KerrMcGee

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Kerr-McGee Oil & Gas Onshore LP
1099 18th Street, Suite 1800
Denver, Colorado 80202
720-929-6000 Fax 720-929-7000

May 6, 2010

Mr. Robert Chesson
Colorado Oil & Gas Conservation Commission
1120 Lincoln Street, Suite 801
Denver, CO 80203

RECEIVED
MAY 07 2010
COGCC

Re: Remediation Workplan
Kerr-McGee Oil & Gas Onshore LP
HSR-Blank 15-5/HSR-Cabral 16-5
SWSE 5-T3N-R66W
COGCC Remediation # 3562
Weld County, Colorado

Dear Mr. Chesson:

Enclosed please find a remediation workplan, prepared by LT Environmental for the subject site. A carbon slurry injectate comprised primarily of BOS 200 was selected as the groundwater remediation option. We are eager to move forward with the remediation efforts. If you approve of the remediation work, please indicate so by signing and dating below.

Feel free to contact me at 720-929-6726 if you have any questions regarding this information.

Sincerely,

Kerr-McGee Oil & Gas Onshore LP

Paul D. Schneider, P.G.
Staff Environmental & Regulatory Analyst

Attachment

cc: Mr. Mike McKee, LT Environmental

COGCC Approved: _____ Title: EPS Date: 5/7/10

COMPLIANCE / ENGINEERING / REMEDIATION

LT Environmental Inc.
4600 W. 60th Avenue
Arvada, Colorado 80003
T 303.433.9788 / F 303.433.1432

May 4, 2010

Mr. Paul Schneider
Kerr-McGee Oil and Gas Onshore LP
1099 18th Street, Suite 1800
Denver, Colorado 80202

Re: Proposed BOS 200® Injection Program
HSR-BLANK 15-5 / HSR CABRAL 16-5
Weld County, Colorado

Dear Mr. Schneider:

LT Environmental, Inc. (LTE) is pleased to present this Scope of Work (SOW) for the HSR-Blank 15-5 / HSR Cabral 16-5 tank battery (Site) remediation program. The proposed BOS 200® injection program described in this SOW is the second phase of remediation at the Site. The first phase of remediation work included source removal through soil excavation. The excavation was described in the Form 27 submitted to the Colorado Oil and Gas Conservation Commission (COGCC) in November 2005. Recent groundwater analytical results for benzene, toluene, ethylbenzene, and total xylenes (BTEX) indicate that further remediation efforts are needed to achieve groundwater remediation goals at this Site. LTE believes the BOS 200® injection program is the most efficient and cost effective means of achieving groundwater remediation goals. A detailed SOW for the proposed BOS 200® injection program is provided below.

REMEDIATION PROGRAM DESCRIPTION

BOS 200® Injection Details

The objective of this SOW is to describe tasks associated with the proposed injection program that is designed to remediate petroleum impacted groundwater at the Site. Source area soil removal has been completed at the Site; however, dissolved phase petroleum hydrocarbon impacts remain in the groundwater.

A carbon slurry injectate comprised primarily of BOS 200® was selected as the groundwater remediation option based on site conditions, including groundwater elevation, vertical distribution of contaminants identified during site assessment activities, lateral extent of contaminants, geologic conditions, and the physical/chemical properties of the contaminants. The BOS 200® product is designed to enhance hydrocarbon degradation by capturing the hydrocarbons in a carbon matrix and promoting microbial activity. The BOS 200® injectate is comprised of activated carbon that is inoculated with bacteria and placed in a water based matrix containing nutrients and sulfate.

