing System for Traditional Cultural Properties," Ph.D. Dissertation, Department of Anthropology, University of Minnesota, Minneapolis, MN, 2009.

Lohman 1972 S.W. Lohman, Groundwater hydraulics, U.S. Geological Survey Prof. Paper 708, p. 70.

Louis Berger 2005 Louis Berger Group, Inc., "Nebraska Historic Buildings Survey, Dawes County," Marion, IA, August 2005, http://www.nebraskahistory.org/histpres/reports/DawesCounty.pdf.

Mahnken 1949 Mahnken, N., "The Sidney-Black Hills Trail," *Nebraska History*, 30(1949):203–225.

McNair 2005 McNair, Abby R., "All About a Line: The Sidney-Black Hills Trail's Impact on the Cultural Landscape of Western Nebraska and South Dakota," M.A. Thesis, Department of Geography, University of Nebraska at Omaha, Omaha, NE, 2005. Available for review at the Museum of the Fur Trade, Chadron, NE.

Miller and Appel 1997 Miller, J.A. and C.L. Appel, "Groundwater Atlas of the United States, Kansas, Missouri, and Nebraska," U.S. Geological Survey Report HA 730-D, Denver, Colorado, 1997.

Morgan and Wheedon 1990 Morgan, George Robert, and Ronald R. Weedon, "Oglala Sioux use of Medical Herbs," *Great Plains Quarterly*, Vol. 10, No. 4, pp. 18–35, University of Nebraska, Lincoln, NE, 1990.

NASS 2014 National Agricultural Statistics Service, "2012 Census of Agriculture, County Profile, Dawes County, Nebraska," May 2014. Accessed April 1, 2016, at http://www.agcensus.usda.gov/Publications/2012/Online_Resources/County_Profiles/Nebraska/cp31045.pdf.

National Environmental Policy Act of 1969, as amended (NEPA), accessed October 2, 2013, at http://energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/Req-NEPA.pdf.

National Historic Preservation Act of 1966, as amended (NHPA), accessed October 3, 2013, at http://www.achp.gov/docs/nhpa%202008-final.pdf.

NCEDC 2017 Northern California Earthquake Data Center, ANSS Composite Earthquake Catalog, accessed on August 27, 2017, at http://www.ncedc.org/anss/.

NDEQ 1990 Nebraska Department of Environmental Quality, "Authorization for Underground Injection and Mineral Production Wells, Crow Butte Resources, Permit Number NE0122611, April 23, 1990.

NDEQ 2005 Nebraska Department of Environmental Quality, "Total Maximum Daily Loads for the Niobrara River Basin. Perimeter of Concern: E. coli Bacteria," December 2005.

NDEQ 2011 Nebraska Department of Environmental Quality, Class III Underground Injection Control Permit for North Trend Expansion Area, effective August 11, 2011.

NDEQ 2012a Nebraska Department of Environmental Quality, "2011 Nebraska Water Monitoring Programs Report," Water Quality Division, January 2012.

NDEQ 2012b Nebraska Department of Environmental Quality, "2012 Water Quality Integrated Report," Water Quality Division, April 1, 2012.

NDEQ 2014 Nebraska Department of Environmental Quality, "2014 Water Quality Integrated Report," Water Quality Division, April 1, 2014, available at http://www.deq.state.ne.us/Publica.nsf/23e5e39594c064ee852564ae004fa010/3eeeed335d69116c86257ccb004d835c/$FILE/NE%202014%20Water%20Quality%20Integrated%20Reporta.pdf.

NDNR 2004 Nebraska Department of Natural Resources, "Report on Hydrologically Connected Groundwater and Surface Water in the Upper Niobrara-White Natural Resource District," October 2004, accessed at http://www.dnr.ne.gov/hydrologically-connected-groundwater-and-surface-water-in-the-upper-niobrara-white-natural-resources-district-october-2004.

NDNR 2013 Nebraska Department of Natural Resources, Memorandum from John Callen to Kevin Hsueh, U.S. Nuclear Regulatory Commission, March 14, 2013, ADAMS Accession No. ML13077A414.

NDNR 2014 Nebraska Department of Natural Resources, "Upper Niobrara-White Groundwater Model," April 2014, available at http://dnr.nebraska.gov/Media/iwm/Niobrara/UNWreport_Final.pdf.

NDNR 2016a Nebraska Department of Natural Resources, "2011 Hydrographic Report, Discharge Records of Streams, Canals, Pumps and Storage in Reservoirs," accessed April 15, 2016, at http://www.dnr.nebraska.gov/hydrographic-report-and-station-list-2011.

NDNR 2016b Nebraska Department of Natural Resources, "State of Nebraska Department of Natural Resources Summary of Non-Abandoned Registered Wells on File," accessed May 6, 2016, at http://prodmaps2.ne.gov/html5dnr/?viewer=groundwater.

NDOR 2015a Nebraska Department of Roads, "Traffic Flow Map of the State Highways, State of Nebraska: Annual Average Daily Traffic, Year Ending December 31, 2014," Nebraska Department of Roads, 2015, accessed March 31, 2016, at http://www.roads.nebraska.gov/media/2510/2014-statewide-traffic-flow-map.pdf.

NDOR 2015b Nebraska Department of Roads, "Standard Summary of Nebraska Motor Vehicle Traffic Accidents," accessed March 31, 2016, at http://www.roads.nebraska.gov/media/3395/counties2014.pdf.

NDOR 2016 Nebraska Department of Roads, "2015 Annual Report Traffic Crash Facts," accessed August 17, 2017, at http://dot.nebraska.gov/media/5341/facts2015.pdf.

