Carmen Johnson CJ

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95-02

WATAUGA COUNTY LANDFILL
PERMIT 95-02
GAS REMEDIATION PLAN

Prepared for

North Carolina
Department of Environment and Natural Resources

Prepared by:

Draper Aden Associates
Consulting Engineers
2206 S. Main Street
Blacksburg, VA 24060

July 19, 2002

DAA JN 6520-10

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SECTION 1.0 INTRODUCTION

1.1 Location and Brief History

The Watauga County Landfill is located in the eastern part of Watauga County to the east of Route 421, approximately 1 mile east of the Town of Boone limits. The landfill was operated as a sanitary landfill under Permit 95-01 from 1972 to 1984 and under Permit 95-02 from 1984 to 1994. The final cap was constructed on the facility in 1996. The original baling facility, used to bale waste prior to disposal, was converted to a transfer station in 1994 and the waste is currently transported to the Waste Management facility in Johnson City, Tennessee.

The County holds permits for a Mulch Treatment and Processing Facility, a Land Clearing Debris Landfill, the closed Sanitary Landfill, and the closed debris fill.

A location map is contained in Appendix A.

1.2 Regulatory Requirements

wrong rules governing this LF. 0.500 Rules are correct ones

Section .1626, (4)(a) – (d) of 15A NCAC 13B, entitled "Operational Requirements for MSWLF Facilities," requires the following relative to gas monitoring and remediation:

(4) Explosive gases control.

(a) Owners or operators of all MSWLF units must ensure that:

(i) The concentration of methane gas generated by the facility does not exceed 25 percent of the lower explosive limit for methane in facility structures (excluding gas control or recovery system components); and

(ii) The concentration of methane gas does not exceed the lower explosive limit for methane at the facility property boundary.

(b)Owners or operators of all MSWLF units must implement a routine methane monitoring program to ensure that the standards of (4)(a) are met. A permanent monitoring system shall be constructed on or before October 9, 1994. A temporary monitoring system shall be used prior to construction of the permanent system.

(i) The type and frequency of monitoring must be determined based on the following factors:

- *Soil conditions*
- *The hydrogeologic conditions surrounding the facility*
- *The hydraulic conditions surrounding the facility' and*
- *The location of facility structures and property boundaries.*

(ii) The minimum frequency of monitoring shall be quarterly.

(c) If methane gas levels exceeding the limits specified in (4)(a) are detected, the owner or operator must:

(i) Immediately take all necessary steps to ensure protection of human health and notify the Division;

(ii) *Within seven days of detection, place in the operating record the methane gas levels detected and a description of the steps taken to protect human health; and*

(iii) *Within 60 days of detection, implement a remediation plan for the methane gas releases, place a copy of the plan in the operating record, and notify the Division that the plan has been implemented. The plan shall describe the nature and extent of the problem and the proposed remedy.*

(iv) *Based on the need for an extension demonstrated by the operator, the Division may establish alternative schedules for demonstration compliance with (4)(c)(ii) and (iii) of the Rule.*

(d) For purposes of this Item, "lower explosive limit" means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at 25 degrees C and atmospheric pressure.

1.3 Purpose of the Plan

The purpose of this plan is to provide NCDENR with the remediation plan for the Watauga County Landfill gas management program. As discussed below, one of the installed probes does exceed the limits. This plan builds on the original gas management plan submitted to DENR on October 23, 1995.

2.0 MONITORING PROGRAM

2.1 Probe Construction

The monitoring probes were constructed in March of 1996 in accordance with the detail and specifications contained in Appendix B.

2.2 Probe location

As review of the location map in Appendix A will indicate, the majority of the Watauga County Landfill is surrounded by undeveloped land, except for the southern property boundary. On this boundary, several homes are within 300' of the limits of waste. On the other boundaries, the few homes and businesses holding property adjacent to the landfill are over 1,000' from the limits of waste. Thus, probes were placed along the southern boundary, drilled to a depth of 40' where bedrock was encountered. These probes along with the landfill structures (Scalehouse, transfer station and dog pound) are monitored quarterly.

2.3 Monitoring Protocol

Landfill gas monitoring of probes and on site structures will be monitored throughout the post-closure care period. Because the landfill stopped receiving waste in April 1994, the facility would have a 10 year post closure period. However, due to groundwater issues, the post closure period is indeterminate and monitoring will continue indefinitely. If the Owner can show that there is no potential for gas migration into structures on site or beyond the site boundaries, the Owner can request from DENR permission to cease gas monitoring. The Owner must continue to monitor until he receives written permission to cease from the Division.

