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CENTER FOR ENVIRONMENT
OFFICE OF ENERGY, ENVIRONMENT, AND TECHNOLOGY
USAID/MEXICO

IN COLLABORATION WITH THE DEPARTAMENTO DEL DISTRITO, MEXICO D.F.

GAS RECOVERY AND UTILIZATION FEASIBILITY STUDY
PRADOS DE LA MONTAÑA LANDFILL
MEXICO CITY, MEXICO

JANUARY 1997

Prepared by: Energy Technology Innovation Project
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TABLE OF CONTENTS

Executive Summary

Introduction 1

Landfill Gas Recovery and Feasibility Evaluations 1

Site Background 3

Field Activities 5

Landfill Gas Generation and Recovery Model Results 11

Conclusions and Recommendations 11

Appendices

A Laboratory Analytical Data
B Static Test Landfill Gas Data

b

EXECUTIVE SUMMARY

The Departamento del Distrito Federal (DDF), the authority responsible for waste disposal in Mexico City, requested USAID/Mexico's technical assistance in performing a prefeasibility study for recovery and use of methane from landfill gas (LFG) for power generation at the Prados de la Montaña Landfill in Mexico City, Mexico (Site). In response to this request, the Center for Environment's Energy Technology Innovation Project (ETIP) was called upon to assist the DDF.

LFG is generated in all landfills. It is a normal by-product of biological anaerobic decomposition of organic materials in landfills. The decomposition process is carried out by anaerobic micro-organisms and results in the formation of a gas that is approximately 55 percent methane (CH_4) and 45 percent carbon dioxide (CO_2), by volume. Other gases such as volatile organic compounds (VOCs) and hydrogen sulfide (H_2S) may be present to LFG in trace concentrations.

Uncontrolled LFG poses several environmental, human health, and safety risks. The methane in LFG, for example, is explosive and a fire hazard. LFG also contains toxic or carcinogenic compounds, contributes to local air pollution, causes objectionable odors, damages or kills vegetation, and contributes to groundwater contamination.

In addition, both LFG and carbon dioxide are greenhouse gases. The role of carbon dioxide as a greenhouse gas is well-known. Due to its higher infrared absorption capacity, methane actually is a much "stronger" (20 - 35 times) greenhouse gas than carbon dioxide. Therefore, LFG is considered to be a significant contributor to global climate change.

The Prados de la Montaña Landfill is located in Mexico City, an area known for severe air pollution. In addition, the continued emission and/or migration of LFG from the Prados de la Montaña Landfill may hinder planned development in the immediate vicinity. Using the USEPA model and the historic refuse disposal information provided by DDF, it was estimated that the Site will generate approximately 331,000 tons of methane over the next 50 years. Therefore, the collection and recovery of LFG from the Prados de la Montaña Landfill will not only provide a source of energy, it also will help in controlling local air pollution, reducing greenhouse gas emissions, and in promoting local development.

As part of its technical assistance to DDF, ETIP designed and implemented an initial LFG recovery investigation at the Prados de la Montaña Landfill. The purpose of the investigation was to assess the Site's LFG quality and potential generation and recovery rates.

This report presents a discussion on: the feasibility of LFG recovery and utilization; evaluation techniques; background information on the Site; a description of field activities performed at the Site; results of LFG generation and recovery modeling performed for the Site; conclusions; and recommendations.

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GAS RECOVERY AND UTILIZATION FEASIBILITY STUDY

INTRODUCTION

The Department del Distrito Federal (DDF), the authority responsible for waste disposal in Mexico City, requested USAID/Mexico City's technical assistance in performing a feasibility study for methane recovery and its use for power generation at the Prados de la Montaña Landfill in Mexico City, Mexico (Site). In response to this request, the Center for Environment's Energy Technology Innovation Project (ETIP) was called upon to assist the DDF.

As part of its technical assistance to DDF , ETIP designed and implemented an initial landfill gas (LFG) recovery investigation at the Prados de la Montaña Landfill (see Figure 1). The purpose of the investigation was to assess the Site's LFG quality and potential generation and recovery rates.

This report presents a discussion on LFG recovery and utilization feasibility evaluation techniques, background information on the Site, a description of field activities performed at the Site, results of LFG generation and recovery modeling performed for the Site, and conclusions and recommendations. No dynamic testing (i.e., pump testing) as originally proposed was conducted due to elevated leachate levels observed within the landfill.

LANDFILL GAS RECOVERY AND UTILIZATION FEASIBILITY EVALUATIONS

LFG recovery and utilization feasibility evaluations require estimation of a site's life-time LFG production capacity and current and future LFG generation and recovery rates. These estimates typically are developed through:

- A mathematical model. Such models predict flow rate, gas quantities, and duration of production based on a number of fixed and variable values developed through application of site specific data and/or assumptions based on experience at similar sites.

- A field testing program consisting of an extraction "pump test" from either a single LFG extraction test well or a limited number of test wells in the portion of the site being tested.

- Or a combination of field testing and modeling.

Field testing programs typically include a drilling program for installation of test wells and monitoring probes and collection of waste samples, and a "pump test" for estimation of well radii of influence (ROI) and current site LFG generation rates.

