

ALTAMONT ENVIRONMENTAL, INC.

ENGINEERING & HYDROGEOLOGY

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May 10, 2002

Mr. James Coffey
NCDENR Division of Waste Management
Solid Waste Section
1646 Mail Service Center
Raleigh, North Carolina 27699-1646

Subject: Landfill Gas Extraction Pilot Study Report
Jackson County Municipal Solid Waste Landfill
Jackson County, North Carolina



Dear Mr. Coffey:

Enclosed is the Landfill Gas Extraction Pilot Study Report for the former Jackson County Municipal Solid Waste Landfill in Dillsboro, North Carolina. The report details procedures, findings, conclusions, and recommendations associated with the two-phase pilot study. Phase 1 involved active extraction using existing shallow vents along the northern property boundary. Phase 2 involved active extraction using newly installed vertical extraction wells along the southeastern boundary.

Representatives of Altamont met with Mr. James Patterson in the Asheville Regional Office on May 6, 2002 to discuss the report. We, along with representatives of Jackson County, would like an opportunity to meet with you to discuss the report and strategy for future actions associated with landfill gas mitigation and monitoring. I will call you after you have had a chance to review the enclosed report to arrange a meeting.

If you have any questions or would like more information please call me at (828) 281-3350.

Sincerely,

A handwritten signature in black ink, appearing to read "John P. Mueller". The signature is fluid and cursive, with a long horizontal stroke at the end.

John Mueller, P.E.

Enclosure: Supplemental Investigation and Remedial Action Report

CC: James Patterson, NCDENR Solid Waste Section, Asheville
Ken Westmoreland, Jackson County Manager

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1.0 BACKGROUND

Altamont Environmental, Inc. (Altamont), on behalf of Jackson County, has historically conducted two types of landfill gas (LFG) monitoring at the closed MSW landfill near Dillsboro, North Carolina. The landfill location is shown on Figure 1. The first program was initiated in approximately 1996 and is related to compliance with the landfill permit conditions. As such, it is a continuing effort. The second LFG program was initiated in January 1999 as part of a groundwater quality assessment. In the second program, Altamont (formerly known as the Fletcher Group of North Carolina) measured LFG concentrations at onsite monitoring locations using the closed-loop protocol recommended by North Carolina Department of Environment and Natural Resources (DENR). The measurements were collected on a monthly basis between January 1999 and November 2001. Jackson County has since taken over the monthly monitoring program. The Monitoring Well, Vent, and Gas Probe Location Map is included as Figure 2.

In January 1999, LFG was detected in concentrations greater than the Lower Explosive Limit (LEL) for methane at several locations on County property and in the groundwater monitoring well (PMW-01) on adjacent property that at the time was owned by Western Builders. Between March 15 and 19, 1999, Altamont oversaw installation of LFG probes in 18 locations near the landfill. These probes were installed as part of the effort to characterize groundwater quality in the vicinity of landfill. LFG concentrations were measured in each of the probes monthly between installation and March 2000.

Jackson County awarded a contract to McGill Associates (McGill) of Asheville, North Carolina on March 24, 1999 for design and construction of LFG control structures. These structures were installed between March 29 and April 9, 1999. Since installation of these structures, LFG measurements in some areas, particularly the northern and southeastern boundaries, have generally remained greater than the LEL. As a result, the County requested that Altamont provide engineering services related to evaluation and mitigation of LFG for the Dillsboro facility.

Altamont submitted a Landfill Gas Mitigation Plan to DENR on September 28, 2001. The plan detailed a two-phased landfill gas mitigation pilot study for the northern (Phase 1) and southeastern (Phase 2) boundaries of the property. After submittal of the plan, Jackson County determined that landfill gas compliance along the southeast side of the landfill could be achieved by purchasing the adjacent property from Webster Enterprises. Since Jackson County was exploring this option, the landfill gas pilot study was redesigned to focus on the northern property boundary. DENR stipulated that if the Webster Enterprises property was not acquired by the end of December 2001, remedial alternatives for the southeast side should be evaluated and implemented. By January 1, 2002, the county had not acquired the Webster Enterprises property, so Altamont proceeded with design and implementation of a pilot study for the southeast side. This Pilot Study Report describes the work completed, summarizes findings, and provides conclusions associated with landfill gas mitigation activities at the northern and southeastern boundaries.

2.0 SCOPE OF WORK AND METHODS

The purpose of the pilot study was to evaluate options for achieving compliance with DENR Solid Waste Management Rules regarding methane concentrations at the northern and southeastern property boundaries. This section describes the field activities that were implemented to satisfy this objective. Phase 1 of the study was implemented at the northern boundary between November 13 and December 3, 2001. Phase 2 of the study was implemented at the southeastern boundary between March 18 and April 2, 2002.

2.1 Phase 1 Pilot Study

The landfill gas mitigation study for the northern property boundary utilized the existing vent system. The objective of Phase 1 was to determine whether the effectiveness of existing passive collection trenches installed by McGill could be improved by applying a vacuum. Vents 1, 10, and 13 were connected to a regenerative blower to draw a vacuum on the vents and connected subsurface gas collection trenches.

2.1.1 Gas Extraction System Setup

Vents 1 and 13 and associated trenches (B and A, respectively) were installed by McGill in 1999. According to plan sheets provided by McGill, the trenches are two feet wide by 6.5 feet deep. The lower two feet of the trenches contain a horizontal perforated pipe bedded in two feet of washed stone. The upper 4.5 feet of the trenches are backfilled with soil and capped with clay. As-built drawings were not prepared by McGill. Trench locations are approximated on Figure 2. Cross-sections showing vent elevations in relation to monitoring probes are presented in Figures 5 through 6. McGill figures showing vent and trench locations and construction details are included in Appendix B of the Landfill Gas Mitigation Workplan (Altamont; September 28, 2001). Vent 10 and associated trench G were installed by Jackson County in the late 1980s. There is no written record of the trench construction details. However, it was installed by Jackson County equipment operator Mr. Verlon Coggins. Altamont interviewed Mr.

*Trenches
A & B*

Trench G

Coggins for construction details. He reported that the trench is 40 or 60 feet long, ten feet deep, and three feet wide. The bottom two feet of the trench were backfilled with No. 57 washed crushed stone. A four-inch diameter perforated PVC horizontal pipe was placed in the middle of the gravel layer and connected to a four-inch diameter PVC vertical riser vent in the middle of the trench. The remainder of the trench was backfilled with trash and capped with clay.

On November 13, 2001, Altamont installed two-inch diameter Landtec Accu-flo vertical wellheads on Vents 1, 10, and 13. The wellheads were connected in series to the blower using four-inch diameter corrugated polyethylene pipe. A condensate knockout drum, flow meter, and pressure meter were plumbed into the system upstream of the blower (see Figure 3). The landfill gas extraction system was started on November 14, 2001, with all wellhead valves fully opened.

Altamont collected landfill gas concentration readings from the following locations during the study period: wellheads at Vents 1, 10, and 13; gas probe locations GP-01, MW-01, GP-02, and GP-03; and the blower exhaust. In addition, gas pressure readings were collected at each of the vents and probe locations. Gas concentrations were measured with a Landtec GEM 500 portable landfill gas meter. Gas probes were purged of two casing volumes prior to recording readings. Tables 1 through 4 provide a summary of readings collected during the study.

2.1.2 System Adjustments

On November 19, 2001, Altamont closed Vents 1 and 10 for 45 minutes to evaluate the effect of increased pressure on Vent 13. Gas concentration and pressure readings were collected before the vents were closed and before they were reopened. After the vents were reopened, Altamont reconfigured the plumbing at the knockout drum to eliminate condensate in the flow meter and facilitate emptying of condensate from the drum. After the reconfiguration, flow readings at the knockout drum were significantly lower. On November 28, 2001, Altamont determined that the flow meter was misaligned and the problem was corrected. Flow measurements collected between November 20 and 27, 2001 were not used.

On November 25, 2001, Vent 10 was closed in an attempt to increase impact on gas probe GP-02. GP-02 was the only probe along the northern boundary that remained above compliance levels for methane. Vent 10 remained closed for the duration of the study. On November 28, 2001, Vent 1 was closed to maximize the radius of influence around Vent 13 and Trench A, near GP-02. Vent 1 remained closed for the duration of the study.

On November 27, 2001, Altamont installed a new shallow gas probe (GP-1A) near GP-1 due to inordinately low concentrations at that location (methane readings were consistently zero). GP-1, the total depth of which was five feet, was removed from the monitoring network and replaced by GP-1A. GP-1A was installed by hand auger to a depth of 4.5 feet. The probe consists of one-inch PVC with 3/16-inch drilled holes. The annulus was filled with pea gravel and sealed with approximately one foot of bentonite at the surface.

2.2 Phase 2 Pilot Study

The pilot study at the southeastern property boundary utilized newly installed vertical gas extraction wells to reduce methane concentrations at compliance monitoring points. The wells were connected to a blower to create vacuum extraction of landfill gas. Details of the system installation and operation are provided in this section.

2.2.1 Design and Installation of Extraction Wells and Gas Probes

On January 22, 2002, two vertical gas extraction wells were installed using bucket auger drilling techniques. Two boreholes were installed with a 24-inch diameter auger to depths of 30 and 36 feet, EW-1 and EW-2, respectively. Both of the wells were constructed using six-inch diameter PVC well casing and perforated screens set in No. 57 washed crushed stone filter pack. The gravel extended one foot above the screen. The remainder of each hole was filled with hydrated bentonite seals and soil. A two-inch diameter Landtec Accu-flo vertical wellhead with gate valve was installed on each of the extraction

wells. Gas extraction well locations are indicated on Figure 2. Figure 6 presents a cross-section through the landfill, including the southeastern boundary study area. Well construction diagrams are presented in Figures 7 and 8.

Water was encountered in EW-1 at 30 feet below ground surface during drilling. This depth was approximately coincident with the bottom of trash. In EW-2, water seeped into the hole from a thin stratum of concrete and rock at a depth of 10 feet. The zone of seepage was sealed with bentonite during completion of the well. The nearest monitoring well, MW-05, is at the toe of the landfill slope approximately 50 feet lower in elevation than EW-1 and EW-2. Groundwater in MW-05 is approximately 50 feet deep. Therefore, the water encountered in EW-1 and EW-2 probably represents a perched condition, since it is approximately 70 feet higher than the groundwater level in MW-05.

Monitoring of methane concentrations in boundary gas probes on the day the extraction wells were installed revealed that all of the probes at the southeastern boundary were in compliance. Therefore, plans to install the blower were suspended until a sustained increase in methane concentrations was observed during monthly monitoring.

A significant increase in methane concentrations at the southeastern boundary was observed during February and March 2002 monitoring events. Therefore, on March 18, 2002, Altamont setup the blower and connected it to the wellheads using four-inch diameter corrugated polyethylene pipe. A condensate knockout drum, flow meter, and pressure meter were plumbed into the system upstream of the blower (see Figure 3). Altamont installed two additional temporary gas probes (TP-1 and TP-2) in the vicinity of the extraction wells as shown in Figure 2. The temporary gas probes were installed to supplement the permanent gas probes and monitoring wells for evaluating radius of influence. The temporary probes were comprised of one-inch diameter PVC with perforated screens (3/16-inch diameter holes). TP-1 was installed to a depth of five feet, with four feet of perforation and a one-foot concrete surface seal. TP-2 was installed to a depth of 4.5 feet, with three feet of perforation and a 1.5-foot concrete surface seal. The annulus of each probe was filled with pea gravel around the perforated section.

2.2.2 System Operation and Monitoring

Altamont tested the extraction system for 30 minutes on March 18, 2002, to check for leaks and to evaluate initial flow, vacuum, and landfill gas concentrations. The extraction system was in continuous operation from Tuesday, March 19 through Friday, March 29, 2002, with daily monitoring during weekdays. The system was off upon arrival on Monday, April 1, probably due to power interruption from storm activity over the weekend. A chronology of operation and monitoring activities is provided in Table 5. Tables 6 through 8 summarize data collected during the study.

The following parameters were measured on a daily basis (except weekends) throughout the study period:

- Extraction system: percent concentrations of methane, carbon dioxide, and oxygen at blower exhaust; flow and vacuum at knockout drum (Table 6).
- Climactic data: barometric pressure and rainfall data was collected throughout the study period (Table 6). These data were collected by the National Weather Service at the Asheville, North Carolina Regional Airport weather station.
- Each extraction well (EW-1 and EW-2): percent concentrations of methane, carbon dioxide, and oxygen; vacuum; flow; BTU value; and water level (Table 7).
- Gas probes and monitoring wells (MW-5, GP-5, GP-6, GP-15s, GP-15d, GP-19, TP-1, TP-2): percent concentrations of methane, carbon dioxide, and oxygen; probe pressure (vacuum); and periodic water level measurements (Table 8).

Upon startup, the system was operated at full vacuum, approximately 56 inches of water. On March 29, the vacuum was adjusted down to approximately 27 inches of water by opening a fresh air bleed at the blower. On April 1, 2002, when the system was restarted after shutting down over the weekend, the vacuum was adjusted down to approximately 5 inches of water for the remainder of the study.

3.0 FINDINGS

This section presents field observations associated with the pilot studies at the northern and southeastern property boundaries.

3.1 Phase 1 Pilot Study

Tables 2 through 3 provide a summary of landfill gas concentrations measured during the study at the northern property boundary. Historical methane concentration charts for each of the northern boundary monitoring points are included in Appendix A. Charts of methane concentrations measured in probes during the study are included in Appendix B.

Monitoring point MW-1 was constructed as a monitoring well, but has also been used for monitoring landfill gas concentrations. The benefit of monitoring landfill gas at a monitoring well is that it can serve as a deep monitoring point if the groundwater level is below the top of screen. The disadvantage is that fluctuations in water level can affect methane concentrations by changing the length of exposed screen. In addition, since groundwater monitoring wells are not constructed to monitor gas, the screened segments are not always at the optimum depth. The water level in MW-1 has historically been very close to the top of screen at 95 feet below ground surface. MW-1 had a methane concentration of 18 percent prior to startup and has ranged from zero to 58.5 percent since January 1999. Concentrations during the study ranged from zero to 5.5 percent. Readings of zero in this monitoring point may be indicative of a submerged screen condition. Methane concentrations during the study did not exhibit any apparent trend.

Monitoring point GP-1 has had a history of erratic methane readings since 1999, characterized by periods of 0.0 percent methane and periods of greater than five percent methane. Readings during the study were consistently 0.0 percent. Altamont suspected that the probe was not functioning properly and, therefore, installed a replacement probe (GP-1A) on November 27, 2001. GP-1A was installed about 15 feet south of GP-1. After installation of GP-1A, methane concentrations increased steadily from 1.3 percent immediately after installation to 11.4 percent 3 days later. During that period, the wellhead on the nearest

vent (Vent 10) was closed. After termination of the study, passive venting resumed at Vent 10 and methane concentrations at GP-1A decreased to 0.3 percent.

Methane concentrations at GP-2 have consistently been greater than 50 percent since 1999. Some reduction in concentrations was observed during the study; however, compliance levels were not attained. Concentrations fell from 40.5 percent prior to startup to 31.1 percent after one day of operation. Concentrations fell to 9.7 percent on November 29 before spiking back up to 36.3 percent the following day. The cause of these fluctuations is not fully understood; however, the data suggests that the existing trench system is not adequate to mitigate methane in the vicinity of GP-2.

Methane concentrations at GP-3 have historically been erratic. There appears to be a cyclical trend with high concentrations in early spring and low concentrations in the fall. The average methane concentration at GP-3 since 1999 was 22.1 percent. However, the average November concentration was 4.8 percent. The concentration before the study was 4.5 percent on November 7, 2001. Vent 1 (connected to Trench B) was the closest extraction point to GP-3. Vacuum was applied to this vent from November 14 to 28, 2001. During that period, methane concentrations ranged from 1.0 to 3.5 percent with no apparent trend in concentrations. Based on seasonal fluctuations, it is unlikely that methane concentrations could have been maintained below five percent for the long term.

3.2 Phase 2 Pilot Study

The setup and operation of the southeastern property boundary pilot study is described in Section 2.2. This section presents findings of the study.

3.2.1 Vacuum, Flow, and Water Levels

The system test on March 18, 2002, indicated a vacuum at each extraction well of 56 inches of water. Initial flows of landfill gas were measured as 16 standard cubic feet per minute (scfm) from EW-1 and five scfm from EW-2. Water levels in EW-1 and EW-2 were at depths of 25.1 and 26.5 feet, respectively, prior to starting the extraction system. As noted previously, the water levels observed in EW-1 and EW-2 during drilling were approximately 30 feet and 10 feet, respectively.

During the course of the pilot study the water levels rose by as much as nine feet. The elevated water levels reduced the length of exposed screen. On March 21, 2002, Altamont pumped 165 gallons of water from EW-2 in order to expose more screen for landfill gas extraction. The water table was lowered by 8.2 feet during the first 40 minutes of pumping. An additional 20 minutes of pumping yielded no additional draw-down, indicating that the rate of recharge had reached equilibrium with the 2.75 gallon per minute pumping rate. By March 22, the water level had returned to the pre-pump-down level.

After approximately one week of operation at full vacuum, ranging from 56 to 65 inches of water, flows in both extraction wells fell to zero. On March 29, the system vacuum was reduced to 27 inches of water. By April 1, after a weekend storm had shutdown the system, the water levels in the extraction wells had dropped back to within a foot of their levels before the system was started. When the system was restarted, flow was measured at vacuum settings of 10, 20, and 5 inches of water. There was no flow of landfill gas at any of these settings. The system was left operating at minimal vacuum (approximately five inches of water with the fresh air bleed valve fully open) for the remaining day of the study.

On April 2, the vacuum line was disconnected and the blower was tested to evaluate maximum flow capability with no vacuum. A flow of 140 scfm was measured. The system was reconnected and operated at a vacuum of 15 inches of water while measuring flow at EW-2. No flow was measured at EW-2. The vacuum was then increased to 60 inches of water. A flow of eight scfm was measured at EW-2, but within a minute the flow decreased to zero.

3.2.2 Landfill Gas Concentrations

Tables 6 and through 8 provide a summary of landfill gas concentrations measured during the study at the southeastern property boundary. Historical methane concentration charts for each of the southeastern boundary monitoring points are included in Appendix A. Charts of methane concentrations measured in probes and extraction wells during the study are included in Appendix B. The following is a summary of methane concentration trends in each monitoring point.

- Concentrations of methane in temporary probe TP-1 ranged between 0.0 and 0.3 percent during the study with no apparent trend related to operation of the gas extraction system. This probe is located within 10 feet of Vent 16 and the associated shallow trench D. The vent and trench structures may be keeping shallow zone methane concentrations low in the immediate vicinity.
- Concentrations of methane in temporary probe TP-2 ranged between 52 and 68 percent during the study with no apparent trend related to operation of the gas extraction system.
- Concentrations of methane in monitoring well MW-5 ranged between 56 and 68 percent during the study with no apparent trend related to operation of the gas extraction system.
- Concentrations of methane in gas probe GP-5 ranged between 5 and 13 percent during the study with no apparent trend related to operation of the gas extraction system.
- Concentrations of methane in monitoring well GP-6 ranged between 19 and 50 percent during the study with no apparent trend related to operation of the gas extraction system.
- Concentrations of methane in monitoring well GP-15s ranged between 8 and 22 percent during the study with no apparent trend related to operation of the gas extraction system.
- Concentrations of methane in monitoring well GP-15d ranged between 0.3 and 16 percent during the study with no apparent trend related to operation of the gas extraction system.
- Concentrations of methane in monitoring well GP-19 ranged between 4 and 27 percent during the study with no apparent trend related to operation of the gas extraction system.
- Methane concentrations in the extraction wells decreased during the course of the study as balance gas (assumed to be primarily nitrogen) concentrations increased.

4.0 CONCLUSIONS AND RECOMMENDATIONS

This section provides a summary of conclusions derived from the pilot studies conducted at the northern and southeastern property boundaries. Recommendations for further action are also provided.

4.1 Phase 1 Pilot Study

The results presented in Section 3.1 lead to the following summary conclusions:

- Gas probe GP-1 appears to be faulty and was replaced by probe GP-1A near the end of the study. Although the impact of active extraction on GP-1A was not evaluated, subsequent readings at GP-1A indicate that location is within compliance limits at the depths monitored.
- Active gas extraction on the existing vents was not effective at reducing the methane concentration at monitoring location GP-2 to below compliance levels (5 percent).
- A modest reduction of methane concentration was achieved at GP-3. However, this result may be due in part to seasonal fluctuations of methane concentrations.
- Seasonal fluctuations previously observed will likely be repeated and the level of control offered by active extraction at Vent 1/Trench B is not likely to provide compliance.

Based on these conclusions, active extraction of landfill gas using the vents and trenches near the northern property boundary cannot be expected to provide sufficient reduction of boundary methane concentrations to maintain long-term compliance. Additional subsurface investigation along the northern property boundary is recommended to evaluate depth and extent of waste deposition, geologic strata conducive to gas migration, and groundwater levels. Alternate strategies for mitigation of landfill gas can then be evaluated. In the meantime, a comprehensive evaluation of the landfill gas monitoring network is recommended to identify data gaps and to ensure the protection of human health until a permanent remedy can be implemented.

4.2 Phase 2 Pilot Study

The results presented in Section 3.1 lead to the following summary conclusions:

- Prior to starting the extraction system, water was encountered in extraction wells EW-1 and EW-2 at depths of 25.1 and 26.5 feet, respectively. During the study, water levels in each well rose by as much as nine feet. The presence of water was unexpected due to nearby observations of groundwater at elevations some 70 feet lower. The rise in water levels can be attributed to the high vacuum on the system and, possibly, rainfall events that were concurrent with the study. The elevated water levels reduced the length of exposed screen, thereby reducing overall effectiveness of the system.
- There was no apparent trend in reduction of methane concentrations in any of the landfill gas monitoring probes.
- Pressure data for the landfill gas monitoring probes indicates that vacuum was not sustained at any of the probes during the study.
- Flow of landfill gas through the extraction wells was not sustained. Initial flows were low and decreased steadily. After 10 days of operation, flow from both wells was zero. This data is indicative of possible plugging of the filter pack.
- Evaluation of landfill gas concentrations shows a steady increase in balance gas (assumed to be primarily nitrogen) concentrations and decrease in methane concentrations in the extraction wells during the course of the study. These data suggest infiltration of ambient air through the cap. The steep sideslope near the wells may provide an infiltration pathway.