2.3.1. Monitoring Schedule

Monitoring shall occur according to the following schedule and protocol:

a. Quarterly for all probes.

b. Probe readings shall be recorded on a form similar to that included in this report. The form shall include at a minimum the following information:

- The number of the probe corresponding to the locations shown on the drawings.
- The concentrations levels.
- The date, time, barometric pressure, atmospheric temperature, general weather conditions, and probe pressures.
- Names of sampling personnel, apparatus used, and methods used.

c. Quarterly, for all on-site structures.

d. Semi Annually, for homes adjacent to southern property boundary. Homes to be monitored are indicated on Figure 1 in Appendix A.

2.3.2. Test Equipment Recommendations

Exterior probes within a landfill routinely measure four parameters: methane content by percent volume, carbon dioxide content by percent volume, oxygen content by percent volume and subsurface pressure in inches of water column. Interior testing routinely measures the methane content, carbon dioxide content and oxygen content by percent volume.

Monitoring for landfill gas can be accomplished with acceptable accuracy with a portable, properly calibrated landfill gas meter. A CES-Landtec Model GA-90, Gem 500 or Gem 2000 or equivalent may be used. The meter shall be capable of analyzing methane, carbon dioxide and oxygen. Analysis of methane and carbon dioxide shall be by means of an infrared gas analyzer. A field calibration kit designed specifically for use with the applicable landfill gas meter shall be used for calibration of the meter.

Subsurface pressure may be measured by a mechanical gauge or by the landfill gas meter if it is so equipped. The Dwyer Magnehelic gauge is recommended. A set of at least two gauges will be needed. The recommended pressure ranges are 0-1 inch of water column and 0-10 inches of water column.

Atmospheric temperature and the barometric pressure shall also be monitored either by using the landfill gas meter if it is so equipped or by separate instruments. A barometer such as an Airguide model 211B and a thermometer such as are sold in hardware stores are adequate to record atmospheric conditions during sampling sessions.

2.3.3. Exterior Monitoring

Gas monitoring probes are located along the landfill's southern perimeter. The location of the probes and a detail of a typical probe are shown on the figures in Appendix A and B respectively. The method for sampling a test probe may be summarized as follows:

a. Prepare report form with the required information on date, time, temperature, atmospheric pressure, probes to be sampled, name of person conducting sampling and location. A sample report is included in Appendix C.

b. Clean around the probe cap to prevent dirt from entering the sample tubes.

c. Remove the probe cap.

d. Prepare the landfill gas meter by successfully calibrating it in accordance with the procedure provided in the meter's operations manual. If the meter is a Landtec landfill gas meter, ensure that there is a filter in the sample line. Prior to monitoring each tube, purge the meter with ambient air and check the meter reading for 0% methane.

e. Select one sample tube and note the probe number and tube depth on the report form.

f. Monitor the static pressure of the sample tube first by using either the gas meter if so equipped or the magnehelic gauge.

g. After monitoring the pressure, monitor the gas in the sample tube. Connect the landfill gas meter to the sample tube. Operate the meter in accordance with the procedures contained in the operations manual. Turn on the meter's pump and purge the sample tube of one tube volume by operating the pump for a predetermined period of time. This time is based on the flow rate of the pump, and the inner diameter and depth of the sample tube. For example, if sampling is performed using a Landtec meter, the purge time is 5 seconds per foot of depth for a ½" diameter sample tube. Observe the line while purging for any water being drawn up through the line. If water is observed stop the pump immediately and disconnect the line to drain the water. Do not attempt to resample the tube.

Pulling water into the meter may require the meter to be returned to the manufacturer for repair.

h. After purging has been accomplished, allow the gas concentrations to stabilize and observe and record the "steady state" methane, oxygen and carbon dioxide concentrations. Also, while the pump is running observe the variation in the methane concentration and record the peak concentration monitored if it is different from the steady state value. The steady state value is typically the concentration officially used for compliance.

i. Repeat the above procedure for the other sample tubes in the probe. Ensure that the meter is completely purged with ambient air before connecting it to the next sample tube.

j. Note any unusual circumstances such as water in the probe, needed repairs, etc.

k. Repeat the above procedures for all probes, noting the time each sampling is started.

Reports should be submitted to the reviewing agency upon completion. A copy of all reports should be kept at the landfill or administrative offices.