Nebraska Revised Statutes, Sections 82-119 through 124, accessed October 2, 2013, at http://nebraskalegislature.gov/laws/browse-chapters.php?chapter=82.

Neuzil and Bredehoeft 1980 Neuzil, C.E., and J.D. Bredehoeft, J.D., “Measurement of In-Situ Hydraulic Conductivity in the Cretaceous Pierre Shale,” 3rd Invitational Well-Testing Symposium, Well Testing in Low Permeability Environments, Proceedings March 26–28, 1980, Berkeley, California, p. 96–102, 1980.

NGPC 2010 Nebraska Game and Parks Commission, “Annual Performance Report: 2009-10. U.S. Department of Interior Fish and Wildlife Service, Sportfish and Wildlife Restoration Program, Wildlife Surveys and Inventories, Project W-15-R, Segment 66,” Nebraska Game and Parks Commission, Wildlife Division, Lincoln, NE, 2010, http://nlc1.nlc.state.ne.us/epubs/G1800/A001-200910.pdf.

NGPC 2011a Nebraska Game and Parks Commission, “Nebraska Wildlife Species Guide,” 2011, accessed November 6, 2012, at http://outdoornebraska.ne.gov/wildlife/newildlife.asp.

NGPC 2011b Nebraska Game and Parks Commission, “State Wildlife Action Plan,” Second Edition, R. Schneider, K. Stoner, G. Steinauer, M. Panella, and M. Humpert (eds.), Nebraska Natural Legacy Project, 2011, available at https://outdoornebraska.gov/wp-content/uploads/2015/09/NebraskaNaturalLegacyProject2ndEdition.pdf.

NGPC 2013a Nebraska Game and Parks Commission, “Range Maps for Nebraska’s Threatened and Endangered Species,” Nebraska Natural Heritage Program, Nebraska Games and Park Commission, Lincoln, NE, January 1, 2013, accessed February 9, 2015, at http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1029&context=nebgamewhitepap.

NGPC 2013b Nebraska Game and Parks Commission, “Nebraska’s Threatened & Endangered Species: Swift Fox *Vulpes velox*,” 2013, available at http://rarespecies.nebraska.gov/wp-content/uploads/sites/2/2014/01/Swift-Fox.pdf.

NGPC 2013c Nebraska Game and Parks Commission, “Nebraska’s Threatened & Endangered Species: Whooping Crane *Grus americana*,” 2013, available at http://rarespecies.nebraska.gov/wp-content/uploads/sites/2/2014/01/Whooping-Crane.pdf.

NGPC 2013d Nebraska Game and Parks Commission, “Nebraska’s Threatened & Endangered Species: Northern Redbelly & Finescale Dace *Phoxinus eos & Phoxinus neogaeus*,” 2013, available at http://rarespecies.nebraska.gov/wp-content/uploads/sites/2/2014/01/Northern-Redbelly-and-Finescale-Dace.pdf.

NGPC 2013e Nebraska Game and Parks Commission, “Nebraska’s Threatened & Endangered Species: Blowout Penstemon *haydenii*,” 2013, available at http://rarespecies.nebraska.gov/wp-content/uploads/sites/2/2013/12/Blowout-Penstemon.pdf.

NGPC 2013f — Nebraska Game and Parks Commission, "2013 Nebraska Bald Eagle Nesting Report," Joel G. Jorgensen and Lauren R. Dinan, Nongame Bird Program, December 2013, available at http://neblandvm.outdoornebraska.gov/2013/12/bald-eagle-nest-numbers-take-unexpected-dip-2013/.

NGPC 2014 — Nebraska Game and Parks Commission, Letter from Michelle Koch to Kevin Hseuh, NRC, Subj: "Crow Butte Resources, Inc., License Amendment Application for the Proposed Marsland Expansion Area In-situ Uranium Recovery Satellite Facility in Dawes County and Sioux County, Nebraska," May 15, 2014, ADAMS Accession No. ML14136A101.

NGPC 2015a — Nebraska Game and Parks Commission, "Wildlife Species Guide: Black Bear" [web page], accessed February 9, 2015, at http://outdoornebraska.ne.gov/wildlife/wildlife_species_guide/blackbear.asp.

NGPC 2015b — Nebraska Game and Parks Commission, "Nebraska Endangered and Threatened Species," November 2015, accessed April 21, 2016, at http://outdoornebraska.gov/wp-content/uploads/2015/09/NebraskaEndangeredAndThreatenedSpeciesList_11192015.pdf.

NGPC 2015c — Nebraska Game and Parks Commission, "Big Game Guide," 2015, accessed May 11, 2016, at http://digital.outdoornebraska.gov/i/502872-big-game-guide-2015.

NGPC 2016a — Nebraska Game and Parks Commission, "Big Game Guide," 2016, accessed May 12, 2016, at http://digital.outdoornebraska.gov/h/i/251441016-big-game-guide-2016.

NGPC 2016b — Nebraska Game and Parks Commission, Natural Legacy Project, Biologically Unique Landscapes, 'Pine Ridge' Accessed August 29, 2016, at http://outdoornebraska.gov/naturallegacyproject/

NIFA 2017 — Nebraska Investment Finance Authority, "The 2017 Profile of Nebraska Demographics, Economics, and Housing," Volume II, Chapter 1, March 13, accessed on July 28, 2017 at http://www.westernes.com/nepdfs/current/Volume%20II%20Chap%20I.pdf.

