Salt Creek Fieldwide Expansion, 2012 Update
ENVIRONMENTAL ASSESSMENT
EA No. WY-060-EA12-206

BLM

Wyoming State Office – Casper Field Office

June 2012

The BLM manages more land – 258 million acres – than any other Federal agency. This land, known as the National System of Public Lands, is primarily located in 12 Western States, including Alaska. The Bureau, with a budget of about $1 billion, also administers 700 million acres of sub-surface mineral estate throughout the nation. The BLM's multiple-use mission is to sustain the health and productivity of the public lands for the use and enjoyment of present and future generations. The Bureau accomplishes this by managing such activities as outdoor recreation, livestock grazing, mineral development, and energy production, and by conserving natural, historical, cultural, and other resources on public lands.

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List of Acronyms and Abbreviations

ACEC	area of critical environmental concern
APC	Anadarko Petroleum Corporation
ACEPMs	applicant committed environmental protection measures
AUM	animal unit month
BLM	Bureau of Land Management
BOPD	barrels of oil per day
CO	carbon monoxide
CO_2	carbon dioxide
dBA	decibels, A-weighted
EA	environmental assessment
EOR	enhanced oil recovery
H2S	Hydrogen Sulfide
Howell	Howell Petroleum Corporation
LACT	lease automatic custody transfer
LOS	levels of service
MA	Management Area
mcf	million cubic feet
MCFD	thousand cubic feet per day
MMBO	million barrels of oil
MSUP	Master Service Use Plan
NO_X	nitrogen oxides
NRCS	Natural Resources Conservation Service
NWMP	noxious weed management plan
PLS	pure live seed
psi	pounds per square inch
RCS	recycle compressor station
RMP	Resource Management Plan
RMU	Resource Management Unit
ROW	right-of-way
ROWs	rights-of-way
ROWA	routine oilfield water analysis
RMU	resource management unit
SCLOU	Salt Creek Light Oil Unit
SCSU	Salt Creek South Unit
SR	State Route
SO_2	sulfur dioxide
UAA	use attainability analysis
U.S.	United States
V	volt
VOCs	volatile organic compounds
VRM	visual resource management
WAG	water alternating gas
WC1	Wall Creek 1
WC2	Wall Creek 2

List of Acronyms and Abbreviations

WDEQ	Wyoming Department of Environmental Quality
WGFD	Wyoming Game and Fish Department
WYPDES	Wyoming Pollution Discharge Elimination System

1.0 Introduction

Howell Petroleum Corporation (Howell), a subsidiary of Anadarko Petroleum Corporation (APC), proposes to continue fieldwide expansion of its ongoing carbon dioxide (CO_2) enhanced oil recovery (EOR) Project within Salt Creek Oil Field, which is located in Natrona County, Wyoming. The first seven phases of EOR in this field (Phases I and VIII) have been completed and Phases XV and XVI are under construction, with associated increases in oil recovery rates reported. Under Fieldwide Expansion 2012 Update, Howell intends to continue its injection of CO_2 into the Wall Creek 1 (WC1) and Wall Creek 2 (WC2) formation in an effort to further increase oil recovery, and to implement injection into the Sundance 2, Sundance 3, Lakota, and Tensleep formations. This Environmental Assessment (EA) examines the proposed implementation of the Salt Creek Fieldwide Expansion, 2012 Update (2012 Update).

Salt Creek Oil Field is located in northern Natrona County approximately 45 miles northeast of Casper, Wyoming primarily on public lands administered by the Bureau of Land Management (BLM) (Figure 1.1). The field boundaries contain the towns of Midwest and Gas Plant Camp, while the town of Edgerton lies immediately to the east of the field. The entire Salt Creek Oil Field encompasses 34.3 square miles of predominately semi-arid grasslands and shrublands and a portion of the Salt Creek watershed. Salt Creek flows in a northerly direction into the Powder River near Sussex, Wyoming. During Phases I and II, Howell injected CO_2 in the northern and western portions of the field, while Phases III and IV involved injection of CO_2 in the northeast/central portion of the field and Phases V, VI, and VII involved injection along the eastern edge of the field (Figure 1.2). The 2012 Update would inject CO_2 throughout the Salt Creek Light Oil Unit (SCLOU) and Salt Creek South Unit (SCSU).

This EA will specifically address the 2012 Update. The Proposed Action would utilize existing infrastructure within Salt Creek Oil Field to the extent possible. Existing flow lines, access roads, and power distribution lines would be used or upgraded. Chapter 2.0 details the proposed drilling development and use of ancillary facilities.

1.1 Existing Development

Salt Creek Oil Field (Figure 1.2) produces oil and gas from 11 horizons with the majority of the recovery coming from the largest of these reservoirs, the Wall Creek 2 (WC2). Wall Creek is the local nomenclature for the Upper Cretaceous Frontier Formation, the most prolific producing horizon of Salt Creek Oil Field. Existing infrastructure in the area includes access roads, pipelines, storage tanks, gas re-compression facilities, electric distribution lines, oil and gas production wells, CO_2 and water injection wells, and other related facilities. Current produced oil volumes from Salt Creek Oil Field are approximately 12,000 barrels of oil per day (BOPD), of which 1,100 BOPD are recovered from the waterflood process, 350 BOPD from the Tensleep, and 10,500 BOPD recovered from the CO_2 flood.

The Salt Creek Oil Field and surrounding region has a long history of oil and gas activity. Initial production began in 1889 and, to date, has produced over 700 MMBO (million barrels of oil), from 11 producing horizons. Primary development transpired between 1915 and 1930 with peak production occurring on September 15, 1923 at 132,000 BOPD (Rosenberg Historical Consultants 2003). During the 1920's the Salt Creek Oil Field was the largest oilfield in the

Rocky Mountain region, and produced nearly 5% of the entire United States' oil supply. Oil production in the early years was produced under primary depletion drive where natural reservoir pressure was able to bring oil to the surface.

Oil production began to fall in the mid-to-late 1920's, due to rapid resource exploitation and declining reservoir pressures. Operators began re-injecting produced gas in 1962 in an attempt to reverse declining reservoir pressures and boost oil production. This practice continued until implemented field-wide in 1971.

Currently there are two distinct producing units that contribute to total field production, the Salt SCLOU and the SCSU. An estimated 4,500 wellbores were drilled to multiple formations at Salt Creek, of which approximately 754 production wells and 568 injection wells were active in the SCLOU waterflooding operations. The SCSU contains an additional 76 production and 75 injection wells. The mature state of the waterflood operations has resulted in very high water-oil ratios (WOR) for the wells currently producing under waterflood. For every barrel of oil produced, over 99 barrels of water must be produced and re-injected (a 0.6 percent oil-cut). The extensive waterflood facilities required to maintain this operation are the largest of any field in the state, rendering the field economics susceptible to minor fluctuations in oil price and operating cost.

The Salt Creek Oil Field was unitized under one operator (Stanolind Production) as the SCLOU on September 1, 1939. Stanolind Production later became Amoco Production Company. Howell acquired the oil field from Amoco and became operator in 1998. Anadarko Petroleum Corporation acquired Howell in December 2002.

Salt Creek CO2 Project
Fieldwide Development EA
Figure 1.1 General Location - Salt Creek Oil Field

1.1.1 Phases I – VIII, XV, and XVI

Within Salt Creek Oil Field, oil production has declined steadily from a peak of 85,000 BOPD in the 1920s to approximately 4,000 BOPD prior to CO_2 injection. In an effort to reverse the declining trend of oil production, Howell constructed an extension of the Shute Creek to Bairoil pipeline to deliver up to 250 million cubic feet (mcf) of CO_2 to be used for tertiary recovery operations in the field. Howell introduced state-of-the-art tertiary EOR technology by injecting CO_2 to increase oil production that would otherwise not be recoverable by existing waterflood operations. With the implementation of Phases I and II, oil recovery in Salt Creek Oil Field has increased from 4,000 to 7,500 BOPD.

The locations of Phases I - V (Figure 1.2) were based on factors such as proximity to local communities and populations; geologically representative areas; and existing roads, facilities, and wells. Actual surface disturbances for Phases I through VII and estimated disturbances for Phases XIII, XV and XVI are summarized in Table 1-1.

Reclaimed acreages are determined by monitoring for re-vegetation success. For reclamation to be considered successful the perennial herbaceous canopy cover of the reclaimed flow lines must reach a minimum of 70% of the adjacent native undisturbed canopy cover, as required for the Storm Water Pollution Prevention Plan objectives set by the Wyoming Department of Environmental Quality (WDEQ).

Phases XV will be commissioned in the third quarter of 2012 while Phases VIII and XVI will be commissioned in the third quarter of 2013. Production from these three phases is expected to increase the total CO_2 production to 14,000 BOPD by 2014.

Table 1-1 Salt Creek Previously Analyzed Surface Disturbance Summary (Short-term and Long-term)

Category	Units	Actual					Estimated		
		Phase I	Phase II	Phase III/IV	Phase V	Phase VI	Phase VII	Phase XV	Phase VIII/XVI
Wells	*Quantity*	238	180	381	240	264	225	228	131
	Acres	58.2	37.1	137.7	107.6	117.5	80.7	139	79
Headers	*Quantity*	13	8	16	8	6	5	6	5
	Acres	3.6	2	2.6	5.5	3.1	1.1	3.1	2.6
Flowlines	Acres	130.4	82.2	158.4	59.4	78	73	152.5	93.1
Trunklines	Acres	89.7	24.6	72.4	28	61	25.9	98.9	23.1
Access	Acres	*	1.4	2.7	26.4	4	4.8	5.5	2.9
Power	Acres	6	0	14	4.6	6.1	<0.1	<0.1	0.1
Facilities	Acres	7.1	0	13	17.2	0	0	12.9	21.5
Temporary Use Areas	Acres	11.5	*	23	23	0	0	45.9	45.9

TOTAL		**306.5**	**147.3**	**423.8**	**271.7**	**269.7**	**185.5**	**457.8**	**268.1**
Re-claimed Acreage		**143**	**69.2**	**69.2**	**0**	**0**	**0**	**0**	**0**
Acres per well		**1.3**	**0.8**	**1.1**	**1.1**	**1.0**	**0.8**	**2.0**	**2.0**
Disturbance summary includes short- and long-term, new and existing disturbance.									
* - Not specifically calculated									

1.2 Purpose and Need

The phased expansion of the CO_2 EOR project would continue to replace the current secondary EOR technology involving waterflooding, thereby increasing oil production by another 20,000 BOPD. Use of the combined waterflood and tertiary EOR could increase ultimate recovery as much as 200 MMBO for the entire Salt Creek Oil Field, extending operations for another 30 to 40 years and the economic life of the field. For comparison, if only the waterflood technology is employed, economically feasible oil extraction would be projected to continue for another 5 to 10 years.

1.2.1 Purpose

The purpose of the phased expansion is to develop oil and natural gas resources on Federal mineral leases consistent with Federal lease rights, where valid and existing rights occur.

1.2.2 Need

The need for the development of oil and gas resources is established by the BLM's responsibility under the Mineral Leasing Act of 1920 (30 U.S.C. 188 *et seq.,*) (MLA) as amended to promote the mining of oil and gas on the public domain. Deposits of oil and gas owned by the United States shall be subject to disposition in the form and manner provided by the MLA, where applicable through the land use planning process.

1.2.3 Decision to be Made

The BLM will decide whether or not to authorize the expansion development activities and, if so, under what terms and conditions.

1.3 Relationship To Statutes, Regulation, and Plans

1.3.1 Conformance to Existing Land Use Plan

Public lands within the Project Area are managed in accordance with the BLM Casper Resource Management Plan (RMP). Goals, objectives and decisions of the Casper RMP with respect to mineral resources (MR) are indicated in Table 1-1 of the RMP, pages 2-15 to 2-17 (BLM 2007). Objectives with respect to oil and gas development include:

- MR: 2.1 – Maintain oil and gas leasing, exploration, and development, while minimizing impacts to other resource values;
- MR: 2.4 – Facilitate the evaluation of public lands for oil and gas potential;

- MR: 3.1 – Maintain opportunities to explore and develop Federal oil and gas resources and other leasable minerals; and
- MR: 3.2 – Maintain opportunities for the collection of subsurface geological (geophysical) data to aid in the exploration of oil and gas resources.

The Casper RMP specified the following decisions/management actions to achieve the above objectives:

- Decision 2004 (Leasable Minerals) - The Casper FO is open to mineral leasing, including solid leasables and geothermal, unless specifically identified as administratively unavailable for the life of the plan for mineral leasing. These open areas will be managed on a case-by-case basis.
- Appendix D - Oil and Gas Operations, Application for Permit to Drill (APD) specified "If necessary, site-specific mitigation can be added to the APD as a Condition of Approval (COA) for protection of surface and/or subsurface resource values in the vicinity of the proposed activity".

In accordance with 43 CFR 1610.5-3(a), the Proposed Action has been determined to be in conformance with the Casper Resource Management Plan (RMP) (BLM 2007). The Project Area has been determined to be suitable for oil and gas leasing and the proposed development with incorporated mitigation measures to reduce impacts to other resource values is consistent with the land use decisions and resource management goals and objectives.

1.3.2 Relationships to Statutes, Regulations, or Other Plans

This EA has been prepared in accordance with the National Environmental Policy Act (NEPA) and is in compliance with all applicable regulations and subsequent laws passed, including Council on Environmental Quality (CEQ) regulations (40 CFR 1500-1508). This EA is tiered to the following previous Salt Creek NEPA documents and are located at the BLM Casper Field Office for review:

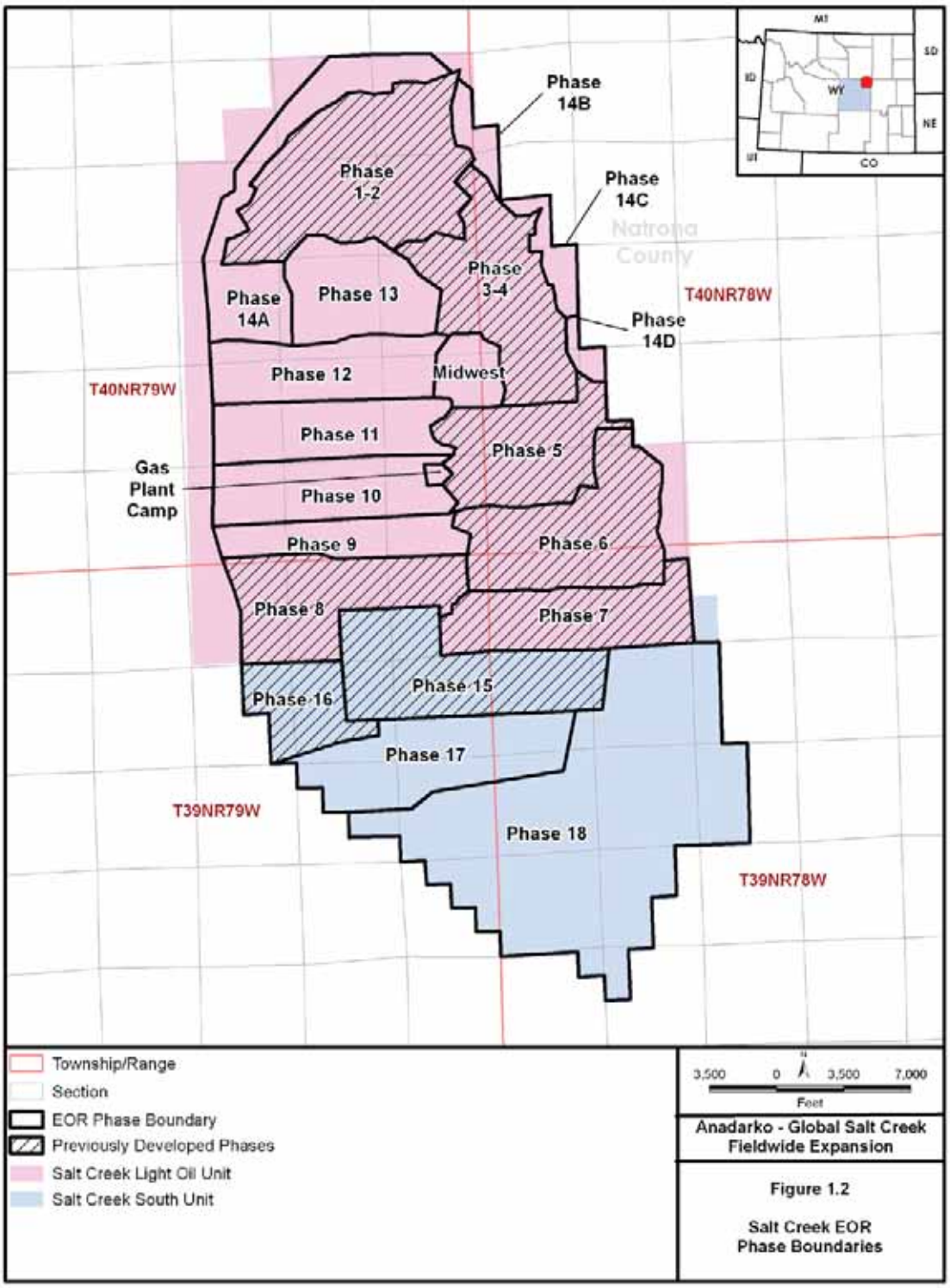
- CO2 Enhanced Oil Recovery Project in the Salt Creek Field Phase I (Phase I EA); EA No. WY-060-04-001 (BLM 2003).
- CO2 Phase II Expansion (Phase II EA); EA No. WY-060-04-053 (BLM 2004).
- Phase III/IV CO2 Enhanced Recovery Project - Salt Creek Oil Field (Phase III-IV EA); EA No. WY-060-EA06-18 (BLM 2006a).
- Salt Creek Phase V Enhanced Oil Recovery Project (Phase V EA); EA No. WY-060-EA07-006 (BLM 2006b).
- Salt Creek Fieldwide Expansion (Fieldwide Expansion); EA No. WY-060-EA07-067 (BLM 2007).