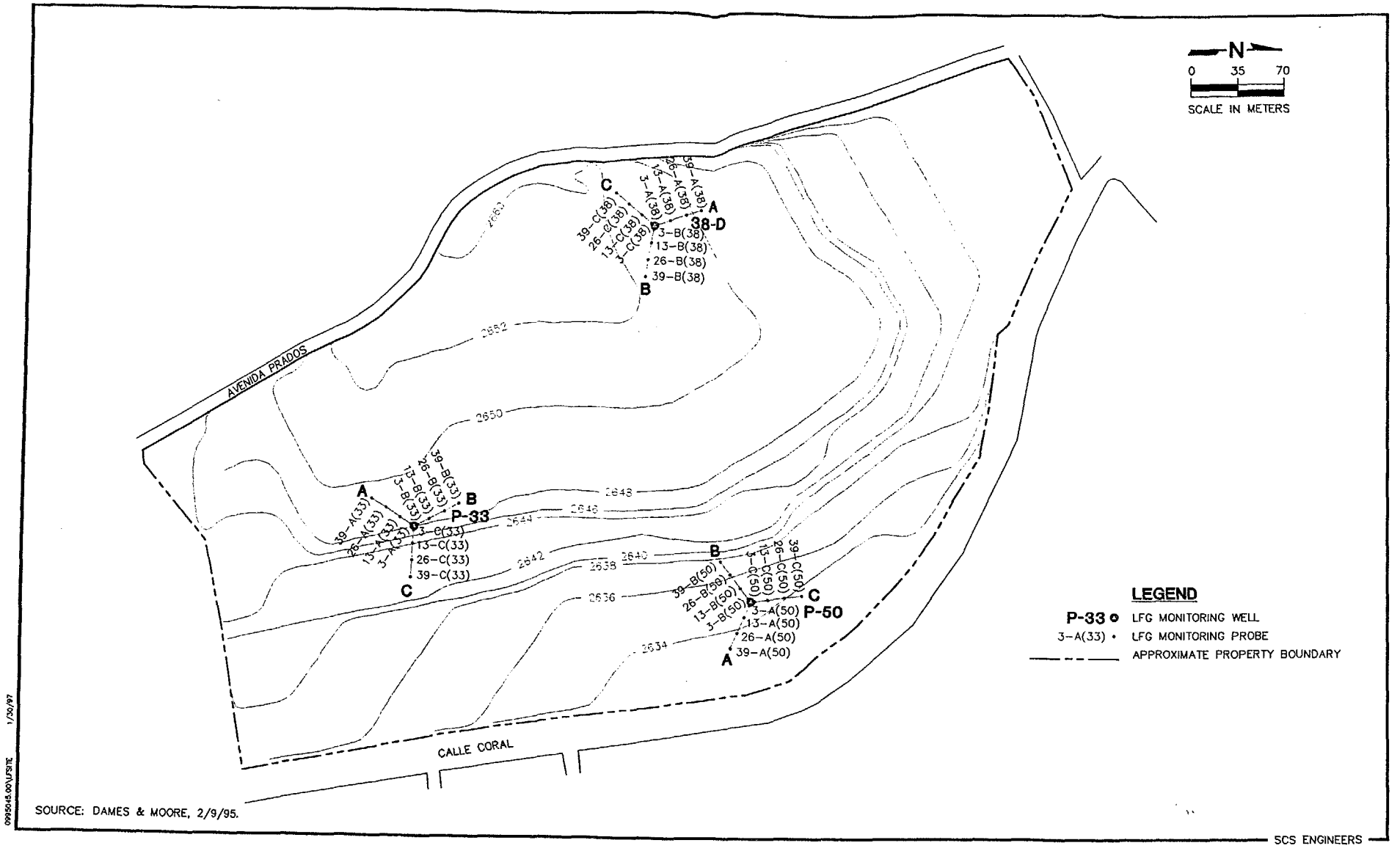

Figure 1. Site Plan, Prados de la Montana, Mexico City, Mexico.

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Typical data collected during a field test program include:

- Collection of refuse samples during test well installation.
- Measurement of landfill leachate levels and static LFG pressures, as well as methane (CH_4), carbon dioxide (CO_2), oxygen (O_2), and balance gas (assumed to be nitrogen (N_2) concentrations immediately after test well installation.
- Measurement of LFG pressures, flows, and methane, carbon dioxide, oxygen, and balance gas concentrations at extraction test wells during the test.
- Measurement of LFG pressures, and methane, carbon dioxide, oxygen and balance gas concentrations at monitoring probes radiating out from the extraction test wells during the test.
- Collection and laboratory analysis of a limited number of LFG samples for concentrations of methane, carbon dioxide, oxygen, nitrogen, volatile organic compounds and sulfur gases.
- Laboratory analysis of refuse samples for volatile solids, moisture, and pH.

The data are reduced and analyzed to estimate the site's current LFG generation rate, as well as where the site is in terms of its lifetime generation curve. Much of the data collected are used to provide site specific information for mathematical models that estimate the site's life-time LFG production capacity, as well as current and future LFG generation and recovery rates.

SITE BACKGROUND

The background information contained within this report was provided to ETIP by the DDF and Dames & Moore (D&M). D&M has been providing landfill closure design services at the Site, under an agreement with a multi-national firm seeking to develop the area around the landfill. ETIP has assumed this information to be valid; however, before relying on this information, third party readers of this report should seek confirmation.

The Prados de la Montaña Landfill is situated on the southwestern outskirts of Mexico City, to the northeast of the Alvaro Obregon, near the boundary with the Cuajimalpa Delegation in an area known as Zedec Santa Fe, which currently is undergoing extensive upscale development. The Site began accepting wastes upon closure of the Alameda Poniente Landfill (formerly the Santa Fe Dump) on March 16, 1987. Reportedly, primarily residential municipal solid waste (MSW) was accepted at the Site; however, industrial wastes and construction and demolition debris (C&D) also were deposited. Although hazardous wastes were not formally accepted, due to the limited control over waste types entering the Site it is likely that some hazardous wastes were disposed. The Site ceased accepting wastes on July 19, 1994. Current control and management of the Site is by the DDF.

Landfill Construction

The Site was built in an abandoned open sand mine. Before the mining operation, the Site consisted of a small mound sloping towards the east. Landfilling at the Site took place in the depression left after mining operations ceased. Of the original 24.95 hectares (61.6 acres) developed for landfilling at the Site, approximately 22.6 hectares (55.8 acres) actually received wastes. The depth of disposed refuse at the Site ranges from 20 to 40 meters (66 to 132 feet) deep, and it is estimated that the Site accepted between 5.6 and 6.4 million tons of wastes.

Reportedly, the landfill was lined by impermeable materials. In 1992, the use of geo-membrane liner began in west areas of the Site. The landfill cap closure system is composed of three layers:

- A soil material base approximately 0.6 meters thick.
- A second soil layer 0.3 meters thick, with a maximum hydraulic conductivity of 1×10^{-6} centimeters per second.
- A third soil layer 0.2 meters thick, on top of which is vegetative cover material.

