COMPLIANCE / ENGINEERING / REMEDIATION

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February 1, 2007

Mr. Dave Brown - BP, Inc.
Ms. Lisa Winn - XTO Energy, Inc.
Mr. Robert Hall - Chevron, Inc.
Ms. Christi Zeller - La Plata County Energy Council

RE: Mitigation of Methane Seep Affecting Vegetation
La Plata County, Colorado

Outcrop Mitigation Advisory Committee:

LT Environmental, Inc. (LTE) has conducted pilot testing of vapor extraction as a means to mitigate methane seeps in the Texas Creek area. This pilot test has been conducted to further evaluate one method to mitigate the methane seep as part of the "greenfields" objective. The test included installing four lateral vent pipes; conducting active and passive soil vapor extraction (SVE) tests; and air injection tests. This pilot test will also include monitoring vegetation conditions in the pilot test area. LTE will examine and document the results of the passive system in the spring in coordination with other work we are conducting in the area.

The vapor extraction test system was designed as a means to release methane from the shallow sediments and limit the displacement of oxygen that affects plant growth. Both active and passive venting systems were evaluated. Passive SVE consists of installing perforated vent lines below grade, extending a ventilation stack above grade, and attaching a wind powered ventilation turbine at the top of the stack. Active SVE consists of attaching a vacuum blower to the horizontal vent lines to actively extract vapors from or inject fresh air into the horizontal trenches. Active air injection was tested first at the site during the week of November 27, 2006, followed by passive venting. Active SVE and air injection were tested during the week of December 11, 2006. Following testing of the active systems, the passive test (turbine vents) will continue without continuous monitoring.

Construction

During the week of November 27, 2006, the lateral vent system was installed in an area of stressed vegetation near the north fork of Texas Creek (Figure 1). Four horizontal vent lines, each 20 feet long, were installed to a depth of approximately three feet below grade. The vent line trenches were separated by distances of 5 feet, 10 feet, and 15 feet, as shown in Figure 2. The vent lines were constructed of 4-inch Advanced Drainage System (ADS) piping covered by a polyester “sock”. The ADS piping is perforated to allow efficient air flow while the sock prevents the perforations from being clogged with backfill. The horizontal vent lines rise above grade at each end and act as a source for fresh air supply to the subsurface. The 4-inch ADS piping was connected to a 3-inch Schedule 40 PVC riser on the inlet side of the trench, and a 2-inch Schedule 40 PVC riser on the capped end of the trench. Each horizontal vent line was then

covered with two feet of native backfill and capped with a two-foot wide 4-mil plastic liner extending the length of the trench. Gravel fill material was not available during construction due to adverse weather conditions. The impervious liner was then covered with one foot of native backfill to return the area to normal grade. The plastic liner was installed to act as a seal, which would prevent vertical release of methane into the root zone and improve the influence of the vent line. The typical construction of the horizontal vent lines are shown in Figure 3.

Eighteen monitoring points were installed at variable distances from the extraction lines to measure the influence of the system. The monitoring points were constructed using poly tubing hammered into the ground to a depth of approximately 3 feet below ground surface. After construction, the test area was enclosed in a barbed wire fence to prevent damage of the vertical risers and monitoring wells by livestock. Frozen ground prevented personnel from seeding the area during testing. Photographs of the test area are included in Attachment 1.

Pilot Test Procedures and Results

After the horizontal vent lines were installed, ambient air was injected into vent line V1 to measure the influence of the system during the week of November 27, 2006 using a rental air compressor. Vapor extraction was not tested at this time due to failure of the blower motor, and other unforeseen weather-related complications. Pressure/vacuum and flowrate measurements for this test (Test I) are tabulated in Tables 1 and 2.

At the conclusion of the fresh air injection testing during the week of November 27, 2006, passive aeration was tested by installing wind driven turbine vents on two of the four horizontal vent lines (V1 and V3). During the week of December 11, after two weeks of passive operation, the passive aeration flowrates were measured using a thermal anemometer. Passive flowrates, shown on Table 1, were measured at approximately 1.1 to 1.3 standard cubic feet per minute (scfm). At the time of measurement, there was insufficient wind to turn the turbines.

