2.0 Proposed Actions and Alternatives

2.1 Proposed Action

Howell is proposing development of Phases III/IV of Salt Creek Oil Field CO_2 EOR Project in Natrona County, Wyoming (Figure 2-1). Phases III/IV would involve continued injection of CO_2 into the WC2 formation. If approved, construction for Phases III/IV would begin in February 2006 and extend to December 2006 with injection of CO_2 to begin in the third quarter of 2006.

2.1.1 Project Overview

This EA analyzes the proposed Phases III/IV expansion, encompassing approximately 2,182 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of CO_2 and water into the reservoir rock to displace liquid hydrocarbons towards production wells where it is withdrawn and further processed.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 Phases III/IV CO_2 injection 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. Phases III/IV field development facilities would include injection and production wells, injection and production pipelines, production test and treating facilities, recycle compressors (including one new compression station), injection manifold headers, and a new electrical substation 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 has been pilot tested within Salt Creek Oil Field and is being successfully implemented for Phases I and II. Howell currently estimates Phases III/IV would produce approximately 3,700 additional BOPD or 22 MMBO over the life of the project using CO_2 injection, in accordance with the production forecast shown in Figure 2-2. An overview of reservoir modeling results for Salt Creek Oil Field suggest that CO_2 EOR could ultimately increase daily production rates by a magnitude of 5 for all project phases, and ultimately increase oil recovery from the entire field by as much as 150 MMBO, extending the life of the field 30 to 40 years.

2.1.1.1 CO_2 Flooding Process

CO_2 flooding is a proven technology that was first attempted in the Mead Strawn Field near Abilene, Texas in 1964. Most commercial CO_2 injection projects have been undertaken since 1980 with an increasing number of projects implemented since then.

EOR using CO_2 injection removes oil left behind by both conventional production techniques and secondary recovery efforts in reservoir rock through either miscible or immiscible interactions with liquid hydrocarbons. Fluids that are miscible will completely mix together into a single fluid, whereas immiscible fluids will not mix together but remain as separate fluids (e.g., oil and water). Under certain conditions of temperature, pressure, and composition, CO_2 can be injected into reservoir rock as a liquid and will become miscible with oil, thereby reducing the viscosity of the fluid and improving the ability of oil to flow through the reservoir rock.

Figure 2-1 11x17

Figure 2-2 81/2x11??

Subsequent water injection then removes oil that was left behind by previous secondary recovery techniques, such as waterflooding.

Howell conducted industry standard laboratory tests (i.e., slim-tube experiments) to determine the temperature and pressure conditions at which CO_2 miscibility is predicted to occur for the WC2 within Salt Creek Oil Field. For the WC2, miscibility is predicted to occur at pressures above 1,200 pounds per square inch (psi) with temperatures at 100º F. Howell has determined that the maximum bottomhole injection pressure at the depth of the WC2 (1,800 feet) is 1,500 psi with an average reservoir pressure of 1,300 psi and an average temperature of 105º F. The WC2 reservoir pressure is sufficient to allow for operation of the CO_2 flood above minimum miscibility pressure. In order to maintain sufficient reservoir pressure, production wells would be configured as flowing wells and back pressure would be maintained on the formation through surface chokes. This operational set-up would allow Howell operations personnel to monitor and adjust well conditions, as necessary, in an effort to maximize oil recovery.