Current Landfill Gas Management

Current LFG management at the Site consists of a passive venting system. The LFG escapes through wells equipped with slotted well screen within a 750 millimeter (mm) diameter borehole. These wells have been installed at approximately 50-meter spacing around the periphery of the Site and at less regular intervals throughout the remaining portions of the Site.

The LFG collected in the wells is emitted to the atmosphere, although flaring of the gas occurs in several of the wells at the Site. Many of the wells are continuously alight, and have been fitted with steel covers with an integral burner assembly to facilitate controlled burning. These have mostly fallen into disuse and have been removed in favor of a 2-inch diameter steel pipe. A locally manufactured gas flare unit is situated at the north-western boundary of the Site and is connected to approximately 15 wells by a subsurface piping network. This system was installed to control LFG migration into tunnels in the surrounding rock formed by quarrying activities. The flare does not appear to be burning much gas and is frequently out of commission.

Previous Landfill Gas Testing Results

An LFG pump test was conducted at the Site in 1994 by Wimpey Environmental (Wimpey) to assess LFG generation and recovery rates at the Site. The test was conducted using 18 of the existing wells at the time. Due to air intrusion, only five wells were used to develop steady state flow data. At the time of the test, these five wells exhibited a combined steady state flow rate of 194 cubic meters (m^3) of methane per

hour. No ROI data was obtained for these wells. Based on this test, Wimpey estimated a peak LFG recovery rate at the Site (assuming a 75 percent collection efficiency) ranging from 50 to 210 million m^3 of LFG per year in 1995. Wimpey predicted a fast decline in LFG production rates at the Site after the peak in 1995.

FIELD ACTIVITIES

Extraction Well And Probe Construction

The DDF installed additional LFG extraction wells beginning in early March 1996. Three of the wells (P-33, P-50, and 38-D) were initially selected for use by ETIP as test wells for the field test program. The wells were selected so as to have one well each in the deep, middle, and shallow depth areas of the landfill.

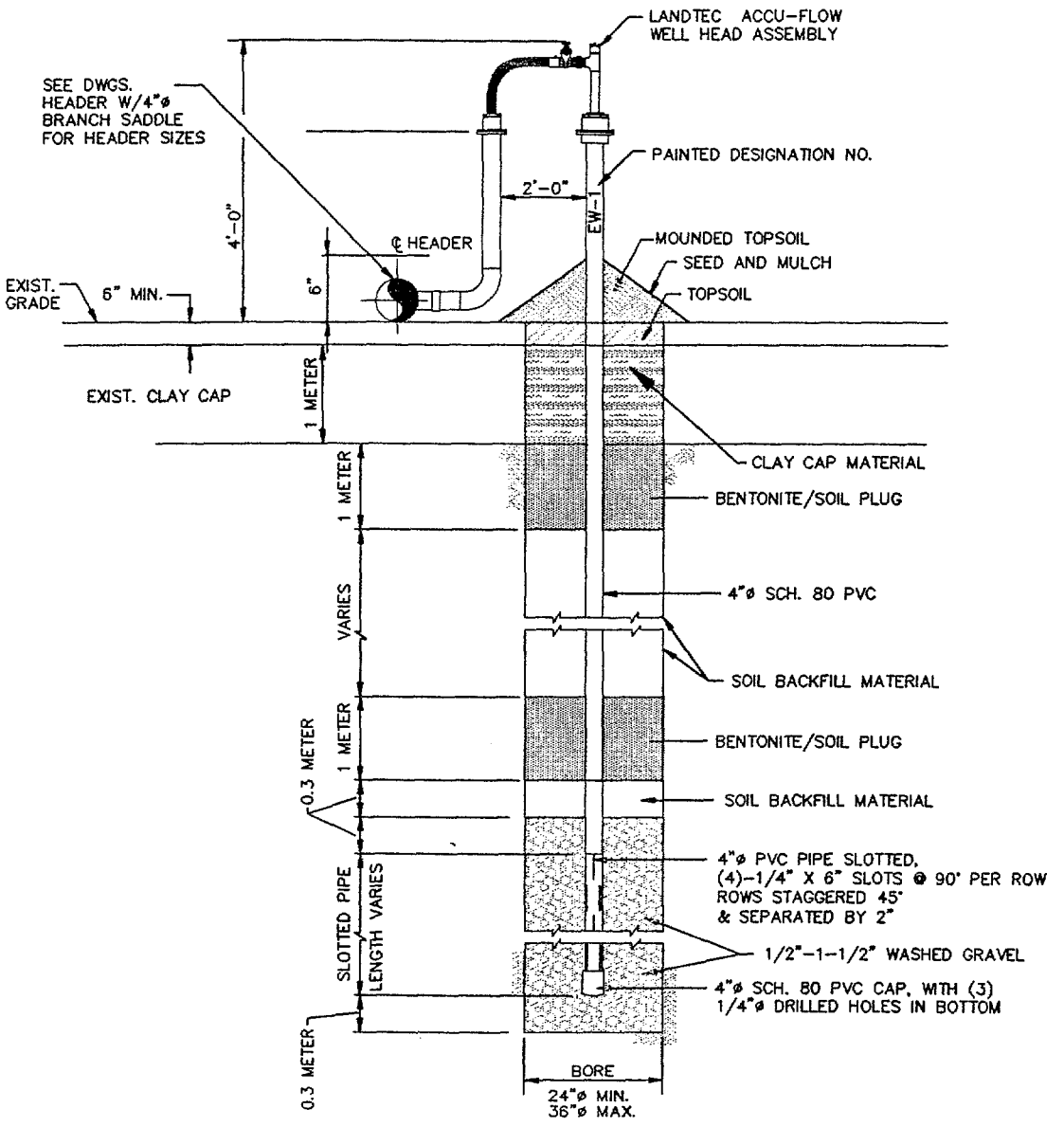
A representative of ETIP observed the installation of wells P-33, P-50, and P-38D between April 1 and April 3, 1996. ETIP provided guidance on the depth of the wells and the construction technique.