The injectate is prepared by mixing BOS 200® with cultured bacteria and clean, potable water. BOS 200® is designed for in-situ treatment of petroleum hydrocarbons under either aerobic or anaerobic conditions. Oxygen serves as the initial electron acceptor utilized by the microbes for the oxidation reaction that degrades the hydrocarbons. Dissolved oxygen is naturally occurring in the groundwater and is also present in the potable water used to hydrate the slurry. Once oxygen has been utilized and depleted, the secondary mechanism for anaerobic degradation of the hydrocarbons is sulfate reduction, where sulfate operates as the terminal electron acceptor. The mixed BOS 200® slurry has the following approximate composition:

Ingredient	Composition (wt %)
Activated Carbon	7.1
Micro-nutrients	0.35
Gypsum (calcium sulfate)	1.8
Water	90.75
Bacteria	6.4×10^7 colony forming units per gram of carbon

wt % = percent by weight

The carbon slurry is injected into the soil under pressure causing outward flow from the injection point through the pores in the granular soil matrix. Once installed, the carbon slurry rapidly reduces hydrocarbon impacts in soil and groundwater as the polar hydrocarbon molecules are removed from these media via adsorption in to the BOS 200® carbon product. Once adsorbed, the hydrocarbon molecules are co-located with bacteria within the carbon's pore network. As a result, hydrocarbon concentrations within the carbon matrix are substantially higher than that which existed in the soil or groundwater prior to injection. Due to this concentration effect, rates of degradation within the carbon matrix are significantly higher than rates commonly observed using conventional in-situ bioremediation technologies. As adsorbed contaminants are degraded, active sites within the carbon become available to adsorb residual contaminants, and the cycle is repeated until the microcosm runs out of electron donors (i.e., petroleum hydrocarbons). At the same time, gypsum present in the formulation provides a continuous source of sulfate (electron acceptors) to support the (anaerobic) degradation process.

The anticipated radius of influence of the injectate at the Site is approximately five feet. Within this treated area, total dissolved solids, conductivity, sulfate, ammonia, and nitrate will likely exceed background levels initially. As the remediation progresses, these parameters are expected to slowly return to background levels. A low, but persistent level of sulfate is typical for a period of approximately two or three years due to the injection of gypsum. The solubility of gypsum is low, and the average groundwater sulfate concentration is not expected to exceed the State groundwater standard of 250 milligrams per liter (mg/L). The gypsum product used in the formulation is principally marketed to the agricultural industry for use as a soil conditioner and plant-growth stimulant.

Byproducts of the anaerobic degradation process include water, carbon dioxide, and a variety of light alkane fermentation products such as methane and sulfide from the reduction of available sulfate. The catalyst formulation is designed to scavenge for sulfide, locking it up as insoluble, non-toxic precipitates. The principal precipitate is expected to be iron sulfide. Consequently, dissolved sulfide is expected to be maintained at a level that is orders of magnitude below the applicable standard.

Injection Design

Based on previous site excavation activities and historical groundwater sampling results (Table 1), LTE has identified the aerial extent of injections for the Site (Figure 1). Analytical results for the past four quarters (2nd Quarter 2009, 3rd Quarter 2009, 4th Quarter 2009, and 1st Quarter 2010) were used to design BOS 200® loadings. The highest observed benzene groundwater concentration during this period was used in design loadings to ensure groundwater remediation goals are achieved. The injection points will be laid out on ten-foot centers in triangular grid patterns. The objective of the injection program is to create a three-dimensional network of BOS 200® slurry interlaced throughout the affected subsurface soils, thus decreasing the likelihood of a significant volume of contaminants moving through the installation without contacting the carbon product. In addition to the horizontal spacing at compact ten-foot centers, injection will be conducted at alternating multiple depths. More

precisely, injection depths will alternate between 2 and 4 feet below ground surface (bgs) and 3 and 5 feet bgs from one injection point to the next. This provides overlap in the subsurface both vertically and laterally, and creates seams of carbon slurry material that are not separated by more than a few feet.

As shown on Figure 1, a single treatment area has been designed to address the elevated benzene concentrations detected at monitoring well MW-03. LTE modeled subsurface carbon and sulfate loadings based on the radial influence of injection derived from the site-specific lithologic conditions, and the vertical distribution of benzene concentrations. The final design loadings represent the amount of carbon product necessary to reduce existing benzene concentrations to below the Colorado Department of Public Health and Environment - Colorado Groundwater Quality Standards (CGWQS) of 5 micrograms per liter (ug/L).