During the week of December 11, 2006, an active vapor extraction test series was conducted at the site. The vapor extraction tests were conducted at two different vent lines (V1 and V3). During the vapor extraction tests, the flow rate from the extraction point was measured using a pitot tube. A thermal anemometer was also used to measure flow and temperature in the extraction manifold. The lateral influence of the system was evaluated by measuring applied pressure or vacuum and flowrate at the monitoring points. The methane and oxygen concentrations were also measured at each monitoring point. The measured pressure/vacuum and flowrate resulting from application of three different flowrates (approximately 10 scfm, 25 scfm, and 50 scfm) on vent line V1 was measured, and is presented in Table 2 and Figure 4. Two different extraction flowrates (approximately 5 scfm and 24 scfm) were tested on vent line V3, and flowrates and pressure/vacuum measurements are presented in Table 3. Flowrate, pressure, methane concentration, and oxygen concentration measured in the 18 monitoring points during the extraction tests are presented in Tables 2 through 5. These measurements typically revealed low negative pressure (vacuum) and methane concentrations ranging from 500 parts per

million (ppm) to 940,000 ppm at the monitoring points before startup. As the testing progressed, methane concentrations decreased, oxygen concentrations increased, and vacuum increased at most of the monitoring points.

Active fresh air injection was also tested at vent line V3 at two different injection flowrates (30 scfm and 65 scfm). In this case, the alternating lines acted as vents to relieve subsurface methane, while ambient air was provided to the subsurface through the blower system. This alternative may provide a more efficient method (lower air flow and lower horsepower requirements) than an active extraction system. Pressure, flowrate, methane, and oxygen concentrations were measured throughout this test at the 18 installed monitoring points, and are presented in Tables 3 through 5. During this test, pressure increased in several monitoring points as flowrate was increased, methane concentrations increased from baseline, and oxygen concentrations seemed relatively constant

Summary

Vapor extraction and injection tests in vent lines V1 and V3 at all tested flowrates resulted in changes of pressure, flowrate, and methane concentrations in monitoring points located up to 40 feet from the injection well, as shown in Figure 3. In general, during active extraction, methane concentrations decreased, positive pressure was reduced as vacuum conditions were observed, and oxygen concentrations increased. Active venting appears to be a viable method for reducing methane and increasing oxygen in the subsurface. The adequacy of the influence of the passive venting system was difficult to discern from the initial testing results. Long-term operation of the passive extraction systems will be compared with the active system results to further evaluate passive venting as an alternative for methane mitigation.

LTE appreciates the opportunity to provide environmental services to the Outcrop Mitigation Advisory Committee. If you have any questions regarding this report or would like additional information, please contact us at (303) 433-9788.

Sincerely,

LT ENVIRONMENTAL, INC.

Gina Lynch, E.I.T.
Staff Engineer

Christopher E. Shephard, P.E.
Principal/Group Manager

Attachments

FIGURES

-No Access-

County Road 502

Pilot Test Area

2 ppm H_2S

2 ppm H_2S

1 ppm H_2S

TC-3

TC-1

Area to Mitigate

LEGEND

Gas Monitoring Probes

Gas Flux Chambers

Visible Methane Seeps in Surface Water

Subsurface Methane Measurements

0 ppm

1ppm - 500 ppm

500 ppm - 5%

6% - 15%

16% - 25%

26% - 50%

51% - 75%

76% - 100%

Subsurface methane measurements collected from temporary soil probes advanced with slide hammer.

Trees

Dead Aspen

Dead Cottonwood

Dead Juniper

Dead Pine

Dead Scrub Oak

Dead Willow

Stressed Cottonwood

Stressed Juniper

Stressed Aspen

Stressed Pine

Stressed Scrub Oak

Tree Stump

Vegetation

Stressed/Dead Vegetation

Non-Vegetative Area

Live Aspen Grove

Geology

Fruitland Formation (Kf)

Fruitland Formation Tongue (Kft)

Kirtland Formation (Kk)

Pictured Cliffs Formation (Kpc)

Pictured Cliffs Formation Tongue (Kpct)

Quaternary Alluvium (Qa)

Quaternary Gravel (Qg)