The gas probes shall be inspected during each quarterly event. Any damages shall be promptly repaired. Sampling tubes within the gas probes shall also be inspected. If the tubes are broken, the probe will be replaced. Caps and pads around gas probes will be inspected and repaired or replaced as needed. If a gas probe is damaged to the point where it must be replaced, DEQ will be notified and the post closure monitoring plan revised accordingly.

2.3.4. Interior Monitoring

Monitoring of interior spaces consists of routine sampling with the landfill gas meter for the presence of methane and oxygen. All accessible site structures are to be included in the monitoring program. In addition, homes adjacent to the southern property boundary are monitored semi annually.

The following procedures for interior monitoring are recommended.

a. Prepare the appropriate report form noting the date, time, person sampling, etc. A sample report form is contained in Appendix C.

b. Calibrate the landfill gas meter in accordance with the meter's operations manual. Ensure that the meter is properly purged in ambient air prior to monitoring the interior spaces.

c. Proceed to the test area and enter as gently as possible. Avoid creating air movement, which can disperse methane. If sampling air in a closed space such as

a sewer clean out, keep the cover closed as much as possible to prevent dispersal of the gas. Monitor all interior rooms and spaces.

d. Place the sample tube in the area to be tested. Let the meter stabilize and read the percent gas indicated. Observe and record the steady state and peak methane levels. Observe and record the steady state oxygen level.

e. Repeat the above procedure in every room or sample area. Note the exact location and corresponding concentration where methane is detected.

f. Replace any covers or caps removed.

If any methane readings over 1.25% by volume are recorded, the affected area should be evacuated immediately if applicable, the source should be investigated and the area ventilated. Do not reoccupy until the gas levels are maintained below 1.25%.

As a general rule, maintaining a good air flow in the building and good ventilation will help prevent potential gas build-up situations. In addition, areas that are usually closed off such as janitorial closets and equipment service areas can be helped with louvered doors and through-the-wall vents.

Reports on interior testing should be transmitted to the reviewing agency immediately upon completion. Any high readings requiring evacuation or extra ventilation should be reported immediately.

Recommended areas for testing are:

Sewer cleanouts
Pipe penetrations of walls and floors
Floor drains and grates
Spaces under cabinets and counters
Closets and cabinets, especially those near sewer lines
Closed rooms
Building foundation vents

2.4 Monitoring Results

Appendix D contains the gas monitoring data from March 21, 1996 through May 2, 2002. As the data indicate, Probe 2 has been out of compliance since it was constructed in March 1996. Data was transmitted to DENR on June 20, 1996. The following section describes the gas control and remediation measures implemented at the landfill to address the situation.

3.0 GAS MANAGEMENT AND REMEDIATION SYSTEM

3.1 Vent System

18'-30' deep

During construction of the landfill cap in 1996, twenty-two (22) passive gas vents were installed in the landfill. Appendix E contains a drawing indicating the location of the vents and the actual drilling data. The purpose of these vents was to protect the cap and release gas to minimize migration. Appendix F contains a detail of the specifications from the closure plan outlining the construction requirements and the construction detail. In addition to construction of the vents, each vent was provided with a candlestick flare which flares the gases to reduce the odors. This was done to protect the adjacent homes on the southern boundary from odors. Information on the flares is also provided in Appendix F.

3.2 Venting

3.2.1. Peak Flow

The mounded shape of the landfill and the synthetic membrane cap keeps runoff out of the waste and therefore keep moisture content low. Consequently, the factors, which control gas production, are such that methane generation should be limited.

Experience has shown that the potential for gas generation varies widely depending on the site and the waste material. Based on reported data for municipal solid waste landfills the estimated gas generation rate would be 0.17 scf per lb. of waste in place per year. If a total maximum waste volume of 100 tpd (average-overlife of facility) then 176 cfm would be expected in 1994 the peak year for production. The generation rate half life should be on the order of 25 years. Modeling data is contained in Appendix G and assumes 100 tpd (5) since permitting began in 1972. Thus, over 21 years, approximately 546,000 tons would have been placed.

3.2.2. General System Design Considerations

Due to the gas generating potential of the waste, a gas collection system was constructed for migration control. Twenty-two vertical vents were installed in the landfill during closure. A candle stick flare was installed on each vent for odor control and methane destruction.

3.2.3 Construction Specifications

Appendix F contains the construction specifications for the existing vents.