The wells were constructed of 4-inch diameter, Schedule 80 PVC pipe installed in 70 centimeter diameter boreholes. The well screen was comprised of 1/4-inch wide by 6-inch long slots cut into the PVC pipe (P-33 and P-50), and ½-inch diameter holes (P-38D) (based on concerns expressed by DDF of potential pipe shear). The well screens were backfilled with gravel to a minimum depth of 0.3 meters above the well screen, and the borehole was sealed with two bentonite plugs installed above the gravel backfill (see Figure 2 for a typical landfill gas extraction well detail). Table 1 presents a summary of the well construction data for each of the three wells.

TABLE 1. SUMMARY OF WELL CONSTRUCTION DATA
PRADOS DE LA MONTANA LANDFILL, MEXICO CITY, MEXICO

Well	Total Depth (meters)	Perforated Length (meters)	Riser Length (meters)
P-33	30	Data Not Available	Data Not Available
P-50	12	Data Not Available	Data Not Available
P-38D	32	22	10

Note: Attempts were made by ETIP on numerous occasions to contact Dames and Moore and the DDF to obtain well construction data for P-33 and P-50; however, ETIP received no responses. The design perforated length and riser length for P-33 and P-50 are 15 meters and 9 meters, respectively, and 8 meters and 5 meters, respectively.



NOTES:

1. BRANCH SHALL BE ROTATED AS REQUIRED.
2. ALL LATERALS SHALL BE 4"ø HDPE PIPE.
3. WELLS SHALL BE INSTALLED TO 75% OF LANDFILL DEPTH.
4. 66% OF WELL PIPE SHALL BE SLOTTED.
5. TOP OF SLOTTED PIPE SHALL BE A MINIMUM OF 15' BELLOW GRADE.

0995045.00\TYPEWELL 1/30/97 (2)

SCS ENGINEERS

Figure 2. Typical Landfill Gas Extraction Test Well.

In addition, 12 monitoring probes were installed at each well. The probes are arrayed around each test well in three radial arms spaced at approximately 120^0 apart. Each radial arm has one shallow monitoring well installed 3 meters away from the test well to a total depth of 3 meters, and three deep monitoring probes installed at 13, 26, and 39 meters away from the test well. Each of the deep monitoring probes is installed to a depth equal to ½ the depth of the screened interval of its associated test well. The probes were constructed of 1-inch diameter PVC pipe and well screen installed in a 8-inch diameter borehole. The boreholes were backfilled with sand with a bentonite seal installed above the well screen. Each probe was equipped with a petcock valve, which was used for probe monitoring (see Figures 3 and 4 for a typical shallow and deep landfill gas monitoring probe detail, respectively).

Perched Leachate Conditions Observed During Well Installation

Based on the results of ETIP's observations during the well installation activities and the work being conducted by ETIP relating to a leachate assessment for the Site, as well as the on-going work being conducted by Dames & Moore, it is evident that the Site exhibits elevated leachate levels within the landfill mound. It has been estimated that the Site currently contains as much as 2.5 million cubic meters of stored leachate. If the free leachate in the landfill is not removed and treated, it will hinder efforts to recover LFG.

Measurements of leachate were collected on May 29, 1996 as a component of the static test program. The results of the leachate levels are as follows: P-50 (5.7 meters below grade), P-38D (5.8 meters below grade), and P-33 (no measurement possible due to foaming of leachate, although it is anticipated that leachate levels are near the surface at P-33).

ETIP also was provided leachate level data and well verification information compiled by Dames and Moore as presented in a transmittal to ETIP dated July 24, 1996. Based on the information in this transmittal, Dames and Moore found that leachate levels ranged from non detectable (in shallow wells) to leachate levels within 1 meter of the landfill (wells 36-F and 40-F).

Drill Cutting Analytical Data

During the installation of each of the test wells, representatives of DDF collected drill cutting samples at various depths for analytical laboratory testing. Table 2 presents the range of test data from each of the wells.