TC-4 Text Reference

0 90 180

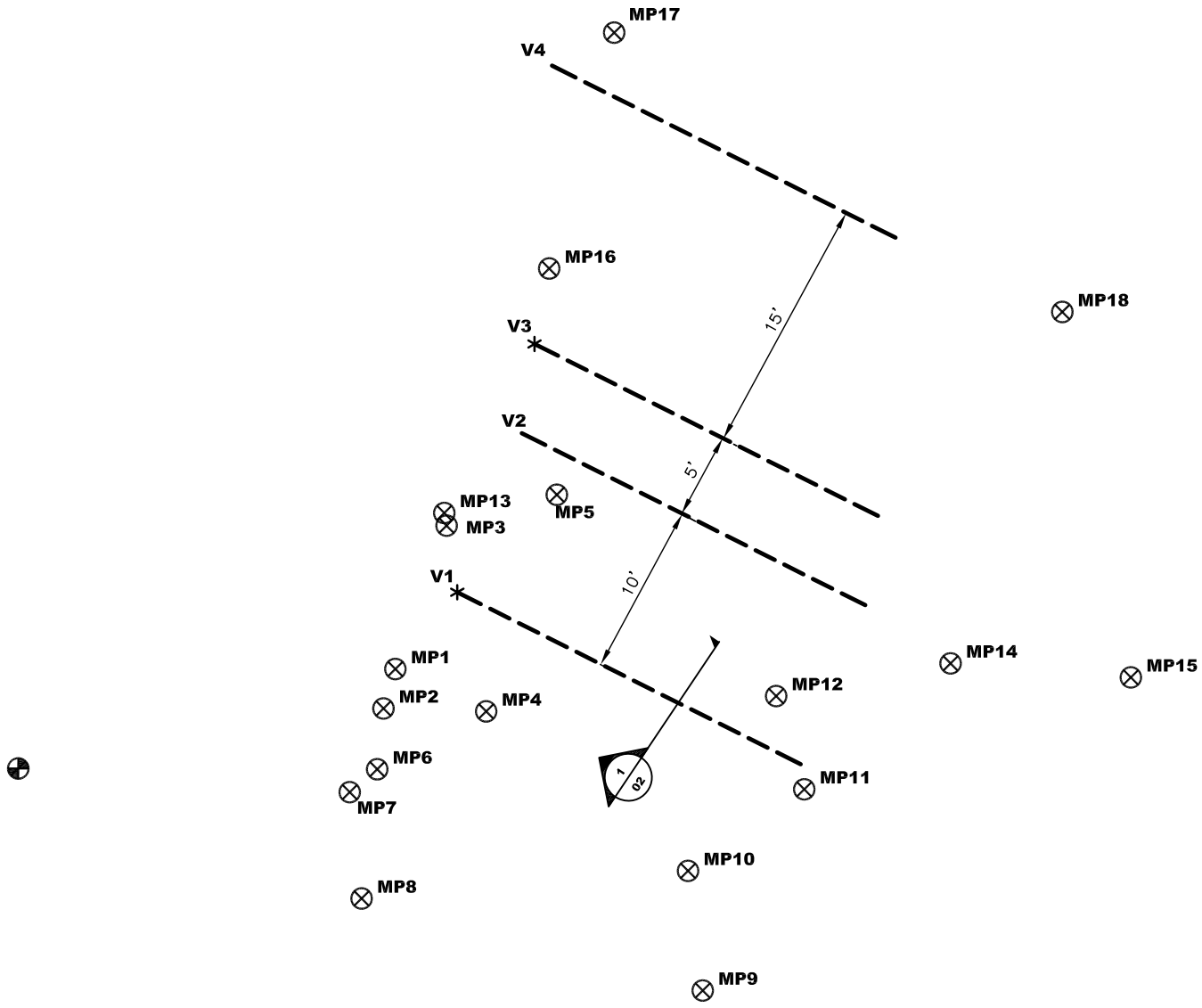
Feet

N

FIGURE 1
SOIL VAPOR EXTRACTION
PILOT TEST AREA
TEXAS CREEK

OUTCROP MITIGATION ADVISORY COMMITTEE

P:\San Juan Basin GIS\LaPlata\Fruitland_OMR\MXDs\Vers._8.3\2006\DETAIL SEEP MAP.mxd