Phase III is located north of the populated areas of Midwest and Edgerton. The Phase IV area examined in the EA surrounds the town of Midwest and to the west of Edgerton (Figure 2-1). Although the towns of Midwest and Edgerton are located in or adjacent to Phases III/IV, the Proposed Action does not entail CO_2 injection beneath the towns. Howell proposes to isolate and monitor the populated areas, as part of the Proposed Action, installing water injection wells around the towns of Midwest and Edgerton and the updip portion of the WC2 reservoir to inhibit CO_2 migration in the WC2 underlying the towns. To achieve reservoir isolation, Howell would implement a two-fold system utilizing both low-pressure production wells to gather the CO_2 and high-pressure water injection wells to divert any CO_2 migration. This process would create a low-pressure sink that would draw CO_2 from the periphery of the development area and prevent it from migrating outside of the development area. The pressure sink effect would be enhanced through the use of a ring of high-pressure water injection wells that would be installed between the development area and the towns. This water injection would provide a “curtain” of high-pressure resistance to force any CO_2 back towards the production wells. This high-pressure water injection ring or water curtain would be located along the northern, eastern, and southern perimeters of Midwest. In addition to this two-fold system for reservoir isolation, Howell would shut-in any active WC2 wells located between the water injection ring and the towns of Midwest and Edgerton in an effort to ensure a uniformly high reservoir pressure underneath the towns. Figure 2-3 illustrates the layout of the water curtain and production system around Midwest.

In the reservoir area west of Midwest, Howell intends to continue its existing waterflood operations, although the injection and production in this area would be at levels slightly lower than those proposed for the CO_2 flood development to the east.

Numerous measures would be undertaken to monitor the effectiveness of the CO_2 confinement techniques. First, the pressures in the reservoir would be monitored routinely and checked against production and injection volumes to alert Howell to any potential fluid losses outside of the development area. Second, any active WC2 and WC1 wells in the waterflood areas would be monitored for the presence of CO_2. This would serve as a direct subsurface indicator of a possible breach in the water curtain. Finally, Howell would undertake temperature surveys in the

Figure 2-3 CO_2 Contain Plan for Midwest

monitoring wells to check for any anomalous cooling effects, which might indicate the presence of CO_2 and a possible breach in the water curtain.

Howell also would design a "Monitor Fence" to be installed around each town. This Monitor Fence would be designed using the same geologic process Howell would use for CO_2 seeps. The Monitor Fence would consist of monitoring wells designed to measure downhole temperature and pressure in the WC2, WC1, and overlying shale formations and surface air monitors. These systems would be integrated into Howells' automation system and operational practices. The Monitor Fence plan is more fully described below and illustrated on Figure 2-3.

The monitoring wells would include approximately eight new Niobrara shale wells spaced around the perimeter of Midwest that would be utilized to help detect the presence of CO_2 within the shale. These wells would be drilled to an approximate depth of 800 feet from existing well pads minimizing any potential new disturbance. The shale wells would be monitored for surface pressure, surveyed periodically for downhole temperature anomalies, and utilized to help capture CO_2 that might escape from the main development area.

Additional pressure and temperature monitors would be installed in approximately 14 existing abandoned wells utilizing fiber optic technology. The fiber optics cable would be cemented in place as part of the abandonment process but would be accessible for electronic monitoring. The fiber optics cable would provide real-time pressure and temperature data along the entire length of the cable. Howell is preparing to test this technology and would implement it if it proves successful.

Horizontal monitoring wells would be drilled south of town in the WC2 and WC1 formations extending under the town of Midwest. Howell would apply for permits to drill three horizontal bores under the town of Midwest approximately 40 to 80 feet below surface. These bores would be drilled if CO_2 migration is detected by the Monitor Fence. The horizontal monitoring wells and bores would be utilized to capture and contain CO_2 that might escape from the main development area through the water curtain (see Figure 2-3).

Surface air monitors designed to detect the presence of potentially harmful concentration levels of H_2S and CO_2 are currently in place around the towns of Midwest and Edgerton. Howell intends to evaluate the current placement and requirements for any additional air monitors.

Howell is developing an emergency response plan, in coordination with the towns of Midwest, Edgerton, and local and county emergency services personnel. This plan would be integrated into Howell's operational procedures. Once completed, Howell will furnish a copy to BLM for its records.