NOAA 2014 — National Oceanic and Atmospheric Administration, "The Enhanced Fujita Scale (EF Scale)" [Web page], National Weather Service, last modified October 26, 2014, accessed May 11, 2016, at http://www.spc.noaa.gov/efscale/.

NOAA 2017 — National Oceanic and Atmospheric Administration, "Storm Events Database: Search Results for Dawes County, Nebraska" [Web page], containing data from January 1950 to April 2017, National Centers for Environmental Information, accessed August 1, 2017, at https://www.ncdc.noaa.gov/stormevents/.

NOGCC 2013 — Nebraska Oil & Gas Conservation Commission, "GIS Data Mining," [Web database], accessed May 11, 2015, at http://www.nogcc.ne.gov/NOGCCOnlineGIS/.

NOU 2016 Nebraska Ornithologists Union, “Nebraska County Checklists,” accessed April 21, 2016, at http://www.noubirds.org/Birds/CountyChecklists.aspx.

NPS 2010a U.S. National Park Service, “Cultural Landscapes Inventory: Agate Fossil Beds National Monument,” Agate Fossil Beds National Monument, Harrison, NE, 2010.

NPS 2010b U.S. National Park Service, “Cultural Landscapes Inventory: Cook Homestead Complex,” Agate Fossil Beds National Monument, Harrison, NE, 2010.

NPS 2010c U.S. National Park Service, “Cultural Landscapes Inventory: Red Cloud Campsite,” Agate Fossil Beds National Monument, Harrison, NE, 2010.

NPS 2012 U.S. National Park Service, “List of National Historical Landmarks by State,” National Historical Landmarks Program, Washington, DC, November 2012, http://www.nps.gov/nhl/designations/Lists/LIST12.pdf.

NRC 1980a U.S. Nuclear Regulatory Commission, “Final Generic Environmental Impact Statement on Uranium Milling,” NUREG-0706, September 1980.

NRC 1980b U.S. Nuclear Regulatory Commission, “Radiological Effluent and Environmental Monitoring at Uranium Mills,” Regulatory Guide 4.14, Revision 1, April 1980.

NRC 1982 U.S. Nuclear Regulatory Commission, “Standard Format and Content of License Applications, Including Environmental Reports, for In Situ Uranium Solution Mining,” Regulatory Guide 3.46, June 1982.

NRC 1992a U.S. Nuclear Regulatory Commission, “Residual Radioactive Contamination from Decommissioning: Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent,” NUREG/CR-5512, October 1992. ADAMS Accession No. ML052220317.

NRC 1992b U.S. Nuclear Regulatory Commission, “Manual for Conducting Radiological Surveys in Support of License Termination,” NUREG/CR-5849. ADAMS Accession No. ML090640319.

NRC 1993 U.S. Nuclear Regulatory Commission, “ALARA Levels for Effluences from Materials Facilities,” Regulatory Guide 8.37, July 1993.

NRC 2003a U.S. Nuclear Regulatory Commission, “Environmental Review Guidance for Licensing Actions Associated with NMSS Programs,” NUREG-1748, August 2003. ADAMS Accession No. ML032450279.

NRC 2003b U.S. Nuclear Regulatory Commission, “License Amendment 16, Crow Butte Resources In Situ Leach Facility, License No. SUA-1534, License Condition 10.4, Excursion Monitoring Parameters and Annual Surety Update,” October 20, 2003. ADAMS Accession No. ML032940073.

NRC 2003c U.S. Nuclear Regulatory Commission, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications,” NUREG-1569, June 2003. Accessed on November 24, 2017 at https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1569/.

NRC 2009a U.S. Nuclear Regulatory Commission, "Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities," NUREG-1910, May 2009. Accessed on November 24, 2017 at https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1910/.

NRC 2009b U.S. Nuclear Regulatory Commission, "Radiological Environmental Monitoring for Nuclear Power Plants," Regulatory Guide 4.1, Revision 2, June 2009. ADAMS Accession No. ML091310141.

NRC 2009c Memorandum and Order (CLI-09-21) In the Matter of Duke Energy Carolinas, LLC, and Tennessee Valley Authority. (Combined License Application for Williams States Lee III Nuclear Station, Units 1 and 2 and Bellefonte Nuclear Power Plant, Units 3 and 4), November 3, 2009. Docket Nos. 52-014-COL, 52-015-COL, 52- 018-COL, 52-019-COL. ADAMS Accession No. ML093070689.

NRC 2011 U.S. Nuclear Regulatory Commission, "Nichols Ranch ISR Project in Campbell and Johnson Counties, Wyoming: Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities — Final Report," NUREG-1910, Supplement 2, Washington, DC, ADAMS Accession No. ML103440120.

NRC 2012a U.S. Nuclear Regulatory Commission, Letter from Larry W. Camper, NRC, to Jim Shakespeare, Northern Arapaho Business Committee, "Invitation for Formal Section 106 Consultation Pursuant to the National Historic Preservation Act Regarding the Crow Butte Resources, Inc. License Amendment Application for the Proposed Marsland Expansion Area In-Situ Uranium Recovery Satellite Facility, in Dawes County and Sioux County, Nebraska," September 5, 2012, ADAMS Accession No. ML12248A266.

NRC 2012b U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to Tribal Historic Preservation Officers, October 31, 2012, ADAMS Accession No. ML12311A501.

NRC 2012c U.S. Nuclear Regulatory Commission, "In Situ Recovery Facilities," March 29, 2012, accessed March 17, 2013, at http://www.nrc.gov/materials/uranium-recovery/extraction-methods/isl-recovery-facilities.html.