LEGEND

MP1 ⊗ MONITORING POINT LOCATION

GAS FLUX CHAMBER

V1 — — — HORIZONTAL VENT LINE

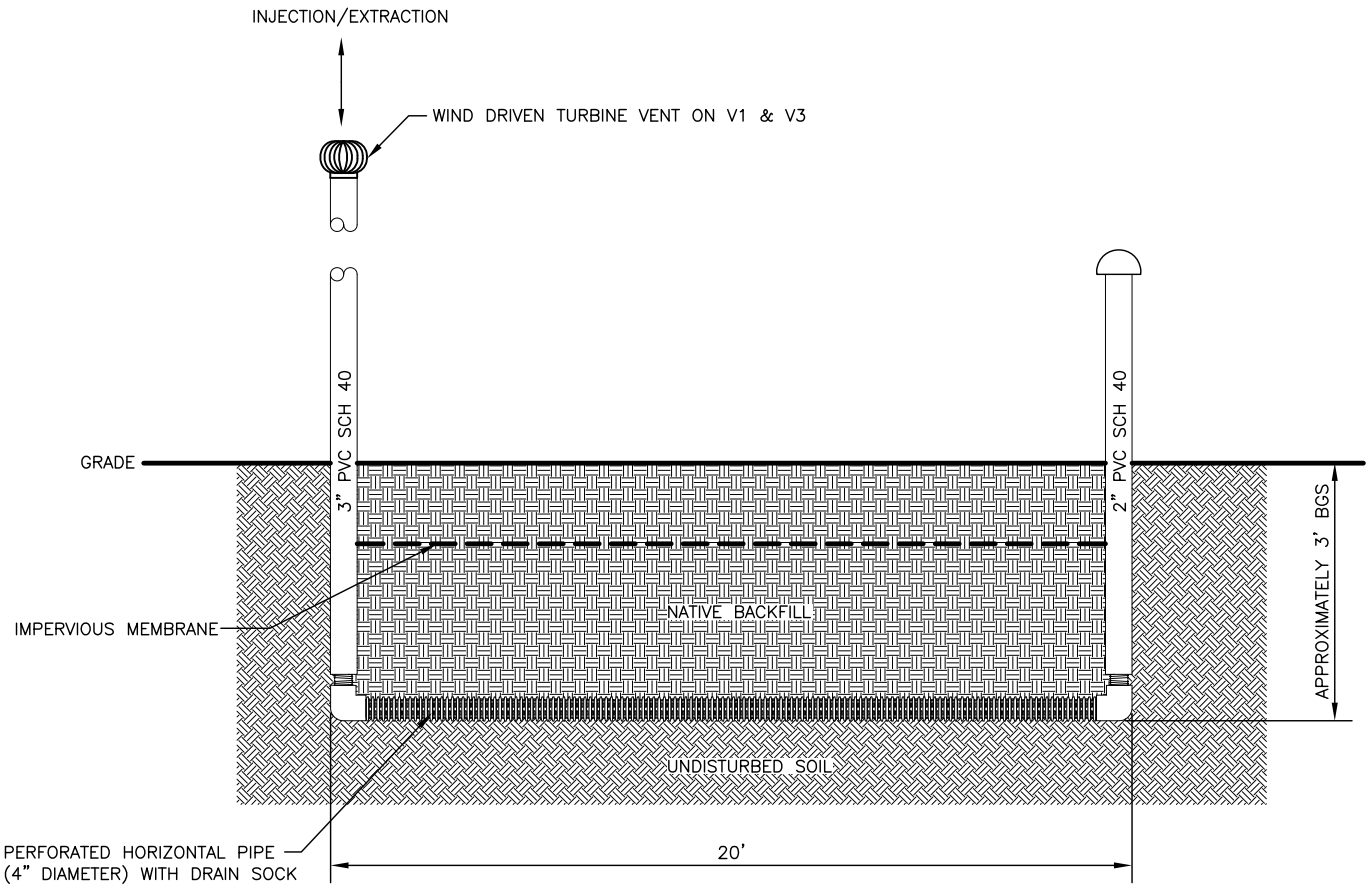
* EXTRACTION OR INJECTION POINT

0 2.5 5 10

FEET