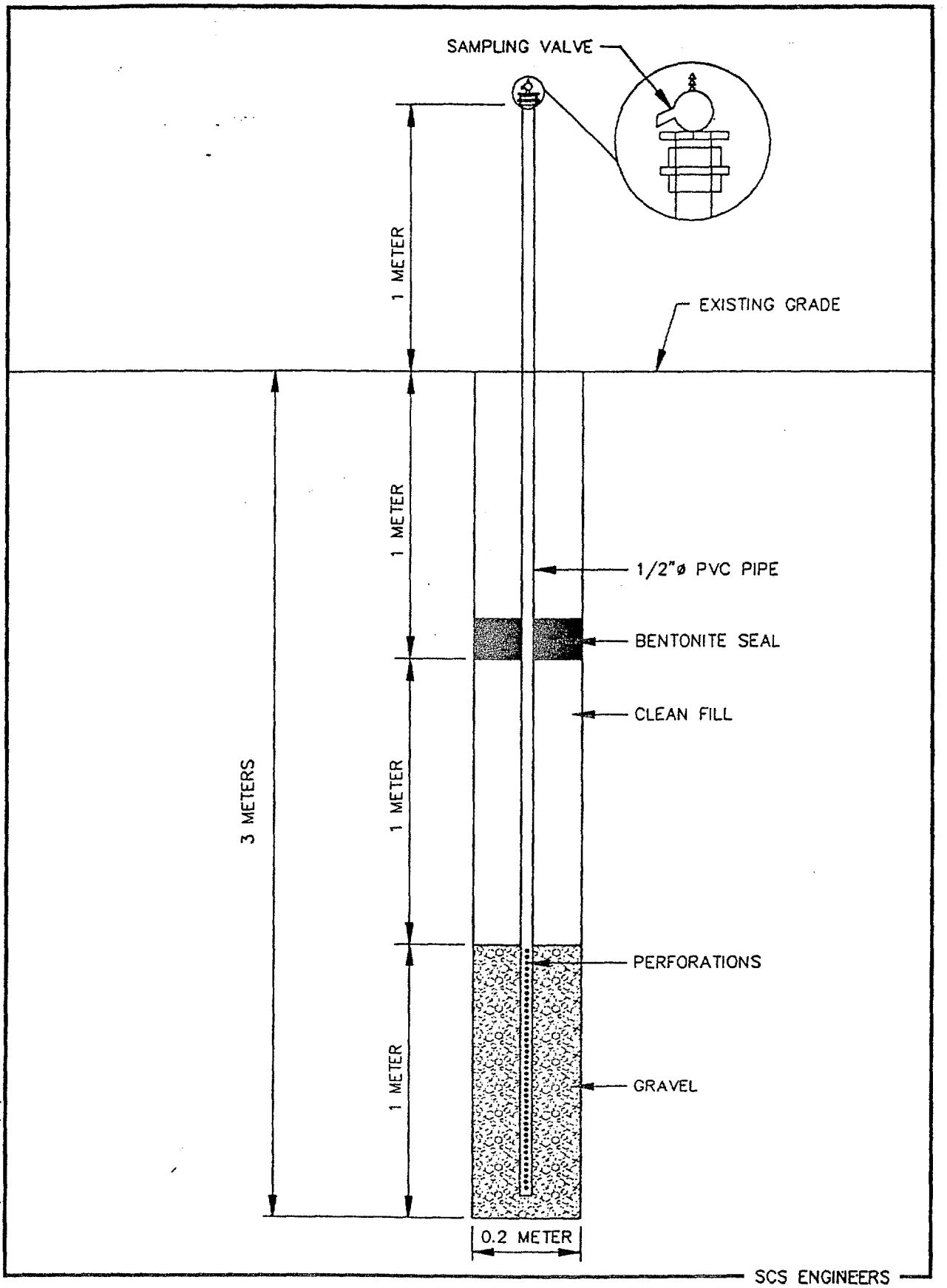


Figure 3. Typical Shallow Landfill Gas Monitoring Probe.

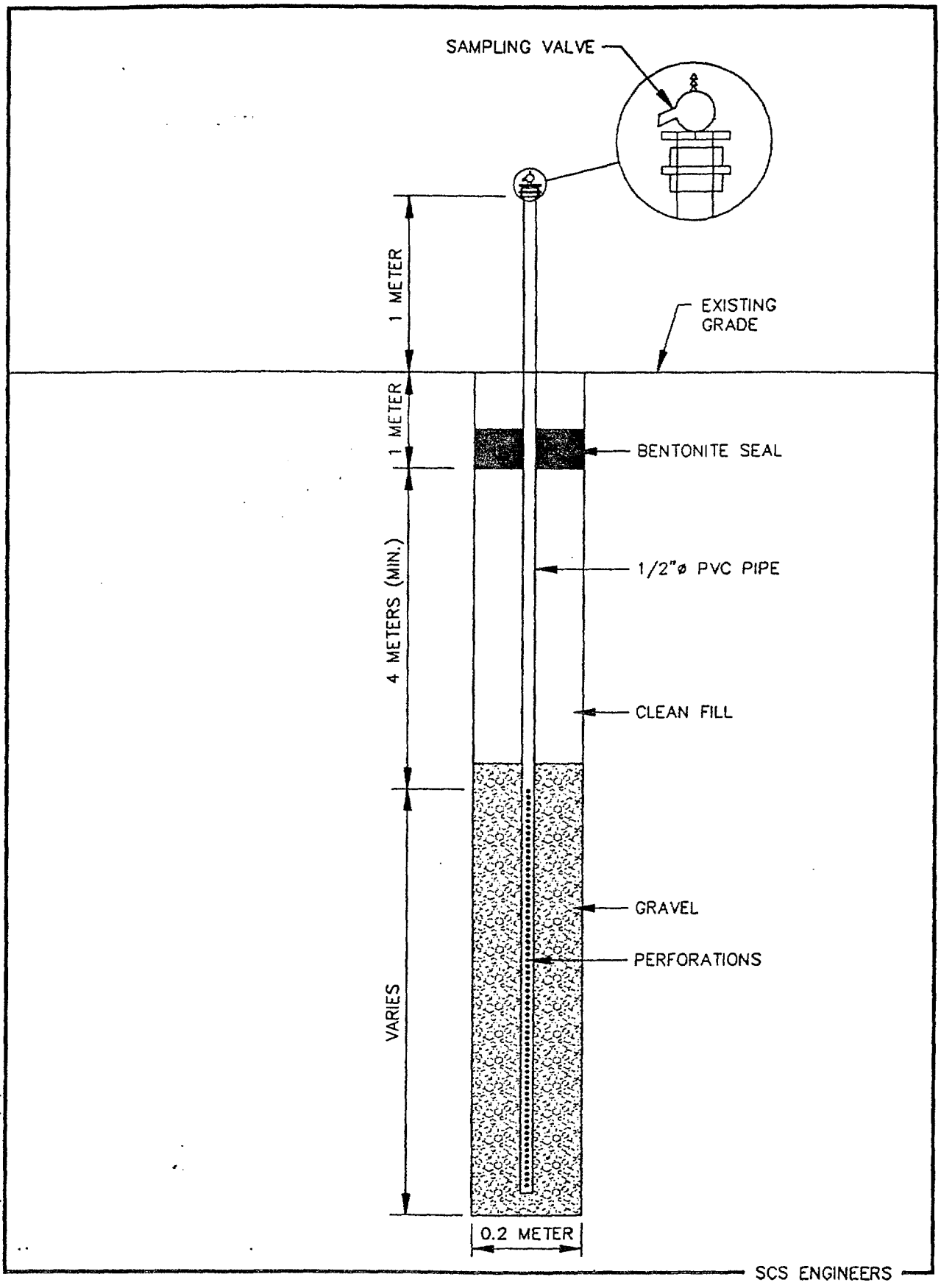


Figure 4. Typical Deep Landfill Gas Monitoring Probe.

TABLE 2. SUMMARY OF DRILL CUTTING ANALYTICAL RESULTS, APRIL 1-3, 1996 PRADOS DE LA MONTANA LANDFILL, MEXICO CITY, MEXICO

Well	pH	Moisture (%)	Volatiles (%)	Temperature (°C)
P-33	No data available			
P-50	7.98 - 8.83	6.2 - 17.4	5.5 - 38.2	21 - 40
P-38D	8.45 - 9.07	10.3 - 25.84	6.18 - 40.5	22 - 56

The results of the analytical data appear to be within the ranges anticipated for typical landfills for the measured variables; however, given the elevated leachate levels within the landfill, the data should be used with caution. Copies of the laboratory reports are provided in Attachment A.