NRC 2012d U.S. Nuclear Regulatory Commission, "Nuclear Materials Facilities," 2012, accessed March 7, 2013, at http://www.nrc.gov/info-finder/materials.

NRC 2012e U.S. Nuclear Regulatory Commission, "Central and Eastern United States Seismic Source Characterization for Nuclear Facilities: Appendices A and B," NUREG-2115, Volume 4, January 2012.

NRC 2013a U.S. Nuclear Regulatory Commission, "2013–2014 Information Digest," NUREG-1350, Volume 25, August 2013.

NRC 2013d U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to Mike George, U.S. Fish and Wildlife Service, February 8, 2013, ADAMS Accession No. ML12334A369.

NRC 2013e U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to L. Robert Puschendorf, State Historic Preservation Officer, February 8, 2013, ADAMS Accession No. ML12334A358.

NRC 2013f U.S. Nuclear Regulatory Commission, Letter from Aby Mohseni to John M. Fowler, Advisory Council on Historic Preservation, May 3, 2013, ADAMS Accession No. ML13094A037.

NRC 2013g U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to Tribal Historic Preservation Officers, January 3, 2013, ADAMS Accession No. ML13003A280.

NRC 2013h U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to Tribal Historic Preservation Officers, April 2, 2013, ADAMS Accession No. ML13091A250.

NRC 2013i U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to Steve Vance, Cheyenne River Sioux Tribe, “Receipt of Comments on the Santee Sioux Nation Tribal Cultural Property Survey Report for the Proposed Crow Butte Marsland and Three Crow Projects and Section 106 Consultation Update,” June 28, 2013, ADAMS Accession No. ML13157A297.

NRC 2013j U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to Gail Hyubeling, Yankton Sioux Tribe, “Receipt of Comments on the Santee Sioux Nation Tribal Cultural Property Survey Report for the Proposed Crow Butte Marsland and Three Crow Projects and Section 106 Consultation Update,” June 28, 2013, ADAMS Accession No. ML13157A221.

NRC 2013k U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to Mary S. Wilson, Standing Rock Sioux Tribe, “Receipt of Comments on the Santee Sioux Nation Tribal Cultural Property Survey Report for the Proposed Crow Butte Marsland and Three Crow Projects and Section 106 Consultation Update,” June 28, 2013, ADAMS Accession No. ML13157A263.

NRC 2013l U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to Tom Hayden, Nebraska Department of Natural Resources, “Request for Information Regarding Resources Potentially Affected by the Proposed Crow butte resource, Inc. License Amendment Application for the Marsland Expansion Area In-Situ Uranium Recovery Satellite Facility, In Dawes County and Sioux County, Nebraska,” February 8, 2013, ADAMS Accession No. ML12334A421.

NRC 2013m U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to Julie Ward, Nebraska Department of Environmental Quality, “Request for Information Regarding Resources Potentially Affected by the Proposed Crow butte resource, Inc. License Amendment Application for the Marsland Expansion Area In-Situ Uranium Recovery Satellite Facility, In Dawes County and Sioux County, Nebraska,” February 8, 2013, ADAMS Accession No. ML12334A435.

NRC 2013n U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to John Callen, Nebraska Department of Natural Resources, “Request for Information Regarding Resources Potentially Affected by the Proposed Crow butte resource, Inc. License Amendment Application for the Marsland Expansion Area In-Situ Uranium Recovery Satellite Facility, In Dawes County and Sioux County, Nebraska,” February 8, 2013, ADAMS Accession No. ML12334A459.

NRC 2014a U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to Michelle Koch, Nebraska Game and Parks Commission, February 5, 2014, ADAMS Accession No. ML14030A088.

NRC 2014b U.S. Nuclear Regulatory Commission, Letter from Kevin Hsueh to Tribal Historic Preservation Officers, May 30, 2014, ADAMS Accession No. ML14150A337.

NRC 2014c U.S. Nuclear Regulatory Commission, “Crow Butte Resources, Inc., Proposed Marsland Expansion Area, NRC Documentation of NHPA Section 106 Review (Draft Cultural Resources Sections of Environmental Assessment),” June 30, 2014, ADAMS Accession No. ML14176B129.

NRC 2014d U.S. Nuclear Regulatory Commission, Letter to L. Robert Puschendorf, State Historic Preservation Officer, Nebraska State Historical Society, “Request for Concurrence with a Finding of No Historic Properties Present for the Proposed Crow Butte Resources, Inc. In Situ Uranium Recovery Marsland Project, Dawes County, Nebraska,” October 30, 2014, ADAMS Accession No. ML14295A516.

NRC 2014e U.S. Nuclear Regulatory Commission, “Final Environmental Assessment for the License Renewal of U.S. Nuclear Regulatory Commission License No. SUA-1534, Docket No. 040-08943, Crow Butte Resources, Inc.,” October 2014, ADAMS Accession No. ML14288A517.

NRC 2014f U.S. Nuclear Regulatory Commission, Materials License No. SUA-1534, Docket No. 40-08943, Crow Butte Resources, Inc., November 5, 2014, ADAMS Accession No. ML13324A101.

NRC 2014g U.S. Nuclear Regulatory Commission, “Tribal Protocol Manual,” NUREG-2173, issued December 2014. ADAMS Accession No. ML14274A014.

NRC 2014h U.S. Nuclear Regulatory Commission, “Safety Evaluation Report (Revised) for the Dewey-Burdock Project Fall River and Custer Counties, South Dakota,” Materials License No. SUA-1600, Docket No. 40-9075, Powertech (USA) Inc., April 2014. ADAMS Accession No. ML14043A347.