FIGURE 2
SITE MAP
TEXAS CREEK SITE
BAYFIELD, CO
OUTCROP MITIGATION ADVISORY COMMITTEE

MS062701 1/07



1/02 **CROSS-SECTION (TYP. OF 4)**

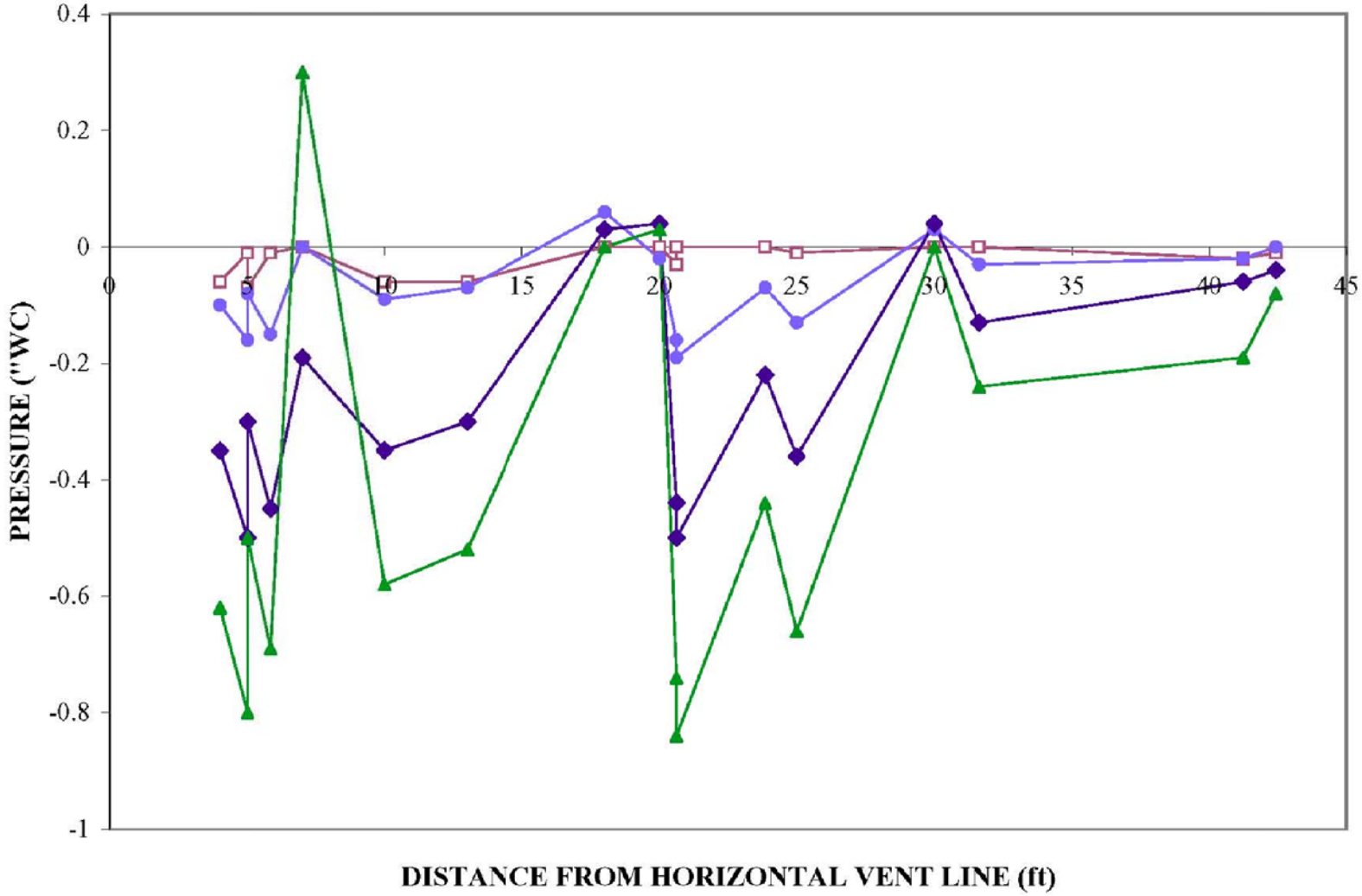
N.T.S.