2.1.1.2 Well Utilization Plan

The Proposed Action for developing Phases III/IV with 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 92 injection wells and

Figure 2-4 Injection 11x17

Figure 2-5 Production 11x17

75 production wells for a total of 167 wells (Figures 2-4 and 2-5). Up to 8 additional new wells may be required to replace existing wells, totaling 14 new wells estimated. Table 2-1 provides a summary of wells proposed for use in the Phases III/IV areas.

Howell plans to equip all injection, production, and monitoring wells similarly. Beginning at the surface, each well would have a new wellhead configuration, including a new single-master valve, bonnet, and casing head. Downhole tubing would be protected with CO_2-resistant material, such as an internal coating or a fiberglass lining. Nickel-plated packers equipped with stainless steel on-off tools would be set approximately 50 feet above the pay zone perforations. Internally and externally protected tail pipe would extend below the packer along with at least one profile nipple constructed of CO_2-resistant materials. Corrosion-inhibited water would be circulated into the tubing-casing annulus for casing protection. A generic schematic illustrating a typical wellbore configuration was provided as Figure 7, in Chapter 2 of the Phase I EA. Injection wells would be permitted, as required through the Wyoming Oil and Gas Conservation Commission (WOGCC). Mechanical integrity tests or packer tests would be performed and reported, as required, to the WOGCC.

Injection and flow to or from the well would be controlled with remotely actuated chokes. The automation controls and chokes would be installed at the header with protection from extreme weather conditions provided by a small building. Pressure transducers would be mounted on both the tubing and casing to continuously monitor wellbore conditions. Excessive casing pressure, an indication of a potential tubing or packer failure, would trigger an automatic alarm. This automation would allow for more efficient well operation through continuous monitoring and would reduce vehicle activity.

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-opened

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 WC2 and isolate the other horizons. Each wellbore, active and abandoned, that penetrates the WC2 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 I/II 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.

Table 2-1 Summary of Phases III/IV Well Utilization

Utility	Phase III	Phase IV	Total
Monitoring	4	5	9
Injection (CO_2)	42	19	61
Injection (Water)	3	23	26
Injection (New)	3	2	5
Production	42	32	74
Production (New)	1	0	1
Plugged & Abandoned	67	119	186
Temporarily Abandoned	1	6	7
Waterflood	0	15	15
Grand Total	**163**	**221**	**384**

New Wells. Howell's plan to complete the Phases III/IV pattern development includes the drilling of 6 new wells, although up to 8 additional wells may be required (14 new wells estimated). Each well would be drilled to an approximate depth of 2,500 feet from the surface, and an individual Application for Permit to Drill (APD), site plans, and plats would be submitted to the BLM for each well, as required. Howell also would obtain an APD to drill 8 shallow shale wells, a WC1 horizontal and a WC2 horizontal well under the town of Midwest in conjunction with the "Monitor Fence" plan, as described in Section 2.1.1.1. New wells would be constructed according to plans previously approved and implemented in the Phases I/II areas and would provide the basis for downhole tubular design and site construction methods.

Abandoned Wells. Howell plans to re-enter and reactivate approximately 80 previously abandoned wellbores in the Phases III/IV area. Howell also anticipates having to re-plug approximately 142 additional existing abandoned wells. The work procedures for re-entry would follow plans and procedures approved and implemented for the Phases I/II areas.

2.1.1.3 Facility Plan

The surface facilities required for the implementation of Phases III/IV would be similar to those installed under Phases I/II and would include much of the existing waterflood facilities. The primary differences would be the use of materials that are compatible with CO_2 and can withstand higher working pressures. Figures 2-4 and 2-5 show the layout of the Phases III/IV injection and production systems, respectively. These figures illustrate the proposed flow line and injection line layout, as well as locations for production test and treating facilities, recycle compressors, and injection manifold headers. Under Phases III/IV, the existing system would be expanded to accommodate newly proposed production and injection wells. New manifolds would be added for the collection of wellhead production, well testing, and the distribution of injection CO_2 and water. New pipeline sections would be added in order to connect the new manifolds to tie-in points already established in the existing gathering/distribution system. Most of the current gathering and injection systems for existing waterflood activities would be replaced by the new system. A new CO_2 recycle compression station would be constructed to expand the current capacity and would include pipelines connecting to the existing compressor station from Phase I (see Figure 2-1).