NRC 2014i U.S. Nuclear Regulatory Commission, “Environmental Impact Statement for the Ross ISR Project in Crook County, Wyoming: Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities,” NUREG-1910 Supplement 5, February 2014, ADAMS Accession No. ML14056A096.

NRC 2017a U.S. Nuclear Regulatory Commission, “List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project,” September 22, ADAMS Accession No. ML17265A111.

NRC 2017b U.S. Nuclear Regulatory Commission, "Tribal Policy Statement," *Federal Register*, Volume 82, No. 5, January 9, 2017. ADAMS Accession No. ML17011A243.

NRCS 2009 Natural Resources Conservation Service, "Blacknose Shiner (*Notropis heterolepis*)," NE-T.G. Notice 604, Section II, U.S. Department of Agriculture, June 2009, available at http://efotg.sc.egov.usda.gov/references/public/NE/Blacknose_Shiner_description.pdf.

NSHS 2011a Nebraska State Historical Society, "Nebraska National Register Sites in Dawes County," Lincoln, NE, 2011, http://www.nebraskahistory.org/histpres/nebraska/dawes.htm.

NSHS 2011b Nebraska State Historical Society, "Nebraska Historical Marker Program," Lincoln, NE, 2011, http://www.nebraskahistory.org/publish/markers/index.htm.

NSHS 2011c Nebraska State Historical Society, Concurrence by Deputy State Historic Preservation Officer on Marsland Expansion Area Uranium Project Cultural Resource Inventory by ARCADIS, May 19, 2011.

NSHS 2012 Nebraska State Historical Society, Letter to Natalie Graves, ARCADIS, from Terry Steinacher, NSHS, Concurrence by Robert Puschendorf, Deputy Nebraska State Historic Preservation Officer, with Findings that No Archaeological, Architectural, or Historic Context Property Resources Will Be Affected by the Marsland Expansion Area Project, March 27, 2012, (included in Graves et al., 2012)

NSHS 2014 Nebraska State Historical Society, Letter to Lydia Chang, NRC, from L. Robert Puschendorf, Deputy Nebraska State Historic Preservation Officer, Concurrence on Findings of No Archaeological, Architectural, or Historic Context Property Resources Will Be Affected by the Marsland Expansion Area Project, November 18, 2014, ADAMS Accession No. ML14343A537.

Parker and King 1998 Parker, P.L., and T.F. King, "Guidelines for Evaluating and Documenting Traditional Cultural Properties," Revised, U.S. Department of the Interior, U.S. National Park Service, National Register Bulletin No. 38, 1998, http://www.nps.gov/nr/publications/bulletins/nrb38/.

Powertech 2011 Powertech (USA), Inc., "Dewey-Burdock Technical Report Request for Additional Information Responses," June 2011. ADAMS Accession No. ML11208B714.

Robertson 2013 Robertson, Ryan, "Citizen Scientists Study Endangered Species in Nebraska," NET News, Nebraska's PBS and NPR Stations, November 7, 2013, accessed February 12, 2015, at http://netnebraska.org/article/news/citizen-scientists-study-endangered-species-nebraska.

Rocky Mountain Wild 2015 Rocky Mountain Wild, "Black-tailed Prairie Dog" [web page], 2015, accessed February 13, 2015, at http://rockymountainwild.org/species/mammals/black-tailed-prairie-dog.

Rolfsmeier and Steinauer 2010 Rolfsmeier, S.B., and G. Steinauer, "Terrestrial Ecological Systems and Natural Communities of Nebraska," Version IV, Nebraska Natural Heritage Program, Nebraska Game and Parks Commission, Lincoln, NE, March 9, 2010. Available at https://prairienebraska.files.wordpress.com/2011/05/gerrys-document-correct-pdf.pdf.

Rolfsmeier et al. 2014 Rolfsmeier, S.B., G. Steinauer, and R. Simpson, "Range Maps for the Terrestrial Natural Communities of Nebraska," Version I, Nebraska Natural Heritage Program, Nebraska Game and Parks Commission, Lincoln, NE, September 2014. Available at https://outdoornebraska.gov/wp-content/uploads/2015/09/RangeMapsForTheTerrestrialNaturalCommunitiesOfNebraska_09012014.pdf.

Santee Sioux Nation 2013 Santee Sioux Nation, "Crow Butte Project, Dawes County, Crawford, Nebraska," Santee Sioux Nation, Tribal Historic Preservation Office, Niobrara, NE, 2013. ADAMS Accession No. ML13093A123.

SC&A 2005 SC&A, Inc., "Assessment of Variations in Radiation Exposure in the United States," prepared for the EPA Office of Radiation and Indoor Air, Contract No. EP-D-05-002, Work Assignment No. 1-03, July 15, 2005, available at http://orau.org/ptp/PTP%20Library/library/Subject/Environmental/radiationbackground.pdf.

SC&A 2011 SC&A, Inc., "Trip Report: Section 106 Information-Gathering Information Meeting and Site Visits for Crow Butte In-Situ Leach License Renewal and North Trend Expansion Area and Dewey-Burdock License Applications, June 7–9, 2011," Vienna, VA, 2011.

SC&A 2012 SC&A, Inc., "Trip Report: Site Visit for Marsland Expansion Area License Application, October 23-25, 2012," Vienna, VA, 2012.

SC&A 2013a SC&A, Inc., "Field Documentation of Potential Places of Tribal Religious or Cultural Importance, Crow Butte Resources, Inc., Crow Butte License Area and Proposed Expansion Areas, Dawes and Sioux Counties, Nebraska," Vienna, VA, December 2013.