SCALE: NOT TO SCALE

FIGURE 3
HORIZONTAL VENT LINE CROSS SECTION
TEXAS CREEK SITE
BAYFIELD, CO

OUTCROP MITIGATION ADVISORY COMMITTEE

MS062701 1/07



Note:
Negative pressure readings indicate vacuum.

FIGURE 4
ACTIVE EXTRACTION TEST
AT HORIZONTAL VENT V1
TEXAS CREEK SITE
BAYFIELD, CO
OUTCROP MITIGATION ADVISORY COMMITTEE

MS062701 1/07

TABLES

TABLE 1
VAPOR EXTRACTION PILOT TEST FLOW SUMMARY
TEXAS CREEK
OUTCROP MITIGATION ADVISORY COMMITTEE

TEST NUMBER	DATE	TEST TYPE	HORIZONTAL VENT LINE	PRESSURE AT HORIZONTAL VENT ("WC)	FLOW RATE (SCFM)
I	11/30/2006	Injection	V1	NM	40*
1	12/12/2006	Extraction	V1	-0.5	8.14
				-0.5	7.43
2	12/12/2006	Extraction	V1	-2.3	26.22
				-2.5	26.23
3	12/12/2006	Extraction	V1	-4.4	48.38
				-4.5	49.57
4	12/12/2006	Extraction	V3	-0.54	4.70
				-0.52	NM
5	12/12/2006	Extraction	V3	-1.7	25.34
				-1.7	28.62
1A	12/14/2006	Injection	V3	1.6	30.12
				1.6	30.63
2A	12/14/2006	Injection	V3	4.2	65.66
				4.4	67.96
P1	12/12/2006	Passive Extraction	V1	-2	1.30
P1	12/12/2006	Passive Extraction	V3	-2	1.10

NOTES:
A negative pressure reading indicates vacuum.
NM = not measured
SCFM = standard cubic feet per minute
"WC = inches of water column
*Flowrate for Test I is estimated based on compressor capability.

TABLE 2
VAPOR EXTRACTION TEST AT V1
PRESSURE AND FLOWRATE MEASUREMENTS
TEXAS CREEK
OUTCROP MITIGATION ADVISORY COMMITTEE

MONITORING POINT	DISTANCE FROM VENT LINE V1 (ft)	Pressure ("WC)					Flowrate (mL/min)				
		TEST I	BASELINE	EXTRACTION TESTING V1			TEST I	BASELINE	EXTRACTION TESTING V1		
		40 scfm	0 scfm	10 scfm	25 scfm	50 scfm	40 scfm	0 scfm	10 scfm	25 scfm	50 scfm
MP1	4.00	0.06	-0.06	-0.10	-0.35	-0.62	35.00	40.20	0.00	0.00	1.82
MP2	7.00	0.01	0.00	0.00	-0.19	0.30	19.80	0.03	0.00	0.00	0.00
MP4	5.00	0.04	-0.01	-0.16	-0.50	-0.80	22.90	16.00	13.10	0.00	14.30
MP5	5.83	0.06	-0.01	-0.15	-0.45	-0.69	24.70	11.30	73.40	0.00	15.10
MP6	10.00	0.02	-0.06	-0.09	-0.35	-0.58	13.20	47.40	0.00	0.00	7.78
MP7	13.00	0.05	-0.06	-0.07	-0.30	-0.52	29.30	40.10	0.00	0.00	4.84
MP8	20.00	0.00	0.00	-0.02	0.04	0.03	1.30	0.00	0.00	0.00	0.00
MP9	23.85	0.00	0.00	-0.07	-0.22	-0.44	4.50	20.10	0.00	4.85	3.91
MP10	20.62	0.00	-0.03	-0.16	-0.44	-0.74	5.60	12.60	90.80	0.00	21.40
MP11	25.00	0.02	-0.01	-0.13	-0.36	-0.66	8.40	8.51	0.00	2.45	16.70
MP12	20.62	0.04	0.00	-0.19	-0.50	-0.84	19.70	4.80	19.30	0.00	34.30
MP13	5.00	0.04	-0.07	-0.08	-0.30	-0.50	19.70	29.90	0.00	0.00	6.31
MP14	31.62	0.03	0.00	-0.03	-0.13	-0.24	24.10	13.40	0.00	0.00	0.10
MP15	41.23	0.01	-0.02	-0.02	-0.06	-0.19	6.80	9.41	0.00	0.00	4.85
MP16	18.00	0.05	0.00	0.06	0.03	0.00	37.90	10.00	5.47	6.53	2.72
MP17	30.00	0.05	0.00	0.03	0.04	0.00	26.90	0.16	NM	0.00	NM
MP18	42.43	0.02	-0.01	0.00	-0.04	-0.08	16.20	7.80	0.00	0.00	0.00