Based on these conclusions, extraction wells placed along the C&D access road do not appear capable of controlling landfill gas along the southeastern property boundary. Despite application of a high vacuum on the system, landfill gas monitoring probes were not influenced during the study. The presence of an unexpectedly high water table in the landfill limits the vertical extent of extraction wells. Due to very steep side slopes along this portion of the landfill, accessible locations for installation of extraction wells are severely limited.

In consideration of these technical challenges, it may be more effective to install extraction wells outside of the landfill, along Landfill Road, in order to achieve greater depth of extraction without being hampered by the shallow zone of perched water associated with the landfill. Additional subsurface

investigation along the southeastern property boundary is recommended to evaluate depth and extent of waste deposition, geologic strata conducive to gas migration, and groundwater levels. Alternate strategies for landfill gas mitigation can then be evaluated. In the meantime, a comprehensive evaluation of the landfill gas monitoring network is recommended to identify data gaps and to ensure the protection of human health until a permanent remedy can be implemented.

FIGURES

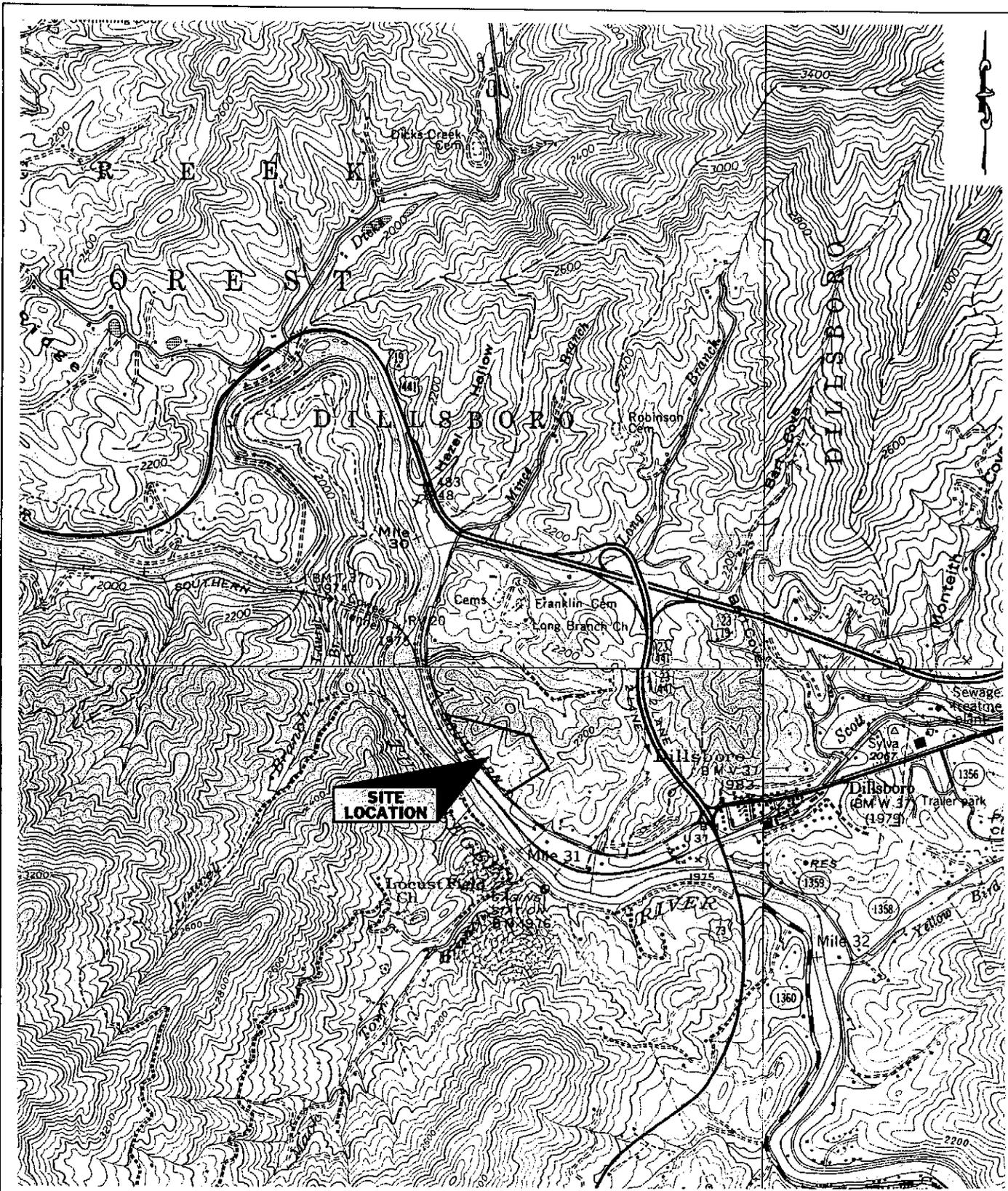


FIGURE 1
 SITE LOCATION MAP
 JACKSON COUNTY LANDFILL
 JACKSON COUNTY, NORTH CAROLINA
 GREENS CREEK, WHITTIER, SYLVA NORTH & SYLVA SOUTH
 NORTH CAROLINA U.S.G.S. QUADRANGLES

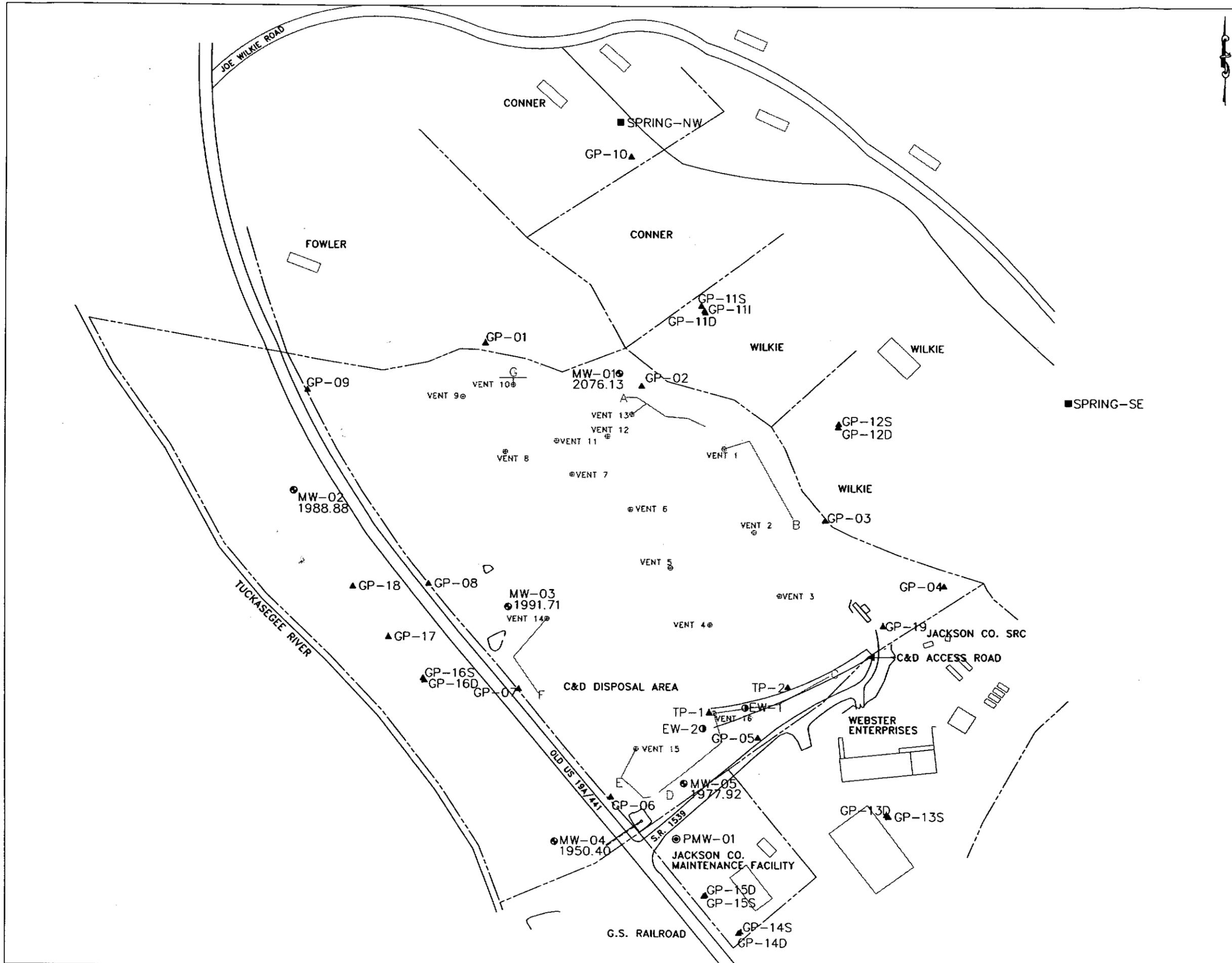
Altamont
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 PHONE 828-281-3350

DRAWN BY: JOHN CHASE DATE: 05-01-02
 PROJECT MANAGER: JIM MCCLUFF
 CLIENT: JACKSON COUNTY
 FILE: PROJECTS/JACKSON CO/FIGURE 1

COUNTOUR INTERVALS: 40 FEET
 MAP DATES: 1940, 1967, & 1946
 PHOTO REVISIONS: 1978 & 1990





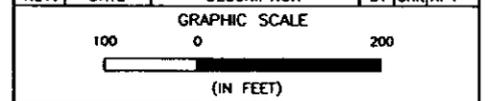
NOTES:

1. BASED ON A METHANE GAS VENTING SITE PLAN BY MCGILL AND ASSOCIATES DATED FEB. 1999 AND A SURVEY COMPLETED BY HUTCHISON-BIGGS & ASSOC. MARCH 6, 2002.

LEGEND:

- MONITORING WELL LOCATION
- ▲ GAS PROBE LOCATION
- - - PROPERTY BOUNDARY
- ⊙ PASSIVE LANDFILL GAS VENTS
- LANDFILL GAS TRENCH (APPROX)
- ⊙ LFG EXTRACTION WELL LOCATION

REV.	DATE	DESCRIPTION	BY	CHK	APV



DRAWN BY: J. CHASE DATE: 04-19-02
 PROJECT NUMBER: 2040.05
 CADD DIRECTORY: /PROJECTS/JACKSON/LFG
 CADD FILENAME: FIGURE 2

Altamont
Environmental, Inc.
 ENGINEERING & HYDROGEOLOGY
 78½ PATTON AVENUE
 ASHEVILLE, NORTH CAROLINA
 PHONE 828-281-3350

MONITORING WELL, VENT, AND GAS
 PROBE LOCATION MAP
 JACKSON COUNTY LANDFILL
 JACKSON COUNTY, NORTH CAROLINA

DRAWING NUMBER
 FIGURE 2

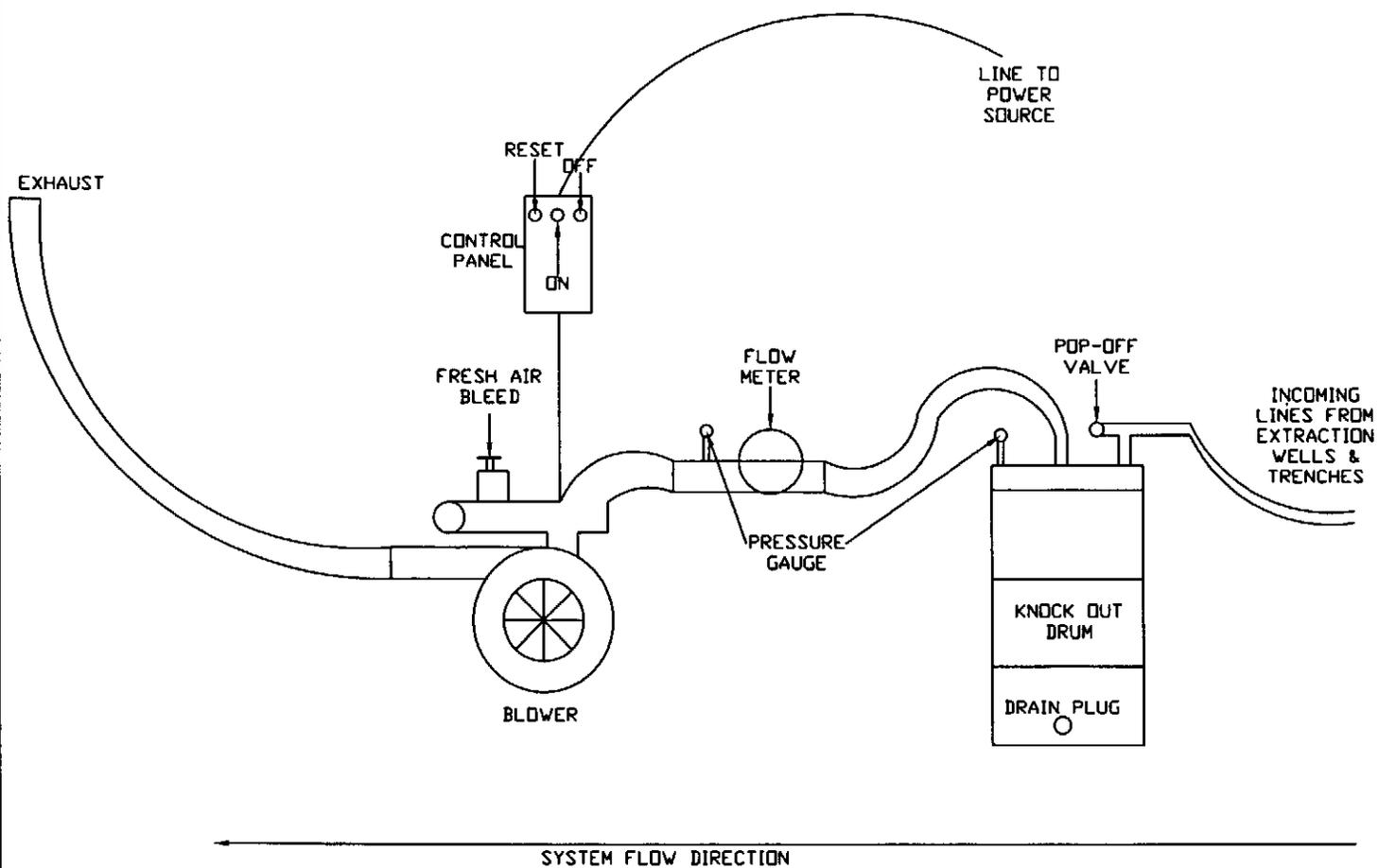


FIGURE 3

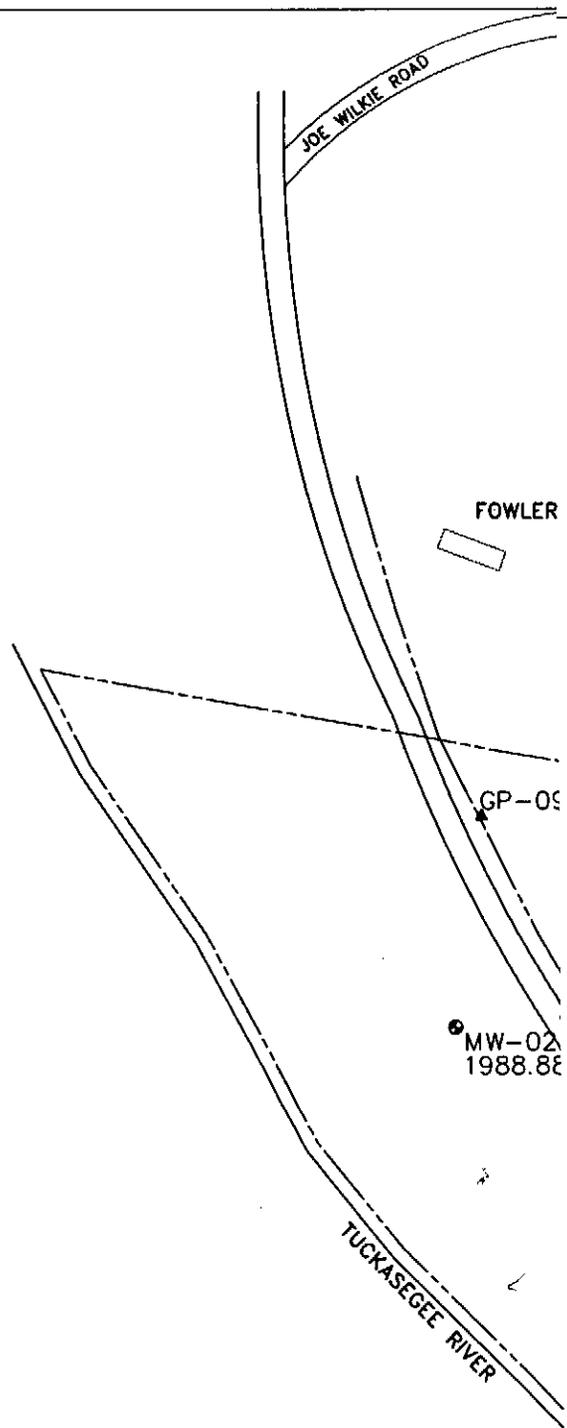
BLOWER SETUP SCHEMATIC
 JACKSON COUNTY LANDFILL
 DILLSBORO, NORTH CAROLINA

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 ASHEVILLE, NORTH CAROLINA
 PHONE 828-281-3350

DRAWN BY: JOHN CHASE
 PROJECT MANAGER: JIM MCCLDUFF
 CLIENT: JACKSON COUNTY DATE: 04-19-02
 FILE: /PROJECTS/JACKSON/204005/EW1

NOT TO SCALE



NOTES:

1. BASED ON A METHANE GAS VENTING SITE PLAN BY MCGILL AND ASSOCIATES DATED FEB. 1999 AND A SURVEY COMPLETED BY HUTCHISON-BIGGS & ASSOC. MARCH 6, 2002.

LEGEND:

- ⊙ MONITORING WELL LOCATION
- ▲ GAS PROBE LOCATION
- - - PROPERTY BOUNDARY
- ⊙ PASSIVE LANDFILL GAS VENTS
- A LANDFILL GAS TRENCH (APPROX)
- ⊙ LFG EXTRACTION WELL LOCATION
- CROSS SECTION (A-A' TYP.)

REV.	DATE	DESCRIPTION	BY	CHK	APV

GRAPHIC SCALE

100 0 200

(IN FEET)

DRAWN BY: J. CHASE DATE: 04-19-02

PROJECT NUMBER: 2040.05

CADD DIRECTORY: /PROJECTS/JACKSON/LFG

CADD FILENAME: FIGURE 3

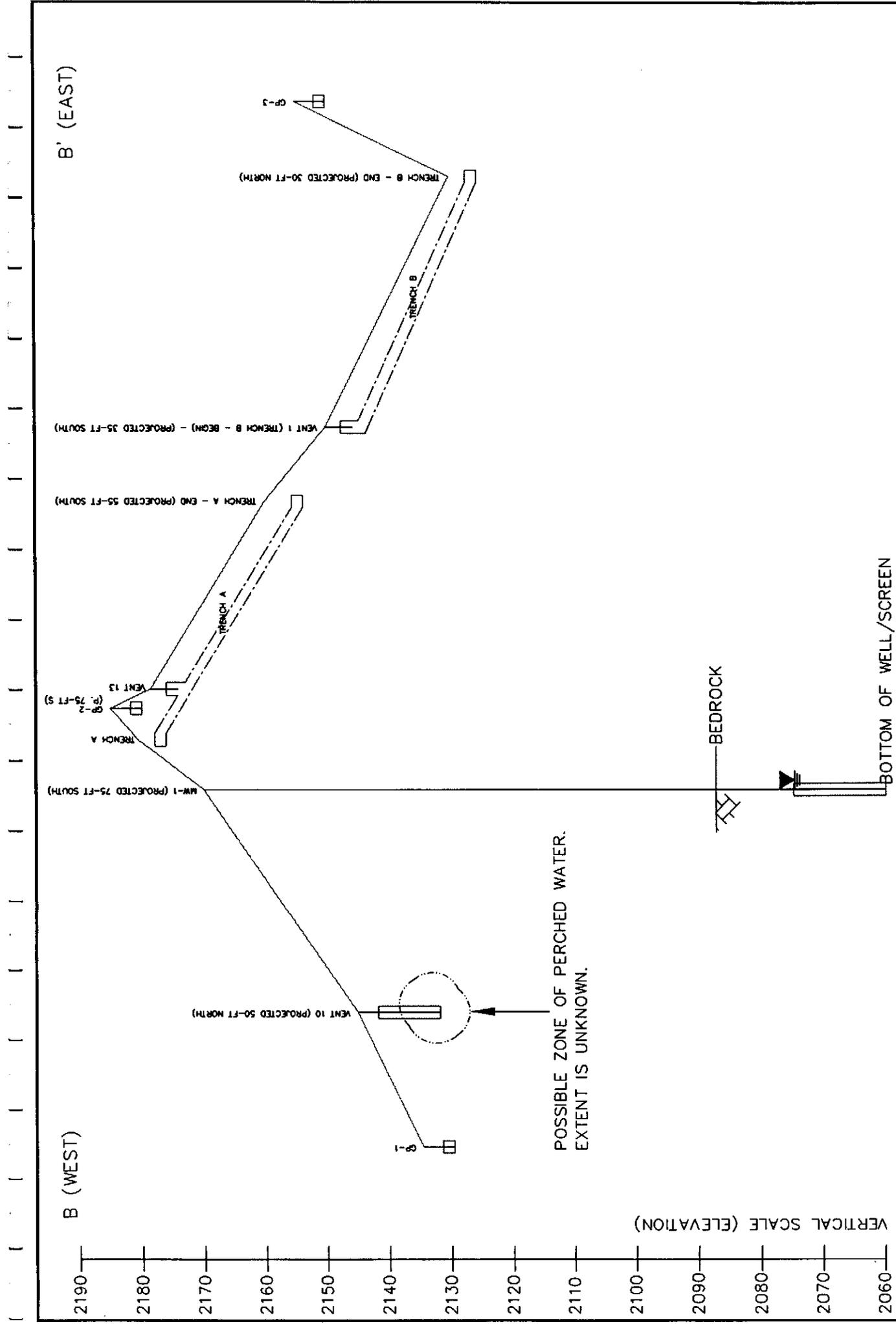
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CROSS SECTION LOCATION MAP
 JACKSON COUNTY LANDFILL
 JACKSON COUNTY, NORTH CAROLINA

DRAWING NUMBER

FIGURE 4



NOTES:
 1. VERTICAL SCALE IS 1-INCH = 20 FEET.
 2. ELEVATIONS ARE BASED ON MEAN SEA LEVEL.
 3. GROUNDWATER MEASUREMENTS TAKEN ON 4-10-02.