SC&A 2013b SC&A, Inc., "Field Documentation of Potential Places of Tribal Religious or Cultural Importance, Crow Butte Resources, Inc., Crow Butte License Area and Proposed Expansion Areas, Dawes and Sioux Counties, Nebraska," Redacted, Vienna, VA, December 2013, ADAMS Accession No. ML14174B378.

SC&A 2013c Karene Riley, SC&A, Inc., personal communication with Larry Hankin, Dawes County Department of Roads, March 12, 2013.

SC&A 2016 David Back, SC&A, Inc., personal communication with B.J. Green, Nebraska Department of Natural Resources, May 6, 2016.

SCS 1977 Soil Conservation Service, "Soil Survey of Dawes County Nebraska," United States Department of Agriculture SCS, in cooperation with University of Nebraska Conservation and Survey Division, February 1977.

Shumway 1921 Shumway, Grant L., "History of Western Nebraska, Vol. II," Western Publishing and Engraving Company, Lincoln, NE. http://archive.org/details/historyofwestche02scha.

Souders et al. 1980 Souders, V.L., F.A. Smith, and J.B. Swinehart, "Geology and Groundwater Supplies of Box Butte County, Nebraska," Nebraska Water Survey Paper Number 47, Conservation and Survey Division, University of Nebraska, Lincoln, NE, April 1980.

Souders 1981 Souders, V.L., "Geology and Groundwater Supplies of Southern Dawes and Northern Sheridan Counties, Nebraska," Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, 1981.

Spalding 1982 Spalding, Roy, "Baseline Hydrogeochemical Investigation in a Part of Northwest Nebraska," Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, 1982.

Spalding and Struempler 1984 Spalding, R.F., and A.W. Struempler, "Monitoring Potential Groundwater Contamination in a Proposed Uranium Mining Area," University of Nebraska, Institute of Agriculture and Natural Resources, Conservation and Survey Division; and Chadron State College, 1984. Available at http://info.ngwa.org/GWOL/pdf/850139216.pdf.

Späth, 2007a Späth, Carl, "Crow Butte Resources, North Trend Expansion Area, Class III Cultural Resource Inventory, Dawes County, Nebraska," Report prepared for Crow Butte Resources, Inc., Crawford, NE. ARCADIS, U.S., Highlands Ranch, CO, February 2007.

Späth 2007b Späth, Carl, "Crow Butte Resources, Three Crow Permit Area, Class III Cultural Resource Inventory, Dawes and Sioux Counties, Nebraska," Report prepared for Crow Butte Resources, Inc., Crawford, NE, ARCADIS, U.S., Highlands Ranch, CO, December 2007, ADAMS Accession No. ML102600501.

Späth and Walth 2003 Späth, Carl, and Cherie K. Walth, "Crow Butte Resources Evaluative Testing of Site 25DW198, Dawes County, Nebraska," Greystone Environmental Consultants, Greenwood Village, CO, 2003.

SRI 2012 SRI Foundation, "Overview of Places of Traditional Religious and Cultural Significance: Cameco/Powertech Project Areas," SRI Foundation, Rio Rancho, NM, 2012.

Standing Rock Sioux 2013 Standing Rock Sioux Tribe, Letter from Mary Wilson to Nathan Goodman, NRC, "Santee and Crow TCP Survey Report for Crow Butte in-situ uranium recovery license renewal," May 1, 2013, ADAMS Accession No. ML13126A327.

Stout et al. 1971 Stout, T.M., H.M. DeGraw, L.G. Tanner, K.O. Stanley, W.J. Wayne, and J.B. Swinehart, *Guidebook to the Late Pliocene and Early Pleistocene of Nebraska*, Nebraska Geological Society, 1971.

Superfund Amendments and Reauthorization Act of 1986 (SARA), accessed May 13, 2016, at http://www.epw.senate.gov/sara.pdf.

Swinehart et al. 1985 Swinehart, J.B., V.L. Souders, H.M. DeGraw, R.F. Diffendal, Jr., "Cenozoic paleogeography of western Nebraska," in Flores, R. M. and S.S. Kaplan, eds., *Cenozoic Paleogeography of the West-Central United States*. Rocky Mountain Paleogeography Symposium 3, Rocky Mountain Section, Society for Sedimentary Geology, pp. 209–229, 1985.

Theis 1935 Theis, C.V., "The Relation between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Groundwater Storage," *Am. Geophys. Union Trans.*, 16(1935):519–524.

Todd 1980 Todd, D.K., *Groundwater Hydrology*, 2nd ed., John Wiley & Sons, New York, p. 535.

University of Nebraska 2017 University of Nebraska-Lincoln, "Northern Long-Eared Bat Information," accessed July 24, 2017, at http://wind-energy-wildlife.unl.edu/northern-long-eared-bat-information.

UNRI 2005 University of Nebraska Rural Initiative, "Rural Depopulation" A Closer Look at Nebraska's Counties and Communities," Randolph L. Cantrell, 2005, accessed October 2, 2013, at http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1012&context=ruralinitiativepubs.

Uranium Mill Tailings Radiation Control Act of 1978, as amended (UMTRCA), accessed October 3, 2013, at http://www.gpo.gov/fdsys/pkg/STATUTE-92/pdf/STATUTE-92-Pg3021.pdf.

Urbatsch and Eddy 1973 Urbatsch, Lowell E., and Robert Eddy, "A Floristic Study of Dawes County, Nebraska," Paper 392, *Transactions of the Nebraska Academy of Sciences and Affiliated Societies*, Nebraska Academy of Sciences, January 1, 1973. Available at http://digitalcommons.unl.edu/tnas/392, accessed April 29, 2015.