The injection area encompasses approximately 375 square feet (ft^2) and includes six proposed injection points symmetrically distributed in a triangular grid pattern. A total of 120 pounds of BOS 200® will be needed to treat the injection area. Injection loadings will be 10 pounds of BOS 200® per injection interval or 20 pounds total per injection point based on the benzene concentrations present at monitoring well MW-03.

Permitting

Prior to initiation of onsite injections, permitting will be completed with the United States Environmental Protection Agency (USEPA) Underground Injection Control (UIC) Office in Denver, Colorado.

Water Source

Water is the carrier fluid for the BOS 200® slurry injectate. Water for the slurry will either be obtained onsite with the landowner's permission or purchased from a commercial provider and stored onsite in a frac tank.

Injection Procedure

Injection will be conducted by Alpine Field Services (Alpine) of Golden, Colorado using a specially designed injection trailer. The trailer is equipped with a gasoline-driven engine, medium-pressure injection pump (up to 1,200 pounds per square inch), various centrifugal transfer pumps, mixers, two polyethylene mixing tanks, and a high-pressure injection hose.

The injection process will commence by adding a pre-determined volume of water to the slurry-mixing tank. A measured amount of BOS 200® is then slowly added to the tank and the mixer is started. Next, a sufficient amount of cultured bacteria is added so that a targeted concentration of petrophilic microbes in the slurry is obtained. Mixing continues for approximately ten minutes prior to injection to ensure the carbon and bacteria are completely mixed.

A small diameter (1.25-inch outer diameter) push rod is driven to the targeted depth, and an injection head is threaded securely onto the rod. Once the slurry is mixed, the pump is engaged, the injection head valve is opened, and the discharge line is pressured up. Pressure is allowed to build in the borehole until the pore pressure is overcome and injectate begins to flow out into the subsurface soils. The injectate propagates outward from the point of the injection as additional slurry is pumped into the injection rod. The pump is subsequently disengaged, and the injection-head valve is closed. A fresh batch of slurry is then prepared, a new injection rod is installed, and the process is repeated.

After the slurry is injected into the subsurface, residual back-pressure, if present, is allowed to dissipate over a period of a few minutes. Therefore, the injection rod is not immediately removed after the injection of slurry. Instead, the injection rods remain in the ground until the transient pressure dissipates. Residual pressure in the subsurface is checked by opening the injection head valve. Once residual pressure has dissipated, the rods are safely removed, and the borehole is sealed with hydrated bentonite.

To prevent the forced migration of impacted groundwater due to displacement, the treatment program involves injection in the perimeter areas of the plume first, followed by the central areas. Thus, the area with the highest levels of impact will be surrounded with the carbon slurry before conducting the central injections.

Groundwater Monitoring

Performance groundwater monitoring activities will be conducted on a quarterly basis to evaluate the injection program progress. LTE anticipates it may require up to two years to reach cleanup goals at the Site.

Please call us at (303) 433-9788 if you have any questions regarding this BOS 200® injectate remediation program SOW or if you require additional information.

Sincerely,

Prepared By
LT ENVIRONMENTAL, INC.

John P. Brown
Staff Geologist

Reviewed By
LT ENVIRONMENTAL, INC.

John E. Cocroft, P.G.
Senior Hydrogeologist/Project Manager

Attachments

TABLE

TABLE 1
GROUNDWATER ANALYTICAL AND FIELD RESULTS
HSR-BLANK 15-5/ HSR-CABRAL 16-5
WELD COUNTY, COLORADO
KERR-McGEE OIL & GAS ONSHORE LP