LEGEND: GROUNDWATER ELEVATION

HORIZONTAL SCALE (IN FEET)



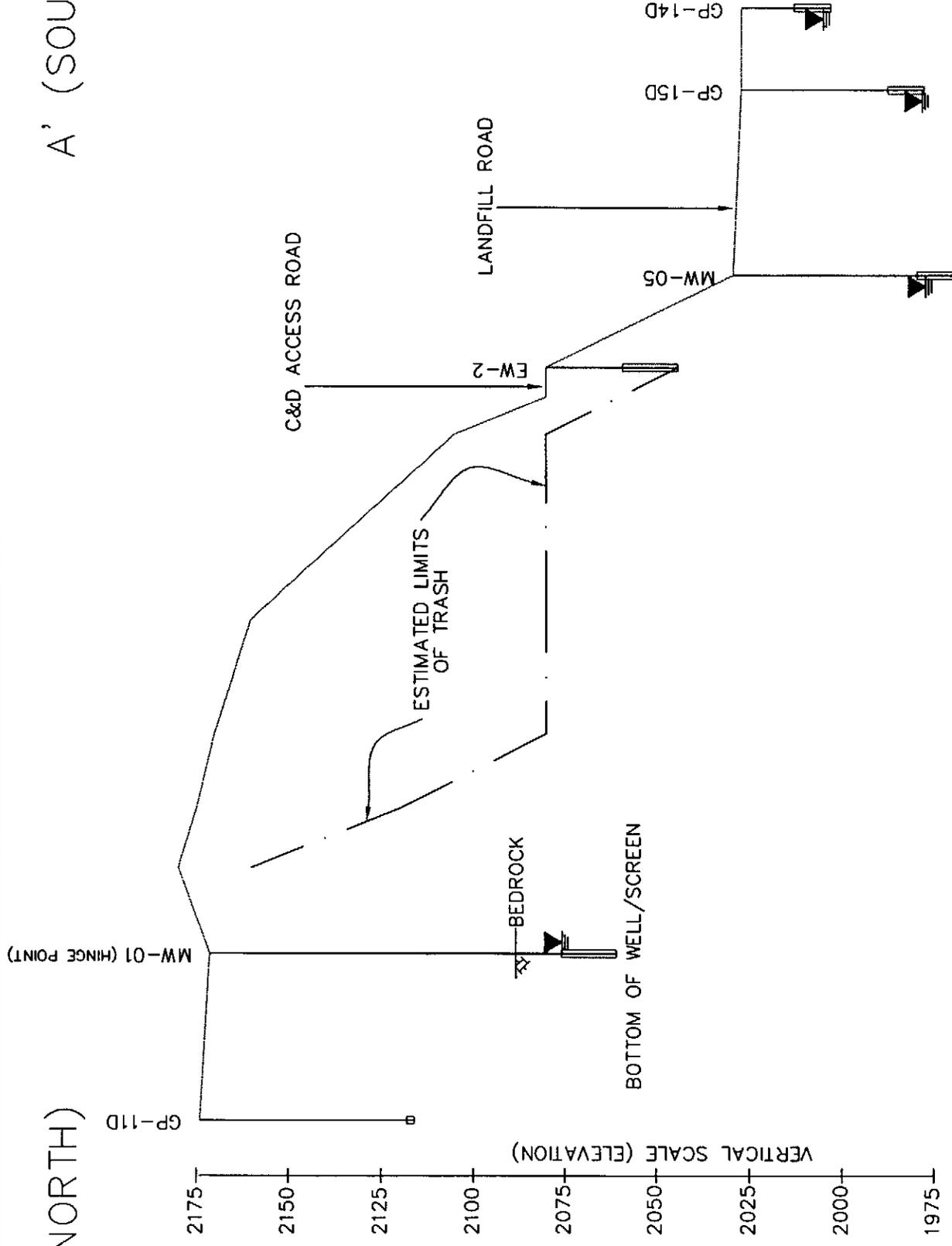
1-INCH = 100- FEET

FIGURE 5
VENT AND PROBE CROSS SECTIONS
JACKSON COUNTY LANDFILL
APRIL 2002

Altamont
Environmental, Inc.
 ENGINEERING & HYDROGEOLOGY
 78 1/2 PATTON AVENUE
 ASHEVILLE, NORTH CAROLINA

A (NORTH)

A' (SOUTH)



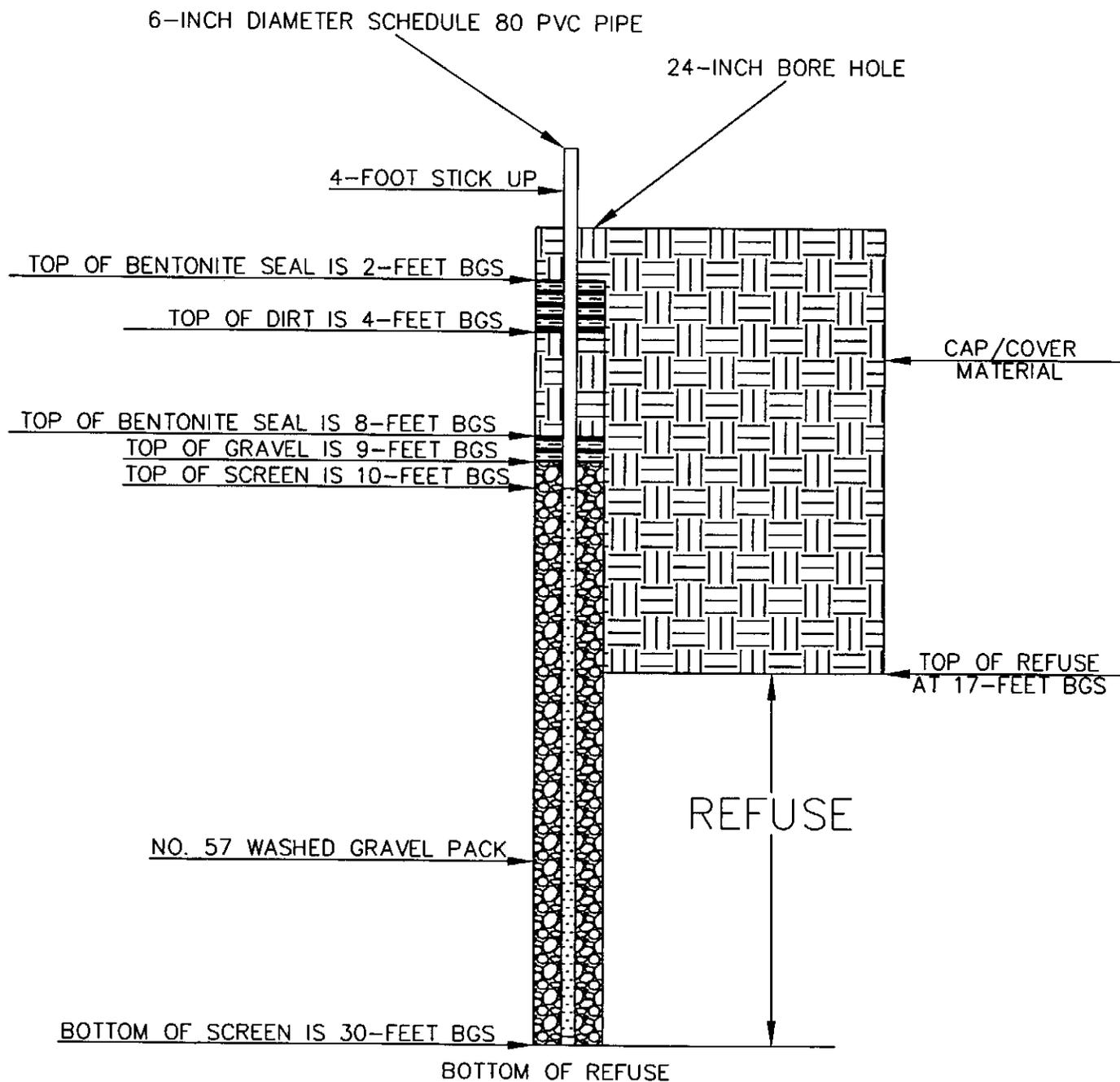
NOTES: 1. VERTICAL SCALE IS 1-INCH = 40 FEET.
2. ELEVATIONS ARE BASED ON MEAN SEA LEVEL.
3. GROUNDWATER MEASUREMENTS TAKEN ON 3-20-02, EXCEPT MW-1 WAS MEASURED ON 4-10-02.

LEGEND:
▲ GROUNDWATER ELEVATION
--- ESTIMATED LIMITS OF TRASH

HORIZONTAL SCALE (IN FEET)
100 0 200
1-INCH = 200- FEET

FIGURE 6
NORTH-SOUTH CROSS SECTION
THROUGH LANDFILL
JACKSON COUNTY LANDFILL
APRIL 2002

Altamont
Environmental, Inc.
ENGINEERING & HYDROGEOLOGY
709, PATTON AVENUE
ASHEVILLE, NORTH CAROLINA



NOTES:
BGS MEANS BELOW GROUND SURFACE

Altamont
Environmental, Inc.
ENGINEERING & HYDROGEOLOGY

78½ PATTON AVENUE
ASHEVILLE, NORTH CAROLINA
PHONE 828-281-3350

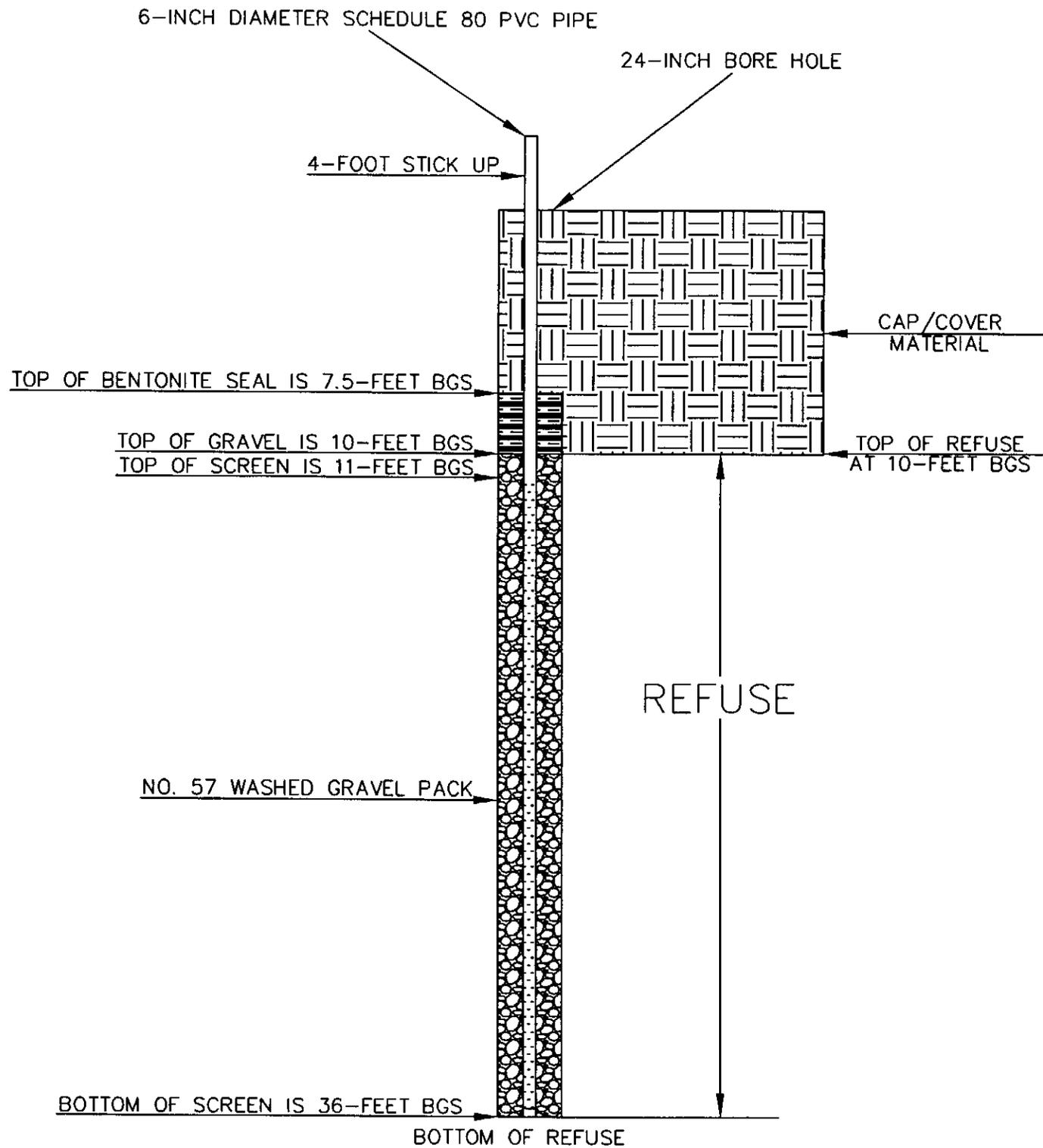
FIGURE 7

DIAGRAM OF LANDFILL GAS EXTRACTION WELL EW-1
JACKSON COUNTY LANDFILL
DILLSBORO, NORTH CAROLINA

DRAWN BY: JOHN CHASE
PROJECT MANAGER: JIM MCELDOFF
CLIENT: JACKSON COUNTY DATE: 04-19-02
FILE: /PROJECTS/JACKSON/204005/EW1

VERTICAL SCALE (IN FEET)





NOTES:
BGS MEANS BELOW GROUND SURFACE

Altamont
Environmental, Inc.
ENGINEERING & HYDROGEOLOGY

78½ PATTON AVENUE
ASHEVILLE, NORTH CAROLINA
PHONE 828-281-3350

DRAWN BY: JOHN CHASE
PROJECT MANAGER: JIM MCELDRUFF
CLIENT: JACKSON COUNTY DATE: 04-19-02
FILE: /PROJECTS/JACKSON/204005/EW1

VERTICAL SCALE (IN FEET)



FIGURE 8

DIAGRAM OF LANDFILL GAS EXTRACTION WELL EW-2
JACKSON COUNTY LANDFILL
DILLSBORO, NORTH CAROLINA

TABLES

Table 1
Summary of Operation and Monitoring Activities
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 1
Dillsboro, North Carolina

Date	Notes
11/7/2001	Complete round of landfill gas readings taken at each landfill gas monitoring point.
11/14/2001	Complete blower setup, turn on blower at 1500 hours, fresh air valve completely closed vacuum at 140 scfm, valves at wellheads fully open
11/15/2001	Take readings, check to see if Vent 10 is obstructed - little or no flow.
11/16/2001	Take readings.
11/17/2001	Take readings.
11/18/2001	Take readings.
11/19/2001	Take readings. Isolate Vent 10 for approximately 45 minutes. Reconfigure blower setup to resolve moisture problem at flow meter.
11/20/2001	Take readings.
11/21/2001	Take readings. Let about 10-gallons of water from the knock out drum.
11/22/2001	No readings taken.
11/23/2001	Take readings. Let about 15 gallons of water from the knock out drum. County placed dirt over cap area with cracks.
11/24/2001	Rain. Take readings. Drain about 6 gallons of water from the knock out drum.
11/25/2001	System off upon arrival. Back up at 11:45. Take readings. Shut off wellhead valve at Vent 10 for remainder of study due to lack of methane in probe GP-01.
11/26/2001	Take readings.
11/27/2001	Installed GP-1A to a depth of 4.5 feet below the existing ground surface approximately 15 feet south of GP-1. Empty 5 gallons of water from knockout drum. GP-1A replaces GP-1, which is suspected to be not operating properly.
11/28/2001	Take readings. Reconfigure blower setup to correct alignment of flow meter. Shut off wellhead valve at Vent 1 for remainder of study to concentrate vacuum on Vent 13 in an attempt to reduce methane concentrations at probe GP-02.
11/29/2001	Take readings.
11/30/2001	Plumbed blower plumbed directly to Vent 13. Vents 1 and 10 are off line.
12/1/2001	No readings taken.
12/2/2001	No readings taken.
12/3/2001	Take readings and shut down blower.

Table 2
Summary of System Readings and Climatic Data
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 1
Dillsboro, North Carolina
November and December 2001

Date	Blower exhaust					System Flow at Knockout	System Vacuum at knockout	Barometric Pressure	24-Hour Rainfall
	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	(scfm)	(inches water)	(inches Hg)	(inches)
11/14/2001	2.7	5.4	17.0	75.0	4.4	140	NA	30.29	0.0
11/15/2001	1.6	3.6	18.2	76.7	4.2	142	11	30.16	NA
11/16/2001	1.2	3.3	18.7	76.9	4.1	145	11	30.28	0.0
11/17/2001	1.1	3.3	18.8	77.2	4.1	145	11	30.35	0.0
11/18/2001	1.5	3.3	18.4	77.3	4.2	145	12	30.39	0.0
11/19/2001	1.4	3.5	17.4	77.8	4.5	145	11	30.29	0.0
11/20/2001	1.2	3.7	18.5	76.5	4.1	NA	NA	30.02	0.0
11/21/2001	2.0	3.8	18.4	76.8	4.2	NA	NA	30.17	0.0
11/23/2001	3.5	2.5	18.6	75.4	4.1	NA	NA	30.08	0.0
11/24/2001	2.6	2.1	18.7	76.7	4.1	NA	NA	30.11	NA
11/25/2001	9.9	7.3	15.9	67.3	4.2	NA	NA	30.10	0.0
11/26/2001	2.2	2.0	18.9	76.7	4.1	NA	NA	30.18	0.0
11/27/2001	2.3	1.7	19.3	76.9	4.0	NA	NA	30.13	0.0
11/28/2001	2.7	1.6	19.1	76.7	4.0	130	29	30.20	0.0
11/29/2001	0.8	0.3	20.1	78.9	3.9	115	35	30.11	0.0
11/30/2001	2.7	2.0	19.0	76.2	4.0	115	35	30.02	0.19
12/3/2001	2.5	1.8	19.2	76.6	4.0	125	36	30.37	NA

Notes: NA = data not collected or not valid

Hg = mercury

scfm = standard cubic feet per minute

Rainfall data collected for Sylva, North Carolina

Barometric pressure data collected at Asheville Regional Airport weather station

Table 3
Summary of Vent Readings
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 1
Dillsboro, North Carolina
November and December 2001

Location	Total Depth (feet bgs)	Associated Trench	Vent 1	Vent 10	Vent 13	Date	Pressure (inches of water)	Flow (scfm)	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio		
Vent 1	6.5	B	Open	Open	Open	11/14/2001	NA	NA	15.6	17.3	10.7	57.0	5.3		
			Open	Open	Open	11/15/2001	NA	NA	2.3	4.3	17.5	75.9	4.3		
			Open	Open	Open	11/16/2001	NA	NA	1.8	3.8	18.1	76.2	4.2		
			Open	Open	Open	11/17/2001	NA	NA	1.6	3.8	18.1	76.9	4.2		
			Open	Open	Open	11/18/2001	NA	NA	1.0	4.2	17.5	77.5	4.4		
			Open	Open	Open	11/19/2001	NA	NA	2.0	4.2	17.0	76.9	4.5		
			Open	Open	Open	11/20/2001	NA	NA	0.8	3.6	18.5	76.9	4.2		
			Open	Open	Open	11/21/2001	NA	NA	0.6	3.0	18.7	77.6	4.1		
			Open	Open	Open	11/23/2001	NA	NA	1.8	1.5	19.2	77.6	4.0		
			Open	Open	Open	11/24/2001	NA	NA	1.2	1.2	19.2	78.5	4.1		
			Open	Open	Open	11/25/2001	NA	NA	6.6	4.8	17.3	71.5	4.1		
			Open	Closed	Open	11/25/2001	NA	NA	2.3	1.8	19.1	76.7	4.0		
			Open	Closed	Open	11/26/2001	NA	NA	1.4	1.3	19.1	78.2	4.1		
			Open	Closed	Open	11/27/2001	NA	NA	1.1	0.8	19.8	78.2	3.9		
			Open	Closed	Open	11/28/2001	NA	NA	-0.5	0.0	0.1	0.0	20.6	79.2	3.8
			Closed	Closed	Open	11/29/2001	NA	NA	0.0	0.0	23.3	14.4	12.6	49.6	3.9
			Closed	Closed	Open	11/30/2001	NA	NA	0.0	0.0	60.7	38.7	0.3	0.0	0.0
Closed	Closed	Open	12/3/2001	NA	NA	NA	NA	NA	NA	NA	NA	NA			

Notes: NA = data not collected or not valid
Hg = mercury
scfm = standard cubic feet per minute
bgs = below ground surface

Table 3
Summary of Vent Readings
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 1
Dillsboro, North Carolina
November and December 2001