The proposed routing of the injection and production lines reflects the use of existing corridors, 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 MSUP.
- Necessary departures from the original scope are approved and properly documented.

Howell's proposed expansion for Phases III/IV includes the continued utilization of existing roads and the existing Lease Automatic Custody Transfer (LACT) 4 and LACT 5 production facilities. It is not anticipated that the produced water discharge volumes at the LACTs 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 Wyoming Department of Environmental Quality (WDEQ) under the established 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.

Production System. New state-of-the-art fiberglass production flow lines would be installed for each production well to connect the wells to existing test and bulk separation facilities (satellite facilities). The existing equipment at these collection facilities would be replaced or upgraded to be compatible with CO_2 production. Gas and CO_2 production would be separated and collected in the high-pressure (HP) system at approximately 350 psi. Oil and water would be transported to existing processing facilities via new fiberglass flow lines, which would be constructed, where feasible, along existing roads and existing flow lines.

Produced oil and water arriving at the LACT 5 processing facility would flow into existing internally coated low-pressure (LP) separators designed to remove water and additional entrained gas. The separated oil and water would be placed into the existing gunbarrels (i.e., large oil tanks) and water tanks, respectively. Hot water would be introduced into the separated oil to enhance further oil-water separation and help break up any emulsions formed during production. Gas separated at the LP separator would be collected with the existing flash gas electrical compressor located within the processing facility and compressed into the 350-psi HP gathering system. Gas separated at the gunbarrels and vapors from the oil and water tanks would be

collected by the existing vapor recovery unit (VRU) and discharged to the flash gas compressor for collection into the HP gathering system.

Existing and new electric recycle compressors would collect the HP gas (350 psi) from a common trunk line and recompress the CO_2 to 1,400 psi, discharging into the main CO_2 supply trunk line that feeds the injection distribution system. The current production facility areas were selected as the sites for compression based on the access to a sufficient power supply and the availability of previously disturbed surface area.

Implementation of Phases III/IV would include the installation of 10 additional production test headers or stations and the construction of a new compressor station (see Figure 2-5 and 2-1, respectively). As with previous field expansions, wellhead production volumes would be transported to the manifold stations via new fiberglass flow lines. Commingled production from the manifold stations would be routed to the LACT 5 facilities through internally coated steel flow lines. Each of the production manifold stations also would include the appropriate well testing facilities, where wellhead production would be separated into its components streams and measured.

Injection System. The WAG injection process would continue to be used for Phases III/IV. The WAG process involves alternating injection wells between water and gas injection on either a time or volume basis. Cycles could be as rapid as weekly or as long-term as annually, depending on the particular oil reservoir being flooded.

The injection system design for Phases III/IV follows the same basic approach as with previous Salt Creek development phases, including the use of centralized injection flow control at the manifold stations. As with other phases, the injection manifold stations would distribute either CO_2 or water to individual wells using remotely actuated valves to select the injected fluid. Well injection volumes would be metered at the manifold station, one meter per well. A total of 10 new injection manifolds would be added under this proposed expansion. Injection fluids (i.e., CO_2 and water) would be delivered to each manifold station via newly constructed pipeline segments connected to the existing water and CO_2 distribution systems (see Figure 2-4 and Table 2-2).