Static Test Program

The purpose of static testing is to establish background pressures in the landfill. The background pressure data subsequently is used during dynamic testing (i.e., pump test) to evaluate whether a particular probe is being affected by the pumping activities, and for use in evaluating ROI for the extraction wells.

Pressure data obtained from the probes is representative of the approximate upper portions of the waste mound. Consequently, slightly higher pressures would be anticipated deeper in the waste mound. The static pressures measured in the landfill are "gauge" pressures rather than "absolute" pressures, and are measured against atmospheric pressure at the surface of the landfill. Consequently, the slight variations in observed pressure may be attributable in part to variations in atmospheric pressure during the day and the lag between the landfill's adjustment to the atmospheric pressure variations.

Static pressure monitoring was conducted on May 30 and 31, 1996. The results of the monitoring are presented in Attachment B; however, given the elevated levels of leachate within the landfill, the data should be used with caution.

Dynamic Test Program

The primary purpose of a Dynamic Test Program is to assess LFG yield, as well as provide information for use in estimating reasonable effective radii of influence for the wells. The elevated leachate levels in the landfill prohibited the conductance of a dynamic test program.

LANDFILL GAS GENERATION AND RECOVERY MODEL RESULTS

The design of a LFG collection system requires an evaluation of current and future LFG generation and recovery rates. ETIP used the Environmental Protectiloping LFG generation projections for the Prados de la Montaña Landfill. The model is driven by three input parameters: refuse disposal tonnage, an ultimate LFG generation rate, and a LFG generation rate constant (or decay factor).

Using historic refuse disposal estimates provided by the DDF and the default values for LFG generation potential and rate, the USEPA model predicts that over the next 50 years, the Site will generate 330,516 megagrams of methane. Given this rate of methane generation, it is estimated that at least through the year 2010, that this Site will generate approximately 1,300 million BTU per day.

The quantity of methane that will actually be collected will be a function of the collection efficiency of the LFG management system. Typical collection efficiencies for LFG systems range from approximately 50 to 90 percent. The actual collection efficiency achieved is dependent upon the type and design of the landfill's cover, the geometry of the landfill, the extraction well spacing, as well as the design and operation of the system.

The quantity of energy from the collected LFG that will actually be available for use will be a function of the recovery efficiency of the energy conversion technology used. Typical energy recovery efficiencies for energy conversion range from approximately 25 to 35 percent. Typical destruction efficiencies for methane in flares, incinerators, engines or other control devices is near 100 percent.

CONCLUSIONS AND RECOMMENDATIONS

- Leachate levels within the landfill are elevated to a point where neither active LFG testing nor LFG recovery are feasible. In order to conduct active LFG testing or LFG recovery at this Site, leachate within the waste mound must be removed and properly managed.

- Based on the results of the LFG model, it appears that LFG recovery and utilization is feasible at this Site; however further assessments subsequent to the control of leachate levels within the landfill are required.

APPENDIX A

LABORATORY ANALYTICAL DATA

DEPARTAMENTO DEL DISTRITO FEDERAL
DIRECCION GENERAL DE SERVICIOS URBANOS
DIRECCION TECNICA DE DESECHOS SOLIDOS
LABORATORIO CENTRAL DE BIOLOGIA AMBIENTAL (L.C.B.A.)

REPORTE DE ANALISIS DE RESIDUOS SOLIDOS

PROGRAMA: PROYECTO EJECUTIVO DEL SISTEMA DE CONTROL DE BIOGAS Y LIXIVIADO PARA EL RELLENO SANITARIO PRADOS DE LA MONTAÑA FASE I PERFORACION Y HABILITACION DE POZOS

SITIO DE MUESTREO:	RELLENO SANITARIO PRADOS DE LA MONTAÑA
PUNTO DE MUESTREO:	POZO No. 33 - D
FECHA DE MUESTREO:	1° ABRIL DE 1996
FECHA DE RECEPCION EN LABORATORIO	1° ABRIL DE 1996
FECHA DE REPORTE:	3 ABRIL DE 1996
RESPONSABLE DEL MUESTREO:	ING. CONSUELO REYES MARTINEZ COORDINACION DE MONITOREO AMBIENTAL Y RESIDUOS ESPECIALES

No. control del L.C.B.A.	Profundidad del Punto de Muestreo (m)	Hora de muestreo	pH	Humedad (%)	Sólidos Volátiles B.S. (%)	Temperatura (°C)
01	6.60	12:45	8.65	20.01	6.18	*
02	9.0	13:00	8.87	23.05	12.2	*
03	12.0	13:20	9.02	25.77	40.5	43
04	14.0	13:50	8.92	25.84	22.7	42
05	17.0	14:10	8.45	13.21	21.6	56
06	20.0	15:25	8.92	18.45	20.2	50
07	23.0	16:00	8.97	15.25	18.8	53
08	26.0	16:40	8.97	19.02	12.6	54
09	29.0	17:20	9.07	20.03	10.03	55

B.S. Base Seca
Metodología utilizada
pH : Método Electrométrico
Humedad: Método Gravimétrico, Técnica de secado
Sólidos Volátiles: Método Gravimétrico, Técnica de Ignición

OBSERVACIONES:
Como dato adicional, se efectuó la medición de temperatura de las muestras en campo.
(*) No se determinó.

Analizó: P.A. Q.B.P. Q. Marcela Lorenzana M.

Revisó: Ing. Silvia Molinero H.

Vo. Bo. P.A. Ing. Ma.Esther Herrera S.

12

well abandoned

DEPARTAMENTO DEL DISTRITO FEDERAL
DIRECCION GENERAL DE SERVICIOS URBANOS
DIRECCION TECNICA DE DESECHOS SOLIDOS
LABORATORIO CENTRAL DE BIOLOGIA AMBIENTAL (L.C.B.A.)