Well Name	Date	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (ug/L)	Depth Water/ (Depth Product) (ft bgs)
BCW01	08/04/2005	**1700**	**4000**	500	**10800**	NM
MW01	09/29/2005	<1.0	<1.0	<1.0	<2.0	1.05
	12/13/2005	<1.0	<1.0	<1.0	<2.0	1.05
	03/28/2006	<1.0	<1.0	<1.0	<1.0	1.00
	06/16/2006	<1.0	<1.0	<1.0	<1.0	2.36
	09/21/2006	<1.0	<1.0	<1.0	<1.0	1.55
	12/27/2006	<1.0	<1.0	<1.0	<1.0	.55
	03/12/2007	<1.0	<1.0	<1.0	<1.0	.45
	06/14/2007	<1.0	<1.0	<1.0	<1.0	1.50
	09/11/2007	<1.0	<1.0	<1.0	<1.0	1.80
	12/10/2007	<1.0	<1.0	<1.0	<1.0	.15
	03/06/2008	<1.0	<1.0	<1.0	<1.0	1.08
	06/10/2008	<1.0	<1.0	<1.0	<1.0	1.54
	09/15/2008	<1.0	<1.0	<1.0	<1.0	.70
	12/11/2008	<1.0	<1.0	<1.0	<1.0	.69
	03/04/2009	<1.0	<1.0	<1.0	<1.0	1.30
	06/01/2009	<1.0	<1.0	<1.0	<1.0	1.23
	09/21/2009	Removed from monitoring				NM
MW02	09/29/2005	**40**	<1.0	270	330	2.10
	12/13/2005	<1.0	<1.0	<1.0	<2.0	1.60
	03/28/2006	<1.0	<1.0	<1.0	<1.0	1.58
	06/16/2006	2.3	<1.0	<1.0	<1.0	2.90
	09/21/2006	<1.0	<1.0	<1.0	<1.0	2.06
	12/27/2006	<1.0	<1.0	<1.0	<1.0	1.06
	03/12/2007	<1.0	<1.0	<1.0	<1.0	.98
	06/14/2007	1.1	<1.0	1.5	<1.0	2.20
	09/11/2007	<1.0	<1.0	<1.0	<1.0	2.20
	12/10/2007	<1.0	<1.0	<1.0	<1.0	.00
	03/06/2008	<1.0	<1.0	<1.0	<1.0	1.70
	06/10/2008	<1.0	<1.0	<1.0	<1.0	2.16
	09/15/2008	<1.0	<1.0	<1.0	<1.0	1.21
	12/11/2008	<1.0	<1.0	<1.0	<1.0	1.23
	03/04/2009	<1.0	<1.0	<1.0	<1.0	1.75
	06/01/2009	<1.0	<1.0	<1.0	<1.0	1.94
	09/21/2009	<1.0	<1.0	<1.0	<1.0	1.90
	12/04/2009	<1.0	<1.0	<1.0	<1.0	.94
	03/04/2010	<1.0	<1.0	<1.0	<1.0	.96

TABLE 1 (Continued)
GROUNDWATER ANALYTICAL AND FIELD RESULTS
HSR-BLANK 15-5/ HSR-CABRAL 16-5
WELD COUNTY, COLORADO
KERR-McGEE OIL & GAS ONSHORE LP