- Use Attainability Analysis Salt Creek and Powder River, Natrona and Johnson County, Wyoming; (UAA); (RETEC 2004).

Necessary permits and authorizations from the BLM would be issued pursuant to the Mineral Leasing Act of 1920, as amended, and the Federal Land Policy and Management Act of 1976, as amended, and would be subject to the rules and regulations in 43 CFR 2800 and 43 CFR 3100. Section 1.3 of the Phase I EA (BLM 2003) contains a complete discussion on Authorizing Actions applicable to continued development of Salt Creek Oil Field and is incorporated herein by reference. Table 1 in Section 1.3 of the Phase I EA (BLM 2003) also provides a brief synopsis of potentially applicable permit requirements by federal, state, and local agencies that have jurisdiction over different aspects of the proposed 2012 Update.

1.4 Public Involvement

Howell has held town meetings periodically in Midwest since 2003, the most recent in October of 2011, to present the proposed development and to answer questions regarding development. Topics discussed included future phase development within Salt Creek Oil Field, monitoring plans for the towns of Midwest and Edgerton, and emergency sirens erected in the towns by Natrona County Emergency Management and subsidized by Howell Petroleum. Going forward, due to the limited attendance of the public meetings, Howell will update project progress and plans via city council meetings. Public meetings will be held as needed.


Phase 14B
Phase 1-2
Phase 14C
Natrona County
Phase 3-4
Phase 14A
Phase 13
T40NR78W
Phase 14D
Phase 12
Midwest
T40NR79W
Phase 11
Phase 5
Gas Plant Camp
Phase 10
Phase 9
Phase 6
Phase 8
Phase 7
Phase 15
Phase 16
Phase 17
T39NR79W
Phase 18
T39NR78W
MT
SD
ID
WY
NE
UT
CO
Township/Range
Section
EOR Phase Boundary
Previously Developed Phases
Salt Creek Light Oil Unit
Salt Creek South Unit
3,500 0 3,500 7,000
Feet
Anadarko - Global Salt Creek Fieldwide Expansion
Figure 1.2
Salt Creek EOR Phase Boundaries

2.0 Proposed Actions and Alternatives

2.1 Proposed Action

Howell is proposing continued fieldwide expansion of the Salt Creek Oil Field CO_2 EOR Development Project in Natrona County, Wyoming, as depicted in Figure 1.2. The 2012 Update would involve continued development and injection of CO_2 into the WC2 and WC1 formations as well as development of the Sundance 2, Sundance 3, Lakota, and Tensleep formations. If approved, implementation of the 2012 Update would begin in 2013 and is projected to extend to at least December, 2020.

Periodic Plans of Development (PODs) would be developed to provide additional detail for proposed actions and to summarize the existing conditions. Each POD would be subject to BLM approval, and additional monitoring of potential impacts including those to wildlife and cultural resources would be considered. A summary of existing disturbance and reclamation success would also be included in the PODs.

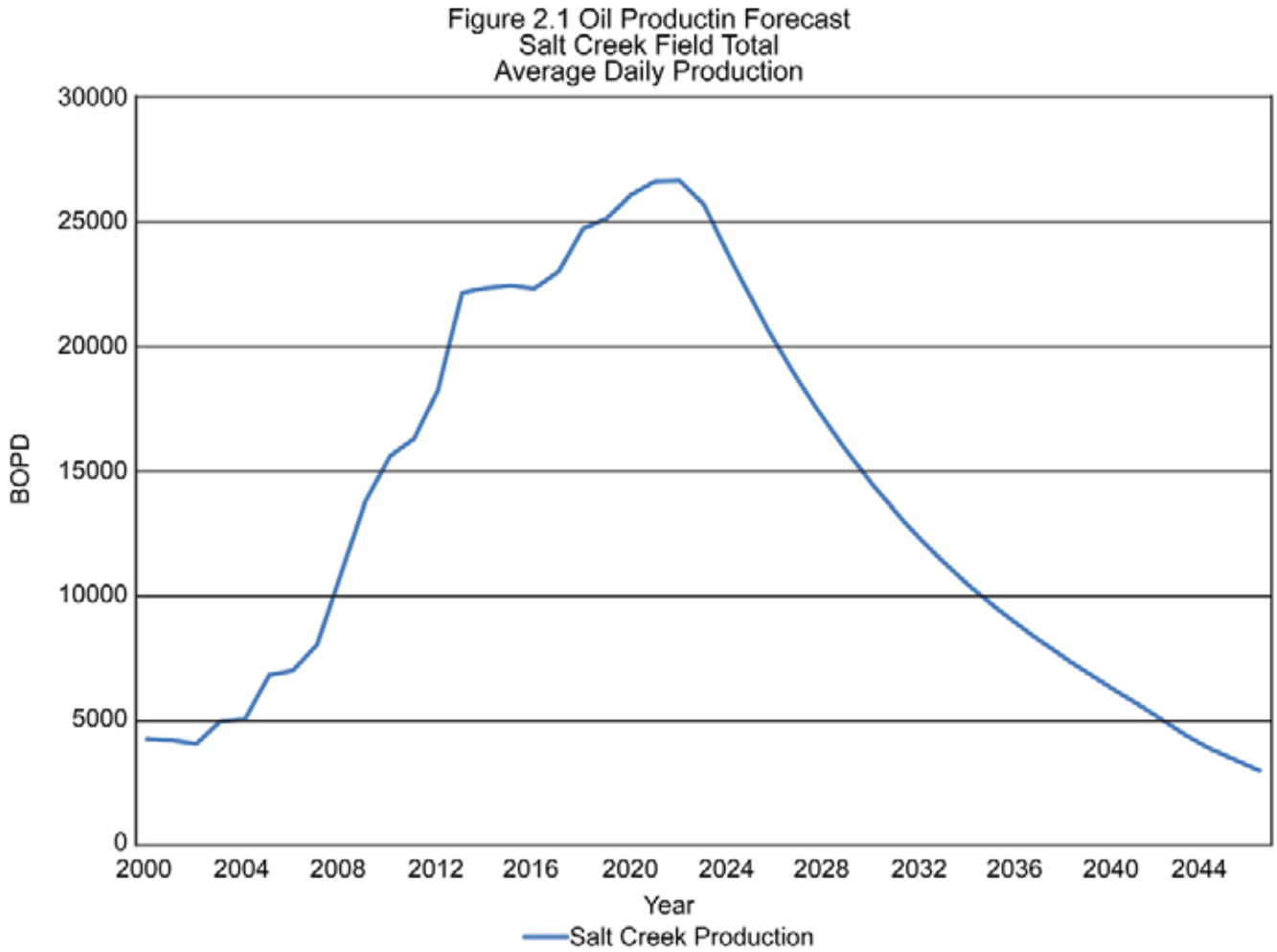
Project Overview

This EA analyzes the continued fieldwide expansion, specifically the 2012 Update, which encompasses approximately 10,197 acres of tertiary EOR development using CO_2 injection. CO_2 EOR involves the alternating injection of CO_2 and water into the reservoir rock to displace liquid hydrocarbons towards production wells where it is withdrawn and further processed. CO_2 produced with the oil would be separated and recycled to the CO_2 injection system for re-injection. The proposed project would be similar to existing waterflood activities; therefore, many of the existing facilities and infrastructure would be used as part of the Proposed Action. Anticipated facilities would include injection and production wells, injection and production pipelines, production test and treating facilities, injection manifold headers, replacement or modification of three existing lease automatic custody transfer (LACT) tank batteries, construction of one new LACT, additional recycle compression stations, and associated electrical lines. Existing wells would be utilized to the extent possible to limit the number of new wells.

The use of CO_2 is being successfully implemented within Salt Creek Oil Field and has resulted in approximately 10,500 BOPD of production attributable to EOR to date. As shown in Figure 2.1, an overview of reservoir modeling results for Salt Creek Oil Field suggests that CO_2 EOR expansion could ultimately increase daily production rates in excess of 20,000 BOPD and increase ultimate oil recovery from the entire field by as much as 200 MMBO, extending the life of the field 30 to 40 years.

2.1.1.1 CO_2 Flooding Process

The 2012 Update encompasses an area located within in T39-40N, R78-79W in both the SCLOU and SCSU (Figure 1.2) and adjacent to the towns of Midwest, Edgerton, and Gas Plant Camp. Although the towns are located within the project area, the Proposed Action does not entail CO_2 injection beneath the towns. Howell continues to isolate and monitor the populated areas as part of previous Proposed Actions. The Phases III/IV EA details the isolation and monitoring efforts associated with the Salt Creek EOR project to ensure CO_2 containment (BLM 2006a).



2.1.2 Well Utilization Plan

The Proposed Action for the 2012 Update and the continuation of the CO_2 flood would maximize the use of existing wellbores, both active and abandoned, thereby minimizing the disturbance of additional surface area. The plan would require approximately 666 injection wells, 678 production wells, and 73 monitor wells for a total of 1417 wells. The number of wells includes up to 586 new wells which may be required to replace existing wells or to optimize pattern efficiency. Table 2-1 provides a conceptual summary of wells proposed for use in the field and a schematic representing a potential expansion scenario is shown in Figure 2.2. Howell plans to equip all injection, production, and monitoring wells similarly to those described in the Phases III/IV EA (BLM 2006a).

Table 2-1 Summary of Salt Creek Well Utilization by Formation

		WELL COUNTS			
Reservoir		# Injectors	# Producers	# Observation	Total Well Count
Wall Creek 2		548	491	57	1096
Wall Creek 1		0	0	0	0
Lakota		46	91	7	144
Sundance		46	91	7	144
Tensleep		26	5	2	33
Total		666	678	73	1417

The following subsections describe the three basic types of wells to be utilized for the Proposed Action:

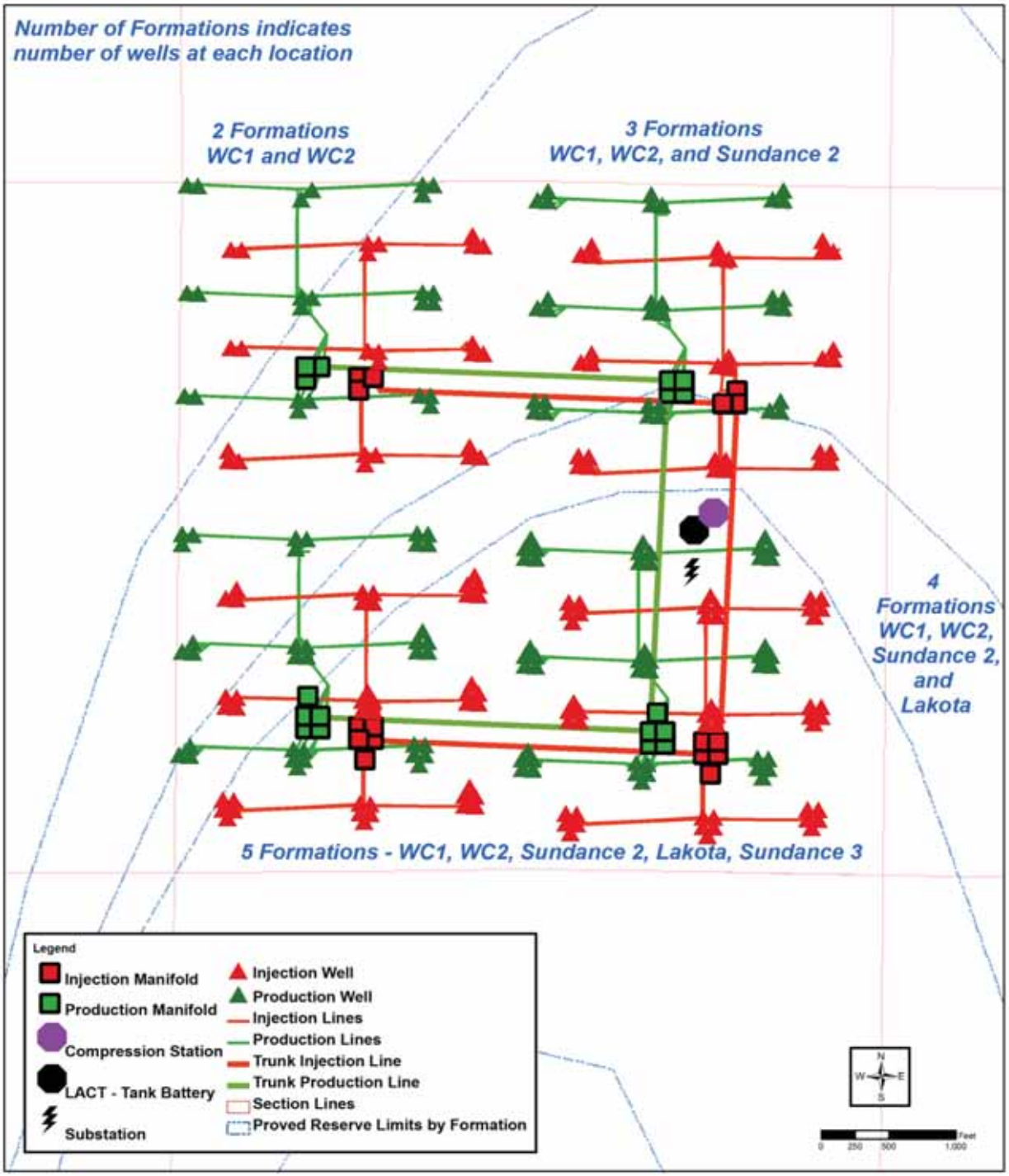
- Existing wells
- New wells
- Plugged and abandoned wells to be re-entered

2.1.2.1 Existing Wells

Many of the existing wells in Salt Creek Oil Field would require additional cement behind the casing to adequately contain the CO_2 within the target formation and isolate the other horizons. Each wellbore, active and abandoned, that penetrates the target formation would be evaluated for zonal isolation by previously run or new cement bond logs. Remedial well work would be conducted utilizing the processes and procedures approved and implemented for the Phases II through VIII, XV and XVI areas.

Existing wells not to be used as either production or injection wells would either be equipped to serve as monitoring wells or be shut in. The shut in wells would be used for emergency backup in the case of the unlikely event of a catastrophic failure of an active well.

Figure 2.2 Production and Injection Schematic
Typical Section
Salt Creek Fieldwide Expansion EA



2.1.2.2 New Wells

Howell's plan to complete the fieldwide pattern expansion includes the drilling of up to 415 new wells. Depending on the target formation, each well would be drilled to an approximate depth of between 900 and 8500 feet from the surface, and would be permitted and constructed according to plans approved in previous EAs for Phases I-VIII, XV, and XVI.