3.3 Protection of Human Health

When Probe 2 was found to exceed the compliance limit, the County took action to assure that the adjacent homes were not affected by gas migration. A program whereby the homes were monitored semiannually was implemented. Four homes are routinely monitored semi annually as indicated on the Figure in Appendix A. A fifth home is monitored when possible as it is only used seasonally and coordination is difficult. To date no gas has been found in any home so monitored. Because this monitoring is in place, it is felt that additional remediation activities is not necessary.

3.4 Concentration Analysis and Corrective Action

An initial indicator of increased methane movement will be an increase of methane concentration. In accordance with the regulations, the following methane concentrations will classify the landfill as out of compliance:

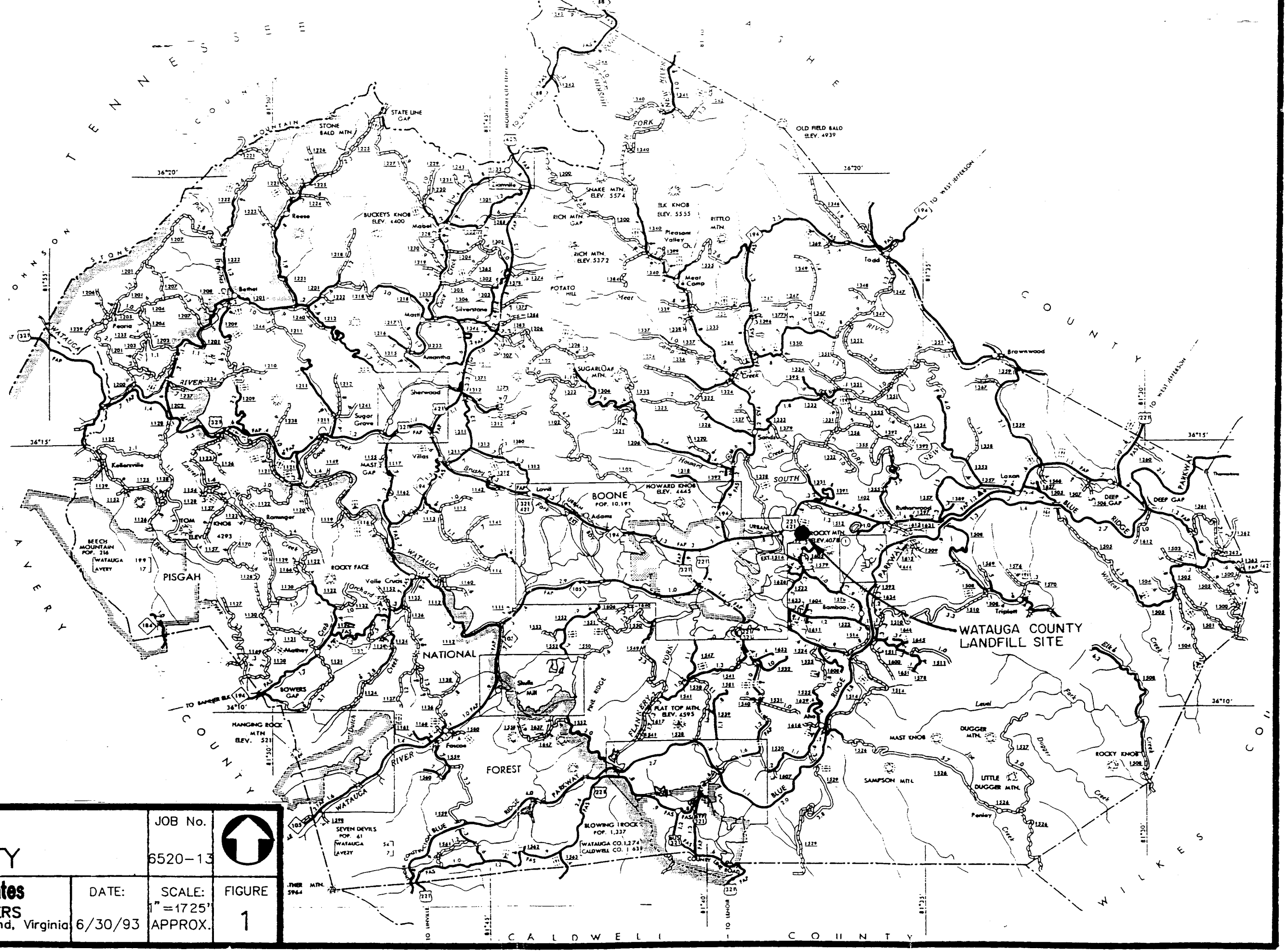
5% by volume methane at the property boundary
1.25% by volume methane in structures

Consistent readings of 5.0% or above in probes and 1.25% or above in structures should dictate that efforts be taken to protect human health.