Well Name	Date	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (ug/L)	Depth Water/ (Depth Product) (ft bgs)
MW03	09/29/2005	**260**	<1.0	94	960	2.30
	12/13/2005	**64**	<1.0	6.0	220	1.90
	03/28/2006	**70**	<1.0	<1.0	59	1.90
	06/16/2006	**16**	<1.0	<1.0	3.6	3.56
	09/21/2006	2.4	<1.0	<1.0	<1.0	2.49
	12/27/2006	**30**	<1.0	1.1	5.8	1.49
	03/12/2007	**610**	<1.0	<1.0	22	1.60
	04/10/2007	**410**	<1.0	<1.0	5.4	1.83
	06/14/2007	**120**	<1.0	<1.0	<1.0	3.00
	09/11/2007	**190**	<1.0	8.7	36	3.10
	12/10/2007	**5.1**	<1.0	<1.0	<1.0	1.00
	03/06/2008	<1.0	<1.0	3.8	160	2.49
	06/10/2008	**160**	<1.0	<1.0	<1.0	2.85
	09/15/2008	**310**	<1.0	<1.0	200	2.53
	12/11/2008	**16**	<1.0	12	<1.0	2.39
	03/04/2009	<1.0	<1.0	<1.0	<1.0	2.51
	06/01/2009	**230**	<1.0	4.4	30	2.96
	09/21/2009	<1.0	<1.0	<1.0	<1.0	2.95
	12/04/2009	**28**	<1.0	<1.0	<1.0	2.48
	03/04/2010	**180**	<1.0	<1.0	<1.0	2.08
MW04	04/24/2006	<1.0	<1.0	<1.0	<1.0	2.50
	06/16/2006	<1.0	<1.0	<1.0	<1.0	2.80
	09/21/2006	<1.0	<1.0	<1.0	<1.0	2.00
	12/27/2006	<1.0	<1.0	<1.0	<1.0	1.00
	03/12/2007	<1.0	<1.0	<1.0	<1.0	1.05
	06/14/2007	<1.0	<1.0	<1.0	<1.0	2.00
	09/11/2007	<1.0	<1.0	<1.0	<1.0	2.18
	12/10/2007	<1.0	<1.0	<1.0	<1.0	1.38
	03/06/2008	<1.0	<1.0	<1.0	<1.0	1.35
	06/10/2008	<1.0	<1.0	<1.0	<1.0	1.81
	09/15/2008	<1.0	<1.0	<1.0	<1.0	1.08
	12/11/2008	<1.0	<1.0	<1.0	<1.0	1.16
	03/04/2009	<1.0	<1.0	<1.0	<1.0	1.54
	06/01/2009	<1.0	<1.0	<1.0	<1.0	1.70
	09/21/2009	<1.0	<1.0	<1.0	<1.0	1.86
	12/04/2009	<1.0	<1.0	<1.0	<1.0	2.21
	03/04/2010	<1.0	<1.0	<1.0	<1.0	1.02

TABLE 1 (Continued)
GROUNDWATER ANALYTICAL AND FIELD RESULTS
HSR-BLANK 15-5/ HSR-CABRAL 16-5
WELD COUNTY, COLORADO
KERR-McGEE OIL & GAS ONSHORE LP

Well Name	Date	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (ug/L)	Depth Water/ (Depth Product) (ft bgs)
MW05	04/24/2006	<1.0	<1.0	<1.0	<1.0	.75
	06/16/2006	<1.0	<1.0	<1.0	<1.0	1.90
	09/21/2006	<1.0	<1.0	<1.0	<1.0	1.15
	12/27/2006	<1.0	<1.0	<1.0	<1.0	.15
	03/12/2007	<1.0	<1.0	<1.0	<1.0	.42
	06/14/2007	<1.0	<1.0	<1.0	<1.0	1.93
	09/11/2007	<1.0	<1.0	<1.0	<1.0	1.24
	12/10/2007	<1.0	<1.0	<1.0	<1.0	.04
	03/06/2008	<1.0	<1.0	<1.0	<1.0	.52
	06/10/2008	<1.0	<1.0	<1.0	<1.0	.98
	09/15/2008	<1.0	<1.0	<1.0	<1.0	.60
	12/11/2008	<1.0	<1.0	<1.0	<1.0	.62
	03/04/2009	<1.0	<1.0	<1.0	<1.0	.90
	06/01/2009	<1.0	<1.0	<1.0	<1.0	1.04
	09/21/2009	<1.0	2.2	<1.0	<1.0	1.03
	12/04/2009	<1.0	<1.0	<1.0	<1.0	1.42
	03/04/2010	<1.0	<1.0	<1.0	<1.0	.59
Colo GW Quality Standards		**5**	**1000**	**700**	**1400**	

Notes: < - less than
ug/L - micrograms per Liter
NA - Not Analyzed/Not Available
GW - Groundwater
Bold numbers indicate result equaled or exceeded standard.
NM - Not Measured
ft bgs - feet below ground surface