NOTES:
NM = not measured
SCFM = standard cubic feet per minute
"WC = inches of water column
mL/min = milliliters of air per minute
A negative pressure reading indicates vacuum.
Extraction testing occurred on 12/12/2006; injection testing occurred on 12/14/2006.
Test I took place on 11/30/2006. The flowrate is estimated.

TABLE 3
VAPOR EXTRACTION TEST AT V3
PRESSURE AND FLOWRATE MEASUREMENTS
TEXAS CREEK
OUTCROP MITIGATION ADVISORY COMMITTEE

MONITORING POINT	DISTANCE FROM VENT LINE V3 (ft)	Pressure ("WC)					Flowrate (mL/min)				
		EXTRACTION TESTING V3		BASELINE	INJECTION TESTING V3		EXTRACTION TESTING V3		BASELINE	INJECTION TESTING V3	
		5 scfm	25 scfm	0 scfm	30 scfm	70 scfm	5 scfm	25 scfm	0 scfm	30 scfm	70 scfm
MP1	19.00	0.10	0.03	0.03	0.01	0.03	26.50	13.10	0.93	0.00	0.02
MP2	22.00	0.04	0.02	0.05	0.03	0.18	0.00	0.10	0.06	0.08	0.00
MP4	15.81	0.05	0.01	0.03	0.09	0.12	6.64	3.11	11.50	19.10	35.00
MP5	13.00	-0.02	-0.08	0.02	0.04	0.02	0.00	0.00	11.00	0.00	0.04
MP6	25.00	0.07	0.06	0.10	0.02	0.01	30.60	23.90	30.70	0.00	0.05
MP7	28.00	0.09	0.06	0.01	0.01	0.02	37.40	29.90	0.02	0.00	0.05
MP8	35.00	0.02	0.04	0.17	0.04	0.03	0.00	0.05	0.01	0.00	0.00
MP9	34.41	0.04	0.10	0.09	0.02	0.02	19.10	7.79	24.70	0.05	0.00
MP10	28.28	0.03	-0.10	0.06	0.01	0.09	6.85	0.00	10.90	0.10	0.00
MP11	29.15	-0.02	-0.30	0.12	0.01	0.02	3.32	0.00	0.00	0.04	0.00
MP12	22.36	-0.04	-0.05	0.04	0.14	0.13	0.00	0.00	0.00	0.07	85.80
MP13	10.00	0.04	-0.04	0.05	0.14	0.25	10.10	0.00	13.90	76.90	116.00
MP14	30.41	0.04	-0.09	0.02	0.13	0.22	0.00	0.00	11.30	54.60	95.60
MP15	40.31	0.01	-0.03	-0.02	0.02	0.02	1.76	0.00	0.15	0.01	0.00
MP16	3.00	0.01	-0.03	0.16	0.02	0.21	2.63	0.00	0.04	0.00	59.40
MP17	20.00	-0.04	0.02	0.14	0.08	0.01	0.07	0.03	0.02	0.02	0.09
MP18	33.54	0.02	-0.10	0.04	0.14	0.24	0.00	0.00	0.03	61.40	110.00

NOTES:
NM = not measured
SCFM = standard cubic feet per minute
"WC = inches of water column
mL/min = milliliters of air per minute
A negative pressure reading indicates vacuum.
Extraction testing occurred on 12/12/2006; injection testing occurred on 12/14/2006.