Location	Total Depth (feet bgs)	Associated Trench	Vent 1	Vent 10	Vent 13	Date	Pressure (inches of water)	Flow (scfm)	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio
Vent 10	10	G	Open	Open	Open	11/14/2001	NA	NA	47.3	33.9	0.5	17.0	34.0
			Open	Open	Open	11/15/2001	NA	NA	46.5	31.6	0.9	22.6	25.1
			Open	Open	Open	11/16/2001	NA	NA	47.0	30.9	0.9	20.7	23.0
			Open	Open	Open	11/17/2001	NA	NA	46.5	33	0.9	21.4	23.8
			Open	Open	Open	11/18/2001	NA	NA	45.1	53.3	1.9	0.0	0.0
			Open	Open	Open	11/19/2001	NA	NA	45.9	34.4	0.6	19.0	31.7
			Open	Open	Open	11/20/2001	NA	NA	48.3	33	0.7	18.4	26.3
			Open	Open	Open	11/21/2001	NA	NA	48.0	34.8	0.9	17.9	19.9
			Open	Open	Open	11/23/2001	NA	NA	35.0	23.2	8.6	33.7	3.9
			Open	Open	Open	11/24/2001	NA	NA	29.4	19.1	10.2	41.2	4.0
			Open	Open	Open	11/25/2001	NA	NA	34.8	23.0	8.7	33.6	3.9
			Open	Closed	Open	11/26/2001	NA	NA	50.4	34.4	3.9	12	3.1
			Open	Closed	Open	11/27/2001	+0.7	NA	48.0	31.0	5.0	18.6	3.7
			Open	Closed	Open	11/28/2001	+0.4	73	46.8	32.3	4.8	15.3	3.2
			Closed	Closed	Open	11/29/2001	+0.1	0.0	32.5	22.0	9.6	36.0	3.8
			Closed	Closed	Open	11/30/2001	-0.38	0.0	60.2	39.1	0.2	0.0	0.0
Closed	Closed	Open	12/3/2001	NA	NA	NA	NA	NA	NA	NA			

Notes: NA = data not collected or not valid
Hg = mercury
scfm = standard cubic feet per minute
bgs = below ground surface

Table 3
Summary of Vent Readings
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 1
Dillsboro, North Carolina
November and December 2001

Location	Total Depth (feet bgs)	Associated Trench	Vent 1	Vent 10	Vent 13	Date	Pressure (inches of water)	Flow (scfm)	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio
Vent 13	6.5	A	Open	Open	Open	11/14/2001	NA	NA	7.6	11.3	12.5	69.0	5.5
			Open	Open	Open	11/15/2001	NA	NA	0.3	2.7	18.8	78.1	4.2
			Open	Open	Open	11/16/2001	NA	NA	0.1	2.4	18.9	78.6	4.2
			Open	Open	Open	11/17/2001	NA	NA	0.3	2.5	19.0	78.2	4.1
			Open	Open	Open	11/18/2001	NA	NA	0.0	2.7	18.3	78.9	4.3
			Open	Open	Open	11/19/2001	NA	NA	0.2	2.5	18.5	78.8	4.3
			Closed	Closed	Open	11/19/2001	NA	NA	40.7	31.4	1.9	26	13.7
			Open	Open	Open	11/20/2001	NA	NA	0.3	2.7	18.9	78.0	4.1
			Open	Open	Open	11/21/2001	NA	NA	0.1	2.6	19.0	78.2	4.1
			Open	Open	Open	11/23/2001	NA	NA	2.8	2.1	19.0	76.4	4.0
			Open	Open	Open	11/24/2001	NA	NA	1.7	1.7	18.8	77.7	4.1
			Open	Open	Open	11/25/2001	NA	NA	8.0	6.4	16.5	69.4	4.2
			Open	Closed	Open	11/25/2001	NA	NA	4.1	3.3	18.0	74.7	4.2
			Open	Closed	Open	11/26/2001	NA	NA	2.8	2.2	18.4	76.6	4.2
			Open	Closed	Open	11/27/2001	NA	NA	1.8	1.4	19.5	77.3	4.0
			Open	Closed	Open	11/28/2001	0.0	0.0	0.1	0.0	20.5	79.3	3.9
			Closed	Closed	Open	11/28/2001	-1.6	49	1.0	0.3	20.0	78.7	3.9
			Closed	Closed	Open	11/29/2001	-0.3	65	0.0	0.0	20.4	79.6	3.9
			Closed	Closed	Open	11/30/2001	-3.0	87	2.4	1.6	19	77.2	4.1
			Closed	Closed	Open	12/3/2001	-3.4	98	2.5	1.7	19.1	76.8	4.0

Notes: NA = data not collected or not valid
Hg = mercury
scfm = standard cubic feet per minute
bgs = below ground surface

Table 4
Summary of Probe Readings
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 1
Dillsboro, North Carolina
November and December 2001

Date	MW-1 (screened from 95 to 110 feet bgs)					
	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (Inches of water)
11/7/2001	18.0	14.0	14.5	53.5	3.7	0.00
11/14/2001	5.5	7.2	16.2	71.0	4.4	0.00
11/15/2001	3.0	5.3	17.7	73.9	4.2	0.00
11/16/2001	0.8	3.3	19.2	76.7	4.0	0.00
11/17/2001	1.8	3.4	18.6	76.6	4.1	0.00
11/18/2001	1.1	4.1	18.6	76.2	4.1	0.00
11/19/2001	1.0	3.4	18.7	76.9	4.1	+0.06
11/20/2001	2.9	4.9	17.8	74.2	4.2	+0.06
11/21/2001	3.3	5.4	18.2	73.6	4.0	+0.04
11/23/2001	0.0	0.0	20.2	79.8	4.0	+0.05
11/24/2001	0.0	0.0	19.9	80.0	4.0	+0.05
11/25/2001	4.7	2.7	18.7	74.2	4.0	+0.035
11/26/2001	0.0	0.0	20.4	79.6	3.9	+0.08
11/27/2001	0.1	0.0	20.6	79.4	3.9	+0.04
11/28/2001	0.1	0.0	20.5	79.4	3.9	+0.02
11/29/2001	0.0	0.0	20.5	79.6	3.9	0.00
11/30/2001	1.5	0.8	19.7	78.0	4.0	0.00
12/3/2001	4.0	2.4	19.0	74.9	3.9	0.00

Notes: NA = data not collected or not valid.
bgs = below ground surface

Table 4
Summary of Probe Readings
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 1
Dillsboro, North Carolina
November and December 2001

Date	GP-1 (screened from 3 to 5 feet bgs)						GP-1A (screened from 2.5 to 4.5 feet bgs)					
	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (Inches of water)	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (Inches of water)
11/7/2001	0.0	4.5	16.9	78.6	4.7	0.00	NA	NA	NA	NA	NA	NA
11/14/2001	0.0	7.1	13.3	79.6	6.0	0.00	NA	NA	NA	NA	NA	NA
11/15/2001	0.0	4.5	15.8	79.7	5.0	0.00	NA	NA	NA	NA	NA	NA
11/16/2001	0.0	6.9	13.9	79.2	5.7	0.00	NA	NA	NA	NA	NA	NA
11/17/2001	0.0	3.0	16.5	80.5	4.9	0.00	NA	NA	NA	NA	NA	NA
11/18/2001	0.0	9.6	14.4	76.0	5.3	0.00	NA	NA	NA	NA	NA	NA
11/19/2001	0.0	7.1	13.3	79.6	6.0	0.00	NA	NA	NA	NA	NA	NA
11/20/2001	0.0	6.0	14.8	79.2	5.4	0.00	NA	NA	NA	NA	NA	NA
11/21/2001	0.0	7.0	14.2	78.8	5.5	0.00	NA	NA	NA	NA	NA	NA
11/23/2001	0.0	4.5	16.2	79.0	4.9	0.00	NA	NA	NA	NA	NA	NA
11/24/2001	0.0	2.7	17.3	79.8	4.6	0.00	NA	NA	NA	NA	NA	NA
11/25/2001	0.0	2.3	18.0	79.7	4.4	0.00	NA	NA	NA	NA	NA	NA
11/26/2001	0.0	4.4	16.1	79.6	4.9	0.00	NA	NA	NA	NA	NA	NA
11/27/2001	NA	NA	NA	NA	NA	NA	1.3	6.9	12.9	78.8	6.1	0.0
11/28/2001	NA	NA	NA	NA	NA	NA	4.0	10.7	10.2	74.8	7.3	0.0
11/29/2001	NA	NA	NA	NA	NA	NA	5.2	11.2	10.0	73.5	7.4	0.0
11/30/2001	NA	NA	NA	NA	NA	NA	11.4	23.0	0.0	65.5	NA	0.0
12/3/2001	NA	NA	NA	NA	NA	NA	8.5	23.0	0.0	69.3	NA	0.0

Notes: Notes: NA = data not collected or not valid.
bgs = below ground surface

Table 4
Summary of Probe Readings
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 1
Dillsboro, North Carolina
November and December 2001

Date	GP-2 (screened from 3 to 5 feet bgs)						GP-3 (screened from 3 to 5 feet bgs)					
	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (inches of water)	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (inches of water)
11/7/2001	40.5	35.9	0.3	23.3	77.7	0.00	4.5	18.1	6.2	71.2	11.5	0.00
11/14/2001	31.1	33.5	0.1	35.5	355.0	0.00	1.9	10	4.5	76.0	16.9	0.00
11/15/2001	32.0	30.6	0.2	36.8	184.0	0.00	2.7	18.7	4.0	76.4	19.1	0.00
11/16/2001	30.0	30.1	0.2	40.0	200.0	0.00	2.3	17.5	5.3	75.2	14.2	+0.005
11/17/2001	28.0	32.5	0.1	39.4	394.0	0.00	1.5	17.5	4.7	75.8	16.1	0.00
11/18/2001	27.5	31.8	0.2	41.0	205.0	0.00	1.0	16.1	5.2	77.3	14.9	0.00
11/19/2001	29.5	31.4	0.0	37.0	NA	0.00	2.4	20.2	3.3	75.1	22.8	0.00
11/20/2001	31.4	32.8	0.4	34.2	85.5	-0.01	3.2	19	4.7	72.3	15.4	0.00
11/21/2001	24.3	31.7	0.4	42.8	107.0	0.00	2.2	17.7	6.1	73.8	12.1	0.00
11/23/2001	23.6	20.9	8.2	48.0	5.9	0.00	3.4	11.4	10.8	74.4	6.9	0.00
11/24/2001	23.3	22.8	6.6	47.1	7.1	0.00	2.7	10.0	11.8	75.1	6.4	0.00
11/25/2001	26.7	24.3	6.2	42.7	6.9	0.00	3.5	11.2	10.7	74.4	7.0	0.00
11/26/2001	26.0	24.7	6.0	43.1	7.2	0.00	2.6	11.6	10.6	75.1	7.1	0.00
11/27/2001	22.7	19.5	9	48	5.3	0.00	2.4	8.7	13.0	75.9	5.8	0.00
11/28/2001	22.5	19.2	9.1	49.6	5.5	0.00	2.0	8.0	13.3	76.2	5.7	0.00
11/29/2001	9.7	8.0	15.4	67.1	4.4	0.00	0.7	1.9	18.3	79.0	4.3	0.00
11/30/2001	36.3	35.1	0.1	29.2	292.0	0.00	6.6	17.9	6.0	69.4	11.6	0.00
12/3/2001	36.5	35.6	0.0	28.3	NA	0.00	3.3	16.9	6.1	73.9	12.1	0.00

Notes: Notes: NA = data not collected or not valid.
bgs = below ground surface

Table 5
Summary of Operation and Monitoring Activities
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 2
Dillsboro, North Carolina
March and April 2002

Date	Notes
3/18/2002	Setup blower and install two temporary probes (to determine radius of influence). Test extraction for 30 minutes.
3/19/2002	Take baseline measurements at nearby wells and probes. Start up system.
3/20/2002	Record measurements from wells and probes, as well as system components. Turn off system briefly to drain knockout drum and measure water levels.
3/21/2002	Take readings. Measure water levels in extraction wells. Pump 150 gallons of water out of EW-2. Turn system back on.
3/22/2002	Take readings. Measure water levels in extraction wells.
3/23/2002	Saturday - no readings collected.
3/24/2002	Sunday - no readings collected.
3/25/2002	Monday - Heather Hyatt check to make sure blower is still operating. Data entry and plot data.
3/26/2002	Tuesday - measure water level change in EWs. Measure landfill gas in wells and probes.
3/27/2002	Take readings and measure water levels in EWs.
3/28/2002	Take readings and measure water levels in EWs. Check pressure/vacuum on passive vent.
3/29/2002	Take readings and measure water levels in EWs. Check flow using mini-magnahelic gauge. Drain .5 gallons of water from vacuum line.
4/1/2002	System off upon arrival. Adjust to 10 inches of water. Take readings and measure water levels in EWs.
4/2/2002	Take readings, measure water levels, adjust system to determine flow rates, turn system off, break down and drop off blower at Wilson.

Table 6
Summary of System Readings and Climatic Data
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 2
Dillsboro, North Carolina
March and April 2002

Date	Blower exhaust					System Flow at Knockout (scfm)	System Vacuum at Knockout (inches water)	Barometric Pressure (inches Hg)	24-Hour Rainfall (inches)
	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio				
3/18/2002	NA	NA	NA	NA	NA	35	53	NA	0.16
3/19/2002	59.3	18.6	3.1	19.0	6.1	28	60	30.20	0.04
3/20/2002	39.5	14.3	3.9	41.8	10.7	28	60	30.06	0.00
3/21/2002	NA	NA	NA	NA	NA	28	60	30.01	0.04
3/22/2002	NA	NA	NA	NA	NA	28	67	30.14	0.00
3/26/2002	21.3	11.4	7.3	60.0	8.2	21	60	30.04	0.00
3/27/2002	26.2	10.2	8.6	60.6	7.0	2	60	30.06	0.38
3/28/2002	21.7	11.0	8.0	59.2	7.4	0	60	30.11	0.00
3/29/2002	9.5	9.7	8.1	72.2	8.9	0	27	30.08	0.00
4/1/2002	0.6	0.3	20.2	78.9	3.9	0	7.5	29.99	0.37
4/2/2002	31.0	13.5	2.4	55.1	23.0	0	7.5	30.04	0.00

Notes: NA = data not collected or not valid

Hg = mercury

scfm = standard cubic feet per minute

Rainfall data collected for Sylva, North Carolina

Barometric pressure data collected at Asheville Regional Airport weather station

Table 7
Summary of Extraction Well Readings
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 2
Dillsboro, North Carolina
March and April 2002

Location	Total Depth (feet bgs)	Screen length (feet)	Date	Vacuum (Inches Water)	Flow (scfm)	BTU value	Depth to Water (feet bgs)	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio
EW-1	30	20	3/18/2002	56	16	132.5	NA	52.6	17.2	4.9	25.1	5.1
			3/19/2002	57	11	117.9	25.1	56.1	16.5	3.4	22.3	6.6
			3/20/2002	59	13	83.9	20.9	44.0	14.6	3.3	37.1	11.2
			3/21/2002	61	11	64.5	22.6	34.5	12.9	4.9	47.1	9.6
			3/22/2002	64	15	78.4	21.0	30.0	12.4	4.7	51.0	10.9
			3/26/2002	65	NA	NA	20.5	24.6	11.2	5.8	58.3	10.1
			3/27/2002	62	2	0.0	19.2	22.2	9.3	8.1	60.8	7.5
			3/28/2002	60	0	0.0	19.0	22.8	9.8	7.3	59.7	8.2
			3/29/2002	24	0	0.0	17.3	10.6	4.1	14.9	70.1	4.7
			4/1/2002	5	0	0.0	24.3	28.0	13.1	3.7	56.6	15.3
			4/2/2002	2.3	0	0.0	24.1	31.5	13.7	2.6	56.0	21.5
EW-2	36	25	3/18/2002	56	5	26.7	NA	40.1	20.1	8.4	31.4	3.7
			3/19/2002	57	6	22.0	26.5	13.5	16.7	9.4	37.1	3.9
			3/20/2002	59	5	9.7	20.2	14.5	11.0	11.5	62.8	5.5
			3/21/2002	61	2	0.0	19.4	13.6	10.8	11.7	66.0	5.6
			3/22/2002	64	0	0.0	19.4	12.0	10.1	11.2	66.6	5.9
			3/26/2002	65	NA	NA	18.1	10.5	8.4	13.0	67.5	5.2
			3/27/2002	62	0	0.0	18.0	9.0	7.0	14.5	68.6	4.7
			3/28/2002	60	0	0.0	17.5	9.5	7.2	14.5	69.1	4.8
			3/29/2002	24	0	0.0	17.5	2.0	2.0	19.0	76.9	4.0
			4/1/2002	5	0	0.0	25.4	20.1	12.5	10.0	58.4	5.8
			4/2/2002	2.2	0	0.0	25.2	28.1	19.9	3.1	48.7	15.7

Notes: NA = data not collected or not valid
scfm = standard cubic feet per minute
bgs = below ground surface

Table 8
Summary of Probe Readings
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 2
Dillsboro, North Carolina
March and April 2002

Date	MW-5 (screened from 50 to 60 ft bgs)						GP-5 (screened from 3 to 5 ft bgs)					
	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (inches of water)	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (inches of water)
3/18/2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3/19/2002	66.3	26.8	0.9	6.0	6.7	+0.35	12.5	5.1	6.4	74.1	11.6	0.00
3/20/2002	67.9	26.7	1.3	4.8	3.7	+0.30	10.0	4.3	9.6	75.3	7.8	0.00
3/21/2002	65.6	32.7	0.5	1.8	3.6	+0.30	10.6	4.8	7.1	76.7	10.8	0.00
3/22/2002	NA	NA	NA	NA	NA	-0.14	NA	NA	NA	NA	NA	0.00
3/26/2002	56.5	28.5	1.7	13.5	7.9	+0.50	12.0	8.1	0.0	79.6	NA	0.00
3/27/2002	67.0	29.3	0.3	3.2	10.7	+0.45	8.5	4.7	8.7	78.3	9.0	0.00
3/28/2002	65.6	26.5	1.3	5.3	4.1	+0.60	12.3	7.4	0.7	79.9	114.1	+0.01
3/29/2002	68.0	26.9	0.7	3.0	4.3	+0.50	11.3	7.0	1.9	79.3	41.7	0.00
4/1/2002	58.7	27.6	0.8	12.9	16.1	+0.50	5.7	3.9	9.3	81.0	8.7	0.00
4/2/2002	65.8	29	0.3	4.7	15.7	+0.60	7.1	5.0	5.8	82.2	14.2	0.00

Notes: NA = data not collected or not valid
Depth to groundwater in MW-5 was 52.4 feet on 3/20/02
Depth to groundwater in GP-15d was 49.35 feet on 3/20/02

Table 8
Summary of Probe Readings
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 2
Dillsboro, North Carolina
March and April 2002

Date	GP-6 (screened from 2.2 to 4.2 ft bgs)						GP-15s (screened from 8.4 to 10.4 ft bgs)					
	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (inches of water)	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (inches of water)
3/18/2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3/19/2002	45.0	26.5	0.4	28.8	72.0	0.00	17.0	17.3	2.3	64.0	27.8	+0.04
3/20/2002	45.5	24.9	0.8	28.2	35.3	0.00	15.5	14.1	5.3	64.3	12.1	-0.04
3/21/2002	28.4	26.6	0.5	45.8	91.6	0.00	8.1	13.1	3.0	74.9	25.0	+0.06
3/22/2002	NA	NA	NA	NA	NA	0.00	NA	NA	NA	NA	NA	0.00
3/26/2002	49.4	27.3	0.0	23.2	NA	0.00	21.8	19.3	0.6	58.7	97.8	+0.04
3/27/2002	19.4	26.0	0.2	54.2	271.0	0.00	21.1	19.7	0.9	58.1	64.6	+0.10
3/28/2002	33.0	23.9	0.2	43.1	215.5	0.00	20.5	18.3	0.9	60.5	67.2	+0.20
3/29/2002	38.4	27.1	0.5	34.2	68.4	0.00	20.0	18.3	0.6	61.5	102.5	+0.17
4/1/2002	20.2	27.5	0.3	51.5	171.7	0.00	18.5	17.4	0.9	62.9	69.9	+0.18
4/2/2002	42.0	28.7	0.3	29.2	97.3	0.00	20.0	18.9	0.6	60.3	100.5	+0.20

Notes: NA = data not collected or not valid

Depth to groundwater in MW-5 was 52.4 feet on 3/20/02

Depth to groundwater in GP-15d was 49.35 feet on 3/20/02

Table 8
Summary of Probe Readings
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 2
Dillsboro, North Carolina
March and April 2002

Date	GP-15d (screened from 40 to 50 ft bgs)						GP-19 (screened from 4.7 to 6.7 ft bgs)					
	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (inches of water)	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (inches of water)
3/18/2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3/19/2002	0.4	0.7	20.3	78.6	3.9	+0.02	22.2	20.3	2.9	78.5	27.1	0.00
3/20/2002	15.2	15.8	1.1	68.6	62.4	-0.03	24.5	20.5	2.5	51.4	20.6	0.01
3/21/2002	8.5	9.9	7.1	73.0	10.3	+0.08	26.3	22.9	1.8	50.4	28.0	0.00
3/22/2002	NA	NA	NA	NA	NA	+0.01	NA	NA	NA	NA	NA	0.00
3/26/2002	13.5	15.6	1.2	69.3	57.8	0.00	24.7	21.7	1.1	51.9	47.2	0.00
3/27/2002	6.8	6.7	11.7	74.5	6.4	+0.12	14.8	12.6	9.4	63.0	6.7	0.00
3/28/2002	9.2	9.9	8.3	72.4	8.7	+0.18	22.8	20.7	3.1	52.7	17.0	+0.01
3/29/2002	0.3	0.2	20.4	79.1	3.9	+0.21	16.3	14.8	7.8	60.2	7.7	+0.01
4/1/2002	15.1	16.3	0.7	67.7	96.7	+0.11	4.0	3	18.4	75.0	4.1	0.00
4/2/2002	14.1	15.5	1.3	68.3	52.5	+0.11	15.1	15.9	8.4	60.6	7.2	0.00