2.1.2.3 Abandoned Wells

Howell plans to workover or re-enter and reactivate approximately 831 previously abandoned wellbores in the project area. Howell also anticipates having to re-plug approximately 1,752 existing abandoned wells. The work procedures for re-entry would follow plans and procedures approved and implemented for the Phases II through XV areas.

2.1.3 Facility Plan

The surface facilities required for the implementation of the 2012 Update would be similar to those installed under Phases I through VIII, XV, and XVI and would include as much of the existing waterflood facilities as possible. The primary differences from waterflood operations would be the use of materials that are compatible with CO_2 production and can withstand higher working pressures. Figure 2.2 shows the layout of a typical section. This figure illustrates a conceptual flow line and injection line layout for areas where multiple target reservoirs are overlaid, as well as locations for production test and treating facilities and injection manifold headers. Under the 2012 Update, the existing system would be extended to accommodate additional EOR wells with new manifolds, flowlines, and pipeline sections. Most of the current gathering and injection systems for existing waterflood activities would be replaced by the new system.

The proposed routing of injection and production lines reflects the use of existing corridors, Rights-of-Way (ROWs), and linear features (e.g., roads). As part of the Proposed Action, Howell would continue to install production and injection lines within the same corridor and follow existing ROWs to the extent practical. Additionally, as with all other phases of the development, Howell would use a Construction Supervisor to ensure that construction and development practices adhere to BLM's guidelines and regulations, such as ROW placement. Howell has either employed contract labor and/or dedicated company personnel to fulfill the role of Construction Supervisor, whose main focus, on behalf of the Project Manager, is to provide on-site company representation and administer the selected installation contractor. This oversight would ensure:

- The scope of work is completed as per the original design, costs, specifications, and applicable permits.

- The work is conducted per Howell's safety and environmental guidelines, regulatory permit requirements, and the Salt Creek Master Service Use Plan (MSUP).

- Necessary departures from the original scope are approved and properly documented.

Howell's proposed 2012 Update includes the continued utilization of existing roads and the replacement or modification of the LACT 11, LACT 20, and LACT 4 in the SCLOU, and A Battery production facility in the SCSU. Howell anticipates constructing a new LACT (LACT 13) in 2013/2014 and other LACTS may be built as conditions warrant.. It is not anticipated that the produced water discharge volumes at any LACT would be significantly altered by the new process; therefore, additional discharge points would not be required. Future produced water quality is expected to be generally consistent to that currently being produced and would be subject to existing permit discharge limits and conditions established by the WDEQ under the established Wyoming Pollution Discharge Elimination System (WYPDES) program. Howell is committed to continuing to meet the requirements of its existing discharge permits per WDEQ requirements and procedures and to implement necessary actions to ensure continued compliance.

2.1.3.1 Production System

This proposed expansion would include the installation of approximately 42 additional header buildings which include both production and injection facilities housed in the same building. The one story building design would be the same as used in Phase XV. As with previous expansions, wellhead production volumes would be transported to the manifold stations via new fiberglass flowlines. Production would be commingled at the production/test header building as in previous phases. However, unlike Phase's 1-IV (but identical to Phases V through VII, and Phase XV), the gas and liquid will be split by bulk separators at the header with liquid and gas routed in separate gathering systems. Each of the production header buildings would also include the appropriate well testing equipment, where individual well production would be tested and measured. Where feasible, new flowlines would be designed and constructed along existing roads and surface disturbances.

Production from the Salt Creek Unit would flow to Salt Creek Unit facilities and production from the Salt Creek South Unit would flow to the A Battery facility.

2.1.3.2 Injection System

The injection system design philosophy follows the same basic approach as with previous phases. Injection flow control previously installed at the wellheads would now be centralized at the injection header buildings. As with all other phases, the injection header buildings would distribute either CO_2 or water to individual wells. These manifolds would be equipped with actuated valves that allow for remote or local selection of the injected fluid (water or CO_2). Well injection volumes would be metered individually at the header buildings. One (1) new injection manifold would be housed in the same building as the production manifold. A similar one story building design as used in Phase XV will be used. Injection fluids, CO_2 and water, would be delivered to the header building via newly constructed pipeline segments tied in to the existing water and CO_2 distribution systems.

2.1.3.3 Gas System

As with Phases I through VIII, XV, and XVI, produced CO_2 gas for 2012 Update would be collected and recycled back to the high-compression gas injection system for re-injection. The required recycle and flash gas compression and dehydration of produced gas would be supported by existing and new facilities. The Phase V EA details this gas gathering system (BLM 2006c). Future recycle compression stations (RCS) would be located adjacent to new or existing production batteries in order to have ready access to power supply and fluid for cooling compressed CO_2.

2.1.4 Ancillary Facilities

2.1.4.1 Access Roads

New access roads would be necessary for 586 new drill wells under the Proposed Action and maintenance access to new power lines. Howell would continue an ongoing program conducted in cooperation with BLM to identify and reclaim unused, redundant, and/or unnecessary roads throughout the life of the Project.

2.1.4.2 Production Batteries

To accommodate this expansion, Howell would retrofit existing batteries and/or construct new production batteries. Each production battery would be designed to process volumes sufficient to support surrounding phase development. The process design would be similar to the existing batteries as detailed in the Base Plan of Development and Phase V EA (Howell 2004, BLM 2006c). Retrofitted batteries would be completed within the confines of existing surface disturbance while a new battery would occupy approximately 500’x 500’ with a total long term disturbance of about 5.7 acres. Howell would acquire all required regulatory construction permits as stipulated by Wyoming DEQ.

2.1.5 Disturbance Estimates

Operations that would result in surface disturbance would include the re-working of existing wells on previously disturbed sites and construction of drilling pads for new wells, new flow lines and injection lines, limited new access roads, and production facilities. Surface disturbance would be either short-term (during construction and site reclamation) or long-term (lasting at least 5 years).

New construction would be sited to incorporate existing facilities, to parallel existing lines and roads, and to build on previously disturbed areas as much as possible. . . . Continued fieldwide expansion from the 2012 Update would require 2,495.2 acres of new disturbance that would be reclaimed in the short-term and 281.5 acres of new disturbance that would result in long-term surface disturbance (see Table 2-2).

Table 2-2 Estimated Surface Disturbance Area for EOR Phases VIII-XIV and XVII-XVIII

Category	Quantities and Assumptions	Qty	Length	Width	Short-Term (ST) (Acres) Existing	New	Total	Long-Term (LT) (Acres) Existing	New	Total
Wells	758 Existing well 125 x 125 LT	758	125	125	0.0	0.0	0.0	271.9	0.0	271.9
	73 Existing observation wells 125 x 125 LT	73	125	125	0.0	0.0	0.0	26.2	0.0	26.2
	1752 Existing wells to be reclaimed 125 x 125 LT	1752	125	125	628.4	0.0	628.4	-628.4	0.0	-628.4
	415 New WC2 250 x 250 ST 125 x 125 LT	415	250	250	0.0	446.6	446.6	0.0	148.9	148.9
	171 New SD3/Lak/TP 310 x 200 ST 125 x 125 LT	171	310	200	0.0	182.1	182.1	0.0	61.3	61.3
Headers	42 Header Buildings 150 x 150 ST 50 x 100 LT	42	150	150	0.0	16.9	16.9	0.0	4.8	4.8
Flowlines	Lines to 1344 wells	1344	1363	25	0.0	1051.3	1051.3	0.0	0.0	0.0
	Lines to Header Buildings Per Phase	7	49000	65	0.0	511.8	511.8	0.0	0.0	0.0
Trunklines Trenches	Center Loop Line - Wet & Dry CO2 Supply, Produced Fluids, and Water Injection Lines	2	19351	65	0.0	57.8	57.8	0.0	0.0	0.0
	Lines from Phase 6/7 to RCS #3 Location	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Valve Sets	70 Valve Sets 86.6 x 86.6 ST	70	86.6	86.6	0.0	9.5	9.5	0.0	2.6	2.6

Table 2-2 Estimated Surface Disturbance Area for EOR Phases VIII-XIV and XVII-XVIII

Category	Quantities and Assumptions	Qty	Length	Width	Short-Term (ST) (Acres) Existing	New	Total	Long-Term (LT) (Acres) Existing	New	Total
	40 x 40 LT									
Access	Access to 42 Headers 150 x 30 LT	42	150	30	0.0	0.0	0.0	0.0	4.3	4.3
	Access to 586 new wells 150 x 20 LT	586	150	20	0.0	0.0	0.0	0.0	40.4	40.4
Power	Lines to 42 Headers 3 x 3 LT	210	3	3	0.0	0.0	0.0	0.0	0.04	0.0
Facilities	Substation Expansion 240 x 346 LT	1	240	346	0.0	0.0	0.0	0.0	1.9	1.9
	Lact Expansions 500 x 750 ST 500 x 500 LT	3	500	750	0.0	8.6	0.0	0.0	17.2	17.2
	Compression Stations 750 x 750 ST 500 x 500 LT	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Temporary Use Areas	1 Area Averaging 1000 x 1000 ST	14	1000	1000	0.0	321.4	321.4	0.0	0.0	0.0
Total					**628.4**	**2606.0**	**3225.8**	**-330.4**	**281.5**	**-48.9**

*Header disturbance included in flowline and trunkline disturbance.

2.1.6 Non-unitized Tracts

Operations to expand EOR in Salt Creek may encompass a number of tracts which are not part of the SCLOU, as well as the adjacent SCSU. During current waterflood operations, lease allocation has been managed by separately metering fluids which are produced or injected in the various leases, then commingling with SCLOU fluids. Future expansion proposes to continue metering of each lease separately. Other options are also being considered and each Plan of Development would address allocation among non-unitized tracts.

2.2 No Action Alternative

The “No Action” alternative would involve continued waterflood operations throughout Salt Creek Oil Field and continued CO_2 EOR in the existing Phases I through VIII, XV, and XVI areas. Currently, about 12,000 BOPD is being produced, with about 10,500 BOPD attributed to CO_2 injection activities. An estimated 50 MMBO remains to be recovered under the No Action

Alternative for the entire field, as compared to an estimated 200 MMBO recoverable by CO_2 EOR for the entire Salt Creek Oil Field. Assuming stability of current oil prices, Salt Creek Oil Field would likely be shut within the next 10 to 20 years under the No Action Alternative.

2.3 Alternatives Considered but Eliminated from Detailed Analysis

EOR techniques have long been utilized by the oil industry to increase hydrocarbon yields from oil and gas bearing structures. To date, various types of waterflood procedures have been used and is the current EOR approach employed throughout Salt Creek Oil Field. In the last 20 years, the use of CO_2 as an EOR agent has become increasingly popular because, under certain conditions, it is much more effective at recovering additional trapped oils than waterflooding.

Implementation of Phases I/II by Howell has demonstrated that CO_2 flooding of the WC2 formation within Salt Creek Oil Field substantially increases recovery of remaining oil reserves. These evaluations, however, did not identify alternative EOR techniques that would be economically viable and effective within this field. Additionally, Howell considered the use of horizontal wells to reduce the number of wells used in the EOR project. Due to high permeability of the WC2 formation, horizontal wells would not develop sufficient sweep efficiency, resulting in poor recovery of oil. Therefore, this option is not technically sound for use in the WC2 formation and thereby also not an environmentally viable project alternative.

3.0 Affected Environment

3.1 Air Quality

Ambient air quality in the project area and the region is generally good. The region encompassing Salt Creek Oil Field is classified as "attainment" with respect to Ambient Standards established by the Wyoming Air Quality Standards and Regulations (WAQS&R) and National Ambient Air Quality Standards (NAAQS). Refer to Sections 3.1.1 and 3.2.1 of the Phase I EA and Section 3.1.3 of the Phases III/IV EA for information on air quality for the Salt Creek area (BLM 2003, BLM 2006a).

3.2 Geology

The topography of Salt Creek Oil Field is characterized by dissected, rolling upland plains with low to moderate relief (badlands, broad valleys, deep eroded gullies, and isolated hills). Elevations in the project area range from 4,750 to 5,150 feet. Refer to Section 3.1.2.1 of the Phase I EA (BLM 2003) for a detailed description of the topography of the Salt Creek area.

Salt Creek Oil Field is located within the transitional zone between the Powder River Basin to the northeast and the Casper Arch to the southwest. The structural framework is the result of the Late Mesozoic Laramide Orogeny. Site geology ranges from the Cody Formation, which forms all outcrops throughout the project area, and the Frontier Formation, which includes the petroleum reservoir rocks of Salt Creek Oil Field. Hydrocarbons are produced from 11 individual units of the Frontier, particularly from the Wall Creek 2 (WC2) formation. A more detailed description of project area geology, including a representative well log that illustrates the relationship among different geologic strata, can be found in the Phase I EA (BLM 2003, Figure 11).

3.3 Water Resources

3.3.1 Surface Water

Salt Creek is classified as a Class 2C stream by the WDEQ. Class 2C waters maintain beneficial uses for propagation of non-game fish, agriculture, wildlife, industrial, and recreation. It does not support game fish or human consumption use. Salt Creek field produced water discharges from all sources provide a significant contribution to Salt Creek water resources. The Phase I EA (BLM 2003) and the Phase III-IV EA (BLM 2006a) presented detailed overviews of water quality issues associated with produced water discharges to Salt Creek.

In March 2010 all of Howell's discharge permits into Salt Creek were consolidated into a single permit (WY0002445) under the WYPDES program. Monitoring results indicate that Howell is meeting the WDEQ permit effluent limit of 100,000 tons per year of TDS or less.

3.3.2 Groundwater

The Salt Creek field is located within the Non-Glaciated Central region that occupies a large area in the eastern and northeastern parts of the state. Hydraulic interconnection and flow paths between hydrogeologic units are not well understood. Generally, the groundwater system can be

divided into an upper topographically controlled system from the ground surface down to 200 feet, and a lower system between 200 and 1,200 feet that has a general northward flow. Water-bearing characteristics of the aquifer system in Natrona County are discussed in more detail in Section 3.1.4.2 of the Phase I EA (BLM 2003) and the Phases III/IV EA (BLM 2006a).

Howell conducts routine monitoring of the upper groundwater system in the vicinity of an existing sewage lagoon. Four shallow monitoring wells are monitored annually for water depth and water quality (metals, pH, TDS, sulfate, chloride, ammonia, nitrate/nitrite). While the monitoring results indicate that the upper groundwater system is not impacted by the sewage lagoon, the background levels of TDS observed indicates that the shallow groundwater does not meet drinking water standards.

3.4 Human Health & Safety and Ecological Risks

3.4.1 Human Health and Safety Risk

Salt Creek Oil Field is an active oil field. The risks associated with surface and injection/production facilities are well understood and manageable (Damen et al. 2003) and are detailed in the Phases III/IV EA (BLM 2006a). The area is open to the public, and public roadways are present throughout the area. Visitors and the residents of the towns of Midwest and Edgerton, therefore have access to public lands within Salt Creek Oil Field, with some restrictions for specific areas, such as drilling sites, treatment facilities, and other extraction-related activities. Potential risks to human health and safety associated with these normal activities, including the possible releases of CO2 or H2S or occurrences of industrial accidents, are potentially present under current conditions. Industrial management of CO2 is a well-established process in many industries, and specific risks associated with CO2 are well understood. Such risks are managed by consistent application of standard safety systems and procedures (Benson 2002) and detailed in the Phases III/IV EA (BLM 2006a).

CO2 and H2S gasses are present in the Salt Creek Oil Field. Howell has developed safety protocols and emergency response procedures to monitor and respond to unplanned CO2 and H2S releases. Howell trains its employees upon initial hire and annually to respond in a safe manner to potential CO2 and H2S releases. Howell has on file at the site office a Field Health and Safety Plan and a Rockies Emergency Response Plan. As discussed in Section 3.2.1 of the Phase I EA (BLM 2003a), ambient concentrations of H2S in the project area have been demonstrated to be negligible and the WDEQ has not required H2S monitoring since 2000.

The communities of Midwest, Gas Plant Camp, and Edgerton are located within or adjacent to the Project Area. Although in the past there have been oil extraction activities within the communities and active pumps are presently located close to the residential and commercial areas, no oil or gas extraction currently occurs inside the town boundaries.

3.4.2 Ecological Risk

The Project area encompasses an operating oil field which has been active for 117 years. The historic and ongoing oil extraction activities have resulted in changes to the natural communities occurring within the Salt Creek Basin and the plant and animal species associated with these communities.