Gas System. As with Phases I/II, produced CO_2 gas for Phases III/IV 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 associated with Phases III/IV would be supported by a new recycle station and by the existing facilities installed during previous phases. Howell's current forecast projects the requirement for additional recycle compression beyond existing capacity of the LACT 5 station by the end of 2006. A new compressor station would be located approximately 3 miles south of the LACT 5 station on the east side of Highway 387 across from the LACT 10 production facility (see Figure 2-1). The compressors would be electrically driven motors requiring a facility substation and distribution lines for power supply (see Figure 2-1). This small electrical substation at each recycle compression facility simply steps down the distribution voltage of 35,500 volts from the

Table 2-2 Estimated Surface Disturbance Area for EOR Phases III/IV

Category	Description	Quantity	Previously Disturbed	New Disturbance	Long-term New Disturbance	Temporary Use Disturbance	Comments
		Used	(acres)	(acres)	(acres)	(acres)	
Wells							
	Work on Existing	157	56.3	0.0	0.0	0.0	
	Rework of PA Wells	186	66.7	0.0	0.0	0.0	A
	New Drill Wells (6)	14	0.0	5.0	5.0	15.1	A, B
	Monitoring Wells						
	Niobrara	8	2.9	0.0	0.0	0.0	
	Monitoring Wells	14	5.0	0.0	0.0	0.0	
	Horizontal Monitors	2	0.7	0.0	0.0	0.0	
	Horizontal Bores	3	1.1	0.0	0.0	0.0	K
	Access Roads to New Wells	24			2.0		
Subtotal			**132.7**	**5.0**	**7.0**	**15.1**	
Injection Headers			**91.7**	**5.7**	**0.5**	**0**	C, D
Production Headers			**79.7**	**5.1**	**0.0**	**0**	A, C, E
Trunk Lines							
	CO_2 Trunk Lines	19	17.8		0.0	0.0	F. G, H
	H_2O Trunk Lines	21	19.8		0.0	0.0	
	Production Trunk Lines	11	14.8		0.0	5.7	
	Suction Line to Compressor	1	0.0	8.6	0.0	0.0	
Subtotal			**52.4**	**8.6**	**0.0**	**6**	
Compressor Station							
	LACT 10 Station	1	0.0	7.7	7.7	5.7	
Subtotal			**0.0**	**7.7**	**7.7**	**6**	
Electrical							
	Substation	1	0.0	5.6	5.6	5.7	
	New Roads	1		0.7	0.7		
Subtotal			**0.0**	**6.3**	**6.3**	**6**	
Electrical Lines							
	PP&L's T-line to Substation	12	0.0	13.8	0.002	7.3	J
	Dist Line to West Feed	20	0.0	0.004	0.004	4.5	J
	Dist Line to Center Feed	40	0.0	0.008	0.008	9.0	J
	Dist Line to Compressor	116	0.0	0.02	0.02	26.6	J

Table 2-2 Estimated Surface Disturbance Area for EOR Phases III/IV

Category	Description	Quantity	Previously Disturbed	New Disturbance	Long-term New Disturbance	Temporary Use Disturbance	Comments
	Production Headers (Poles)	80	0.0	0.02	0.02	14.7	F, I
	Injection Headers (Poles)	80	0.0	0.02	0.02	14.7	
	New Roads to Facilities	3	0.0	0.02	0.02	0.0	
Subtotal		**348**	**0**	**14**	**0.1**	**77**	
Staging Area		1	0.0	0.0	0.0	5.7	
Totals			**356.5**	**52.3**	**21.6**	**114.9**	
Total New Disturbance				**167.2**			
Total New Short-Term Disturbance				**145.6**			

Comments:

A - Well count increased to allow for additional unplanned wells.
B - After drilling, production would actually only use a 125' x 125' pad. (250 x 250) – (125 x 125) = 375 x 125 (1.07 acres of temporary disturbance).

C - 3-inch fiberglass lines would run on existing ROWs except for new wells and headers.

D - The only long-term new disturbance would be for the injection header building locations and new wells.

E - Production headers would be replacements for current waterflood headers except for C6 and B7.

F - Assume no long-term disturbance for all trunk lines and flow lines, as they would be reclaimed.