REPORTE DE ANALISIS DE RESIDUOS SOLIDOS

PROGRAMA: PROYECTO EJECUTIVO DEL SISTEMA DE CONTROL DE BIOGAS Y LIXIVIADO PARA EL RELLENO SANITARIO PRADOS DE LA MONTAÑA FASE I PERFORACION Y HABILITACION DE POZOS

SITIO DE MUESTREO: RELLENO SANITARIO PRADOS DE LA MONTAÑA
PUNTO DE MUESTREO: POZO No. 50
FECHA DE MUESTREO: 02 DE ABRIL DE 1996
FECHA DE RECEPCION EN LABORATORIO 02 DE ABRIL DE 1996
FECHA DE REPORTE: 10 DE ABRIL DE 1996
RESPONSABLE DEL MUESTREO: ING. CONSUELO REYES MARTINEZ
COORDINACION DE MONTOREO AMBIENTAL Y RESIDUOS ESPECIALES

No. control del L.C.B.A.	Profundidad del Punto de Muestreo (m)	Hora de muestreo	pH	Humedad (%)	Sólidos Volátiles B.S. (%)	Temperatura (°C)
10	3.0	10:25	8.80	11.50	19.21	22.C
11	6.0	10:45	8.74	10.30	5.33	32.C

B.S. Base Seca
Metodología utilizada
pH : Método Electrométrico
Humedad: Método Gravimétrico, Técnica de secado
Sólidos Volátiles: Método Gravimétrico, Técnica de Ignición

OBSERVACIONES:
Estas muestras corresponden al segundo pozo reubicado a 15 m del original.
Como dato adicional, se efectuó la medición de temperatura de las muestras en campo.

Analizó: P. L. Q.B.P.
Q. Marcela Lorenzana M.

Revisó:
Ing. Silvia Molinero H.

Vo. Bo. P.A.
Ing. Ma.Esther Herrera S.

DEPARTAMENTO DEL DISTRITO FEDERAL
DIRECCION GENERAL DE SERVICIOS URBANOS
DIRECCION TECNICA DE DESECHOS SOLIDOS
LABORATORIO CENTRAL DE BIOLOGIA AMBIENTAL (L.C.B.A.)

REPORTE DE ANALISIS DE RESIDUOS SOLIDOS

PROGRAMA: PROYECTO EJECUTIVO DEL SISTEMA DE CONTROL DE BIOGAS Y LIXIVIADO PARA EL RELLENO SANITARIO PRADOS DE LA MONTAÑA FASE I PERFORACION Y HABILITACION DE POZOS

SITIO DE MUESTREO: RELLENO SANITARIO PRADOS DE LA MONTAÑA
PUNTO DE MUESTREO: POZO No. 50
FECHA DE MUESTREO: 07 DE ABRIL DE 1996
FECHA DE RECEPCION EN LABORATORIO 07 DE ABRIL DE 1996
FECHA DE REPORTE: 10 DE ABRIL DE 1996
RESPONSABLE DEL MUESTREO: ING. CONSUELO REYES MARTINEZ
COORDINACION DE MONTOREO AMBIENTAL Y RESIDUOS ESPECIALES

No. control del L.C.B.A.	Profundidad del Punto de Muestreo (m)	Hora de muestreo	pH	Humedad (%)	Sólidos Volátiles B.S. (%)	Temperatura (°C)
12	2.9	16:25	7.98	17.4	38.2	21.0
13	6.0	16:55	8.81	10.2	7.67	26.0
14	9.0	17:15	8.83	9.0	16.1	34.0
15	12.0	17:45	8.68	11.9	5.5	38.0
16	14.0	18:10	8.65	6.2	7.7	40.0

B.S. Base Seca
Metodología utilizada
pH : Método Electrométrico
Humedad: Método Gravimétrico, Técnica de secado
Sólidos Volátiles: Método Gravimétrico, Técnica de Ignición

OBSERVACIONES:
Estas muestras corresponden al tercer pozo reubicado a 28 m del pozo original.
Como dato adicional, se efectuó la medición de temperatura de las muestras en campo

Analizó: P.S. Q.B.P.
Q. Marcela Lorenzana M.

Revisó:
Ing. Silvia Molinero H.

Vo. Bo. P.S.
Ing. Ma.Esther Herrera S.

APPENDIX B

STATIC TEST LANDFILL GAS DATA

LANDFILL GAS DATA COLLECTION FORM
PRADOS DE LA MONTAÑA LANDFILL
MEXICO CITY, MEXICO
STATIC TESTS

Date: 5/30, 5/31, 5/31, 1996 **Time:** 12:40 P, 9:00 A, 3:20 P **Barometric Pressure** _____

Inspector: _____ **Weather and Temperature:** 87°F- 90°F Warm and Hazy

Sample Location	Pressure (in. w.c.)			Methane (%)			Carbon Dioxide (%)			Oxygen (%)			Balance (%)			Flow Rate (cfm)		
P-33	0	-	-	65.5	-	-	34.5	-	-	0	-	-	0	-	-	1	-	-
3A(33)	0	0	0	0	1.6	0.6	0	0	0	20.1	19.5	0	79.9	78.9	99.4			
13-A(33)	2.1	1.7	2.0	63.1	66.5	66.5	36.9	33.5	33.5	0	0	0	0	0	0			
26-A(33)	24.2	-	27.2	62.8	-	67.9	37.2	-	32.1	0	-	0	0	-	0			
39-A(33)	32.2	-	31.1	64.1	-	75.0	35.9	-	25.0	0	-	0	0	-	0			
3-B(33)	0	0	0	64.1	68.8	70.0	35.9	31.2	30.0	0	0	0	0	0	0			
13-B(33)	9.4	9.9	9.3	64.1	75.8	73.4	30.9	24.2	26.6	0	0	0	5	0	0			
26-B(33)	0	0	0	1.1	3.5	3.3	0.2	1.8	1.0	19.6	18.5	18.6	79.1	76.2	77.1			
39-B(33)	12.3	10.6	13.1	64.2	71.6	71.5	34.8	28.4	28.5	0	0	0	1	0	0			
3-C(33)	0.1	0	0	63.9	68.9	69.5	36.1	31.1	30.5	0	0	0	0	0	0			
13-C(33)	52.0	51.6	56.6	65.6	72.5	72.8	34.4	27.5	27.2	0	0	0	0	0	0			
26-C(33)	63.7	51.8	62.7	66.4	71.2	72.9	33.6	28.8	27.1	0	0	0	0	0	0			
39-C(33)	44.0	42.5	44.2	66.7	73.3	73.6	33.3	26.7	26.4	0	0	0	0	0	0			

NOTES:
1. Measurements of levels taken before the start of tests on 5/29 at 12:00 PM - Leachate: 5.5 m below grade, Sludge: 18 m below grade
2. Heat rate for the first test on P-33 is 39 Btu/hr.
3. Measurements for P-33 could not be taken for the second and third tests because of leachate discharge.
4. Measurements on second test for probes 26A & 39B could not be taken because of instrument battery discharge.