3.5 Soils and Reclamation

Upland soils are derived from residual interbedded shales and sandstones, as well as stream alluvium or colluvial material. Valley or bottomland soils have developed in unconsolidated stream sediments. The soils are generally low in organic matter and are alkaline and saline-sodic. The saline-sodic nature of existing soil resources is discussed, in part, in Section 3.2.2 of the Phase I EA (BLM2003a). Overall textural families primarily are fine or clayey, but may also range from fine-loamy to coarse loamy. Textures within a given soil profile may vary, as well. Slopes range from nearly level to moderately steep with the deeper soil profiles occuring in less sloping to flat terrain. Rangeland livestock grazing, wildlife habitat, and oil drilling activities are the dominant land uses on these soils.

Comprehensive county-wide information is available from the Natural Resources Conservation Service (NRCS) soil survey for Natrona County (NRCS 1997). In addition, the Phase I EA (BLM 2003) provides detailed site-specific information for the overall project area. Refer to Section 3.1.3.2, Major Soil Types, in the Phase I EA (BLM 2003) for a complete and detailed description of the soil map units found within the project area.

3.6 Wetlands

Streamside wetlands along Salt Creek are represented by two distinct communities. The lowest streamside terraces, immediately adjacent to surface water in the creek, are dominated by a mix of chairmaker's rush (*Schoenoplectus pungens*) and foxtail barley (*Critesion jubatum*) with occasional stands of sedge (*Carex* sp.) and alkali cordgrass (*Spartina gracilis*). These wetlands correspond to the streamside marsh and riparian grassland types discussed under Riparian Communities in Section 3.7.2.

A transitional wetland community, dominated by salt cedar (*Tamarix chinensis*), inland saltgrass, and poverty sumpweed (*Iva axillaris*) is supported on the next level terrace above the active stream channel, with salt cedar forming relative dense stands in some areas. The uppermost terrace along the stream channel does not support wetlands. The dominant species on this terrace are black greasewood (*Sarcobatus vermiculatus*), silver sagebrush (*Seriphidium canum*), and upland grass and weedy species such as cheatgrass (*Anisantha tectorum*), smooth brome (*Bromopsis inermis*), and clasping peppergrass (*Lepidium perfoliatum*), none of which is classified as a hydrophytic species.

Jurisdictional wetlands and other waters of the U.S. are limited in extent in the 2012 Update project area and are restricted to the Salt Creek drainage and Howell's WYPDES discharge channel that empties into Salt Creek. These sites are described in detail in the Phase I and Phases III/IV EAs (BLM 2003, BLM 2006a).

3.7 Vegetation and Weeds

3.7.1 Vegetation

Landscape units within the project area and the surrounding region were mapped in the Phase I EA (BLM 2003) using a supervised vegetation classification system applied to Landsat 7 imagery (Phase I EA, Appendix 8). The regional map (see Figure 34, Phase I EA) portrays eight

vegetation types as well as other landscape units including rivers and streams, commercial/industrial sites, residential areas, major roads, and agricultural areas. In general, the vegetation within the Project area and adjacent sites can be classified into three general types: riparian communities, lowland communities, and upland communities. Further discussion of these communities and areal extent of all mapped units is provided in the Phase I and Phases III/IV EAs (BLM 2003, BLM 2006a).

3.7.2 Weeds

In Section 3.3.1.1.4 of the Phase I EA (BLM 2003), five species of noxious weeds were identified for the overall project area, including Russian knapweed (*Acroptilon repens),* Canada thistle (*Breea arvense*), bull thistle (*Cirsium vulgare*), halogeton (*Halogeton glomeratus), and* Scotch thistle (*Onopardum acanthium*). These species and others are described in detail in the Phase I and Phases III/IV EAs (BLM 2003, BLM 2006a). A weed management plan has been developed by Howell in cooperation with the BLM and the Natrona County Weed and Pest office. The plan includes education, treatment, prevention, and monitoring objectives. The plan is updated periodically and is kept on file with BLM.

3.8 Terrestrial Wildlife

Terrestrial wildlife resources commonly associated with the Salt Creek Basin are described in of the Phase I and Phase III-IV EAs (BLM 2003, BLM 2006a). Historic oil exploration and development within Salt Creek Oil Field since 1889 has substantially modified the upland habitats and wildlife use by both resident and migratory species.

Big game species that occur in the Project area are limited to mule deer and pronghorn. Both are relatively common. Wyoming Game and Fish Department (WGFD) big game herd units within the proposed project area were described in the Phases III/IV EA (BLM 2006a).

Other representative mammals that occur in the Project area include predators such as the coyote, bobcat, and red fox. These predators typically rely on medium-to-small sized prey species, which include two cottontail rabbit species, white-tailed jackrabbit, deer mouse, other rodent species, and the black tailed prairie dog.

Resident and migratory bird species that occur or move through the project area are diverse, ranging from raptors, upland game birds, and passerines to waterfowl and other water birds. Generally, bird use is opportunistic in Salt Creek Oil Field, with individuals occupying areas that provide sufficient breeding, foraging, and roosting habitats. The overall number of birds, however, is expected to be lower in the field than in surrounding, undisturbed areas. The Phase I and Phase II EAs (BLM 2003, 2004) contain detailed information on representative bird species documented for the project area, encompassing a number of passerines or songbirds and both waterfowl and water bird species associated with the Salt Creek drainage and adjacent riparian habitats.

Amphibians are limited to aquatic habitats, primarily along Salt Creek and its tributaries. Documented species include the Woodhouse’s toad and chorus frog. Reptiles recorded include three species of snakes, including the wandering garter snake, bull snake, and prairie rattlesnake

(BLM 2003). Rattlesnakes and bull snakes tend to be wide ranging and may be found throughout the upland and riparian habitats. Garter snakes tend to be more prevalent in the riparian areas.

3.9 Aquatic Biology

Aquatic animals such as muskrat are present in Salt Creek. A diverse benthic community is present, although higher diversity and abundance is found in the lower reaches of the creek (which are shallow, swift, and rocky) than in the reaches in the immediate Phases III/IV Project area, which are slower and deeper, with silty substrate. In summer this upper reach has abundant submerged macrophyte growth. Elevated temperatures in the reach near the discharge points result in ice-free conditions for much of the year.

The Salt Creek tributaries are ephemeral or intermittent water bodies, and generally lack permanent aquatic life. During flow periods, opportunistic species may use these streams, including fish such as the flathead chub (*Platygobio gracilis*), which specializes in spawning in small, ephemeral headwaters. In streams and draws receiving produced water discharges (such as lower Castle Creek) permanent aquatic life may be present, including aquatic insects and some benthic invertebrates.

The aquatic biology of the Salt Creek system is fully described in Section 3.3.2 of the Phase I EA (BLM 2003). Additional information based on detailed analysis of aquatic biota, aquatic communities, and current conditions of the Salt Creek system also can be found in the Salt Creek use attainability analysis (UAA) (RETEC 2004). Current aquatic life in Salt Creek appears to be unimpaired and fairly diverse as noted in the Phase I EA (BLM 2003) and in the UAA. Continued existence of most if not all of this aquatic community is generally dependent on the perennial water provided by the produced water discharges.

3.10 Special Status Species

3.10.1 Plants

A total of eight plant species are considered to be of special interest within the proposed Project area. These species include one endangered, one threatened, and six BLM sensitive species. . Table 3-1 presents selected habitat characteristics for each of these species.

Table 3-1 Special Status Plants

Common Name	Scientific Name	Status	Habitat Characteristics	Habitat Observed in Project Area
Colorado butterfly plant	*Guara neomexicana* ssp. *coloradensis*	Threatened	Subirrigated alluvial soils of drainage bottoms surrounded by mixed prairie, not known to occur in Natrona County	No
Blowout penstemon	*Penstemon haydenii*	Endangered	Sand dunes	No
Ute ladies'-tresses	*Spiranthes diluvialis*	Threatened	Seasonally moist soils and wet meadows of drainages below 7,000 feet in elevation.	No

Common Name	Scientific Name	Status	Habitat Characteristics	Habitat Observed in Project Area
Laramie Columbine	*Aquilegia laramiensis*	BLM	Shady, and usually level, microsites associated with granite outcrops, boulders, crevices, ledges, and cliff bases shaded by tree cover between 5,400-10,100 feet amsl.	No
Porter's Sagebrush	*Artemisia porteri*	BLM	Sparsely vegetated badlands of ashy or tufaceous mudstones and clay slopes; endemic to Wind River Basin, Fremont County.	No
Many-stemmed Spider flower	*Cleome multicaulis*	BLM	Semi-moist, open, saline banks of shallow ponds and lakes with Baltic rush and bulrush.	No
Williams' Wafer-Parsnip	*Cymopterus williamsii*	BLM	Open ridgetops and upper slopes with exposed limestone outcrops or rockslides; endemic to Bighorn Mountains.	No
Limber Pine	*Limber Pine, Pinus flexilis*	BLM	Dry, rocky sites at many elevations (4,900-11,800 feet amsl) within its range. Limber pine can occur scattered throughout forested regions on more mesic sites, especially in low density, open areas.	No
Laramie False Sagebrush,	*Sphaeromeria simplex*	BLM	Cushion plant communities on rocky limestone ridges and gentle slopes.	No

3.10.2 Terrestrial Animals

The Phase I EA (BLM 2003) outlined a number of special status species for the overall Salt Creek Basin. Subsequent site-specific field surveys were conducted in 2005 and 2006 for both the Phases III, IV, and V areas (ENSR 2005a, 2005b, 2006) and throughout Salt Creek Oil Field (Wildlife Consulting Services 2005a, 2005b, 2005c). Based on these data, the BLM initially identified 22 special status animal species for the proposed Phases VIII through XIV, XVII, and XVIII EOR expansion project, encompassing 1 federally listed, 1 federal candidate, and 20 BLM sensitive species. Table 3-2 Special Status Species categorizes the potential of occurrence of these species in the project area. Figure 3.1 Raptor Nests and Prairie Dog Habitat indicates the location of raptor nests and prairie dog habitat within the project area.

3.10.3 Aquatic Species

A review of federal and state documentation conducted for the Salt Creek UAA (RETEC 2004) did not identify any special status aquatic species likely to be specifically present in Salt Creek or its tributaries. Two species of fish are listed for the Powder River downstream of the confluence

with Salt Creek; however neither of these species is present or expected to occur in the project area.

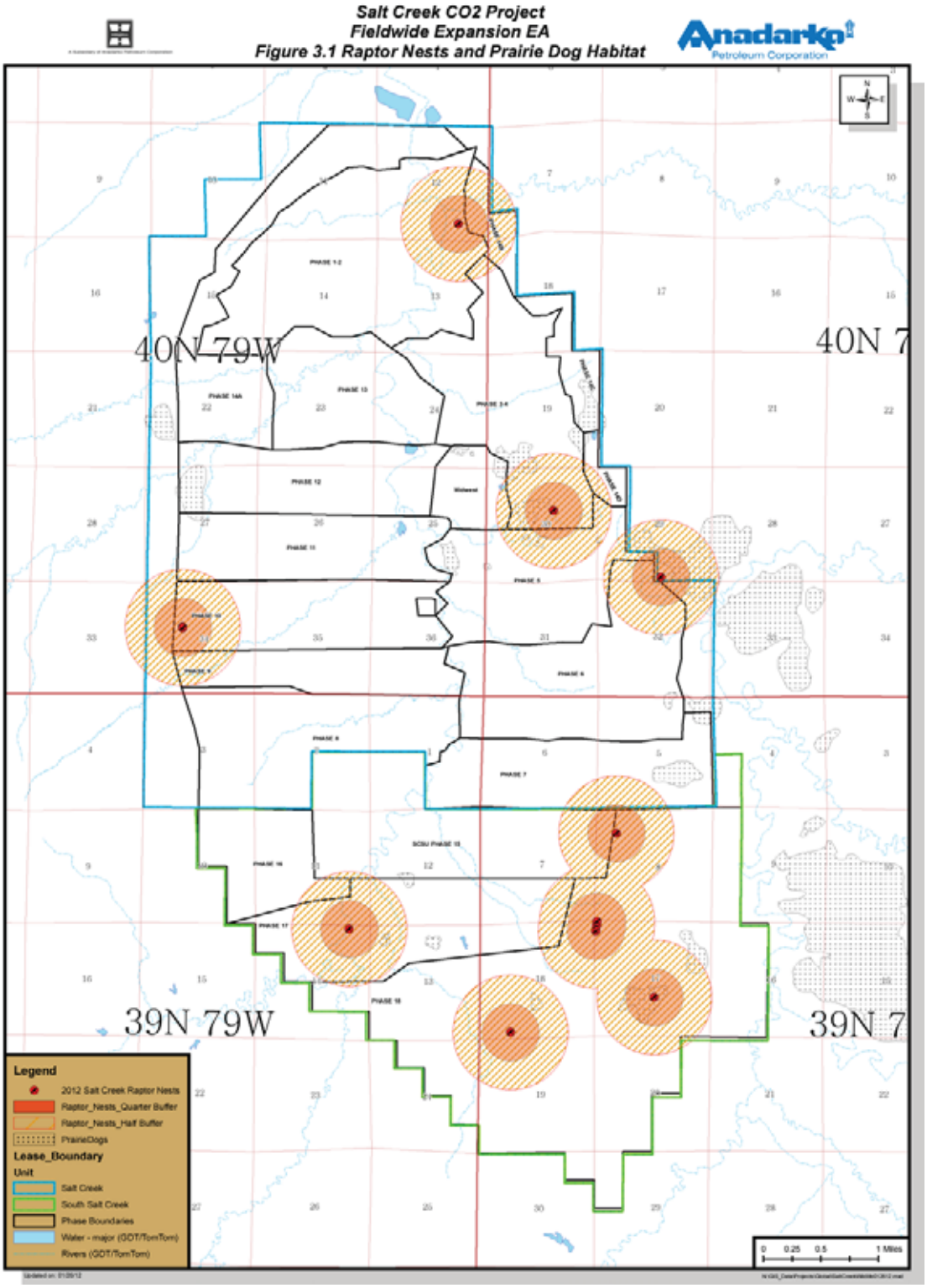
Table 3-2 Special Status Species

Common Name	Scientific Name	Status[1]	Potential to Occur in Project Area
Bald eagle	*Haliaeetus leucocephalus*	FT[2]	Low
Black-footed ferret	*Mustela nigripes*	FE	Low
Boreal toad	*Bufo boreas boreas*	FC	Low
American peregrine falcon	*Falco peregrines*	BLM	Low
Farruginous hawk	*Buteo regalis*	BLM	Moderate
Western burrowing owl	*Athene cunicularia hypugea*	BLM	Documented
Greater sage-grouse	*Centrocercus urophasianus*	FC/BLM	Low
Sage thrasher	*Oreoscoptes montanus*	BLM	Documented
Brewer's sparrow	*Spizella breweri*	BLM	Documented
Sage sparrow	*Amphispiza belli*	BLM	Documented
Sparrow, Baird's	*Ammodramus bairdii*	BLM	Low
Loggerhead shrike	*Lanius ludovicianus*	BLM	Moderate
Mountain plover	*Charadrius montanus*	BLM	Low
Long-billed Curlew	*Numenius americanus*	BLM	Low
Yellow-billed Cuckoo	*Coccyzus americanus*	BLM	Low
Trumpeter Swan	*Cygnus buccinator*	BLM	Low
White-faced Ibis	*Plegadis chihi*	BLM	Low
White-tailed Prairie Dog,	*Cynomys leucurus*	BLM	Low
Black-tailed prairie dog	*Cynomys ludovicianus*	BLM	Documented
Swift fox	*Vulpes velox*	BLM	Low
Spotted bat	*Euderma maculatum*	BLM	Low
Townsend's big-eared bat	*Corynorthinus townsendii*	BLM	Low
Fringed Myotis,	*Myotis thysanodes*	BLM	Low
Long-eared Myotis	*Myotis evotis*	BLM	Low
Northern leopard frog	*Rana pipiens*	BLM	Low

[1] Status:

FE = Federally listed as endangered
FT = Federally listed as threatened
FC = Federal candidate species
BLM = BLM Sensitive Species

[2] On August 9, 2007, the bald eagle will be delisted and will become a BLM Sensitive Species.