Notes: NA = data not collected or not valid

Depth to groundwater in MW-5 was 52.4 feet on 3/20/02

Depth to groundwater in GP-15d was 49.35 feet on 3/20/02

Table 8
Summary of Probe Readings
Closed Jackson County MSW Landfill
Landfill Gas Pilot Study - Phase 2
Dillsboro, North Carolina
March and April 2002

Date	TP-1 (screened from 1 to 5 ft bgs)						TP-2 (screened from 1.5 to 4.5 ft bgs)					
	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (inches of water)	Methane (percent)	Carbon Dioxide (percent)	Oxygen (percent)	Balance (percent)	Balance: Oxygen Ratio	Pressure (inches of water)
3/18/2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3/19/2002	0.0	1.3	9.3	89.3	9.6	0.00	59.3	21.3	1.8	9.0	5.0	0.00
3/20/2002	0.0	0.3	19.0	80.7	4.2	-0.02	60.6	19.7	2.6	12.7	4.9	+0.01
3/21/2002	0.0	0.7	18.8	80.6	4.3	-0.01	67.1	23.0	1.3	7.6	5.8	+0.01
3/22/2002	NA	NA	NA	NA	NA	-0.02	NA	NA	NA	NA	NA	+0.02
3/26/2002	0.1	0.4	18.7	80.8	4.3	0.00	59.8	22	1.6	11.3	7.1	+0.02
3/27/2002	0.0	0.2	19.6	80.1	4.1	0.00	63.8	23.3	2.2	9.8	4.5	+0.02
3/28/2002	0.3	0.0	20.4	79.6	3.9	0.00	58.2	21.6	3.6	14.8	4.1	+0.02
3/29/2002	0.0	0.1	20.2	79.8	4.0	0.00	55.8	22.9	2.9	10.6	3.7	+0.01
4/1/2002	0.1	0.4	17.5	82.1	4.7	0.00	52.3	20.8	2.7	21.7	8.0	0.00
4/2/2002	0.0	0.4	17.2	82.5	4.8	0.00	67.8	24.1	0.3	6.4	21.3	+0.01

Notes: NA = data not collected or not valid

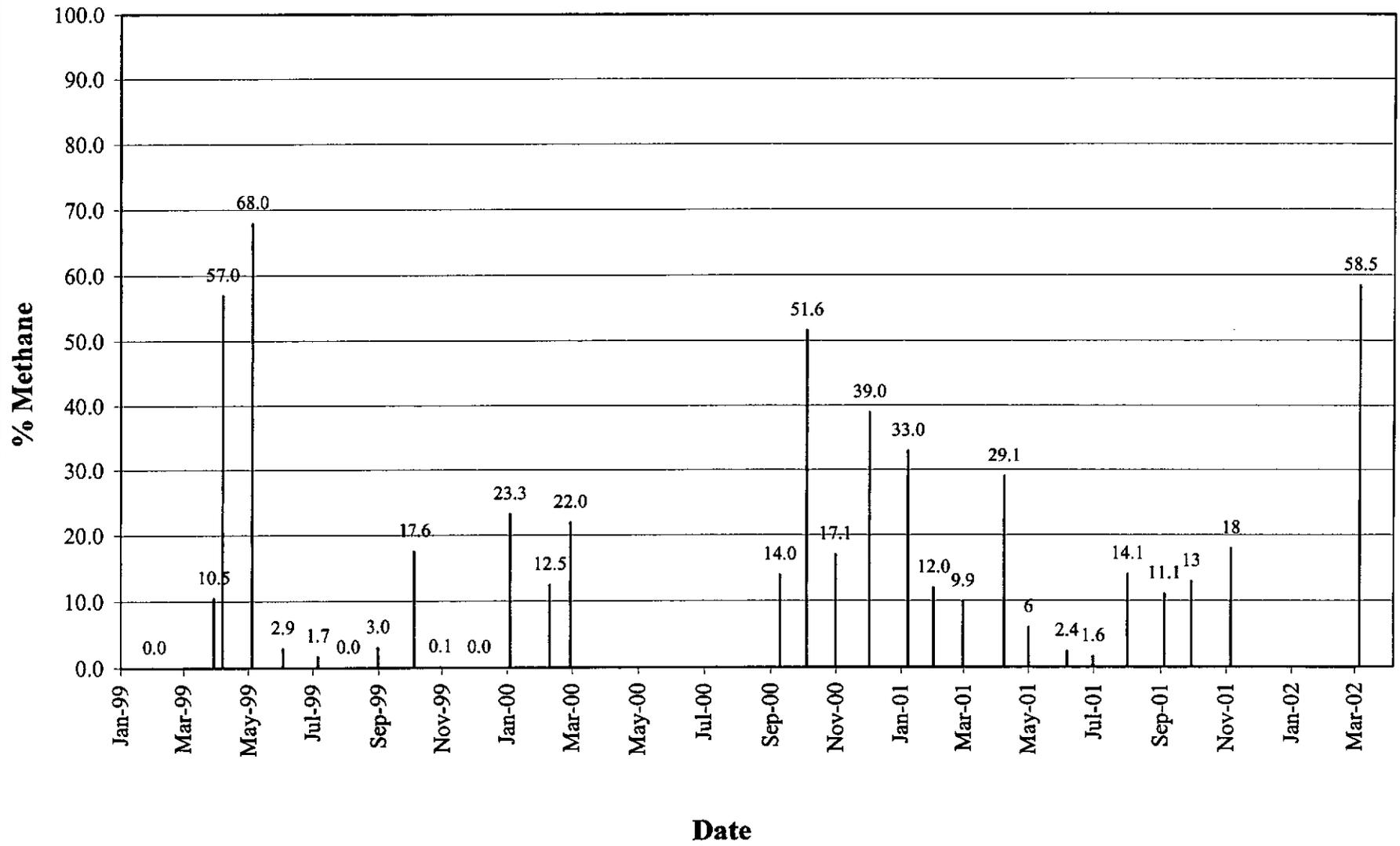
Depth to groundwater in MW-5 was 52.4 feet on 3/20/02