FIGURE

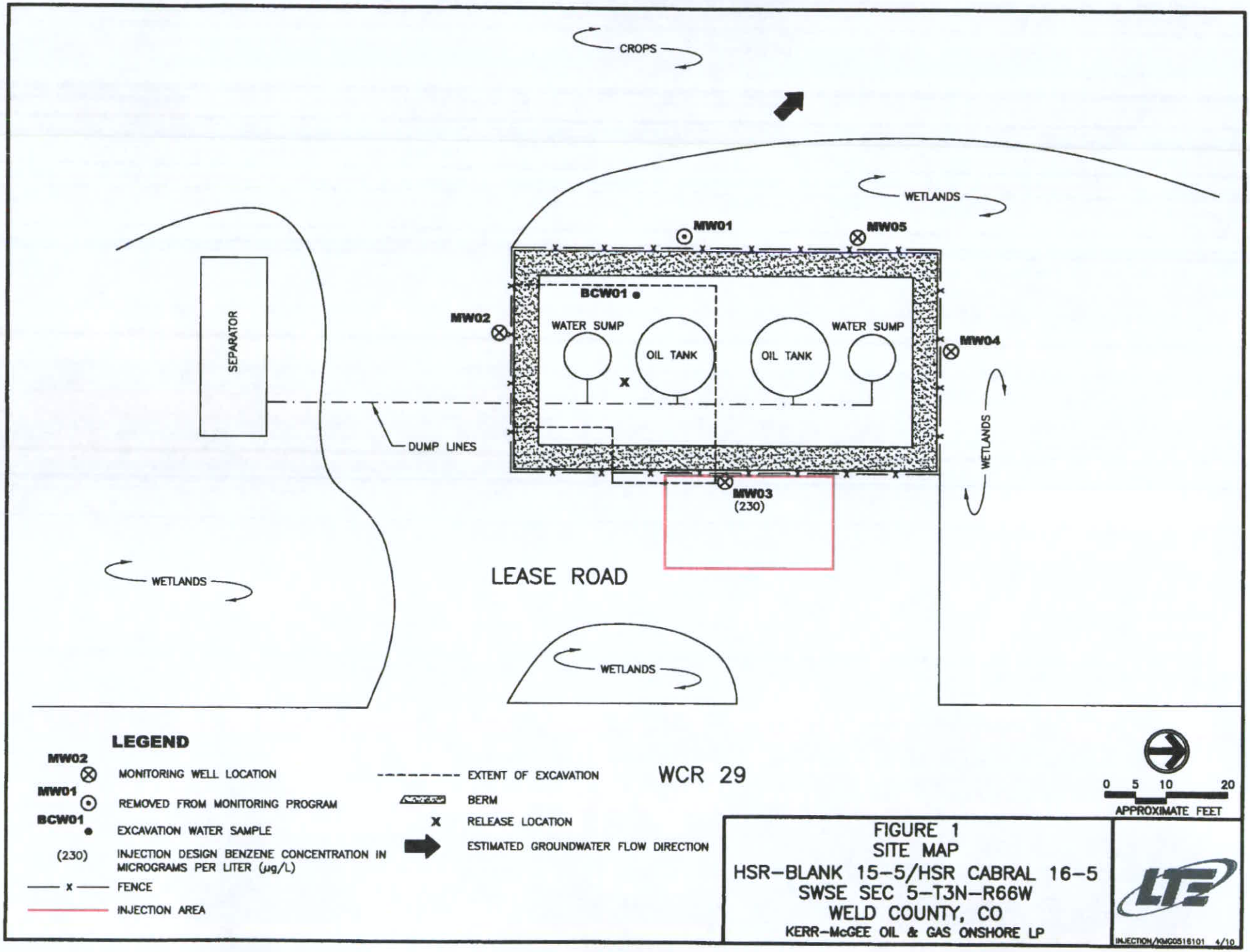

FIGURE 1
SITE MAP
HSR-BLANK 15-5/HSR CABRAL 16-5
SWSE SEC 5-T3N-R66W
WELD COUNTY, CO
KERR-McGEE OIL & GAS ONSHORE LP

INJECTION/KMG0516101 4/10