Salt Creek CO2 Project
Fieldwide Expansion EA
Figure 3.1 Raptor Nests and Prairie Dog Habitat
Anadarko
Petroleum Corporation
40N 79W
40N 7
39N 79W
39N 7
Legend
2012 Salt Creek Raptor Nests
Raptor_Nests_Quarter Buffer
Raptor_Nests_Half Buffer
PrairieDogs
Lease_Boundary
Unit
Salt Creek
South Salt Creek
Phase Boundaries
Water - major (GDT/TomTom)
Rivers (GDT/TomTom)
0 0.25 0.5 1 Miles

3.11 Cultural Resources

Numerous cultural resource studies have been completed in the project area beginning in 1978 as part of compliance with the National Historic Preservation Act of 1966, as amended. While some of these studies do not meet current standards, almost the entire current project area has been the subject of intensive cultural resource inventories (Class III) that meet current standards. These inventories have been previously enumerated in other Environmental Assessments covering the project area and will not be repeated (#WY-060-04-001, #WY-060-EA06-18 and #WY-060-EA7-067).

In summary, there is evidence of human occupation in the project area for over 5,000 years. However, oil field activity of the last 100 years has severely impacted the surface evidence of the prehistoric occupation. Most of the remaining prehistoric sites are located in the North Salt Creek Unit. A segment of the historic Bozeman Trail (48NA3024) has also been documented in the project area. Parts of the Bozeman Trail are listed on the National Register of Historic Places (NRHP); however the segment in the project area has been determined to be a non- contributing segment.

The dominant cultural resource present in the project area is the Historic Salt Creek Oil Field (48NA296). The boundaries of the Historic District coincide with the both unit boundaries depicted in Figure 1.2 (Light Oil Unit and South Oil Units combined). The Salt Creek Oil Field has been developed for over 100 years and has been determined to be a historic district that is eligible for listing on the National Register of Historic Places (NRHP). Within the district there are areas that contribute and do not contribute to its eligibility. Other historic period sites associated with the development of the oil field are also present such as old town sites, field camps and a railroad. Robert Rosenberg completed a historic overview of the field in 1988 (Rosenberg 1988). Included in the overview was a framework for determining what remaining historic elements would contribute or not contribute to the overall National Register eligibility.

3.12 Range Management and Grazing Resources

Although much of the surface in the Project area is public, portions are leased by one lessee for livestock grazing. Range improvements in the project area include pasture fences and stock reservoirs. Currently, cattle are fenced out of the LACT facilities, but individual wells are not fenced.

3.13 Land Use

Most of the surface and the minerals in Salt Creek Oil Field are publicly owned and administered by the BLM. There are a few exceptions, including a section where the state owns both surface and mineral rights (Sec. 36, T. 40 N., R. 79 W.) and several smaller areas where either the surface or both the surface and minerals are privately owned. Midwest is privately owned and was developed as a company town, but subsequently sold to the residents. Surface rights in Edgerton are private, but the oil and gas rights are owned by the federal government and administered by the BLM. Surface rights in Gas Plant Camp are private, but the oil and gas rights are owned by the State of Wyoming.

The current land use in the project area includes oil and gas production, wildlife habitat, domestic livestock grazing, and some recreation. Midwest and Edgerton are primarily residential with some supporting commercial activities, while Gas Plant Camp is primarily residential.

The Phase I and Phases III/IV EAs (BLM 2003, BLM 2006a) discuss grazing uses and stocking rates.

3.14 Socioeconomics

In the immediate project vicinity, services and population are concentrated in the Towns of Midwest and Edgerton and at Gas Plant Camp. The city of Casper, population approximately 53,316, is located approximately 30 miles south of the study area.

The towns of Midwest and Gas Plant Camp are within the boundaries of Salt Creek field. The 2010 census reports a combined population of 195 in Edgerton and 404 for Midwest and Gas Plant Camp; separate figures are not available (U.S. Census 2010).

The project area's local economy is based heavily on oil and gas production and has been for over a century. For more information please refer to the Phase I EA (BLM 2003) which presents housing unit, employment, wage, and other socioeconomic statistics.

3.15 Recreation

Recreation opportunities in the vicinity of Salt Creek Oil Field are discussed in greater detail in the Phase I EA (BLM 2003). The oil field itself receives minor use for dispersed recreation such as wildlife viewing, hunting, and OHV travel. Two reservoirs constructed in 2001, Water Tank Reservoir and Petro Reservoir, are located about 5 miles south of Midwest. Initially fed by Salt Creek Oil Field discharge water, they are now fed by higher quality groundwater from the Madison formation. They are stocked with rainbow trout by the WGFD and have been attracting fishing activities, especially in drought years when other water features have been low or dry (Conder 2005). There are no designated Wilderness Areas, Wild and Scenic Rivers, or Wilderness Study Areas in or near the project area.

3.16 Visual Resources

Under the BLM's visual resource management (VRM) System, public lands are normally evaluated for visual quality and sensitivity and, based on the results of the inventory, designated as one of four VRM classes with associated objectives for management of the visual environment under the umbrella of the Resource Management Plan (RMP) for the area (BLM 1986). The project area was excluded from this process because it is part of a management area (MA). The Salt Creek MA is established on areas determined to have a high development potential as defined in the Casper Field Office RFD Scenario for Oil and Gas Development (BLM 2007)..

Upon final field closure in 30 to 40 years or more and full-field reclamation is ultimately achieved, the landscape of the former Salt Creek Oil Field would once again be primarily characterized by the dissected, rolling upland plains punctuated by badlands, broad valleys, deep eroded gullies, and isolated hills that characterized the landscape before oil was discovered in the late 1800s.

3.17 Noise

Noise levels in the vicinity of the Proposed Action have not been measured. Based on studies from other areas, it is expected that noise levels away from the industrial activity immediate to Salt Creek Oil Field would be quite low, influenced mainly by wind. The background noise in the area without these influences is likely in the range of 40 to 45 dBA (decibels, A-weighted) (EPA 1971). When the wind is blowing, the noise levels may be substantially higher. Noises from operations in the oil field include large diesel engines, compressors, heavy equipment operations, pipes clanking, and other industrial type noises. The nearest noise sensitive receptors are residences in Midwest, Gas Plant Camp, and Edgerton and, perhaps, the schools in Midwest. At times, depending on the particular activity occurring in the oil field, the oil field noise sources may be within 200 to 300 feet of a sensitive receptor. These activities have been ongoing for over 100 years in Salt Creek Oil Field and many of the residents of Midwest, Gas Plant Camp, and Edgerton are employed in the oil field. Under these circumstances, it can be assumed that most residents are acclimated to the oil field noises and don't find them objectionable under most circumstances.

3.18 Transportation

Transportation access to the project area is almost exclusively highway oriented. The primary route is I-25/U.S.87, which runs north and south approximately 5 miles east of the project site. State Route (SR) 387 connects to I-25 at exit 227 and passes just north of the project site before heading northeasterly toward Wright and Gillette. SR 259 runs south from Midwest, passing through the project area and then intersecting I-25 at exit 210. The three highways are paved and in generally good to excellent condition. Traffic counts for the state and federal highways are presented in the Phase I EA (BLM 2003). The counts indicate levels of service (LOS) on the highways are currently at an "A" level, which means traffic flows freely with few restrictions, even at peak traffic periods. There also is a network of county and BLM roads serving rural areas in the vicinity, none of which is paved. These roads are typically in poor to fair condition and are irregularly maintained, at best (BLM 2003).

4.0 Environmental Consequences

The Proposed Action to expand the existing EOR for the 2012 Update conforms to the plans and policies of the BLM's Casper Field Office RMP. Specifically, the Proposed Action is in accordance with the planning decisions outlined in the Salt Creek Management Area (MA) (BLM 2007). The Salt Creek MA comprises approximately 347,000 acres of both BLM-administered surface lands (91,000 acres) and federal mineral estate (206,000 acres). Pertaining to the project area and Proposed Action elements, the Salt Creek RMA states that the management focus will encompass mineral development, special management emphasis for the Salt Creek ACEC based on soil conditions, protection of cultural resources in connection with historic significance of oil field development, and realty support associated with energy and non-energy linear ROWs.

Under the Approved Resource Management Plan (RMP) for the Casper Field Office, the ACEC designation was not retained and was replaced by a Management Area (MA) designation (BLM 2007). The Salt Creek MA would be established on areas determined to have a high development potential as defined in the Casper Field Office RFD Scenario for Oil and Gas Development (23,911 acres, of which 19,325 are federal surface). Oil and gas development would be a priority in the area with minimum restrictions. New oil and gas leases in this area would be issued with standard stipulations only. The Final Environmental Impact Statement for the RMP was published in June of 2007 and the Record of Decision was published in December, 2007.

During the first five phases of CO_2 development, Howell has demonstrated commitment to improving the environment in Salt Creek. The operator has replugged wells which were not abandoned according to current standards, buried cement, eliminated unused pumping units and power lines, and removed abandoned equipment and scrap materials. These efforts were recognized in the Casper RMP (BLM 2007). Howell has committed to employ applicant committed environmental protection measures (ACEPMs) proposed in previous EAs prepared for the Phase I, Phase II, Phase III-IV, and Phase V projects (BLM 2003, 2004, 2006a, and 2006b), as well as those listed in the Salt Creek MSUP and site-specific mitigations, which are summarized in Appendix A of this document. No additional mitigation measures are required as the current measures have served to eliminate or reduce direct and indirect impacts to the maximum extent practicable.

4.1 Air Quality

4.1.1 Proposed Action

Additional surface disturbance and activity levels associated with the Proposed Action may temporarily result in an increase in the wind-blown dust generated from increased traffic on the existing and newly constructed access roads, well sites, pipelines, facility and storage sites, and electric line ROWs in the project area. Increased activities associated with vehicles and equipment engaged in construction, drilling, workover, and other installation activities associated with the project may result in a temporary increase in combustion emissions. As flow lines, wellhead equipment, and production facilities are upgraded, however, the potential for degrading

air quality resulting from line or equipment failure would decrease. Gas plant operations would remain unchanged.

The Phase I EA discussed potential ambient impacts of a CO_2 pipeline rupture for the proposed Phase I operations at Salt Creek (BLM 2003). The initial modeling study (BLM 2003) outlined potential short-term impacts in the unlikely event of pipeline failure. No long-term ambient air quality impacts would be expected. The Phases III/IV EA discussed monitoring subsurface pressure to isolate CO_2 and prevent seeps. Potential air quality impacts from the 2012 Update due to CO_2 seeps would, therefore, be expected to range from no impacts, particularly in populated areas, to negligible or minimal impacts in remote areas.

4.1.2 No Action

Under the No Action Alternative, activities associated with the existing waterflood operations within the 2012 Update project area would continue. Under the No Action Alternative scenario, the ambient air quality in and around the project area would be expected to remain unchanged. Currently, there are no ambient air quality exceedances or other issues with respect to Wyoming Air Quality Standards and Regulations.

4.1.3 Mitigation and Monitoring

No additional mitigation or monitoring measures applicable to air quality have been developed for the Proposed Action.

4.2 Geology

4.2.1 Proposed Action

The project region has been under similar development for over a century, most of the proposed operations would be located at existing facility sites, and overall the proposed 2012 Update activity would avoid steep or unstable slopes. Hence, no impact associated with reduced slope stability would be anticipated. Some minor changes in topography from cut and fill operations would be anticipated during construction of new roads and drill pads. However, the impacts from this activity would be minimal.

No impacts to surface geological structure would be anticipated from continued removal of petroleum hydrocarbons under the Proposed Action. There is no record of detectable earthquakes induced by water injection in the project region, and no record of subsidence as a result of oil production.

4.2.2 No Action

No impacts to topography and geology would be expected under the No Action Alternative. A certain amount of underground geological resources (i.e., oil and gas) would not be recovered, as the No Action Alternative would continue with the waterflood operations and EOR in the Phases I through VIII, XV, and XVI areas.

4.2.3 Mitigation and Monitoring

No additional mitigation or monitoring measures applicable to geology have been developed for the Proposed Action.

4.3 Water Resources

4.3.1 Surface Water

4.3.1.1 Proposed Action

Changes in surface water resources as a result of the Proposed Action have been collectively evaluated on the basis of the anticipated 2012 Update of the enhanced oil recovery program. The partial contributions from each phase have not been disaggregated, as all discharges would be routed through the existing discharge points. The Phase I EA concluded that the primary anticipated effect would be a temporary increase in the total volume of produced water discharged to Salt Creek (and affected tributaries). However, recent (2005) operating data gathered during Phases I and II implementation indicate that CO_2 injection also may affect the composition of produced water discharges from the field.

The effects of the Proposed Action on Salt Creek hydrology would be considered small in the context of historical flows. No significant change in water quantity or quality is expected with the 2012 Update. Additional water volumes released for downstream use may result in an overall positive effect on water budgets.

No adverse impacts (e.g., sedimentation, siltation) to Salt Creek water quality from the 2012 Update construction activities would be anticipated, based on Howell's committed soil erosion control and reclamation measures. The Phase I EA details these committed protection measures that also would apply to the Fieldwide Expansion Project.

4.3.1.2 No Action

Under the No Action Alternative, the 2012 Update of the EOR would not be implemented and the project area would continue under waterflooding only. No additional water quantity issues or changed water quality would be anticipated for the 2012 Update of the EOR program. The additional water provided for the Powder River Basin water budgets would not occur, reducing downstream beneficial water use. No changes in water quality would occur, positive or negative, in relation to the waterflood baseline.

4.3.1.3 Mitigation and Monitoring

No additional mitigation or monitoring measures applicable to surface water resources have been developed for the Proposed Action beyond those described in Appendix A - ACEPMs. Howell would continue monitoring water volumes and water quality of produced water discharged from LACTs to Salt Creek as part of the established WYPDES monitoring program.

4.3.2 Groundwater

4.3.2.1 Proposed Action

The maximum reservoir pressure under current waterflood operations is approximately 1,200 pounds per square inch (psi). An estimated maximum reservoir pressure during CO_2 injection operations would be around 1,500 psi. Howell conducted petrophysical analysis and matched the results of this analysis with the results from step-rate injection tests in the WC2 horizon. It was determined that the maximum injection pressure for the reservoir would be 1,550 psi, which is higher than the maximum reservoir pressure anticipated during the CO_2 injection operations. Maintaining the pressure difference between maximum injection pressure and maximum reservoir pressure would allow the project operators to maintain reservoir integrity during WAG injection operations.

In summary, the Proposed Action is not expected to impact the groundwater resources. No changes in the hydraulic head in the upper and lower hydraulic units of the Powder River sedimentary basin nor leakage from the Wall Creek horizons into the upper and lower hydraulic units would be expected as a result of proposed operations in the WC2. No underground sources of drinking water were identified in areas overlying the WC1 and WC2 within the light oil unit of the Salt Creek Oil Field (EPA 1987). Furthermore, the public water supplies for the towns of Midwest, Edgerton, and Gas Plant Camp are obtained from the Casper Regional Water System, which would not be impacted by the Proposed Action.

4.3.2.2 No Action

No additional development activities and/or operations that would affect groundwater resources in the project area would occur under the No Action Alternative. The current waterflood and EOR in the Phases II through VII, XV, and XVI areas would continue.

4.3.2.3 Mitigation and Monitoring

No additional mitigation measures applicable to groundwater have been developed for the Proposed Action beyond those described in Appendix A - ACEPMs. Currently, there are no regulatory groundwater monitoring requirements for the project operations; however, Howell personnel conduct groundwater monitoring from selected wells for operational purposes under the routine oilfield water analysis (ROWA) and annual groundwater monitoring program for Salt Creek Oil Field Sewage Lagoon, as required by Permit Number 94-372 issued by WDEQ. Howell would continue the sewage lagoon and the ROWA groundwater monitoring programs, but no additional monitoring measures were identified for the proposed 2012 Update EOR project.

4.4 Human Health & Safety and Ecological Risks

4.4.1 Proposed Action

The potential for localized occurrence of CO_2 seeps in the project area would be considered a potential risk to human health and the environment. Sections 2.1.1.1 and 2.1.3 of the Phases III/IV EA (BLM 2006a) summarize the measures, approach, and actions Howell has

implemented to understand, predict, and minimize or prevent the occurrence of CO_2 seeps for future EOR phases.