G - When two or more lines have the same ROW, they would be co-trenched to minimize the disturbance area.

H - 40-foot ROWs would apply, extending to a maximum of 80-foot ROWs where multiple, larger-diameter steel lines would be required.

I - Allow for 8 poles per header, 9-square-foot (3'x3') long-term disturbance per pole.

J - Allow 9-square-foot long-term disturbance per pole; approximate 200-foot spacing between poles.
K - Horizontal bores would only be installed if CO_2 migration is detected. The three horizontal bores may be bored from one existing well location.

electric distribution line to the working voltage of 4,160 volts to power the individual recycle compressors. A smaller transformer also steps down the distribution voltage to 480 volts for the supporting utility systems. This "stepdown substation" would be similar to that installed at the LACT 5 Compressor Station during Phase I.

The design, construction, and operation of the new compressor station would be similar to the LACT 5 station with one unit installed during 2006 and expansion capability for up to five 40 million cubic feet per day (MMCFD) units. The CO_2 gathering and injection trunk lines would be extended from LACT 5 to transport produced gas and recycled CO_2 injection gas to and from the LACT 10 compression station. Recycled CO_2 injection gas would be commingled with the discharge from LACT 5 into a common pipeline for distribution into the field. Howell also has updated its scenarios of releases and air dispersion modeling analyses of CO_2 and H_2S through a model calibration effort (see Appendix A).

The proposed CO_2 trunk line extending from the new compressor station north into the Phase IV area would be constructed similarly to the existing trunk line constructed for Phase I. The new pipe would cross the Salt Creek drainage (see Figure 2-1); however, Howell proposes to “bridge” the channel with the pipe, avoiding direct surface disturbance to the stream bed, channel, or associated riparian areas. As detailed in Section 2.1.6.2 of the Phase I EA (BLM 2003a), Howell also would minimize excessive sediment load to surface water drainages and avoid wetlands, streams, and riparian areas. Where such areas are unavoidable, the appropriate permits would be obtained and every effort would be made to minimize suspended sediment and potential contaminant loads to surface water. Construction at drainages would be limited to periods of low flow, and channel crossings would be made perpendicular to the channel.

2.1.1.4 Ancillary Facilities

Access Roads

Given the existence of an extensive network of access roads in Salt Creek Oil Field, a minimal number of new access roads would be required for the Phases III/IV development. New access roads only would be necessary for the 6 to 14 new drill wells under the Proposed Action, resulting in approximately 2 acres of new surface disturbance for a maximum of 14 new wells. 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 Phases III/IV Project.

Electrical Substation and Connecting Lines

A new electric substation would be constructed as part of the Proposed Action to meet the electrical requirements of Phases III/IV development, including the new recycle compressor station located across from LACT 10. The substation, identified as Claim Jumper Switchyard, would be located southwest of the town of Midwest in Section 34 (see Figure 2-1) and would consist of two portions, one owned by Howell and the other by Pacific Power & Light (PP&L). The total disturbance area would be 350 feet x 700 feet, or 5.6 acres. Each portion of the substation would be fenced separately, and each would contain the equipment necessary to safely supply electrical power to Salt Creek Oil Field. The substation would be accessed from the

existing road, with only a short section of new road being necessary. Power would be supplied to the electrical substation from PP&L's main 230-kV transmission line with a separate return line to the main line (see Figure 2-1), totaling approximately 1.0 mile of transmission line ROW. PP&L would be responsible for the construction and operation of the 230-kV transmission and 34.5-kV distribution underbuild to the Claim Jumper Switchyard from their main line. An additional 6.7 miles of new, 34.5-kV distribution lines would extend from the substation into Salt Creek Oil Field to service the new compressors. Howell would own, operate, and maintain the 34.5-kV distribution lines from the substation into Phase IV. Electric lines would be constructed in accordance with the standards for raptor (i.e., bird of prey) protection outlined in APLIC (1996) and referenced in the Master Surface Use Plan (MSUP) for Salt Creek and South Salt Creek Units.