Depth to groundwater in GP-15d was 49.35 feet on 3/20/02

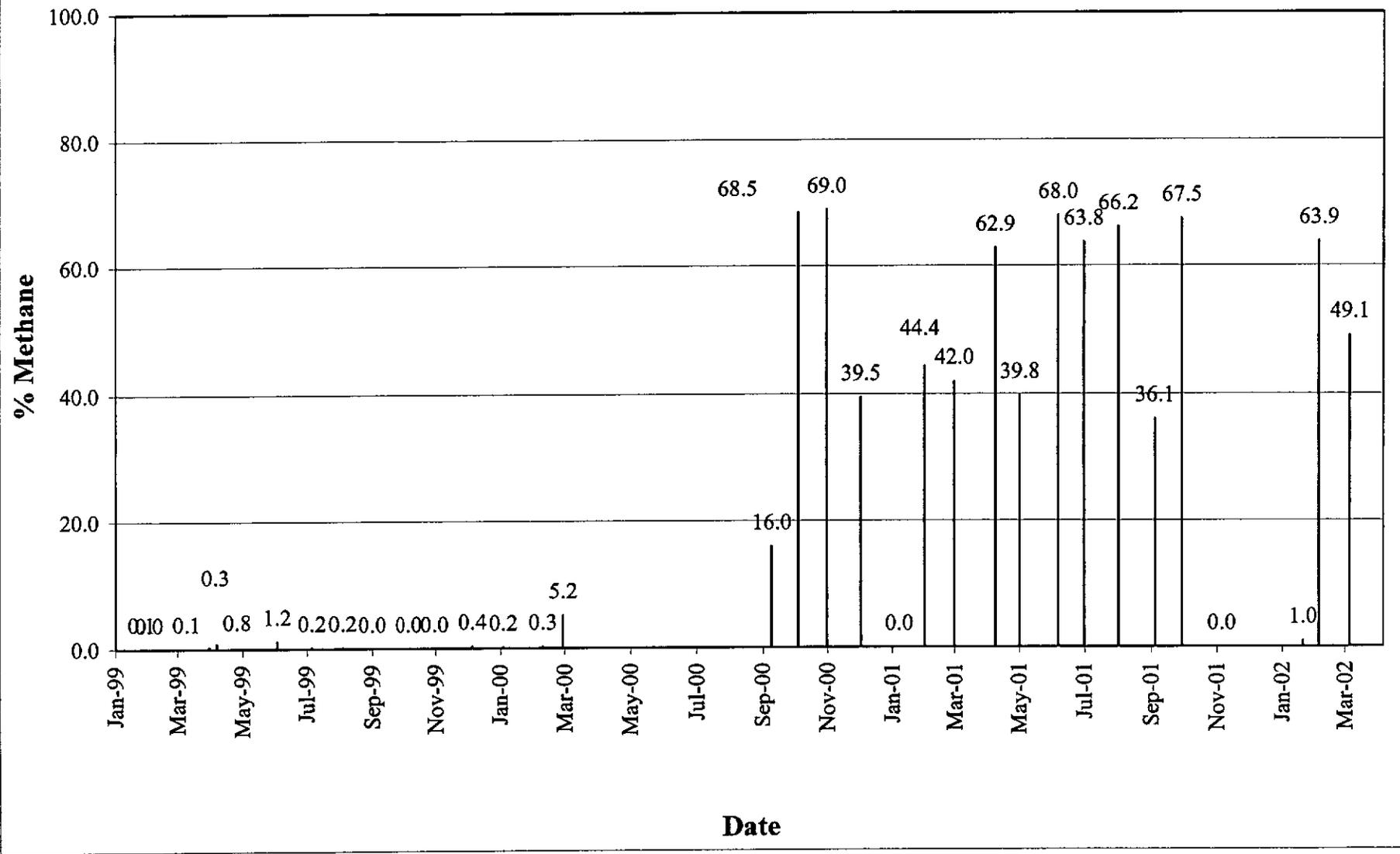
APPENDIX A

**HISTORICAL CHARTS OF METHANE
CONCENTRATION VERSUS TIME FOR PILOT STUDY
PROBES**

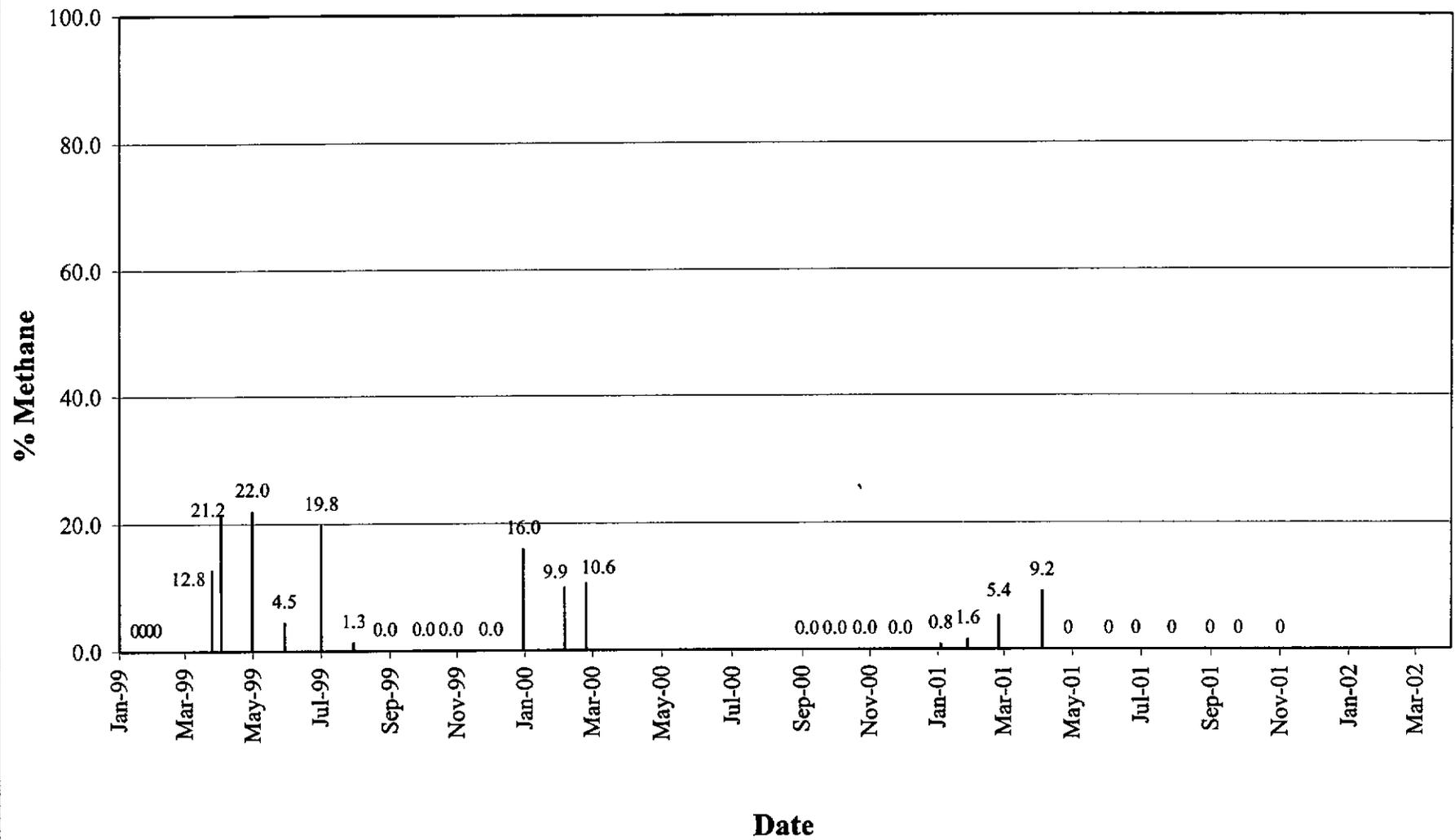
Percent Methane in MW-1



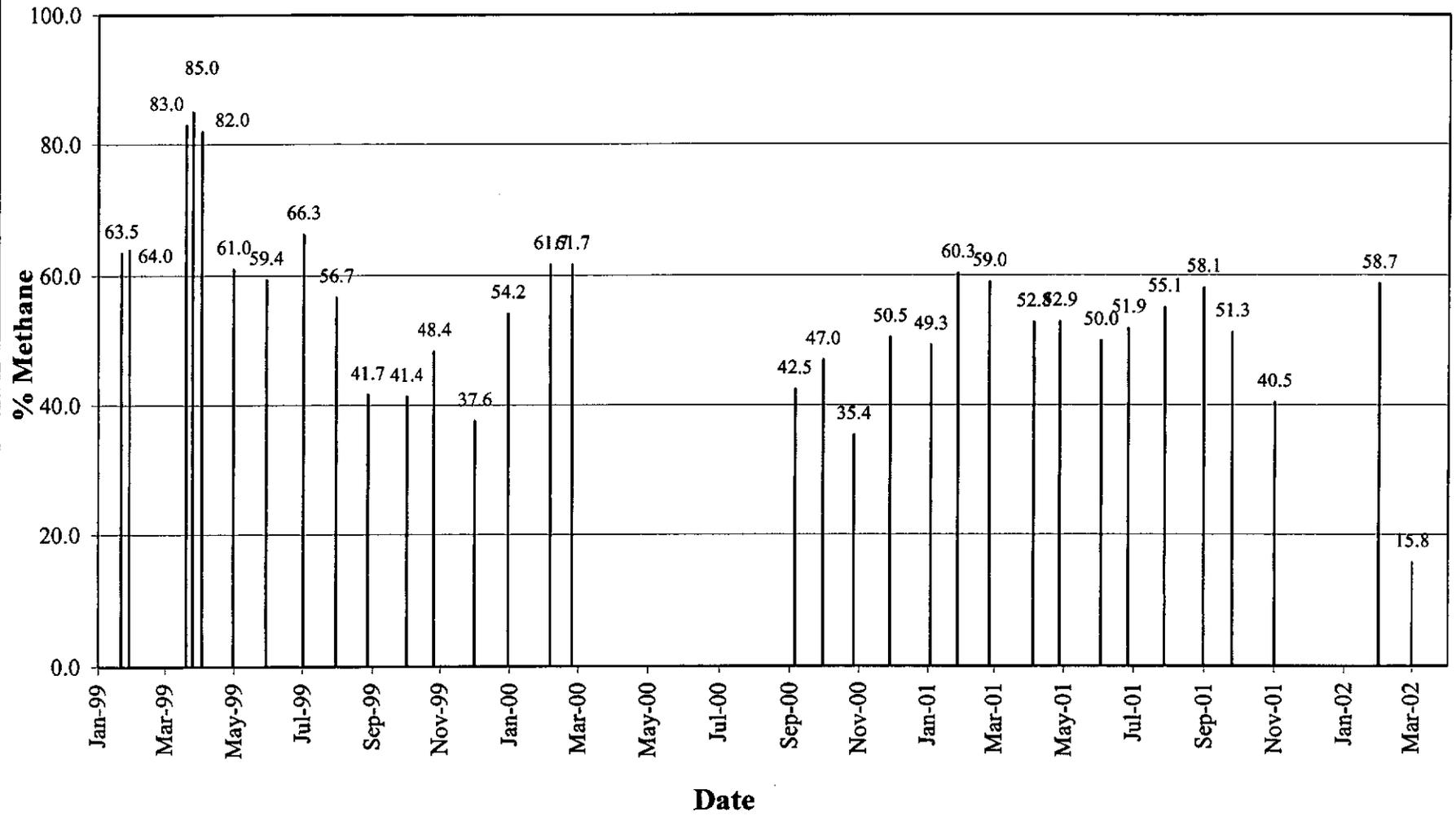
Percent Methane in MW-5



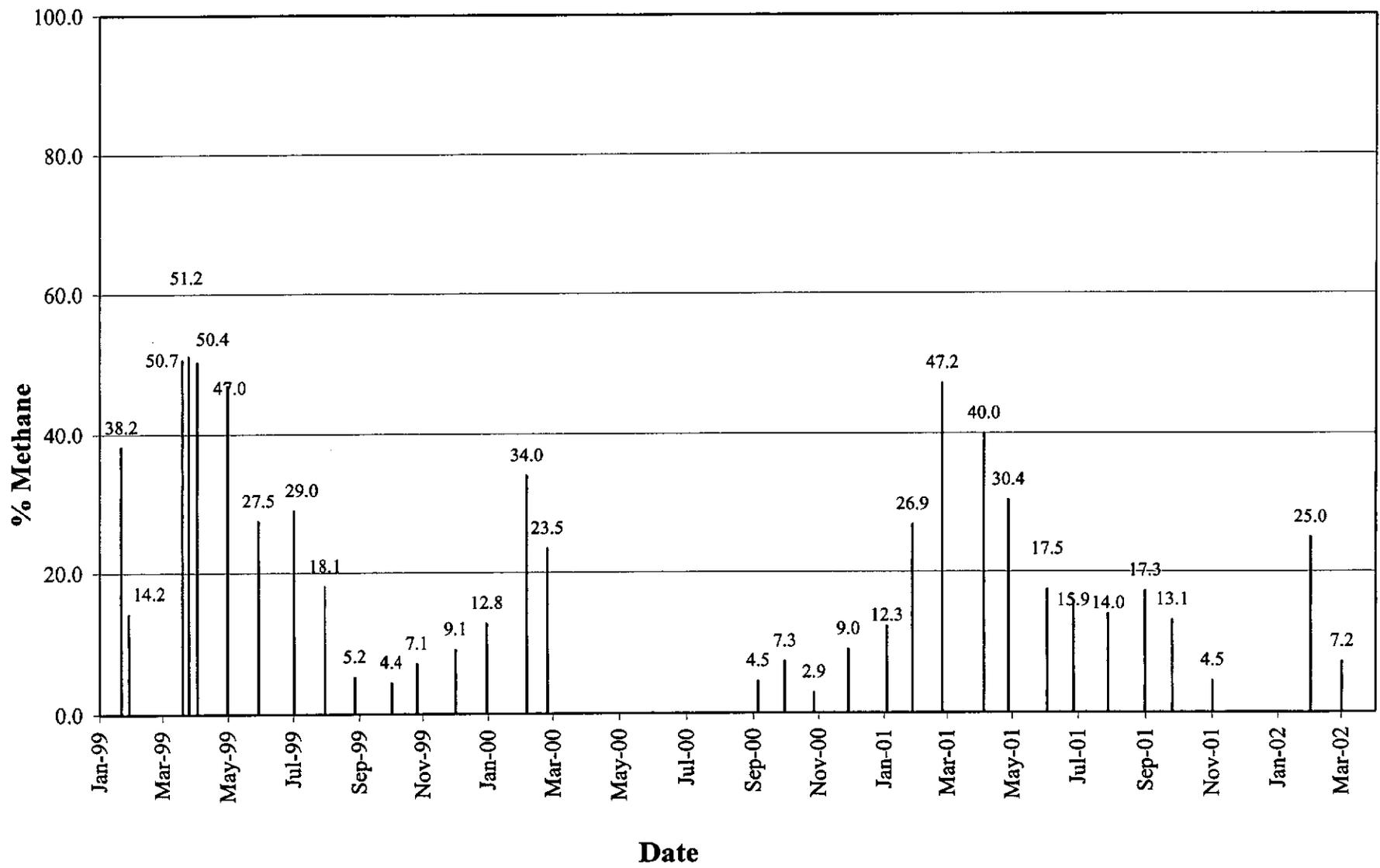
Percent Methane in Gas Probe 1



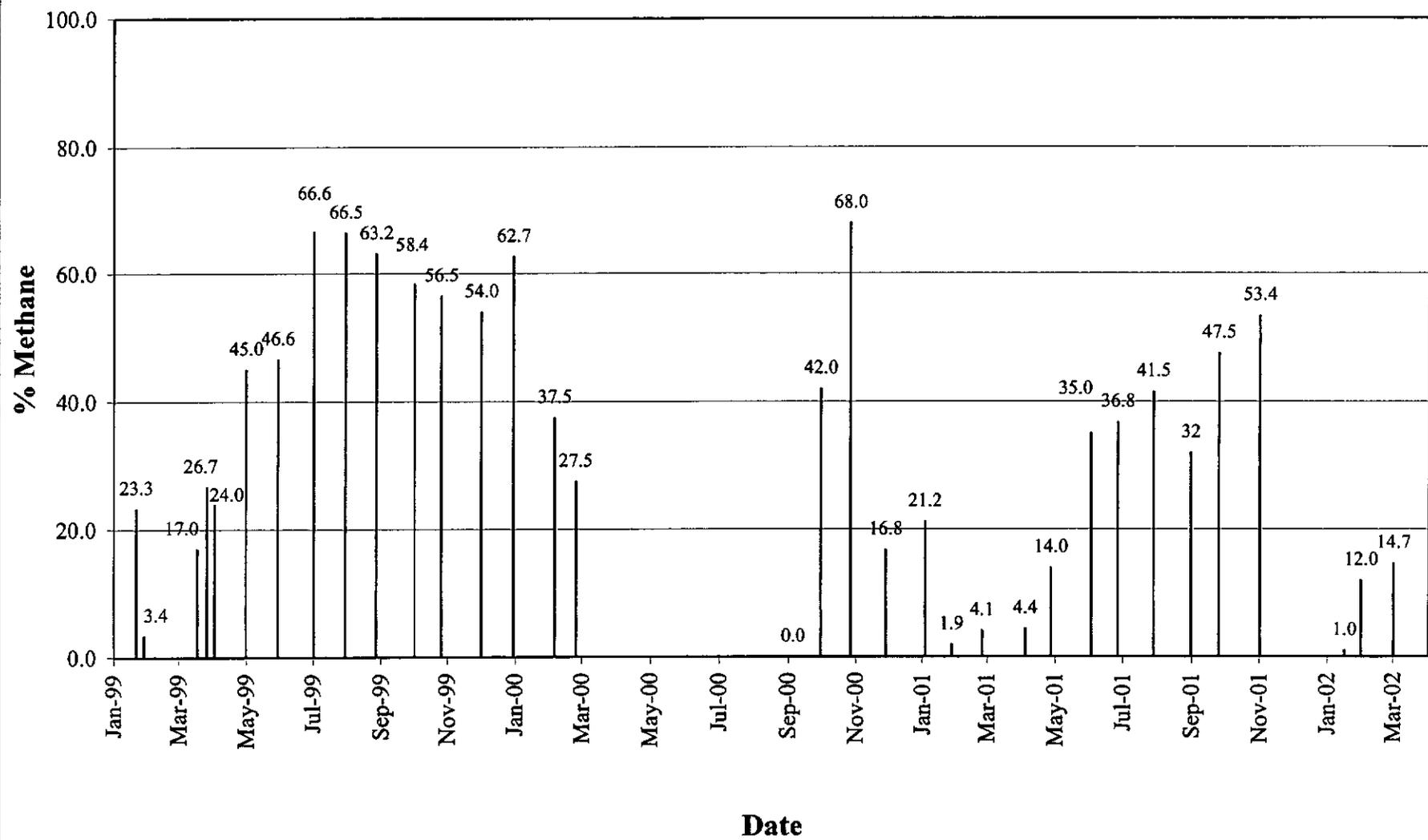
Percent Methane in Gas Probe 2



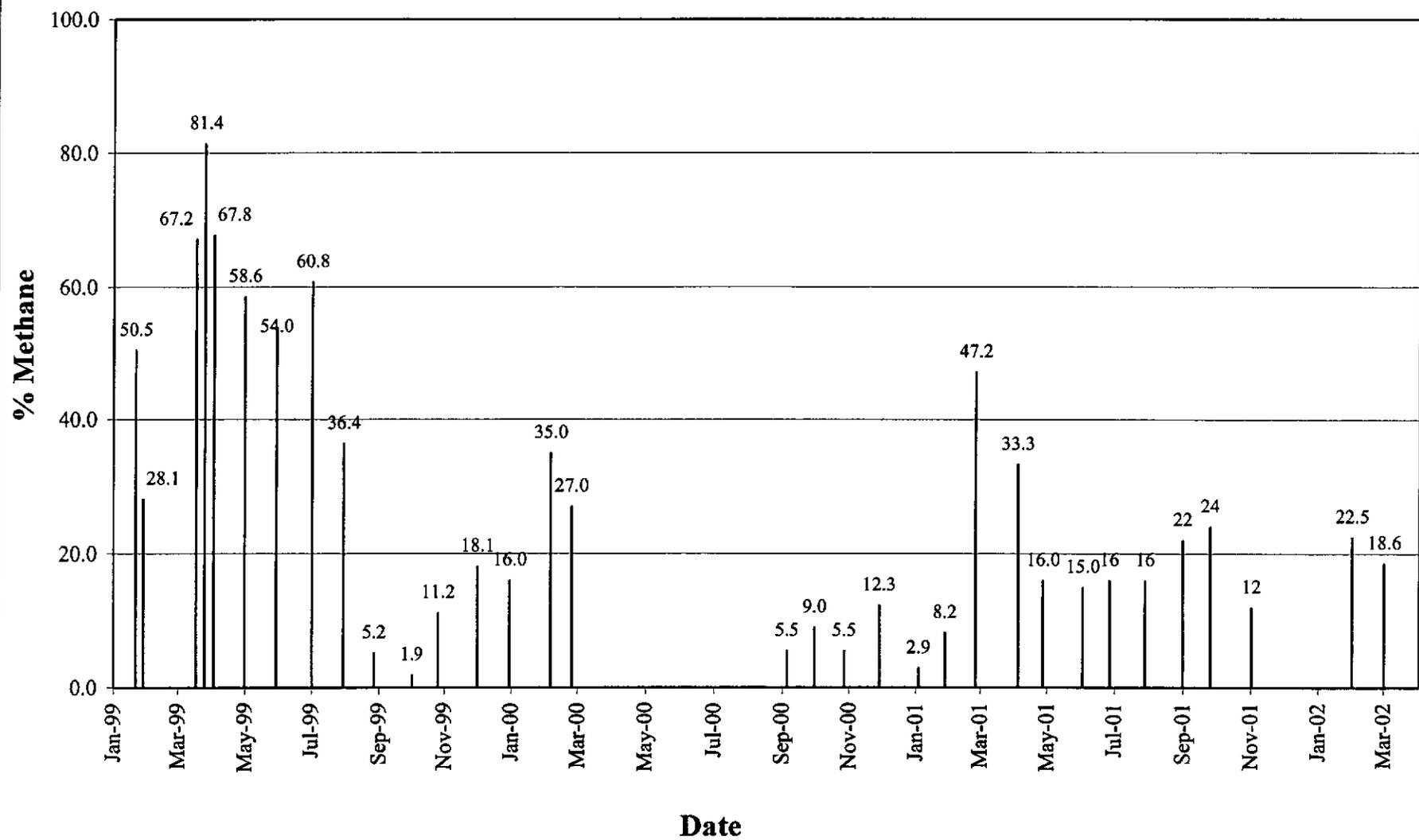
Percent Methane in Gas Probe 3



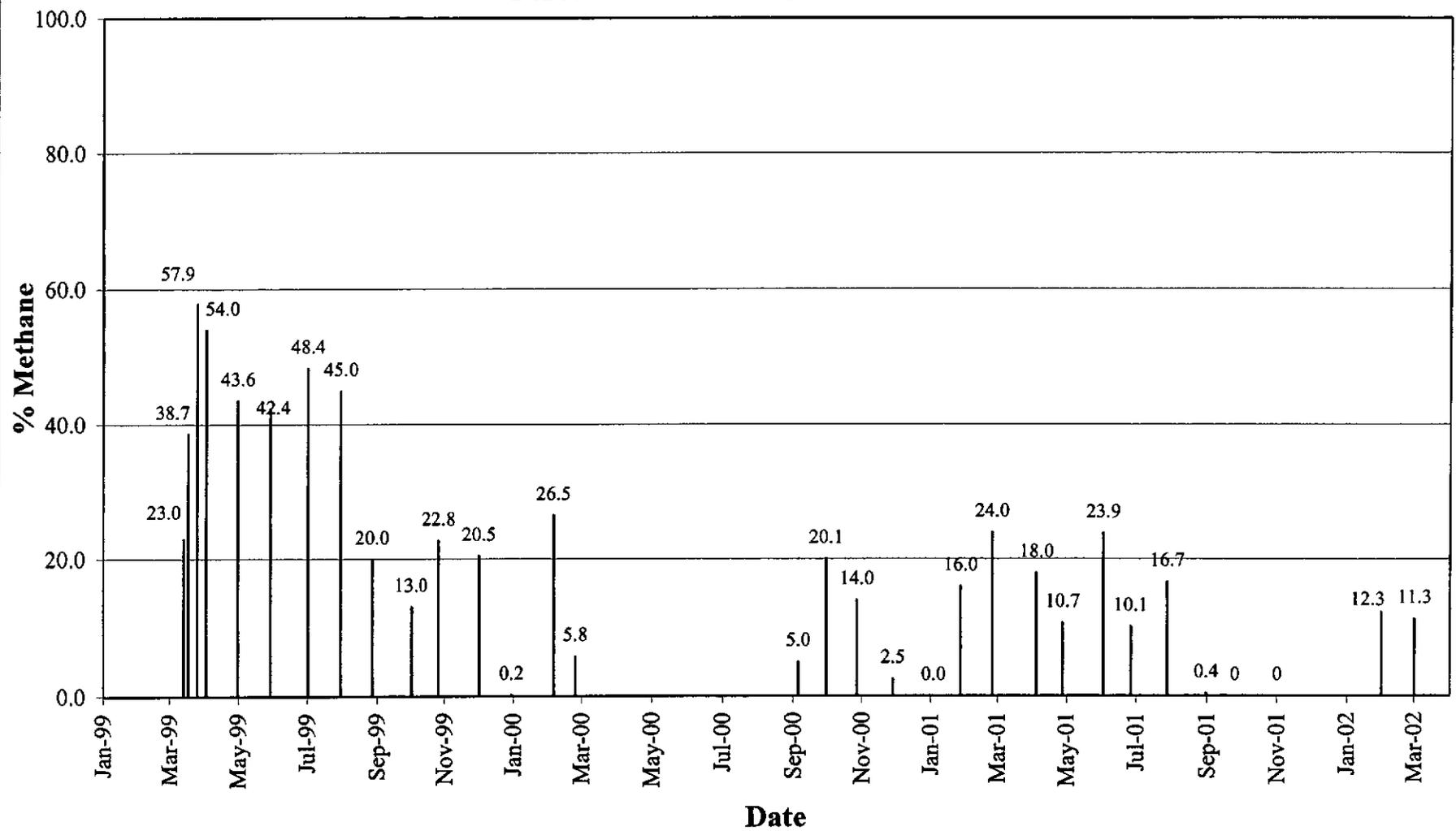
Percent Methane in Gas Probe 5



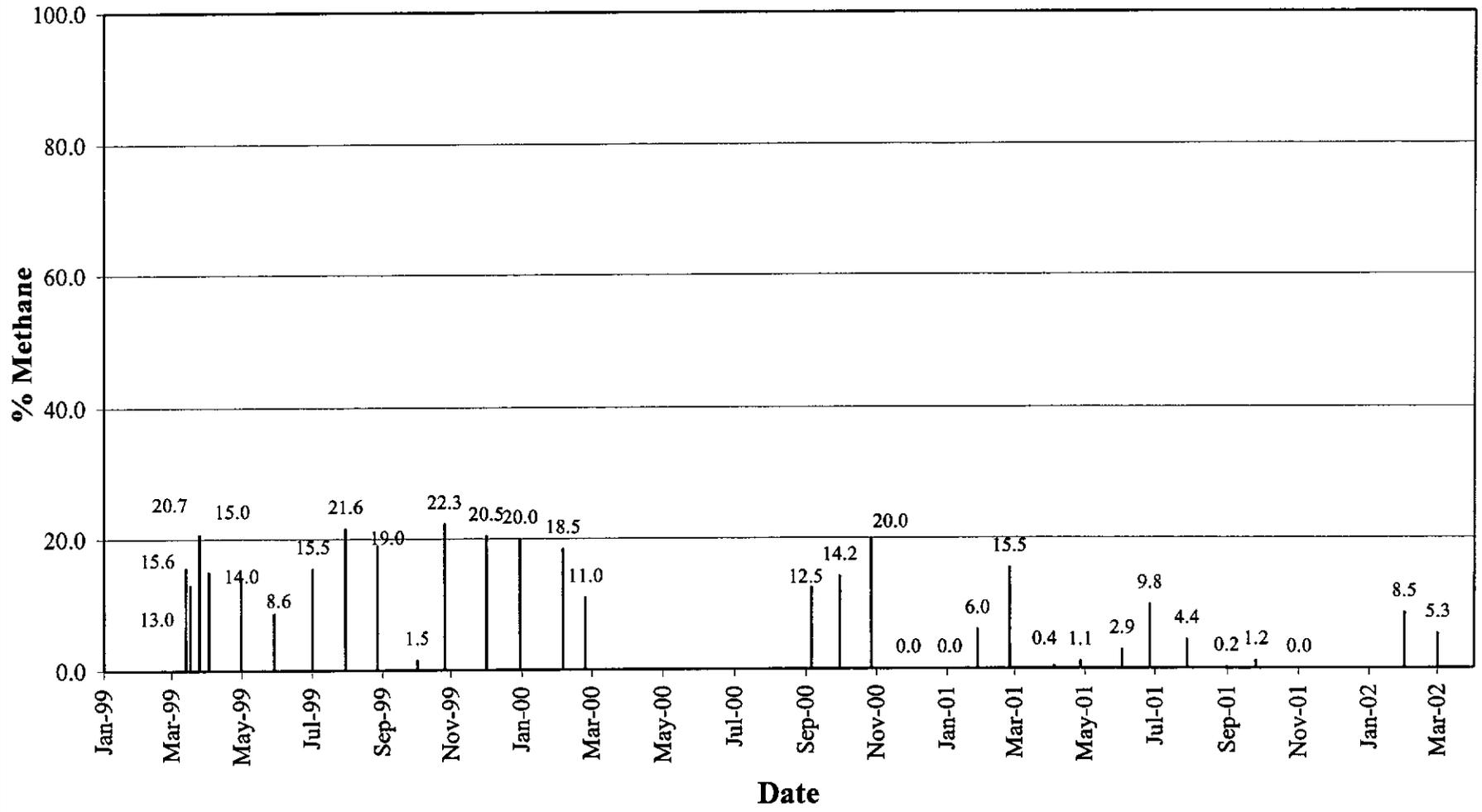
Percent Methane in Gas Probe 6



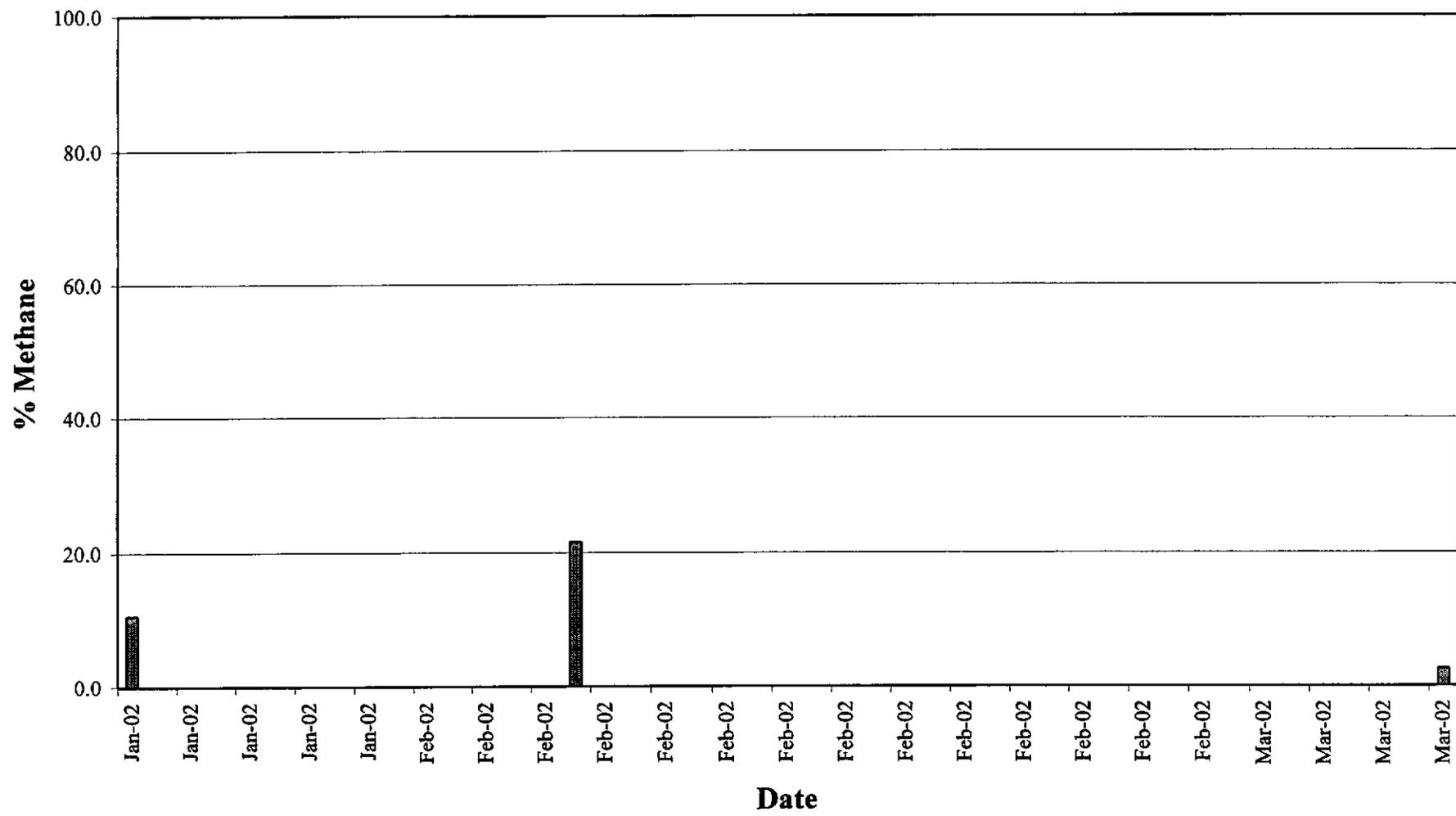
Percent Methane in Gas Probe 15s



Percent Methane in Gas Probe 15d



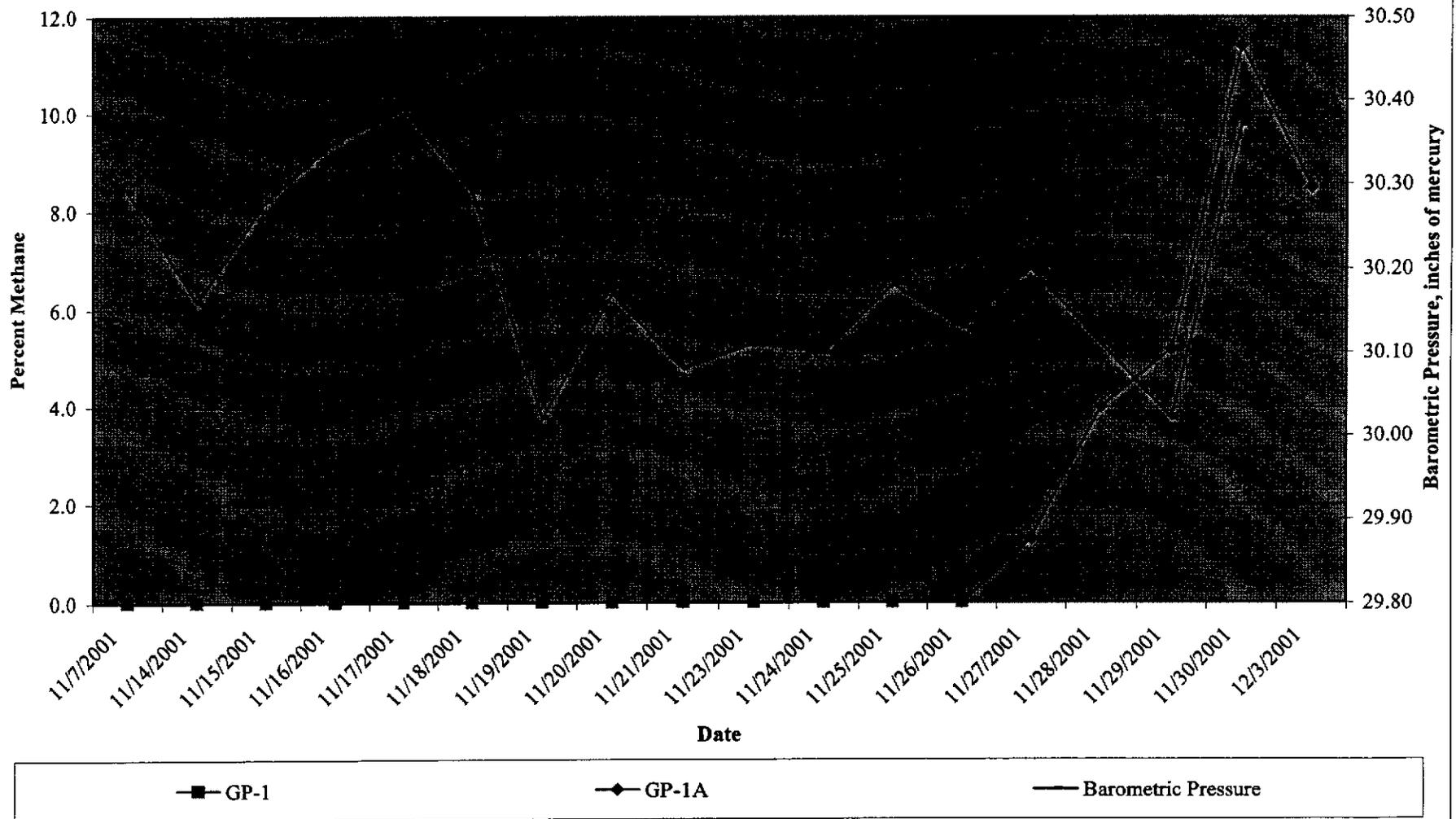
Percent Methane in Gas Probe 19