Potential impacts to human health from exposure to CO_2 would primarily apply to confined or protected spaces if a CO_2 seep were to occur in that specific area. However, the probability of a seep surfacing in a confined space is low to none, based on a series of ongoing well improvements, future drilling scenarios, and project monitoring in the towns under Phases III through V and the Proposed Action to prevent any CO_2 buildup and provide early detection if warranted (see Sections 2.1.1.1 and 2.1.3). CO_2 seeps occurring outside of town would be expected to be rare occurrences. If present, the likelihood of unacceptable human exposure in such locations is low due to the small footprint of toxic conditions, infrequent occurrence of windless conditions, low intensity of use of land in most of the project area, and application of containment and monitoring measures currently implemented and proposed by Howell for continued Fieldwide Expansion.

CO2 and H2S gasses are present in the Salt Creek Oil Field. Howell has developed safety protocols and emergency response procedures to monitor and respond to unplanned CO2 and H2S releases. Howell trains its employees upon initial hire and annually to respond in a safe manner to potential CO2 and H2S releases. Howell has on file at the site office a Field Health and Safety Plan and a Rockies Emergency Response Plan. As discussed in Section 3.2.1 of the Phase I EA (BLM 2003a), ambient concentrations of H2S in the project area have been demonstrated to be negligible and the WDEQ has not required H2S monitoring since 2000.

The potential for ecological risks also is low. This assessment is based on the low probability of seeps occurring; the small footprint of the seeps, if present; likely avoidance of active seeps by some wildlife; and containment measures implemented by Howell to minimize access to seep areas.

4.4.2 No Action

Under the No Action Alternative, the 2012 Update EOR would not occur. The current waterflood and EOR in the Phases II through VIII, XV, and XVI areas would continue while economically practicable. No adverse impacts to human health and ecological communities would be anticipated beyond the risks inherent in an active oil field, and Howell would continue to monitor and minimize existing CO_2 seeps associated with Phase I, anticipating continued full control.

4.4.3 Mitigation and Monitoring

Howell has developed a detailed approach to prevent CO_2 seeps and to contain them if they were to occur as part of the Proposed Action This CO_2 Seep Containment Plan is summarized in Section 2.1.3 of the Phases III/IV EA (BLM 2006a). The containment measures are designed to minimize the surface expression of CO_2 seeps, thus eliminating or minimizing potential adverse impacts. Application of these containment measures reduces the probability of occurrence of a seep and minimizes exposure pathways, if it were to occur, thereby reducing the risk to human health, safety, and the environment. Mitigation measures are summarized in Appendix A – ACEPMs.

4.5 Soils and Reclamation

4.5.1 Proposed Action

Based on the inherent nature of the soil resources in the project region (i.e., steep topography and erodible soil material), loss from erosion is likely. Soil loss is expected on disturbed surface areas during dry and windy conditions from increased road travel. During wet conditions, soil loss due to wheel rutting, compaction, and associated water erosion also would be expected from increased vehicle traffic. The potential for soil loss would be greatest during the short-term construction phase of the Proposed Action. Soil erosion, whether from wind or water, would likely continue to occur on disturbed areas until they were successfully reclaimed.

The ACEPMs described in Appendix A would aid in reducing potential impacts to soils from the Proposed Action. These ACEPMs include reclamation with native species, regular monitoring of reclamation success, and continued implementation of a noxious weed management plan on file with BLM. A Storm Water Pollution Prevention Plan and Spill Prevention, Control, and Countermeasure Plan are currently in place and would continue to be implemented for the proposed 2012 Update project to minimize impacts to soils and associated resources. Post-construction monitoring on a regular basis would be undertaken to ensure surface reclamation is undertaken in a timely manner and applicable erosion control measures are effective, including revegetation. The MSUP on file at the Casper BLM Field Office outlines surface reclamation practices designed to reduce the environmental impact of project activities on the soil and vegetation resources within the project area. Reclamation seed mixes will be developed during the APD process in coordination with BLM..

4.5.2 No Action

Under the No Action Alternative, no additional surface-disturbing activities associated with CO_2 injection from the 2012 Update would occur, with the exception of those associated with the existing waterflood and EOR operations. Therefore, the potential for additional soil loss due to wind and water erosion, and the potential for soil and water contamination attributable to the 2012 Update Project area activities, would not occur. Without the implementation of the 2012 Update EOR Project, the additional potential disturbances to soil resources from these project phases would not occur, and the economic life of Salt Creek Oil Field would likely be shortened. The indirect effect of this alternative on the soil resource would be that reclamation of the entire project area would begin sooner.

4.5.3 Mitigation and Monitoring

No additional mitigation measures applicable to soils or reclamation have been developed for the Proposed Action.

4.6 Wetlands

4.6.1 Proposed Action

Based on the development scenarios presented for the Proposed Action, the avoidance of wetland areas and the ACEPMs described in Appendix A for vegetation and wetland resources, no adverse impacts to wetlands would be anticipated.

4.6.2 No Action

The No Action Alternative would result in the same type and level of impacts that have occurred over the past several years in Salt Creek Oil Field, although a lower level of well drilling, workover activity, and field maintenance would occur if the Proposed Action is not implemented. Activity in the well field would continue at a decreasing level until the field becomes uneconomical. Field abandonment and project closure would be followed with the appropriate decommissioning, reclamation, and revegetation activities, as described in Howell's existing Reclamation Plan (see Item #10 in Appendix B, Phase V EA, BLM 2006b).

Wetlands that have developed along the WYPDES discharge channel into Salt Creek would likely be reduced as discharge flows decline. Continuing the existing waterflood operations would not produce any adverse impacts compared to current conditions, unless regulatory pressure results in more reinjection and/or reduction in Salt Creek flow, which could reduce wetland/riparian values. If the amount of water in Salt Creek is reduced as a result of decreased or eliminated WYPDES discharge, it is possible that wetland changes could occur as the floodplain and riparian areas become drier.

4.6.3 Mitigation and Monitoring

No additional mitigation measures applicable to wetlands have been developed for the Proposed Action beyond those described in Appendix A – ACEPMs.

4.7 Vegetation and Weeds

4.7.1 Proposed Action

The Proposed Action would result in additional short-term and long-term losses of vegetation in the areas of new construction. The Proposed Action would focus on use of existing well pads and roads that have been previously disturbed. Riparian vegetation would likely not be impacted within the project area, since no construction activity would disturb riparian communities along Salt Creek.

The ACEPMs described in Appendix A should be adequate to protect and minimize impacts to vegetation resources in the project area. New well locations and associated roads and pipelines would be located to avoid or minimize impacts in areas of high value, such as wetland/riparian areas. The reclamation seed mix discussed in Section 4.4.4 would be used to enhance revegetation and minimize noxious weeds. The MSUP outlines surface reclamation plans that should be effective in reducing the environmental impact to the soil and vegetation resources in the project area. Section 2.1.6.5 of the Phase I EA (BLM 2003) states that Howell will monitor for noxious weeds and will apply BLM-approved weed control techniques, as necessary on sites

affected by oil field operations. The noxious weed management plan on file with BLM provides a comprehensive plan to control the spread of noxious weeds and other invasive species that would be applied for the Proposed Action.

4.7.2 No Action

The No Action Alternative would result in the same degree of impact to vegetation that has occurred over the past several years. Activity in the field would continue at a declining level until field abandonment and project closure occurs. The applicable decommissioning, reclamation, and revegetation activities would be completed earlier than under the Proposed Action.

No new disturbances that could enhance the spread of weedy plant species would occur. The NWMP would be instituted with the existing weed population decreasing as weed control activities are applied and become effective.

4.7.3 Mitigation and Monitoring

No additional mitigation or monitoring measures applicable to vegetation and weeds have been developed for the Proposed Action beyond those described in Appendix A – AECPMs.

4.8 Terrestrial Wildlife

4.8.1 Proposed Action

Potential impacts to terrestrial wildlife species were assessed based on potential species' presence, overall habitat quality, and relative degree of historical and ongoing oil extraction activities in and near the 2012 Update area and in Salt Creek Oil Field. The incremental loss and disturbance of native habitats, habitat fragmentation, animal displacement, and direct loss of wildlife species from project construction and operation would be expected to be low. The reworking of existing wells, the use of existing roads and some power lines, and the use of existing ancillary facilities would minimize the degree of new surface disturbance.

Howell's reclamation plan (see Section 4.5 and Appendix B, Phase V EA, BLM 2006b), would reclaim areas of short-term disturbance following well drilling activities. Areas of habitat loss associated with long-term disturbance would have an incremental impact, given the degree of existing disturbance within Salt Creek Oil Field and the level of commitment to utilize existing infrastructure to the extent possible. As existing wells are abandoned under the 2012 Update, pads and access associated with these wells would be reclaimed. Additionally, the ACEPMs presented in Appendix A delineate committed protection measures to minimize impacts to terrestrial wildlife that also would apply to the 2012 Update. Specifically, logical site selection for wells, new access roads, flow lines, and ancillary facilities would aid in minimizing the potential effects to terrestrial wildlife habitats.

4.8.2 No Action

Under the No Action Alternative, potential short- and long-term habitat loss and fragmentation would be the same as under the current EOR regime. No incremental increase in impacts to

terrestrial wildlife species would occur beyond that already permitted within Salt Creek Oil Field. No potential increase in incidental mortalities of small- to medium-sized animals would occur from CO_2 seeps in low-lying draws or gullies beyond those anticipated for implementation of Phases I through IV, albeit this number would be expected to be low.

4.8.3 Mitigation and Monitoring

No additional mitigation or monitoring measures applicable to terrestrial wildlife species have been developed for the Proposed Action beyond those described in Appendix A – ACEPMs.

4.9 Aquatic biology

4.9.1 Proposed Action

The EOR program (including the Proposed Action for the 2012 Update) is projected to increase water volumes on a temporary basis (see Section 4.3.1). As Salt Creek has an established perennial aquatic life community adapted to the existing conditions, the effect of increased water flows in the Salt Creek system overall would be positive. In the arid conditions of the region, increased water availability has a positive effect on aquatic resources limited by water availability.

The ongoing WYPDES monitoring program, through effluent limits, ensures protection for the designated uses of the receiving stream. As proposed in the Salt Creek UAA (RETEC 2004), as long as cumulative discharges to Salt Creek do not increase over current (waterflood only) levels aquatic life should be protected and remain unimpaired.

4.9.2 No Action Alternative

Under the No Action Alternative, no additional water discharge would occur to Salt Creek. Any beneficial effects of the additional water supply to resident aquatic life would not occur. Water quality in Salt Creek would not change over the baseline water quality conditions in the creek based on waterflooding only and the Phases I and VII, XV, and XVI EOR development.

4.9.3 Mitigation and Monitoring

The ACEPMs to minimize erosion described in Appendix A and the ongoing WYPDES monitoring would adequately reduce the chance of adverse impacts to aquatic life in Salt Creek. No additional mitigation or monitoring measures applicable to aquatic biological resources have been developed for the Proposed Action.

4.10 Special Status Species

4.10.1 Plants

4.10.1.1 Proposed Action

The Proposed Action occurs in an area that has been disturbed for over 100 years in the search for and development of petroleum resources. The threatened, endangered, and other special

status plant species evaluated by this analysis are not known to occur in project area region, and no habitat for these species was observed within the project area boundaries. Based on the historical use of Salt Creek Oil Field, lack of plant species' observations, and the committed environmental protection measures to avoid steep slopes during construction, it can be assumed that no impacts to threatened, endangered, or other special status plant species would occur as a result of the proposed project.

4.10.1.2 No Action

Activity in the well field would continue at a decreasing level until the field becomes uneconomical. Field abandonment and project closure with the appropriate reclamation, revegetation, and weed control activities would be completed. No impacts to special status plant species would be associated with the No Action Alternative.

4.10.1.3 Mitigation and Monitoring

No additional mitigation or monitoring measures applicable to special status plant species have been developed for the Proposed Action.

4.10.2 Terrestrial Animals

4.10.2.1 Proposed Action

Potential direct, indirect, or cumulative impacts from construction and operation of the Proposed Action on special status animal species are similar to those from previous projects and are detailed in the Phase I and Phases III/IV EAs (BLM 2003, BLM 2006a). The ACEPMs presented in Appendix A delineate committed protection measures to minimize impacts to terrestrial wildlife applicable to the expansion.

4.10.2.2 No Action

Under the No Action Alternative, current levels of EOR activities would continue until field closure and reclamation. Potential impacts to special status animal species examined for the Proposed Action would be the same as under the current EOR regime. If species are present, the anticipated incremental increase in surface disturbance, habitat fragmentation, or animal displacement would continue under the current levels already permitted within Salt Creek Oil Field. However, the ACEPMs outlined in Appendix A would help in mitigating potential habitat effects and impacts to special status species.

4.10.2.3 Mitigation and Monitoring

No additional mitigation or monitoring measures applicable to special status animal species have been developed for the Proposed Action beyond those described in Appendix A – ACEPMs.

4.10.3 Aquatic Species

4.10.3.1 Proposed Action

The Proposed Action would not affect any federally listed, state-listed, or BLM sensitive aquatic species, since no sensitive aquatic species have been documented in Salt Creek or its tributaries. Any changes in water discharge quality or quantity from the Proposed Action would not be of such magnitude that water quality or quantity conditions would change significantly in the receiving waters in the Powder River where sensitive fish species (e.g., sturgeon chub, shovelnose sturgeon) may occur.

4.10.3.2 No Action

No effect on sensitive aquatic species would be expected under the No Action Alternative and current waterflood conditions continue in that area.

4.10.3.3 Mitigation and Monitoring

No additional mitigation or monitoring measures applicable to special status aquatic species have been developed for the Proposed Action beyond those described in Appendix A –ACEPMs.

4.11 Cultural Resources

4.11.1 Proposed Action

Prior to authorizing future actions, the BLM cultural resource specialist will analyze each undertaking to determine: 1) any further cultural resource inventory needs, and 2) evaluate its potential to affect any cultural resources eligible for or listed on the NRHP. Most, if not all, of the inventory needs will involve a current assessment of previously documented prehistoric or historic period resources. The assessment will analyze and document the property's current condition. The analysis will assess the property's integrity and apply the four National Register criteria as outlined in 36CFR60.4. If resources are found to be eligible for the NRHP (or contributing to its eligibility in the case of a large district), avoidance or project redesign will be the first option and will result in a no effect determination. In those rare circumstances where NRHP eligible resources cannot be avoided, appropriate mitigation measures will be developed in consultation with the Wyoming SHPO. The measures will also be implemented prior to approving the action.

In general, specific compliance procedures for meeting the requirements of the National Historic Preservation Act, as amended, are outlined in a State Protocol Agreement between the Wyoming BLM and Wyoming SHPO dated March 8, 2006. All requirements of this protocol agreement will be followed for all BLM authorized actions under this environmental assessment.

4.11.2 No Action

Under the No Action Alternative, no additional impacts would occur to cultural resources.

4.11.3 Mitigation and Monitoring

A standard stipulation for cultural resources will be included as a COA for each authorized action under this EA as stated below:

> The operator is responsible for informing all persons in the area who are associated with this project that they will be subject to prosecution for knowingly disturbing historic or archaeological sites, or for collecting artifacts. If historic or archaeological materials are uncovered during construction, the operator is to immediately stop work that might further disturb such materials, and contact the authorized officer (AO) of the BLM Casper Field Office. Within five working days the AO will inform the operator as to:
>
> - whether the materials appear eligible for the National Register of Historic Places;
>
> - the mitigation measures the operator will likely have to undertake before the site can be used (assuming in situ preservation is not necessary); and,
>
> - a timeframe for the AO to complete an expedited review under 36 CFR 800.11 to confirm, through the State Historic Preservation Officer, that the finds of the AO are correct and that mitigation is appropriate. The AO will provide technical and procedural guidelines for the conduct of mitigation. Upon verification from the AO that the required mitigation has been completed, the operator will then be allowed to resume construction measures.

Any surface disturbing activities shall have prior cultural resource consideration. Cultural resources will be considered pursuant to current applicable law, regulation, and policy guidance. Anadarko is responsible for informing all personnel associated with any project activities that they will be subject to prosecution for damaging, altering, removing or excavating any archeological, historical, or vertebrate fossil on site. If archeological, historical, or vertebrate fossil materials are discovered, Howell will suspend all operations that may further disturb such materials and immediately contact the authorized BLM officer. Operations are not to resume until written authorization to proceed is issued by the authorized officer.