TABLE 4
VAPOR EXTRACTION TEST METHANE CONCENTRATIONS SUMMARY
TEXAS CREEK
OUTCROP MITIGATION ADVISORY COMMITTEE

MONITORING POINT	METHANE CONCENTRATION (PPM)								
	BASELINE	EXTRACTION TESTING V1			EXTRACTION TESTING V3		BASELINE	INJECTION TESTING V3	
MP1	900000	390000	44000	2500	730000	890000	780000	850000	930000
MP2	3500	0	0	500	0	0	4500	5500	18500
MP4	890000	6500	0	0	50000	40000	950000	920000	930000
MP5	940000	150000	18500	7500	25500	23000	930000	930000	610000
MP6	880000	200000	50000	50000	610000	890000	950000	940000	940000
MP7	890000	700000	690000	430000	850000	850000	4500	8000	910000
MP8	500	0	0	0	740000	2000	500	1000	12000
MP9	940000	50000	0	50000	3500	810000	950000	940000	10000
MP10	940000	12000	0	500	850000	150000	950000	930000	910000
MP11	940000	50000	50000	50000	860000	50000	2000	NM	NM
MP12	940000	270000	80000	30500	120000	150000	2500	940000	930000
MP13	940000	480000	42000	4500	890000	50000	940000	940000	850000
MP14	940000	50000	4500	2000	50000	13500	940000	940000	880000
MP15	940000	300000	2500	500	570000	5500	NM	13500	NM
MP16	940000	940000	940000	910000	920000	3000	5000	750000	50000
MP17	3000	NM	NM	NM	910000	NM	7500	920000	920000
MP18	910000	570000	210000	50000	60000	6500	NM	920000	920000

NOTES:
NM = not measured
PPM = parts per million
Extraction testing occurred on 12/12/2006; injection testing occurred on 12/14/2006.

TABLE 5
VAPOR EXTRACTION TEST OXYGEN CONCENTRATIONS SUMMARY
TEXAS CREEK
OUTCROP MITIGATION ADVISORY COMMITTEE

MONITORING POINT	OXYGEN CONCENTRATION (%)								
	BASELINE	EXTRACTION TESTING V1			EXTRACTION TESTING V3		BASELINE	INJECTION TESTING V3	
MP1	1	13.1	19.8	20.7	4.8	1.0	5.8	3.4	1.0
MP2	20.9	20.0	20.1	20.7	20.8	20.7	19.6	19.5	19.5
MP4	1.2	18.3	20.1	20.8	14.3	3.7	1.1	0.9	0.8
MP5	1.1	15.4	16.1	18.9	15.6	19.8	1.0	1.0	2.5
MP6	1	14.3	18.2	18.9	6.4	1.0	0.8	0.9	1.0
MP7	1.2	7.0	6.8	14.1	2.1	1.1	19.9	19.4	1.1
MP8	19.4	20.4	20.1	20.8	3.3	20.7	19.5	19.4	19.5
MP9	1	19.3	20.1	19.8	20.2	1.0	1.0	0.9	19.8
MP10	1	20.0	20.1	20.9	1.4	17.2	0.7	0.8	0.9
MP11	1	18.9	18.8	19.9	1.7	19.1	19.5	NM	NM
MP12	0.9	15.2	12.6	18.9	16.9	17.4	19.4	1.1	0.8
MP13	1.2	11.9	19.4	20.8	0.9	19.2	1.1	0.8	0.6
MP14	0.9	18.1	20.9	20.8	19.1	20.2	0.9	0.8	0.8
MP15	1.1	13.1	20.9	20.8	4.6	20.4	NM	19.1	NM
MP16	0.9	1.9	0.9	1.0	0.9	20.4	18.3	2.3	9.1
MP17	20.4	19.8	NM	NM	0.8	NM	19.7	1.0	0.8
MP18	1	6.0	15.3	18.8	19.2	20.3	NM	0.9	0.8

NOTES:
NM = not measured
% = percent
Extraction testing occurred on 12/12/2006; injection testing occurred on 12/14/2006.

ATTACHMENT 1

TEST AREA PHOTOGRAPHS


ELITE Series