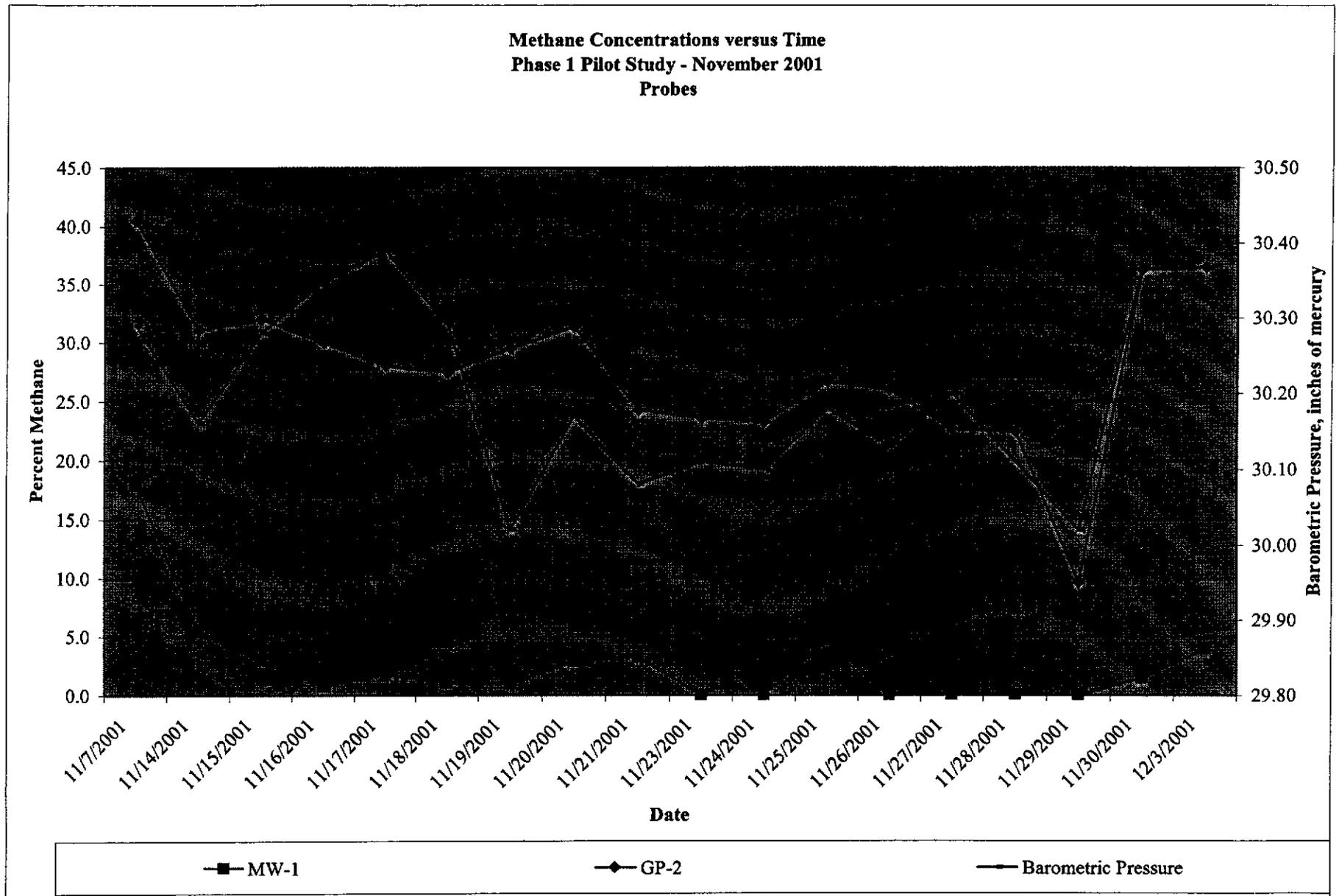
APPENDIX B

**CHARTS OF METHANE CONCENTRATIONS IN
PROBES DURING PHASE 1 PILOT STUDY**

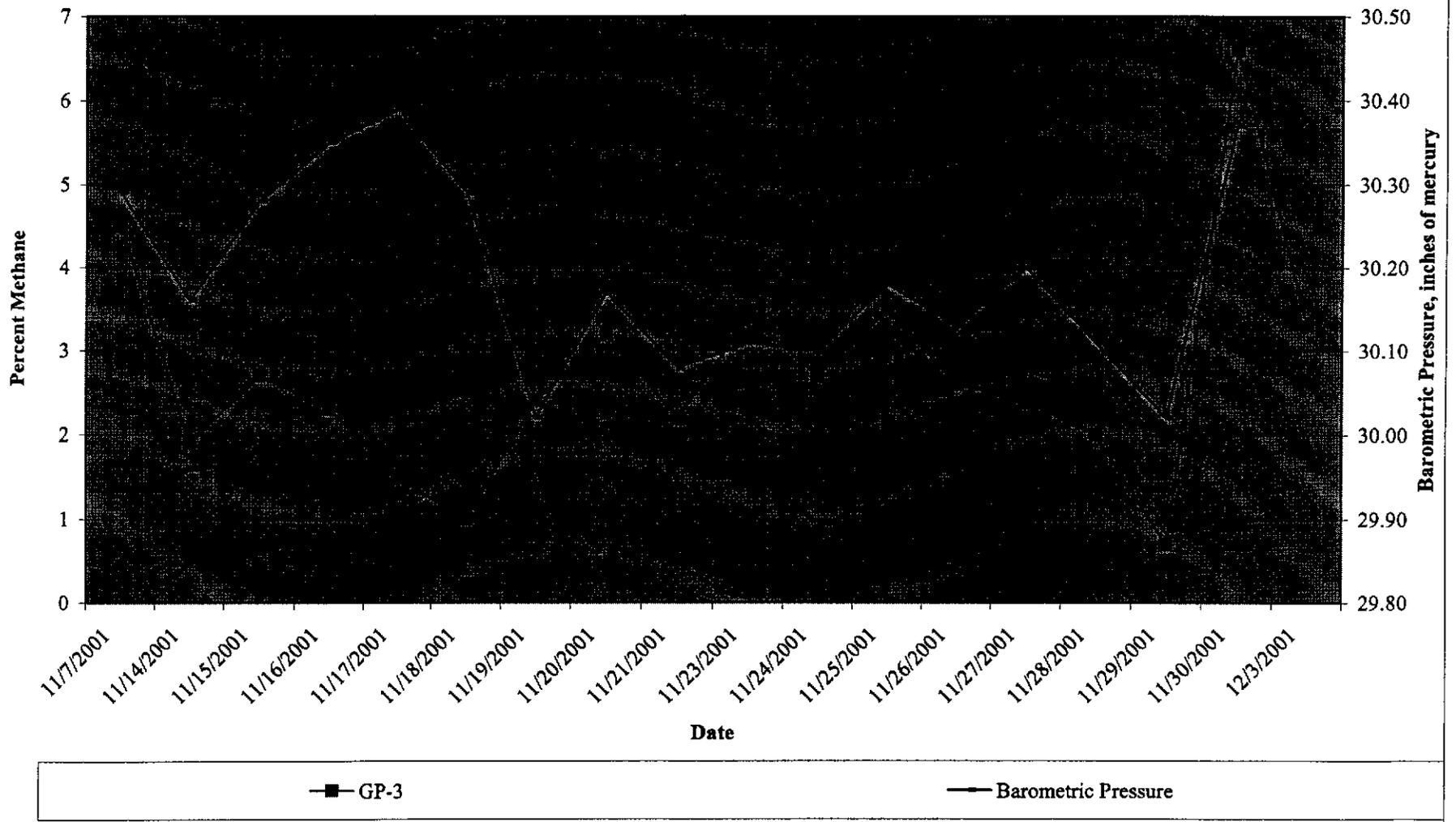
Methane Concentrations versus Time
Phase 1 Pilot Study - November 2001
Probes



Probe summary (2) Chart 1



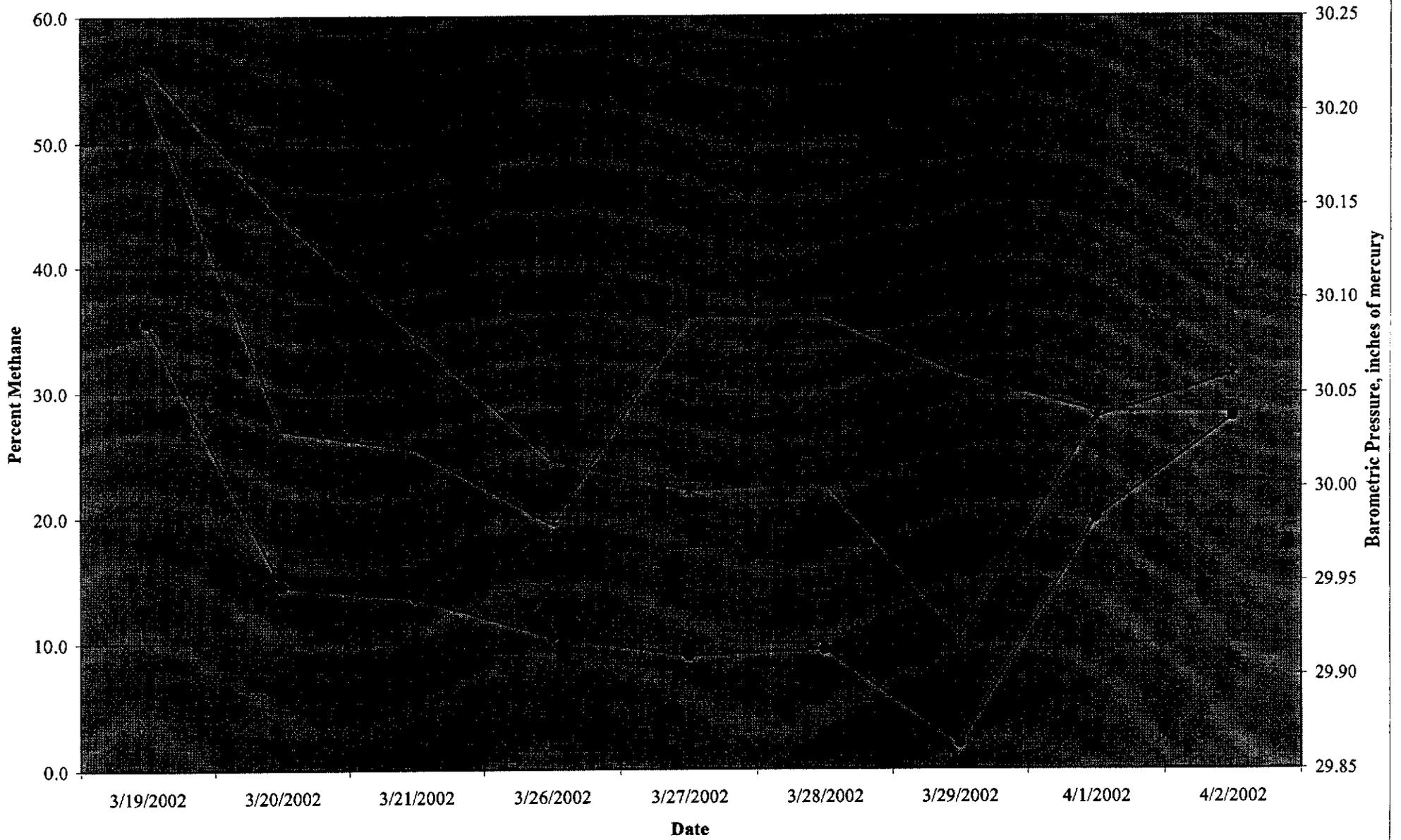
**Methane Concentrations versus Time
Phase 1 Pilot Study - November 2001
Probes**



APPENDIX C

**CHARTS OF METHANE CONCENTRATIONS IN
EXTRACTION WELLS AND PROBES DURING PHASE 2
PILOT STUDY**

**Methane Concentrations versus Time
Phase 2 Pilot Study - March 2002
Extraction Wells and Probes**

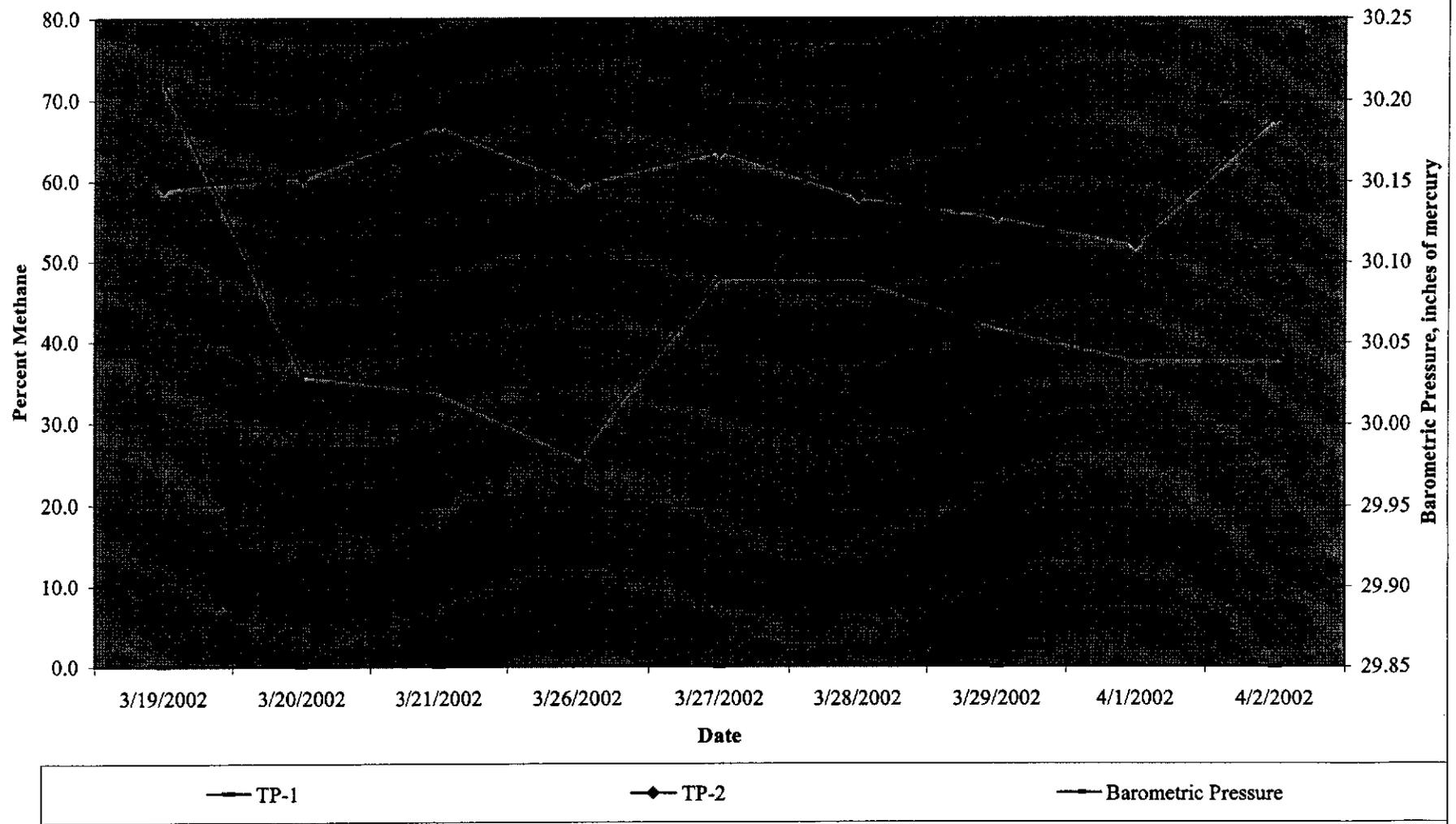


—*— EW-1

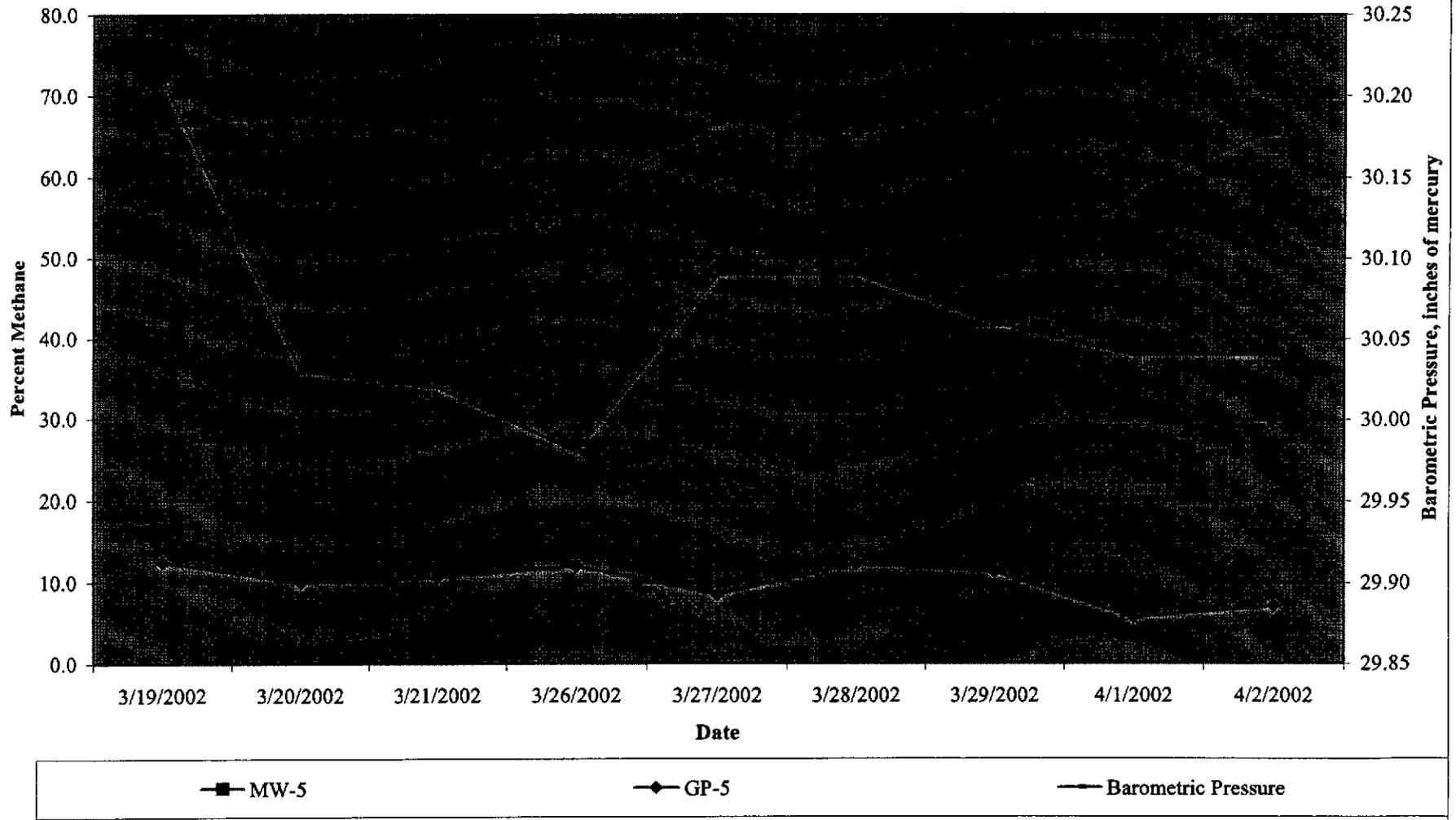
—●— EW-2

— Barometric Pressure

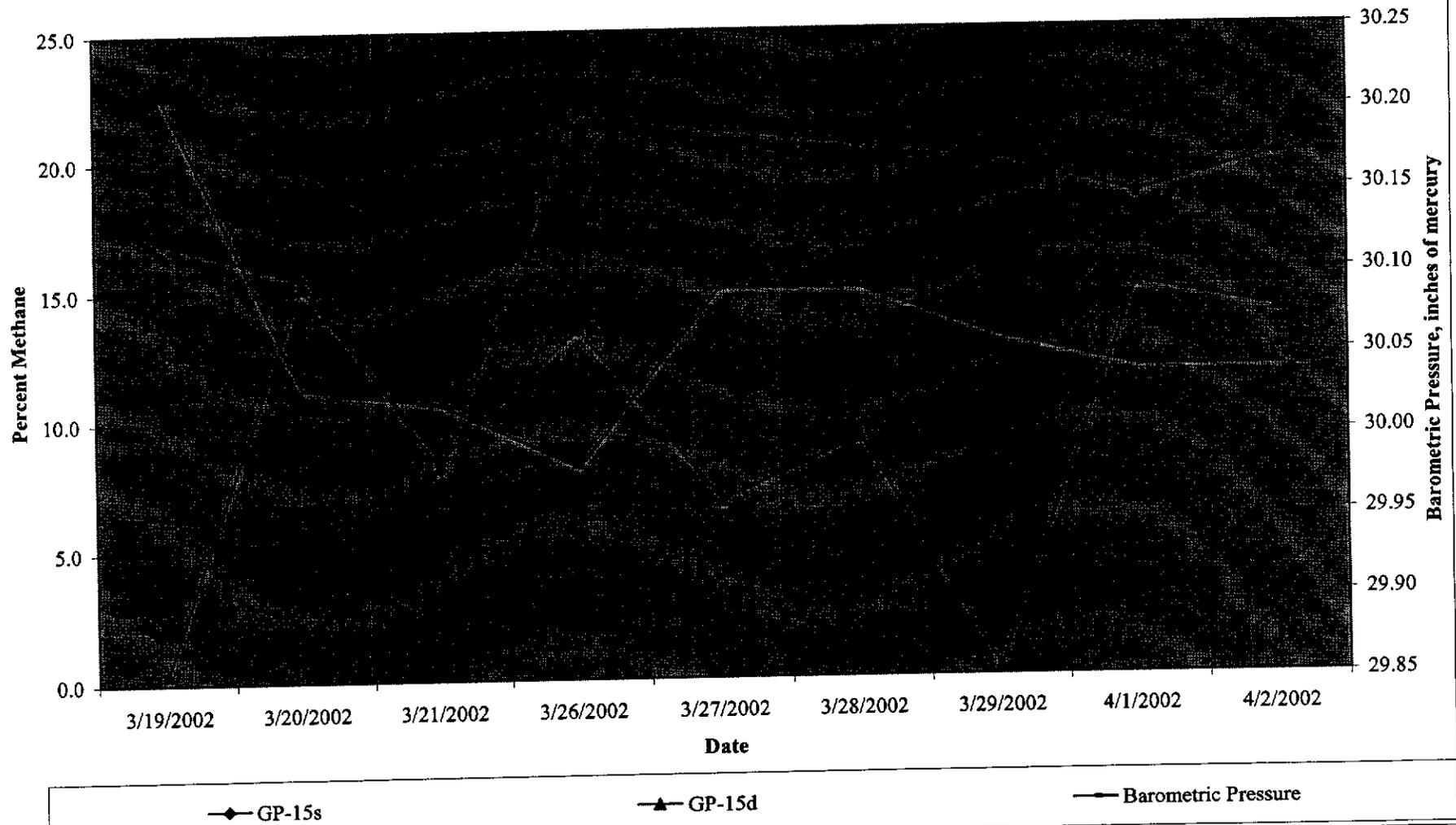
**Methane Concentrations versus Time
Phase 2 Pilot Study - March 2002
Extraction Wells and Probes**