In general, if cultural resources that are eligible for or listed on the NRHP cannot be avoided and will be affected then the process outlined in the Wyoming BLM/SHPO Protocol Agreement (3/8/2006) will be followed.

4.12 Range Management and Grazing Resources

4.12.1 Proposed Action

Under the Proposed Action, some grazing lands would be affected. Following full-field production in an estimated 30 to 40 years, the wells would be plugged and abandoned and the field (including the 2012 Update area) would be reclaimed.

The ACEPMs described in Appendix A would reduce potential impacts to range resources in the 2012 Update area. In accordance with Howell's Reclamation Plan (see Item #10 in Appendix B,

Phase V EA, BLM 2006b), new surface disturbance for pipelines, wells, power lines, and other ancillary facilities would be reclaimed as soon as practicable with the approved seed mixture.

After construction is completed, the short-term disturbed areas would be reclaimed and revegetated. The BLM typically requires a 2-year period without grazing on reclaimed areas to facilitate the success of the reclamation effort. The short-term loss of grazing capacity on the affected lands would continue through this period. Howell also has committed to coordinate directly with the grazing lessee to review applicable options to minimize potential grazing impacts in the short term. Once reclamation is successfully completed, it is expected that the reclaimed areas would be more productive for grazing than the native pasture.

4.12.2 No Action

Under the No Action Alternative, development would continue under the existing EOR and waterflood operations. No additional grazing area would be lost from EOR activities beyond those already permitted within Salt Creek Oil Field.

4.12.3 Mitigation and Monitoring

ACEPMs developed to minimize potential impacts to range resources and livestock grazing are summarized in Appendix A. Howell would continue to communicate and coordinate with the grazing allotment operator, aiding in compensating the allotment operator for the anticipated loss by providing temporary fencing of reclaimed areas, alternative pastures, or supplemental livestock feed. Howell, BLM, and the grazing lessee would develop a mutual agreement as to the specific option or options to be implemented.

4.13 Land Use

4.13.1 Proposed Action

The Proposed Action would have essentially no effect on surface ownership or existing land use outside the project area. The potential effects to livestock grazing, the primary land use, is discussed in Section 4.12.

4.13.2 No Action

The No Action alternative would have essentially no effect on surface ownership or land use, except that reclamation would begin earlier on previously disturbed areas. Additionally, field closure, with its attendant reclamation requirements, would occur in 10 to 20 years rather than 30 to 40 years.

4.13.3 Mitigation and Monitoring

No additional mitigation or monitoring measures applicable to land use for the Proposed Action are necessary beyond those proposed for Range Management in Section 4.12.3.

4.14 Socioeconomics

4.14.1 Proposed Action

The Proposed Action would result in a short-term increase in workforce at Salt Creek, with an estimated long-term employment increase of 3 individuals per year expected during the development phases of the project. Housing markets in Midwest/Edgerton and Casper would continue to be tight but impacts of this limited number of employees would be minimal. The Proposed Action would have mostly beneficial effects on the economy. Increasing the total recoverable oil from Salt Creek Oil Field and extending the life of the field would increase property and severance taxes to the county and the state. Royalty payments to the federal and state governments also would increase and a portion of the tax and royalty increases would accrue back to the local communities.

4.14.2 No Action

The No Action Alternative would mean no additional workers would be required. Existing personnel would continue to operate the field at current levels as long as it remained economical to produce oil from the field.

4.14.3 Mitigation

No mitigation or monitoring will be needed for socioeconomic impacts as none are anticipated for the Proposed Action or for the No Action Alternative.

4.15 Recreation

4.15.1 Proposed Action

The Proposed Action would have minimal, if any, effect on recreation activities in the area. Access through the 2012 Update area may be restricted at times, but there are ample alternative recreation opportunities nearby to accommodate local recreation needs, including potential increased demand from project-related population increases.

4.15.2 No Action

The No Action alternative would have no effect on recreation in the project area.

4.15.3 Mitigation and Monitoring

No mitigation or monitoring measures will be needed for recreation impacts as no impacts are anticipated for the Proposed Action or for the No Action Alternative.

4.16 Visual Resources

4.16.1 Proposed Action

The Proposed Action would modestly improve the visual character of the project area in the short term by removing pump jacks, power lines, roads, and other structures that would be made obsolete by the EOR Program and by replacement of aging facilities.

Any new facilities would be painted in colors to minimize contrast with the natural environment, to be approved by the BLM. In the short term, these project facilities would be visible from public viewing areas and would add to the industrial character of the Salt Creek Field landscape. They would be offset in this time frame by the reduction in pump jacks and related facilities in the well field and by reclamation of obsolete disturbance areas.

In the longer term, most of the disturbance areas would be reclaimed and facilities would be removed, which would reduce visual impacts.

Final rehabilitation of the landscape character of the project area would not be accomplished until after closure and reclamation of Salt Creek Oil Field because of the extensive previous disturbance and development.

4.16.2 No Action

The No Action Alternative would have no effect on the visual environment in the short term. It would result in closure and reclamation of the project area in the 10 to 20 year time frame rather than the 20-to 40-year time frame anticipated under the Proposed Action.

4.16.3 Mitigation and Monitoring

No additional mitigation or monitoring measures applicable to visual resources have been developed for the Proposed Action.

4.17 Noise

4.17.1 Proposed Action

The Proposed Action would increase noise in the project area to some degree because of the construction and drilling activities planned in the short term.

4.17.2 No Action

The No Action Alternative would not change the existing noise environment in the project area.

4.17.3 Mitigation and Monitoring

High noise project activities in close proximity to schools should be conducted when schools are not in session. Compressor stations and other long-term noise sources should be constructed away from potential noise sensitive areas or in areas with natural topographic screening to minimize adverse effects of project noise. Howell should log and investigate any noise

complaints related to the project to determine whether any unwelcome noise effects could be reduced. These ACEPMs are summarized in Appendix A.

4.18 Transportation

4.18.1 Proposed Action

The Proposed Action would generate an increase in worker commuting traffic during the construction period and an increase in heavy truck traffic particularly during construction and to a lesser extent during operation of the project. An unlikely worst-case scenario of all construction workers driving separately to the project area would only generate an additional 300 vehicle trips in the peak hour, however, which would not cause the LOS to drop out of the "A" level. Truck traffic would have minimal effect on traffic flows, at worst causing some annoyance to drivers in areas where passing is difficult or prohibited. Effects on traffic safety would be minor with the probability of an accident increasing roughly in proportion to the increase in vehicle trips.

4.18.2 No Action

The No Action Alternative would have no perceptible effect on traffic.

4.18.3 Mitigation and Monitoring

No additional mitigation or monitoring measures applicable to transportation have been developed for the Proposed Action beyond those described in Appendix A - ACEPMs.

4.19 Unavoidable Adverse Impacts

Anticipated impacts from implementation of the 2012 Update project that cannot be fully mitigated have been identified for the Proposed Action. These unavoidable impacts would remain after application of the ACEPMs listed in Appendix A and a number of construction and operation procedures that Howell has developed as part of the Proposed Action.

Unavoidable adverse impacts from the Proposed Action are summarized for the applicable resource disciplines:

1. Fugitive dust: $PM_{10}/PM_{2.5}$ from construction activities and initial temporary increase in vehicular traffic.

2. Combustion emissions from mobile sources (gasoline and diesel vehicles) and non-road engines (e.g., drilling/workover rigs): $PM_{10}/PM_{2.5}$, NO_x, SO_2, CO and VOCs, but levels expected to be negligible.

3. Potential negligible-to-minimal air quality impacts from CO_2 seeps in remote locations.

4. Minor changes in topography from cut and fill activities for new pad, road, and LACT construction.

5. Extremely low risk to humans and low risk to animals, if future CO_2 seeps surface.

[6] Some loss of topsoil productivity from vegetation removal, soil compaction, and removal of organic matter; soil exposure and soil loss from wind and water erosion from construction and operation activities until successful reclamation has been achieved and vegetation has re-established; and potential soil contamination from spills or leaks during project development and operation.

[7] Short-term and long-term removal of vegetation for new disturbance.

[8] An increase in weed species until successful implementation of the NWMP and site monitoring, following which weed populations would decline through time.

[9] Short-term and long-term removal of relatively low value wildlife habitat for new disturbance.

[10] Incremental long-term increase in minor habitat fragmentation and terrestrial wildlife displacement from surface disturbance and increased noise levels until final reclamation.

[11] Loss of some small- and medium-sized animals that use below-surface burrows along low-lying drainages, if a CO_2 seep were to occur in this area.

[12] Incremental reduction in habitat carrying capacities, potential displacement during construction activities, and possible short-term loss of productivity for that breeding season for sage thrasher, Brewer's sparrow, sage sparrow, and loggerhead shrike.

[13] Potential impacts to prairie dogs from construction activities in previously undisturbed areas, if avoidance measures are not feasible.

[14] Some loss of archaeological or cultural resources from unidentified sites.

[15] Some loss of domestic cattle forage.

[16] A small increase in pressure on the already tight rental housing market to a very small degree.

[17] A localized, short-term increase in noise due to traffic and construction activities, and some long-term, localized increases in noise due to operation of compressors.

[18] Minor increase in traffic on area roads.

4.20 Relationship between Short-Term Use of the Environment and Long-Term Productivity

For the Salt Creek Fieldwide Expansion, 2012 Update EA, short-term use of the environment is defined as occurring during project construction and development stages. Long-term productivity refers to the life of the project through final successful project reclamation. Use of the combined waterflood and tertiary EOR could ultimately extend operations for another 30 to 40 years and the economic life of the field. Upon final project completion, facility removal, and successful

reclamation, the landscape character would return to the nature of the area prior to regional oil development in the long term.

Examples of short-term use of the environment include increased noise; dust; and surface disturbance from new drilling pad, access road, and power line construction. These impacts are temporary in nature and mitigatable with current technology and industry practices. Ongoing actions, such as continual road closures, aid in returning the long-term productivity of the land. If reclamation and revegetation were successful within a few years, some of the surface disturbance associated with the 2012 Update Project would be considered to be short-term. Disturbance to the surface areas that cannot be reclaimed in the short term would result in long-term impacts until final field closure and reclamation.

Some of the economic benefits identified for the Proposed Action would increase and extend the benefits of employment, energy production, and public fiscal enhancements in the long term, for up to 40 years.

5.0 Cumulative Impacts

CEQ (40 CFR 1508.7) defines cumulative impacts as:

> "…the impact on the environment that results from the incremental impact of 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. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

The Proposed Action incorporates a number of committed environmental protection measures structured to reduce, minimize, or avoid adverse impacts on the environment. These measures are presented in Section 2.1.6 of the Phase I EA (BLM 2003) and Section 2.1.1 of this 2012 Update EA. Additionally, components of the Proposed Action described for the project in Chapter 2.0 provide further resource protection, where applicable.

As summarized in Section 4.19, Unavoidable Adverse Impacts, residual effects remain after application of these measures to minimize environmental impacts from implementation of the Proposed Action. Other past, present, and reasonably foreseeable future projects in the region also may have residual impacts, and in conjunction with the residual impacts identified for the Proposed Action would result in cumulative effects to specific resources located in and near the Salt Creek Basin. While much of the following discussion focuses on cumulative adverse impacts, it should be noted that beneficial cumulative impacts also would occur, as described.

5.1 Past, Present, and Reasonably Foreseeable Actions

Chapter 5.0 of the Phase I EA (BLM 2003) details a number of past, present, and reasonably foreseeable future projects identified for Salt Creek Oil Field and its surrounding region. Those projects or actions most directly related to the proposed 2012 Update EOR Project would be the past 117-year development of the entire Salt Creek Oil Field, including the recent Phases I – V development within the SCLOU and the Proposed Action comprised of ongoing waterflood and CO_2 EOR projects and future CO_2 development extending from the SCLOU into the SCSU. From a regional perspective, the Phase I EA also delineates other oil recovery and development projects. Given the current momentum of the oil and gas industry in the Salt Creek and Powder River Basins, future expansions of oil and gas recovery are only expected to increase.

A potential project identified for the Salt Creek Oil Field area is the extension of CO_2 pipelines both for use in other owned fields and for sale of CO_2 to other parties.

5.1.1 Other CO_2 Development

Other ROW projects associated with CO_2 development may include extension of the CO_2 pipeline to the Sussex Field to support potential CO_2 development in the Sussex, West Sussex, and Meadow Creek fields. The proposed route for this extension was approved under a previous environmental assessment conducted for PetroSource Corp. A third party pipeline may also be constructed from a point near or within the Salt Creek LOU to a location near Casper for commercial sales of CO_2 to private parties. Long-range plans may include additional extension

of the CO_2 pipeline to support EOR flooding further north into the Powder River Basin in as yet unidentified fields.

5.1.2 Aquifer Recharge Project

Anadarko has recently constructed an injection station on private land on the northern edge of SCLOU and installed the Powder River Basin Water Pipeline from the County Line CBM project to SCLOU. Additional pipelines and injection wells may be planned, as well as an additional injection station, although siting is focused on private surface.

5.2 Cumulative Impacts

As discussed, the project area has experienced intensive oil field development and surface disturbance since 1889, encompassing an extensive network of roads, well pads, pump jacks, pipelines, electric power lines, processing facilities, and ancillary actions. Overall, the Proposed Action would incrementally add to the existing and proposed level of development and disturbance within Salt Creek Oil Field. However, as discussed above, measures have been developed to minimize potential impacts, including ongoing reclamation efforts through field development, closure, and abandonment. Section 5.2 of the Phase I EA (BLM 2003) details the net or residual cumulative impacts identified for development of Phases I-X by resource. The following information outlines those new, cumulative issues identified during the analyses for the proposed 2012 Update Project in conjunction with the past, present, and reasonably foreseeable actions, as described.

5.2.1 Air Quality

As discussed in Section 5.2.1.1 of the Phase I EA (BLM 2003), substantial development and oil recovery actions have been ongoing since the field's inception in 1889. Anticipated cumulative effects to air quality from past, present, and reasonably foreseeable future actions in conjunction with the proposed 2012 Update Project would be incremental and temporary, as detailed in the Phases III/IV EA (BLM 2006a).

The 2012 Update Project would have a beneficial impact on global greenhouse gas emissions by injecting CO_2 that would otherwise be vented to the atmosphere. Howell purchases CO_2 from ExxonMobil's Shute Creek Plant in southwestern Wyoming and transports it via pipeline to the Salt Creek Field. Over the past eight years of EOR operations approximately 268 billion cubic feet (bcf) of CO_2 have been injected at the Salt Creek Field. Over the next six years an estimated 295 bcf of CO_2 would be sequestered by continued EOR operations.

5.2.2 Geology

No additional cumulative impacts to area geology or topography would be anticipated beyond the modifications to surface topography and recontouring of construction sites, as described in the Phase I EA (BLM 2003, Table 42).

5.2.3 Water Resources

5.2.3.1 Surface Water

The overall cumulative effects to surface water resources were essentially described both in the Phase I EA (BLM 2003, Section 5.2.1.3) and in Section 4.3.1 of the Phases III/IV EA, as the effects on surface water resources, and specifically Salt Creek, have been described for the EOR program as a whole and not segregated for each development phase. Because a gradual decline in produced water from waterflooding alone is projected, the cumulative effect of the temporary increases in water volumes from the entire EOR program would be to slow the overall decline in produced water discharge volumes to Salt Creek and thence to the Powder River water budget.

5.2.4 Groundwater

No additional cumulative impacts to groundwater resources would be anticipated based on the ACEPMs, as described in Appendix A and in Chapter 2.0 of this EA.

5.2.5 Human Health & Safety and Ecological Risks

No additional cumulative impacts to human health and safety or ecological resources would be anticipated. Section 4.4 describes the relative impact assessment for the ongoing Phases I through V projects, forecasting future potential occurrences and exposure probabilities. The implementation of Howell's CO_2 Seep Containment Plan and approaches for controlling and monitoring CO_2 flooding as part of the Phases III/IV project (see Chapter 2.0 of the Phases III/IV EA, BLM 2006a) would be anticipated to continue to predict, locate, control, and minimize future seep occurrences. No other CO_2 sources would apply to the cumulative impacts analysis for human health and ecological risks. In summary, the likelihood of exposure to CO_2 is very low for humans and low for small burrowing mammals and ground-dwelling birds, and potential cumulative effects would essentially be the same as those discussed in Section 4.4 of the Phases III/IV EA.