USA.com 2016 USA.com, "Dawes County Natural Disasters and Weather Extremes" [Web page], World Media Group, LLC, 2016, accessed May 11, 2016, at http://www.usa.com/dawes-county-ne-natural-disasters-extremes.htm#TornadoIndex.

USACE 1992 U.S. Army Corps of Engineers, "Clarification and Interpretation of the 1987 Manual," memorandum from Major General Arthur E. Williams, March 6, 1992, at http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_025086.pdf.

USBR 2008 United States Bureau of Reclamation, "Reclamation Managing Water in the West. Resource Management Plan, Box Butte Reservoir, Nebraska, Great Plains Region," November 2008.

USCB 1995a U.S. Census Bureau, "Nebraska, Population of Counties by Decennial Census: 1900 to 1990," 1995, accessed March 4, 2013, at http://www.census.gov/population/cencounts/ne190090.txt.

USCB 1995b U.S. Census Bureau, "South Dakota, Population of Counties by Decennial Census: 1900 to 1990," 1995, accessed March 4, 2013, at http://www.census.gov/population/cencounts/sd190090.txt.

USCB 1995c U.S. Census Bureau, "Wyoming, Population of Counties by Decennial Census: 1900 to 1990," 1995, accessed March 4, 2013, at http://www.census.gov/population/cencounts/wy190090.txt.

USCB 2000 U.S. Census Bureau, "DP-1; Profile of General Demographic Characteristics: 2000; Census 2000 Summary File 1 (SF 1) 100-Percent Data," 2001, accessed May 13, 2016, at http://factfinder2.census.gov.

USCB 2010 U.S. Census Bureau, "DP-1; Profile of General Population and Housing Characteristics: 2010; 2010 Census Summary File 1," 2011, accessed May 13, 2016, at http://factfinder2.census.gov.

USCB 2017a U.S. Census Bureau, QuickFacts, [web page], accessed July 28, 2017, at https://www.census.gov/quickfacts/fact/table/US/PST045216.

USCB 2017b U.S. Census Bureau, QuickFacts, [web page], accessed July 28, 2017, at https://www.census.gov/quickfacts/fact/table/US/PST045216.

USCB 2017c U.S. Census Bureau, Google public data, accessed July 28, 2017, at https://www.google.com/publicdata/explore?ds=kf7tgg1uo9ude_&met_y=population&idim=place:3111195&hl=en&dl=en.

USFWS 2010 U.S. Fish and Wildlife Service, "Black-footed Ferret," Fact Sheet, U.S. Fish and Wildlife Service Region 6, December 2010, accessed February 9, 2015, at http://www.fws.gov/mountain-prairie/factsheets/Black-Footed-Ferret.pdf.

USFWS 2011a U.S. Fish and Wildlife Service, "Black-Tailed Prairie Dog," Fact Sheet, U.S. Fish and Wildlife Service Mountain-Prairie Region, Endangered Species, last updated May 19, 2011, accessed February 13, 2015, at http://www.fws.gov/mountain-prairie/species/mammals/btprairiedog/.

USFWS 2011b U.S. Fish and Wildlife Service, "Gray wolf *Canis lupus*" [fact sheet], March 2011, available at http://www.fws.gov/klamathfallsfwo/es/factsheet/GrayWolf2011.pdf.

USFWS 2013 U.S. Fish and Wildlife Service, Ecological Services, Nebraska Field Office, Letter from Michael D. George to Kevin Hsueh, U.S. Nuclear Regulatory Commission, March 7, 2013, ADAMS Accession No. ML13080A302.

USFWS 2014a U.S. Fish and Wildlife Service, "Endangered and Threatened Wildlife and Plants; Threatened Species Status for the Rufa Red Knot; Final Rule," *Federal Register*, Vol. 79, No. 238, p. 28338, December 11, 2014, available at http://www.gpo.gov/fdsys/pkg/FR-2014-12-11/pdf/2014-28338.pdf.

USFWS 2014b U.S. Fish and wildlife Service, “Rufa Red Knot Background Information and Threats Assessment. Supplement to Endangered and Threatened Wildlife and Plants, Threatened Species Status for the Rufa Red Knot (*Calidris canutus rufa*),” Northeast Region, New Jersey Field Office, November 2014, available at https://www.fws.gov/northeast/redknot/pdf/20141125_REKN_FL_supplemental_doc_FINAL.pdf.

USFWS 2014c U.S. Fish and Wildlife Service, “U.S. Range of Rufa Red Knot,” eBird Basic Dataset, Cornell Lab of Ornithology, records through February 2014, accessed February 10, 2015, at http://www.fws.gov/northeast/redknot/redknot_maps.html.

USFWS 2014d U.S. Fish and Wildlife Service, “Northern long-eared bat (Myotis septentrionalis) Proposed Listing – Memorandum Changes May 12, 2014,” Memorandum from the Nebraska Ecological Services Field Office to Federal Agencies, State Agencies and Stakeholders, May 12, 2014.

USFWS 2014e U.S. Fish and Wildlife Service, “First Bat Proposed as Endangered Due to White-nose Syndrome,” Inside Region 3, last updated March 31, 2014, accessed February 19, 2015, at http://www.fws.gov/midwest/insider3/March14Story8.htm.

USFWS 2015a U.S. Fish and Wildlife Service, “Gray wolf (Canis lupus),” Environmental Conservation Online System, accessed February 12, 2015, at http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=A00D.

USFWS 2015b U.S. Fish and Wildlife Service, “Whooping crane (Grus americana),” Environmental Conservation Online System, accessed February 12, 2015, at http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B003.