Watauga's efforts have included venting the landfill and monitoring the homes. No other efforts are planned.

APPENDIX A

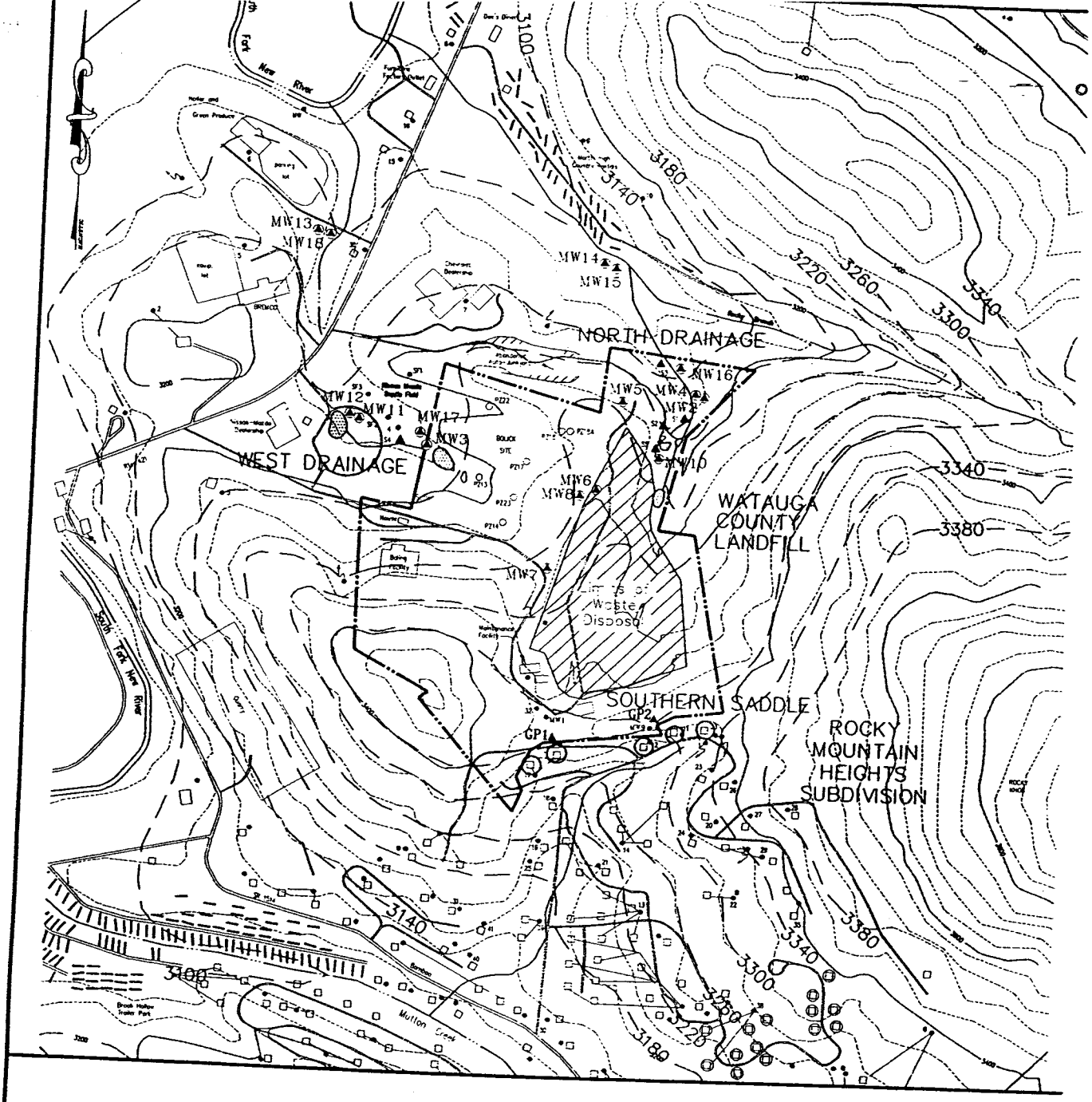
LOCATION MAP



LOCATION MAP
WATAUGA COUNTY

Draper Aden Associates CONSULTING ENGINEERS Blacksburg, Virginia – Richmond, Virginia Nashville, Tennessee	DATE: 6/30/93	SCALE: 1" = 1725' APPROX.	FIGURE 1