2.1.2 Disturbance Estimates

Operations that would result in surface disturbance would include the re-working of existing wells on previously disturbed sites and construction of 1) drilling pads for new wells, 2) new flow lines and injection lines, 3) limited new access roads, and (4) production facilities. Surface disturbance would be either short-term (during construction and site reclamation) or long-term (during or beyond the life of the project).

New construction for Phases III/IV would be sited to incorporate existing facilities to the greatest extent possible. Table 2-2 provides a summary of disturbance estimates for Phases III/IV.

New wells would initially require a 250-foot x 250-foot pad for drilling operations. After completion, the well pads would be reclaimed, resulting in a 125-foot x 125-foot pad. Total long-term disturbance from new drilling activities would be approximately 5.0 acres.

New production collection buildings and flow lines would replace existing facilities and parallel the existing lines and roads to the extent possible. Fiberglass flow lines (3 inches in diameter) would be buried approximately 36 to 48 inches below the ground surface. New injection header buildings would be located on existing disturbance, where possible, and would consist of 20-foot x 30-foot pre-fabricated metal buildings. The total long-term disturbance for new buildings is projected to be approximately 0.5 acre.

The new compression station would be located to take advantage of existing roads and designed similarly to the existing facility located adjacent to LACT 5. The total long-term disturbance is estimated to be 7.75 acres based on a 450-foot x 750-foot footprint similar to actual acreage utilized at the LACT 5 station. The trunk line extensions would be installed within a common corridor utilizing a 60-foot construction ROW. Long-term disturbance for the trunk line extensions would be 5.0 acres assuming a 90% revegetation success rate.

Trunk lines are typically steel pipelines that either distribute or collect fluids for separation/processing or injection. These lines vary in size from 6 to 12 inches in diameter and would be trenched and buried 36 to 48 inches below the ground surface. Typically, 40-foot ROWs would be required for flow lines; however, the larger-diameter, steel trunk lines should require an 80-foot ROW to allow for multiple lines in the same corridor and to provide flexibility for pipe construction (e.g., poly liner installation, below-grade welding). This ROW requirement

parallels the approach and methods implemented for the Phase II EOR development. Areas would be reclaimed in accordance with Howell's reclamation plan, assuming a 90% revegetation success rate for long-term disturbances associated with trunk lines and flow lines.

Estimated surface disturbance associated with new access roads to the 6 to 14 new well sites would be approximately a maximum of 2 acres. New electric power lines to new production and injection header stations would result in an estimated 77.0 acres of short-term disturbance and 0.1 acre of residual long-term disturbance. This long-term estimate is based on approximately 9 square feet of remaining surface disturbance in the long term for each of the estimated 160 new power distribution poles.

Total disturbance estimates for Phases III/IV would be 145.6 acres for new disturbance that would be reclaimed in the short term and 21.6 acres of new disturbance that would result in long-term surface disturbance (see Table 2-2).

2.1.3 CO_2 Seep Containment Plan Summary

During 2004 and 2005, minor amounts of the CO_2 injected into the WC2 reservoir seeped to the surface in a small, confined area within Phase I (T40N, R79W NE ¼ S14) (Figure 2-6). Of the 150 MMCFD of CO_2 injected, an average of 12 thousand cubic feet per day (MCFD) has been recorded surfacing only in this limited area of Phase I, which equates to 0.008% of the total CO_2 injected. Howell initially eliminated a number of the seeps by performing remedial well work and continues its efforts to ultimately eliminate all of the seeps occurring from the CO_2 injection in the WC2. However, to ensure the integrity of the Proposed Action, Howell is proposing to implement a number of containment and monitoring procedures. In addition to these measures, Howell also completed a dispersion modeling analysis to determine potential downwind concentrations occurring as a result of the reservoir seep or a well blowout. (see Appendix A).