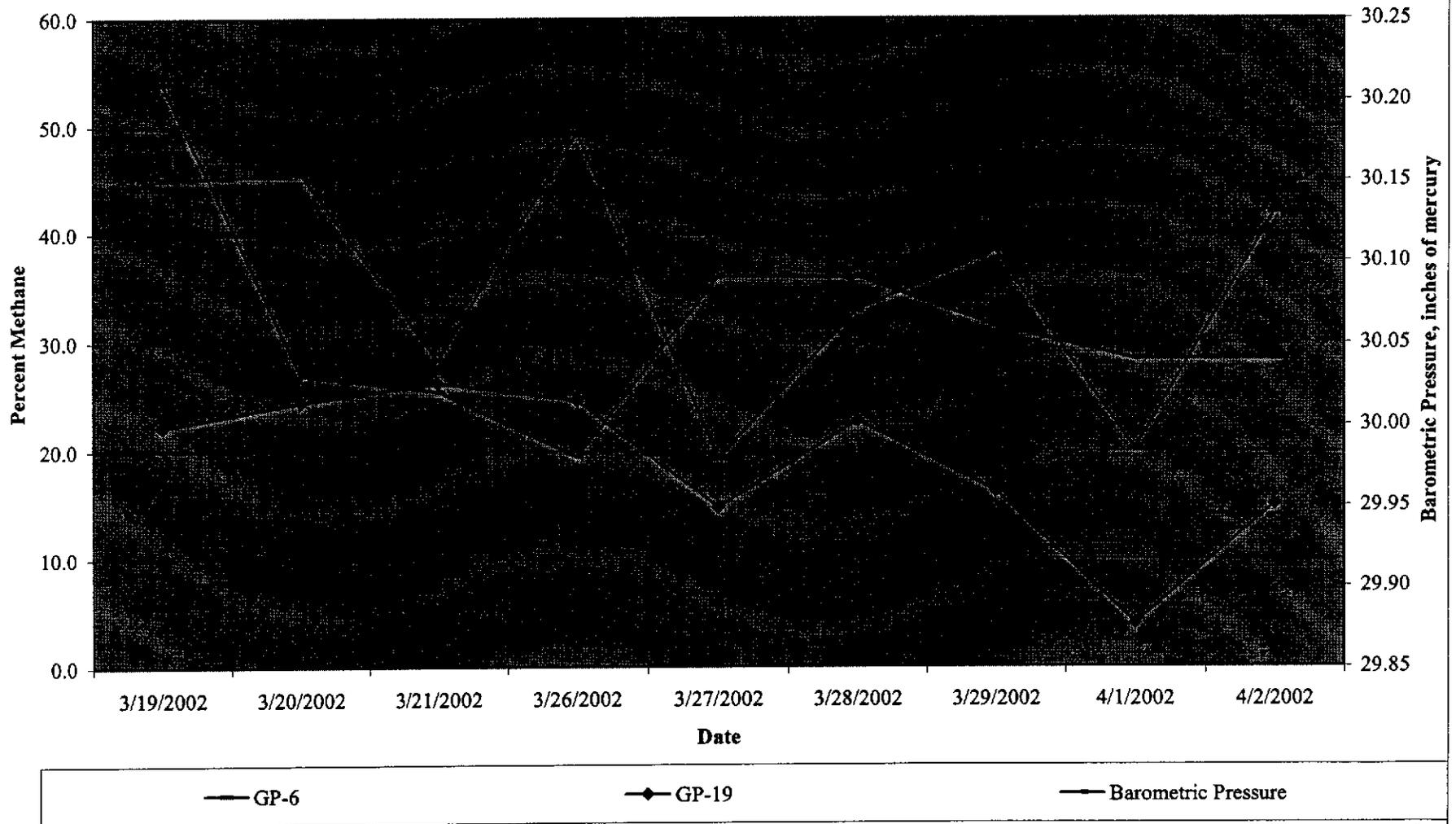
**Methane Concentrations versus Time
Phase 2 Pilot Study - March 2002
Extraction Wells and Probes**



**Methane Concentrations versus Time
Phase 2 Pilot Study - March 2002
Extraction Wells and Probes**



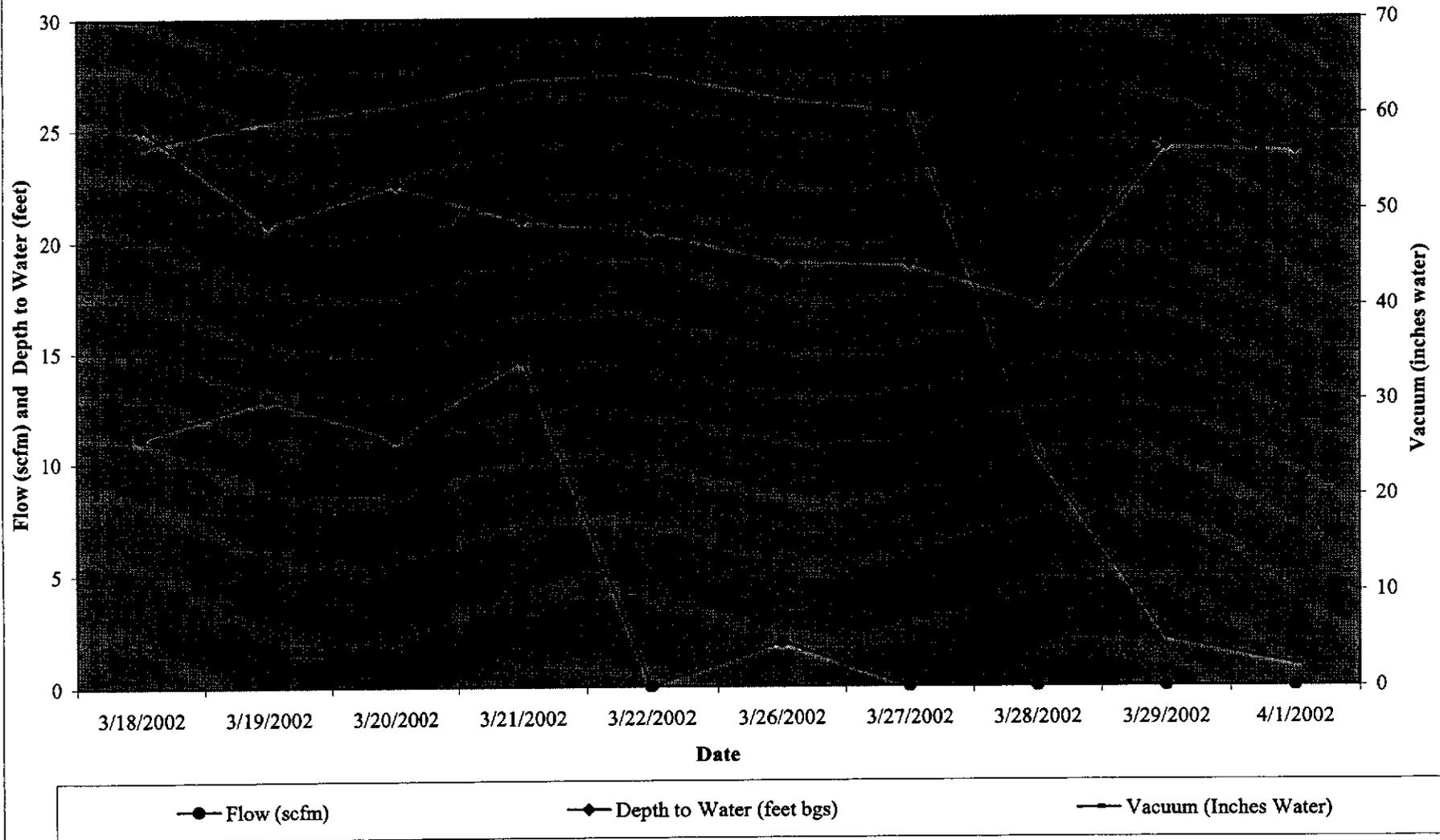
Methane Concentrations versus Time
Phase 2 Pilot Study - March 2002
Extraction Wells and Probes



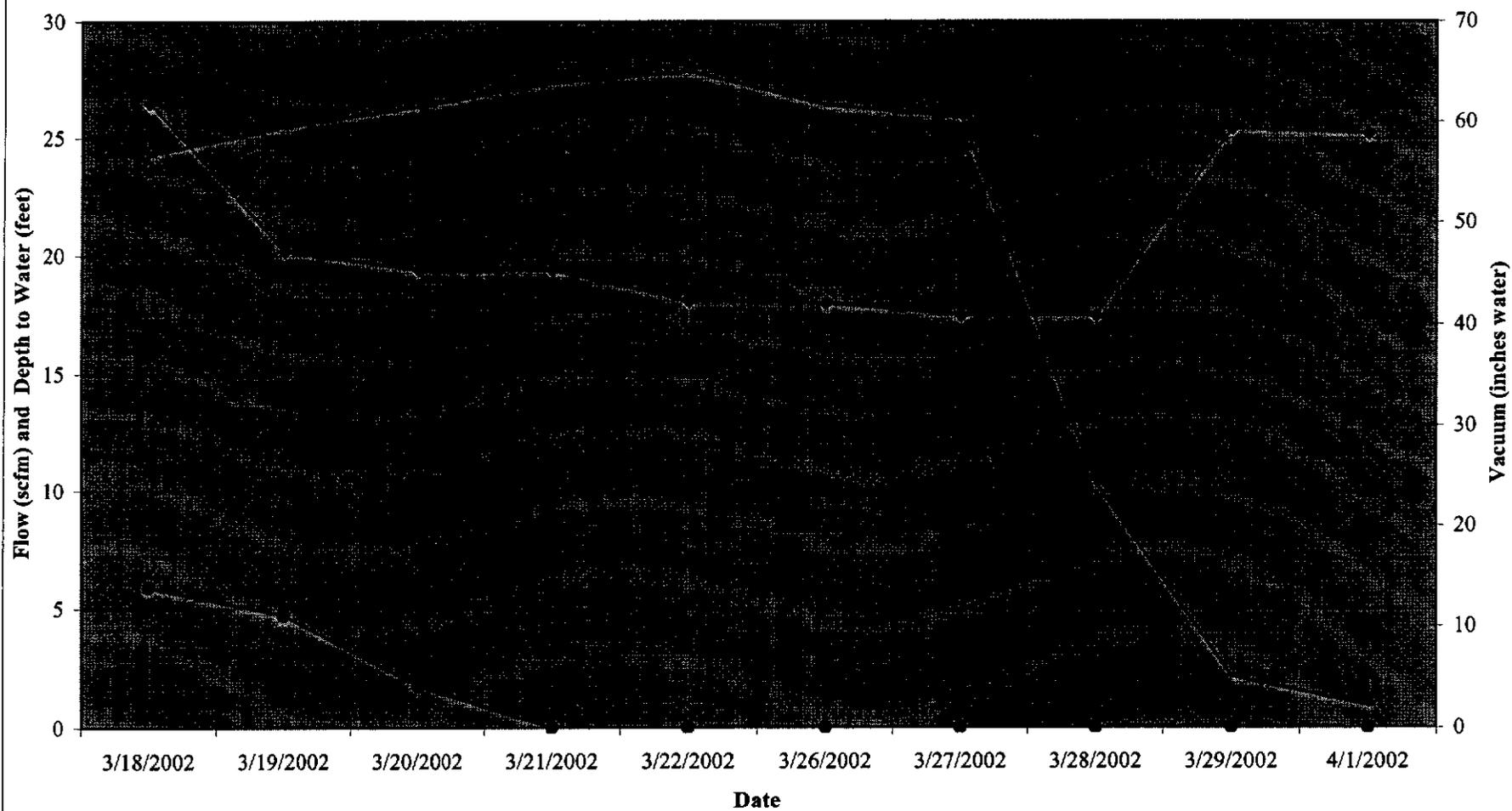
APPENDIX D

**CHARTS OF FLOW, DEPTH TO WATER AND
VACUUM FOR EXTRACTION WELLS DURING PHASE
2 PILOT STUDY**

Landfill Gas Extraction Well EW-1
Phase 2 Pilot Study - March 2002



Landfill Gas Extraction Well EW-2
Phase 2 Pilot Study - March 2002



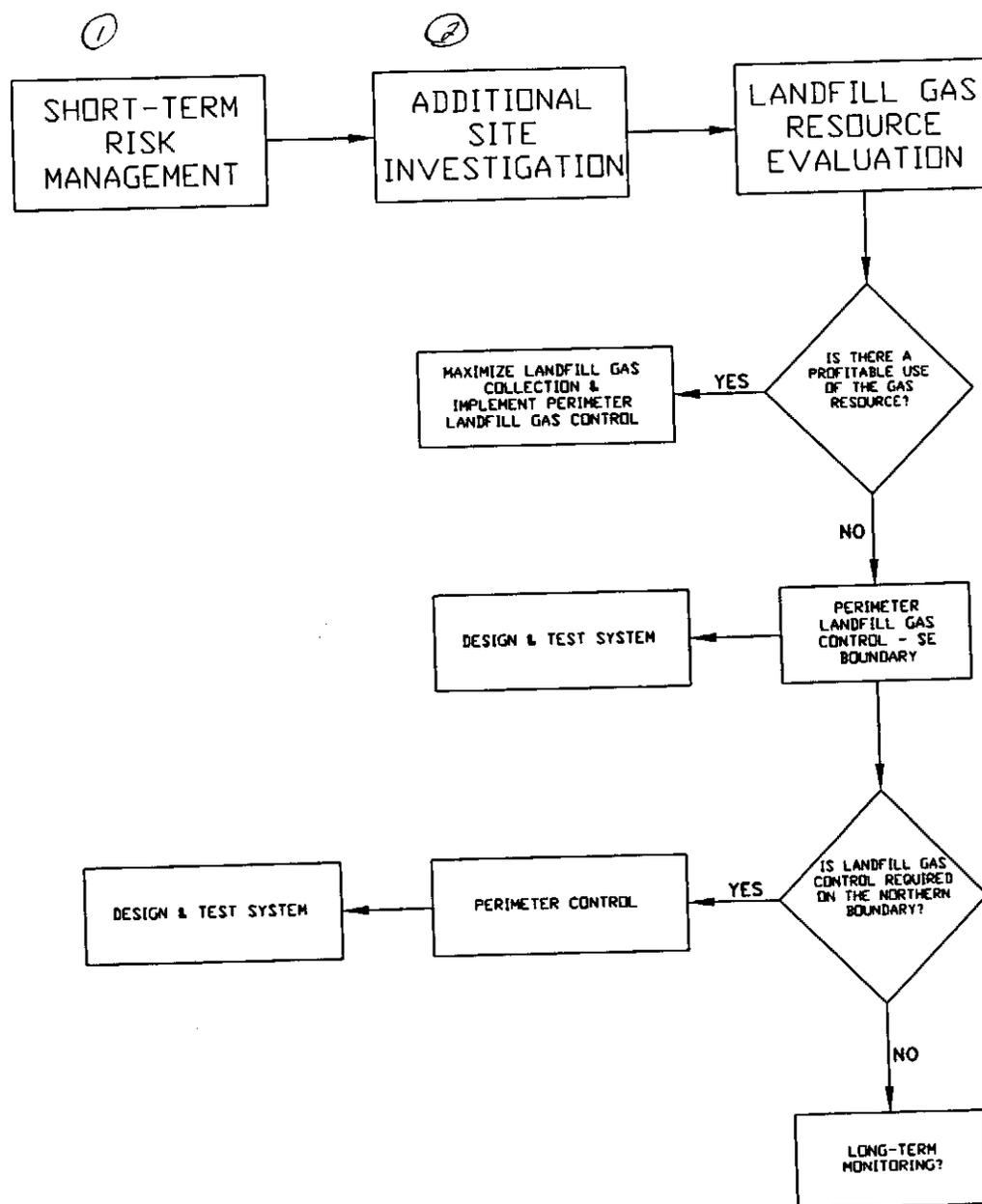
● Flow (scfm)

◆ Depth to Water (feet bgs)

— Vacuum (Inches Water)

5-20-02

- Spoke w/ J. Patterson
- No obvious threat to public health.
- Has not spoken w/ anyone w/ the county.
- Doesn't know the county's perspective on the proposed meeting.
- Suggests a series of deals connected to retraction blower.



Altamont
Environmental, Inc.
 ENGINEERING & HYDROGEOLOGY

78½ PATTON AVENUE
 ASHEVILLE, NORTH CAROLINA
 PHONE 828-281-3350

DECISION DIAGRAM:
 STRATEGY FOR LANDFILL GAS RISK MANAGEMENT
 & MIGRATION CONTROL
 JACKSON COUNTY MSW LANDFILL
 DILLSBORO, NORTH CAROLINA

DRAWN BY: JMC
 PROJECT MANAGER: JM
 CLIENT: JACKSON COUNTY DATE: 05-02-02
 FILE: /PROJECTS/JACKSON COUNTY/05/LFG DECISION CHART

DRAFT COPY FOR REVIEW

ALTAMONT ENVIRONMENTAL, INC.

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TEL. 828.281.3350 FAC. 828.281.3351
www.altamontenvironmental.com

STRATEGY FOR LANDFILL GAS RISK MANAGEMENT AND MIGRATION CONTROL

May 6, 2002

1. Short-Term Risk Management

- a. Meet with county and regulators to discuss risk-based approach
 - i. Identify Health & Safety risks
 - ii. Propose agreement for risk-based approach (i.e., installation of rigorous monitoring system to offset enforcement at property boundary)
- b. Identify Health & Safety risks to humans and real property
 - i. County Maintenance Building
 1. Evaluate building methane monitoring system
 - a. Determine necessary number of detectors
 - b. Identify locations for detectors
 - c. Establish action level for alarm activation
 - d. Develop high-level alarm response plan
 2. Conduct quarterly screening with Photo Ionization Detector (PID) around building (e.g., at base of walls, cracks in slab, conduit openings, etc.)
 - ii. Nearby residences and Commercial Buildings
 1. Re-evaluate adequacy of landfill boundary monitoring system
 - a. Plot structures on area map (completed in LFG Pilot Study Report)
 - b. Develop cross-sections using existing information
 - c. Identify gaps in monitoring system
 - d. Install multi-depth probes between landfill and structures, as necessary

2. Additional Site Investigation (Based on agreement with DENR that future investigation and mitigation is to be risk-based)

- a. Identify information needs for remedial system design (as appropriate on basis of discussions with DENR)
 - i. Evaluate adequacy of current monitoring network (e.g., in southeast area)
 - ii. Install additional probes as needed
 - iii. Use pre-disposal topography and boring logs to develop geologic cross-sections
 - iv. Evaluate nature of leachate pool identified during Pilot Study (i.e., is it perched, is it recharging groundwater, how extensive is it, how does its presence affect gas collection)
 - v. Assess low-flow conditions in extraction wells installed as part of the Phase 2 Pilot Study
 1. Visual inspection
 2. Excavate and evaluate

- vi. Estimate leachate generation using Hydrologic Evaluation of Landfill Performance (HELP) model

3. Landfill Gas Resource Evaluation

- a. Base first evaluation on the assumption that energy recovery revenue must offset development costs
- b. Base second evaluation on potential for grants and other benefits (e.g., value of "good" public works)
- c. Evaluate usage at asphalt plant
 - i. Determine BTU usage on monthly basis
 - ii. Identify current energy rates and historic fluctuations in cost
 - iii. Determine potential revenues and balance against probable developmental costs
- d. Evaluate electric generation for nearby use by commercial or county-owned facilities
 - i. Internal combustion engine
 - ii. Small microturbine
 - iii. Determine potential revenues and balance against probable developmental costs

**Order of Magnitude Costs for
Implementing Landfill Gas Strategy
(Refer to Attached Flow Chart)**

May 6, 2002

1. Short-term Risk Management	\$16,000
2. Additional Site Investigation	\$13,000
3. Landfill Gas Resource Evaluation	\$10,000
4. Southeastern Boundary LFG Control	\$300,000
5. Northern Boundary LFG Control	\$360,000

Note: Current budget for FY 2002-2003 is based on assumption that costs for item Nos. 4 and 5 will be lessened by either negotiated changes in scope with DENR or cost-spreading into FY 2003-2004.