LANDFILL GAS DATA COLLECTION FORM
PRADOS DE LA MONTAÑA LANDFILL
MEXICO CITY, MEXICO

Date: 5/30, 5/31, 5/31, 1996 **Time:** 9:10 A, 7:50 A, 4:15 p **Barometric Pressure** _____

Inspector: _____ **Weather and Temperature:** 66°-91°F Warm and Hazy

Sample Location	Pressure (in. w.c.)			Methane (%)			Carbon Dioxide (%)			Oxygen (%)			Balance (%)			Flow Rate (cfm)		
P-50	0.1	0	0	68.9	67.9	70.5	28.5	32.1	29.5	2.6	0	0	0	0	0	1	1	0
3-A(50)	0.2	0	0	70.4	69.8	71.2	29.6	30.2	28.8	0	0	0	0	0	0			
13-A(50)	0.7	0.4	0.5	71.2	70.3	71.5	28.8	29.7	28.5	0	0	0	0	0	0			
26-A(50)	0.8	0.3	0.4	70.0	68.4	71.5	30.0	31.6	28.5	0	0	0	0	0	0			
39-A(50)	0.8	0.2	0.3	71.0	70.2	70.6	29.0	29.8	29.4	0	0	0	0	0	0			
3-B(50)	0.7	0.1	0.2	71.1	84.6	78.3	28.9	15.4	21.7	0	0	0	0	0	0			
13-B(50)	0.3	-	0.2	71.5	70.6	71.4	28.5	29.4	28.6	0	0	0	0	0	0			
26-B(50)	0.4	0	0	1.1	0.3	1.2	0.3	0	0	19.5	0	0	79.1	99.7	98.8			
39-B(50)	0.4	0	0	2.4	1.8	1.8	0.9	0.6	0.1	19.3	0	19.7	77.4	97.6	78.4			
3-C(50)	1.0	0.2	0.3	73.6	72.6	72.8	26.4	27.4	27.2	0	0	0	0	0	0			
13-C(50)	1.5	0.3	0.4	66.7	66.4	68.6	33.3	33.6	31.4	0	0	0	0	0	0			
26-C(50)	1.2	4.1	0.4	2.9	1.0	2.3	0.2	0	0	19.3	19.4	19.9	77.6	79.6	77.8			
39-C(50)	1.6	0.9	0.7	1.4	1.3	2.3	0.5	1.3	0.6	0	19.4	19.6	98.1	78.0	77.5			

NOTES:
1. Measurements of levels taken before the test on 5/29 at 11:35 AM - Leachate: 5.7 m below grade, Sludge: 11 m below grade
2. Heat rate for first two tests on P50 is 11 Btu/hr each.

LANDFILL GAS DATA COLLECTION FORM
PRADOS DE LA MONTAÑA LANDFILL
MEXICO CITY, MEXICO
STATIC TESTS

Date: 5/30, 5/31, 5/31, 1996 **Time:** 1:45 P, 9:50 A, 3:30 P **Barometric Pressure** _____

Inspector: _____ **Weather and Temperature:** 90°-100°F Warm and Hazy

Sample Location	Pressure (in. w.c.)			Methane (%)			Carbon Dioxide (%)			Oxygen (%)			Balance (%)			Flow Rate (cfm)			Heat Rate Btu/hr		
38-D	0	0	0.1	60.3	65.9	65.9	39.7	34.1	34.1	0	0	0	0	0	0	0	8	11	0	77	122
3A(38)	0.1	0	0.1	61.9	66.5	67.4	38.1	33.5	32.6	0	0	0	0	0	0						
13-A(38)	1.0	0.6	0.7	60.7	68.5	66.4	39.3	31.5	33.6	0	0	0	0	0	0						
26-A(38)	0	0.3	0	0.2	0.7	0.7	0	0	0	19.6	0	19.6	80.2	99.3	79.7						
39-A(38)	0.2	0.1	0	61.1	67.2	66.5	38.9	32.8	33.5	0	0	0	0	0	0						
3-B(38)	0.3	0.3	0.4	62.0	67.5	67.0	38.0	32.5	33.0	0	0	0	0	0	0						
13-B(38)	0.9	0.7	0.5	63.1	66.6	65.7	36.9	33.4	34.3	0	0	0	0	0	0						
26-B(38)	-	6.2	5.0	-	69.3	67.4	-	30.7	32.6	-	0	0	-	0	0						
39-B(38)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-						
3-C(38)	-	0	0.1	-	70.2	68.3	-	29.8	31.7	-	0	0	-	0	0						
13-C(38)	-	2.2	1.2	-	7.0	15.8	-	4.0	0.8	-	0	15.9	-	89.0	67.5						
26-C(38)	-	0.5	0.6	-	69.3	67.8	-	30.7	32.2	-	0	0	-	0	0						
39-C(38)	-	0.2	0.2	-	68.7	67.3	-	31.3	32.7	-	0	0	-	0	0						

NOTES:
1. Measurements of levels taken before the first test on 5/29 at 11:15 A: Leachate: 5.8 m below grade, Sludge: 13.5 m below grade
2. Measurements for probe 39-B(38) could not be taken because of leachate discharge.
3. Measurements on first test (5/30) are incomplete because the instrument battery got discharged.