Howell is developing a process based on geological review to identify areas potentially susceptible to CO_2 seepage. The first step in this identification process is to identify major faults by integrating the surface and subsurface features. The surface geology is mapped using outcrop locations in conjunction with fault and fracture characterization. The subsurface geology is mapped using wireline well data and 3D seismic information. The fault and fracture characterization typically includes the following: orientation, geometry, mineralization, density, and offset. This geologic information will then be used to help predict areas where CO_2 seeps may occur.

Remedial Work on Existing Wells: Remedial well work on existing wells is the first step to reducing or eliminating CO_2 seeps. Howell intends to examine all existing wells located within the Phases III/IV areas in an effort to determine which wells need to be repaired and, if warranted, perform such repairs. Howell also may take additional steps such as pressure testing the casing to ensure well integrity, or conducting a cement bond evaluation.

Figure 2-6

Subsurface Containment: In the event well remediation does not fully address CO_2 seepage, Howell would implement the following steps, as necessary:

- Install shallow vertical wells (between 100 and 800 feet below ground surface) that would be completed in naturally fractured zones.
- Install a horizontal bore that would be drilled approximately 20 to 80 feet below a CO_2 seep.
- Install drains in or near natural draws, as this appears to be the primary area where the CO_2 seeps surface.

For both the shallow vertical wells and horizontal bore, Howell would install pumps at the lowest available point to remove shale fluids displaced by the CO_2. These fluids would be collected and processed, along with the CO_2 flood-produced fluids at a nearby LACT battery. Liquids collected by drains in or near natural ravines would be removed by vacuum truck and transported to a nearby LACT battery for processing. CO_2 recovered during these procedures would be gathered into a low-pressure system and compressed by blowers into the main CO_2 recycle system. Howell is currently fencing prominent CO_2 seeps to restrict human and animal access directly into the seep area.

Howell plans to continue to investigate and evaluate new technology and will update the existing CO_2 Seep Containment Plan design, as necessary. In this ongoing effort, Howell also will continue efforts to integrate subsurface 3-D seismic data and surface geology mapping. Any such changes would be integrated into the Plan. Howell will continue to communicate directly with the BLM and the towns of Midwest and Edgerton regarding any changes to the Plan.

2.1.4 Applicant Committed Environmental Protection Measures

Howell initially developed a number of Applicant Committed Environmental Protection Measures (ACEPM) for Phase I (BLM 2003). These measures also applied to Phase II and will be committed to as part of Phases III/IV. Additional protection measures developed and incorporated into the Phases III/IV Project include the following:

2.1.4.1 CO_2 Seep Containment Plan

The CO_2 Seep Containment Plan is summarized above in Section 2.1.3. This measure was developed to address existing seeps for the Phase I expansion and potential future CO_2 seeps, if warranted. To the extent required, this measure shall be applied during development of Phases III/IV.

2.1.4.2 Livestock Grazing Coordination Measure

Howell would coordinate with the grazing lessee for the Phases III/IV area to discuss and review options to minimize grazing impacts from the Proposed Action with the overall goal of resting reclaimed areas from grazing for a 2-year period, where practicable and feasible. Options may

include: 1) temporary fencing of reclaimed areas; 2) providing alternate grazing pastures; or 3) providing supplemental livestock feed. Howell and the grazing lessee would develop a mutual agreement as to the specific option or options to be implemented.

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/II areas. Currently, about 7,000 BOPD is being produced, with about 3,000 BOPD attributed to CO_2 injection activities. Oil production is expected to increase marginally by the end of 2006, as Phases I/II production from CO_2 injection activities comes to full production estimates. An estimated 50 MMBO remains to be recovered under the No Action Alternative for the entire field, as compared to an estimated 22 MMBO recovered by CO_2 EOR in the Phases III/IV area only and compared to 150 MMBO 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.