5.2.6 Soils and Reclamation

No additional cumulative impacts to soils and reclamation efforts would be anticipated beyond the incremental increase in soil loss, surface compaction, and potential contamination, as described in the Phase I EA (BLM 2003, Table 42). However, the majority of cumulative impacts to soil resources would be expected to be short-term and associated primarily with initial land disturbances associated with construction activities in the Salt Creek Basin related to upgrading existing infrastructure and adding new wells, roads, and pipelines.

5.2.7 Wetlands

No impacts to wetlands or riparian habitats would be anticipated for the Proposed Action; therefore, no cumulative effects would apply to this analysis.

5.2.8 Vegetation and Weeds

Removal of vegetative cover and disturbance of soils from cumulative projects may result in accelerated wind and water erosion, and an associated increase in sediment yield above natural

background levels in the short term. Following successful reclamation measures of the project area, native vegetation would be expected to re-establish. Cumulative disturbances delineated within the entire Salt Creek Oil Field (including disturbance existing before EOR development) were estimated at 4,900 acres in the Phase I EA (BLM 2003) and revised to 5,900 in this EA. Potential future projects including Powder River Basin Water Pipeline Project would increase anticipated cumulative surface disturbance to be approximately 6,000 to 6,200 acres.

Noxious weed populations would likely increase to some degree in the short term, as additional well, corridor, and facility sites are disturbed. Implementation of the NWMP (Appendix A, Phase V EA, BLM 2006b) during operations would serve to decrease to manageable levels or, in some instances, eliminate noxious weed populations in the proposed disturbed areas. The successful application of the NWMP would result in a decrease in such weed populations in the region as compared to projects and developments that do not have a similar plan in place. Therefore, the activities associated with the project would not contribute to the long-term increase in noxious weed populations in the region and no increase in cumulative impacts would be expected.

5.2.9 Terrestrial Wildlife

Potential cumulative impacts to terrestrial wildlife would primarily involve the incremental habitat fragmentation and loss throughout the region, as oil and gas development projects continue to be implemented. The increase in field infrastructure, human presence and activities, and ongoing projects' operations would continue to displace some terrestrial wildlife species more susceptible to disturbances than those species that are more likely to habituate to human activities and increasing surface disturbance. Loss of some animals also would occur. However, given the historic use by the oil and gas industry, relative habitat values, the existing levels of habitat fragmentation, ongoing habitat loss, and direct effects to individual animals occurring over the last 100 years in and near the Salt Creek Basin, the incremental cumulative impacts to wildlife would not be expected to significantly affect these populations.

5.2.10 Aquatic Biology

No adverse impacts to aquatic biological resources would be anticipated for the Proposed Action; therefore, no cumulative effects would apply to this analysis.

5.2.11 Special Status Species

5.2.11.1 Plants

No threatened, endangered, or sensitive plant species are known to occur in the project area. Habitat for these species is lacking for all but the sensitive species, Nelson's milkvetch. Habitat for this species is minimal, and occurs in limited areas. Environmental protection measures limiting development on steep slopes, where such habitat may occur, has been committed to by Howell (BLM 2003). Therefore, no cumulative impacts to special status plant species would be anticipated.

5.2.11.2 Terrestrial Animals

No federally listed wildlife species are known to occur in the area of the Proposed Action; therefore, no cumulative effects to federally endangered or threatened species would occur. Potential cumulative effects to the other BLM sensitive species examined for the Proposed Action would predominantly entail the incremental habitat fragmentation and loss throughout the region, as described for terrestrial wildlife species (Section 5.2.9).

5.2.12 Aquatic Species

No adverse impacts to sensitive aquatic biological resources would be anticipated for the Proposed Action; therefore, no cumulative effects would apply to this analysis.

5.2.13 Cultural Resources.

No additional cumulative impacts to cultural resources would be anticipated beyond the potential impacts to known or unknown cultural sites, as described in the Phase I EA (BLM 2003, EA #WY-060-04-001, Table 42, Section 5.2.1.7). The past use and disturbances associated with Salt Creek Oil Field do not preclude the possibility of intact buried cultural resource remains existing at depth as is suggested on site forms for some previously recorded sites. However, the mitigation and monitoring measures developed in the 2003 EA will minimize most potential cumulative impacts to significant cultural resources.

5.2.14 Range Management and Grazing Resources

Cumulative issues anticipated for range and grazing resources would parallel those discussed for the Proposed Action in Section 4.12. Cumulative grazing impacts would entail the incremental loss of livestock forage and reduction in associated AUMs throughout the project region until successful reclamation mitigation efforts restore or replace loss of livestock forage production.

5.2.15 Land Use

Potential cumulative impacts associated with regional land use would primarily involve cumulative effects to grazing, as discussed in Section 5.2.14. Other cumulative land use impacts would include the incremental increase in oil field infrastructure and use in and near the Salt Creek Basin.

5.2.16 Socioeconomics

No additional cumulative impacts to socioeconomic conditions would be anticipated beyond the beneficial increase in regional employment opportunities and tax base and the incremental increase in housing and other public services demands, as described in the Phase I EA (BLM 2003, Table 42, Section 5.2.1.8) and in Section 4.14 of the Phases III/IV EA (BLM 2006a).

5.2.17 Recreation

Minimal, if any, adverse impacts to recreational resources would be anticipated for the Proposed Action; therefore, no cumulative effects would apply to this analysis.

5.2.18 Visual Resources

Cumulative impacts to visual resources would be similar to those discussed for the Proposed Action in Section 4.16. An incremental increase in oil field infrastructure would introduce new visual features to the landscape, adding to the industrial character of the area. Some of the cumulative effects would be offset by the ongoing reduction in pump jacks and related facilities in the well field and by reclamation of obsolete disturbance areas.

5.2.19 Noise

No additional cumulative impacts to sensitive receptors from an incremental increase in noise levels would be anticipated beyond localized short-term increase in construction-related noise levels, as described in the Phase I EA (BLM 2003, Section 5.2.1.4) and long-term noise sources during project operation (Section 4.17 of this EA).

5.2.20 Transportation

No additional cumulative impacts to transportation would be expected beyond the incremental increase in traffic volumes during project construction and operation, as described in Section 4.18 of this EA. No adverse impacts to traffic safety would be anticipated for the Proposed Action; therefore, no cumulative effects would apply to this resource issue.

6.0 Consultation

Bureau of Land Management (BLM), Casper Field Office

- Patrick Moore, Assistant Field Manager, Minerals and Lands
- Kathleen Lacko, Planning & Environmental Coordinator: EA Project Manager
- Art Terry, Environmental Protection Specialist: Technical Reviewer
- Matt Halbert, Petroleum Engineer
- Shane Gray, Wildlife Biologist: Terrestrial and Aquatic Biology, Special Status Species
- Jude Carino, Archaeologist: Cultural Resources
- John Mesrobian, Lead Petroleum Engineer Technician
- Eve Bennett, Recreation Planner: Visual Resources
- Randy Sorenson, Realty Specialist: Reviewer

Project Applicant – Howell/Anadarko Petroleum Corporation

- Dave Applegate, Regulatory Advisor
- John Farrell, Environmental Health Specialist
- Jennifer Leinonen, Regulatory Analyst
- Danny Morse, Area Production Superintendent
- Ken Hendricks, Production Engineering Manager

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8.0 Appendix A

Applicant Committed Environmental Protection Measures (ACEPMs)

Environmental Parameter	**Potential Gross Impacts**	**Mitigation Measure**	**Potential Net Impact**
Air Quality	Localized degradation of air quality from fugitive dust due to construction activities (new well sites, roads, workovers, compressor stations, LACT modifications, new production and injector flow lines) vehicle travel on dirt roads. A localized increase in gaseous emissions from mobile sources of SOX, NOX, CO, soot, hydrocarbons from drilling rigs, vehicles, dozers, excavators, ozone from electric motors, etc. Small amounts of CO2 may migrate to surface in limited areas	Implement fugitive dust control (water spraying) as needed. Reclaim disturbed areas as soon as possible. Perform routine maintenance of equipment. Encourage carpooling to and from work sites. Ensure integrity of all well bores in project area. Install other devices e.g. horizontal bores, vertical shallow wells, or drains if needed	Short-term: minor increases in localized dust, gaseous emissions. Long-term: no major impacts. Potentially over 295 BCF of CO2 geosequestration over the life of the project is a beneficial impact. Impacts range from none in populated areas to negligible to minimal in remote areas.

Environmental Parameter	**Potential Gross Impacts**	**Mitigation Measure**	**Potential Net Impact**
Surface Water	Increased sedimentation of Salt Creek and drainages from runoff of disturbed sites during construction activities. Potential contamination with polluted (diesel fuel, oil) surface runoff. Potential changes in produced water quality or quantity that is discharged into Salt Creek.	Control surface disturbances within 500 feet of perennial streams. Protect riparian zones. Implement erosion and sediment controls (sediment ponds, silt fencing, geotextiles, etc.). Follow reclamation plan to ensure proper drainage. Provide secondary containment of all fuel storage facilities and SPCC program. Monitor water quality and flow of produced water discharged into Salt Creek and affected tributaries. Meet WYPDES limitations on discharges.	Slight, localized and temporary increases in sedimentation possible, but not major; No major hydrocarbon contamination anticipated. Produced water quality discharged to Salt Creek from Proposed Action expected to be of similar quality that is discharged to Salt Creek from current waterflooding operations. Long-term slight decrease in produced water discharged to Salt Creek not considered major. Long-term: no major impact.

Environmental Parameter	**Potential Gross Impacts**	**Mitigation Measure**	**Potential Net Impact**
Groundwater	Potential contamination of non-potable aquifers with produced water, hydrocarbon mixtures, or other hazardous chemicals. Contamination from fuel / lubricant spills. Contamination of shallow non-potable aquifers from Midwest sewage lagoon.	Design wells to within current industry standards; demonstrate mechanical integrity of wells. Set adequate surface casing and plug wells with cement at various depths. Use standard blow-out prevention equipment. Provide secondary containment of fuel storage areas and line bottom to protect groundwater. Implement SPCC program. Monitor groundwater at wells near sewage lagoon.	No major impacts in the short-term or long-term.
Human Health and Safety	Very low probability of CO_2seep in occupied areas.	Ensure integrity of all well bores in project area. Install other devices e.g. horizontal bores, vertical shallow wells, or drains if needed. Follow the CO2 Seep Containment Plan, as identified in Phases III/IV EA (BLM 2006a) Continue training with the Field Health and Safety Plan and the Rockies Emergency Response Plan.	None anticipated.

Environmental Parameter	**Potential Gross Impacts**	**Mitigation Measure**	**Potential Net Impact**
Topography and Landscape	Modifications to surface topography from excavation, cut and fill operations, and recontouring of sites from construction of new well pads, flowlines, and short access roads, and new CO2 facilities.	Reclaim and revegetate disturbed areas as soon as possible. Use geotextiles when grade >20%.	Long-term small scale changes in topography and landforms. No major impacts to topography and landscape.
Soils	Soil compaction, loss of fertility and erosion from construction activities (new well sites, roads, workovers, compressor stations, LACT modifications, new production and injector flow lines). Contamination from fuel / lubricant spills.	Implement erosion and sediment control plan and top soil stockpiling. Reclaim soils while phases / activities progress. Prevent or minimize surface contamination via secondary containment mitigation. Monitor until reclamation is successful	Short-term: some soil loss at construction sites and temporary disturbance of 2,495 acres. Mitigation and restoration of all soils except for 281 acres which is considered minor, as 655 acres of past disturbance will be reclaimed. Duplicate and unnecessary existing roads will be closed and reclaimed throughout the project.
Wetlands	No gross impacts are predicted as wetlands are limited in the project area.	Avoid wetlands whenever possible. Cross wetlands perpendicular to flow during dry conditions. Restore wetlands and wetland soils to pre-project conditions. Handle wetland soils selectively.	No major impacts in the short-term or long-term.

Environmental Parameter	**Potential Gross Impacts**	**Mitigation Measure**	**Potential Net Impact**
Vegetation and Weeds	Direct vegetation removal and retardation of growth and development.	Minimize vegetation disturbance and removal. Avoid disturbance to riparian areas. Reclaim and revegetate disturbed areas. Provide secondary containment. Implement NWMP.	Short-term: 2,495 acres of vegetation removed over a 10-15 year period. Long-term: 281 acres of vegetation removed; impact is minor, as 655 acres of past disturbance will be reclaimed. Duplicate and unnecessary existing roads will be closed and revegetated, a positive impact. Some temporary increase in weed population, no residual impact.

Environmental Parameter	**Potential Gross Impacts**	**Mitigation Measure**	**Potential Net Impact**
Terrestrial Wildlife	Removal of some grassland and shrubland habitat in the short-term; Displacement and destruction of some terrestrial wildlife within the immediate area of project activity.	Minimize project footprint of disturbance. Avoid disturbance to the Salt Creek riparian corridor as it is the most valuable wildlife habitat. Reclaim and revegetate disturbed areas as soon as possible. Construct power lines in accordance with APLIC standards. Retrofit power lines to APLIC standards when re-energizing lines or following incidents of bird mortality.	Removal of an average of 250 acres per year of some grassland and shrubland habitat in the short-term that will be reclaimed. Short-term: possible reduction in some terrestrial wildlife activity in immediate areas of disturbance; not a major impact. Long-term: no major impacts as a result of 281 acres of grassland and shrubland habitat lost, as 655 acres of past disturbance will be reclaimed. Power lines represent a low incremental impact to raptors, moderate risk to individual birds, long-term benefit of retrofitted structures.

Environmental Parameter	**Potential Gross Impacts**	**Mitigation Measure**	**Potential Net Impact**
Aquatic Biology	Localized, temporary increase in sedimentation from runoff of construction areas, new roads and well pads may negatively impact aquatic life in Salt Creek. Hydrocarbon / hazardous material spills into drainages / Salt Creek. Slight reduction in produced water discharged to Salt Creek in the long-term may reduce amount of water available in the creek.	Implement erosion and sediment control program to minimize sediment inputs to Salt Creek. Provide secondary spill containment, SPCC. Protect riparian area as buffer zone. Monitor of grazing impacts.	Existing aquatic life adapted to wide fluctuations in flow, temperature, and TSS in Salt Creek. Produced water discharge reduction not major impact on amount of water in Salt Creek. No major short-term or long-term impact.
Threatened or Endangered Species	Disturbance to T&E species or habitats.	None necessary.	No major impact as there are no known occurrences of plant or animal T&E species within the project boundary.
Cultural Resources	Disturbance of archaeological resources and artifacts from construction activities.	Implement cultural resources mitigation program if artifacts are uncovered during construction operations and notify BLM authorities.	No major impacts.

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Range Management	Temporary loss of AUMs. Slight possibility of injury to individual livestock.	Reclaim disturbed sites as soon as possible. Fence sites as needed to prevent livestock access. Coordinate with grazing leaseholder to mitigate any damages.	Short-term reduction in AUMs. No major impact.
Socioeconomic Conditions	Increased employment opportunities; increased tax and/or royalty revenues for county, state and federal government. Slight reduction in grazing land available for ranchers within the concession. Increase in traffic.	Provide employee training programs. Reclamation/revegetation of disturbed habitats while phases progress. Promote driving safety, training, car pooling.	Positive impact. Short-term: increased job availability; Long-term: increased job availability and extended employment; positive tax revenues. No major impact.
Visual Resources	Improved visual quality as a result of removal of existing unused equipment, power lines, and roads.	Bury flowlines and reclaim corridors. Reclaim temporary work areas as soon as practical. Paint buildings an approved BLM-specified color.	Long-term benefit as pumping units and unused equipment will be removed.

Environmental Parameter	**Potential Gross Impacts**	**Mitigation Measure**	**Potential Net Impact**
Noise	Localized increase in noise from construction & drilling activities, compressor stations; increased vehicle travel.	Provide personal protective equipment and localized noise controls. Site equipment away from sensors. Employ natural screens. Avoid running equipment during school hours if within close proximity to schools. Log and investigate complaints of noise.	Short-term: minor increases in localized noise.
Transportation	Increased traffic resulting in increased road wear.	Encourage carpooling to and from work sites.	Short-term minor impacts.