USFWS 2016a U.S. Fish and Wildlife Service, “Information for Planning and Conservation (IPaC) Trust Resources: Box Butte County,” 2016, accessed April 20, 2016, at https://ecos.fws.gov/ipac/.

USFWS 2016b U.S. Fish and Wildlife Service, “IPaC Trust Resources: Dawes County,” 2016, accessed April 20, 2016, at https://ecos.fws.gov/ipac/.

USFWS 2016c U.S. Fish and Wildlife Service, “Red Knot (Calidris canutus rufa),” Environmental Conservation Online System, accessed May 11, 2016, at http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0DM.

USFWS 2016d U.S. Fish and Wildlife Service, “Northern Long-Eared Bat (Myotis septentrionalis),” Environmental Conservation Online System, accessed May 11, 2016, at http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=A0JE.

USFWS 2016e U.S. Fish and Wildlife Service, “Greater sage-grouse (Centrocercus urophasianus),” Environmental Conservation Online System, accessed May 11, 2016, at http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B06W.

USFWS 2016f U.S. Fish and Wildlife Service, "Species Profile for Northern Long-Eared Bat (*Myotis septentrionalis*)," Environmental Conservation Online System, accessed September 2, 2016, at http://ecos.fws.gov/ecp0/profile/speciesProfile?spcode=A0JE.

USFWS and NMFS 1998 U.S. Fish and Wildlife Service and National Marine Fisheries Service, "Endangered Species Consultation Handbook," U.S. Fish & Wildlife Service and National Marine Fisheries Service, March, accessed on November 30, 2017 at https://www.fws.gov/endangered/esa-library/pdf/esa_section7_handbook.pdf.

USGS 1998 U.S. Geological Survey, "Groundwater and Surface Water: A Single Resource," U.S. Geological Survey Circular 1139, Winter, T.C., J.W. Harvey, O.L. Franke, and W.M. Alley, Denver, CO, 1998, available at http://pubs.usgs.gov/circ/circ1139/.

USGS 2005 U.S. Geological Survey, "Estimated Use of Water in the United States County-Level Data for 2005," 2005, accessed December 14, 2012, at http://water.usgs.gov/watuse/data/2005/index.html.

USGS, 2008 U.S. Geological Survey, "Seismic-Hazard Maps for the Conterminous United States, 2008," Scientific Investigations Map 3195, Sheet 2, accessed on June 11, 2013 at http://pubs.usgs.gov/sim/3195/.

USGS 2010 U.S. Geological Survey, "Quaternary Fold and Fault Database for the United States," updated November 3, 2010, accessed October 21, 2013, at http://earthquake.usgs.gov/hazards/qfaults/.

USGS 2011 U.S. Geological Survey, "Seismic-Hazard Maps for the Conterminous United States, 2008: Peak Horizontal Acceleration with 10 percent Probability of Exceedance in 50 Years," Petersen, M.D.; Frankel, A.D.; Harmsen, S.C.; Mueller, C.S.; Haller, K.M.; Wheeler, R.L.; Wesson, R.L.; Zeng, Y.; Boyd, O.S.; Perkins, D.M.; Luco, N.; Field, E.H.; Wills, C.J.; and Rukstales, K.S., USGS Scientific Investigations Map 3195, Sheet 1, 2011, accessed May 9, 2016, at http://pubs.usgs.gov/sim/3195/.

USGS 2013 U.S. Geological Survey, "2009 Minerals Yearbook: Nebraska," December 2009, accessed May 11, 2015, at http://minerals.usgs.gov/minerals/pubs/state/2009/myb2-2009-ne.pdf.

USGS 2014 U.S. Geological Survey, "Estimated Use of Water in the United States in 2010," Circular 1405, Maupin, M.A.; Kenny, J.F.; Hutson, S.S.; Lovelace, J.K.; Barber, N.L.; Linsey, K.S., 2014, available at http://pubs.usgs.gov/circ/1405/pdf/circ1405.pdf.

USGS 2016a U.S. Geological Survey, "White River Group," http://tin.er.usgs.gov/geology/state/sgmc-unit.php?unit=NETw%3B0, accessed May 10, 2016.

USGS 2016b U.S. Geological Survey, "Water Use in the United States" [Web Page], http://water.usgs.gov/watuse/, last modified May 2, 2016.

USGS 2016c U.S. Geological Survey, “Search Earthquake Archives” [Web page], USGS Earthquake Archives, 2016, accessed May 12, 2016, at http://earthquake.usgs.gov/earthquakes/search/.

Van Vlack et al. 2012 Van Vlack, K., R. Stoffle, S. De Sola, H. Johnson, and H. Acosta, “Agate Fossil Beds Cultural Affiliation Study, Nebraska,” Bureau of Applied Research in Anthropology, University of Arizona, Tucson, AZ, 2012.

WNS 2017 White Nose Syndrome, “White-nose syndrome map,” June 30, accessed July 24, 2017, at https://www.whitenosesyndrome.org/resources/map.

Wyoming Fuel Company 1983 Wyoming Fuel Company, “Crow Butte Project, Dawes County, Nebraska, Application and Supporting Environmental Report for State of Nebraska,” submitted to Nebraska Department of Environmental Control, 1983.

Yankton Sioux 2013 Yankton Sioux Tribe, Letter from Lana Gravatt to Nathan Goodman, NRC, “Santee and Crow TCP Survey for Crow Butte in-situ uranium recovery license renewal,” May 1, 2013, ADAMS Accession No. ML13126A309.