JOB No. 6520-13



LEGEND

- Existing Ground
- Overhead Power Line
- Stream
- Pond
- Existing Residence/Multi-unit Residence
- Existing Mobile Home
- Assessment Monitoring Wells
- Surface Water Sampling Locations
- Piezometer
- Groundwater Potentiometric Elevation
- Septic Field Monitoring Wells
- Spring
- Spring Used as Potable Water Source
- Existing Potable Well/ Sampled Well Ref. No.
- GP1 Gas Monitoring Well

(Inferred from static water level data obtained on April 11-13, 1995)

LANDFILL GAS MONITORING
PROBE LOCATIONS
WATAUGA COUNTY LANDFILL
WATAUGA COUNTY, NORTH CAROLINA

Job No.: 6520-20
Scale: 1" = 300'±
Date: 09 SEPTEMBER 95

FIGURE 1

Draper Aden Associates
CONSULTING ENGINEERS
Blacksburg, VA - Richmond, VA - Nashville, TN

APPENDIX B

MONITORING PROBE DETAIL
&
SPECIFICATION

I. INTRODUCTION

Draper Aden Associates (DAA) is soliciting bids on behalf of the Watauga County Board of Commissioners for subcontracting services for drilling and installation of two (2) gas monitoring probes at the Watauga County Landfill.

The enclosed invitation (solicitation) for bids encompasses air rotary borehole drilling and subsequent completion of two (2) gas monitoring probes, as described below. All submitted bids must contain a completed Drilling Estimate Form (DEF), which is located in Appendix A. The DEF must include unit prices for materials or services for the estimated depths of drilling and quantities of materials shown. The bidder shall provide unit costs and summation of the total drilling bid estimate. Please note the actual drilling depths may be different from those estimated herein, under field conditions encountered.

The Driller subcontracted for this work will be expected to provide drilling equipment capable of completing the scope of work outlined here, and able to adjust to changes in drilling depth and weather. Should drilling conditions vary significantly from the estimated scope of work presented here, the unit costs provided by the Driller on the DEF will provide the proper billing schedule. The Driller must return the DEF to Draper Aden Associates by the time and date specified on the cover of the bid and on the DEF.

All subcontracted invoicing for drilling services according to the unit prices provided on the DEF will be billed directly to the Owner, and mailed directly to Draper Aden Associates for approval of the invoice.

II. HEALTH AND SAFETY REQUIREMENTS

Prior to the start of any work, the Contractor and all Subcontractors shall show evidence that a proper health and safety plan has been developed for the work to be undertaken. Work will not be allowed to commence until evidence of a health and safety plan has been produced. The Contractor and Subcontractors shall be solely responsible for the health and safety of all individuals under employment with them.

III. SCOPE OF WORK

Drilling and monitoring probe installation activities will be observed by DAA. Determination of the drilling depths and locations will be the responsibility of DAA. As built drawings of the installed monitoring probes shall be provided by the Contractor at the end of the project.

A. Gas Probe Borehole Drilling

Two (2) gas monitoring probes will be installed at the Watauga County Landfill to monitor for landfill gas migration. Figure 1 presents the proposed probe locations. Both probes will be located near the property boundary, not within solid waste. Both will be drilled to bedrock. The borehole depths will range from 35 to 40 feet. Total drilling footage is expected to be approximately 80 feet.

No soil sampling will be conducted.

Drilling will be conducted with a 6¼-inch air rotary drill. The gas probes will be installed within the open borehole. Electricity is not available for probe drilling/installation at the site. Water is available at the on-site bailing facility

B. Gas Probe Construction

The gas monitoring probes will vary in total projected depth from 35 to 40 feet. Figure 2 presents the gas probe construction specification. Each gas probe will contain four (4) gas probes, one each accessing the 0-5 feet, 5-10 feet 10-20 feet and 20-40 feet depth intervals.

Cumulatively, the two gas monitoring probes will require approximately 90 feet of PVC piping to be installed.

Depth for each probe and screen within the borehole will be determined in the field by the Engineering Technician, depending on total depth of the borehole.

The following discussion outlines probe construction. (Figure 2)

Each gas probe borehole will contain multiple 1/2-inch diameter, schedule 40 PVC screens and risers. A one-foot long section of perforated riser will be used along with the appropriate length of solid riser to provide a 6-inch stickup at the surface. The 1/2-inch PVC pipe shall be perforated along the bottom one-foot length. The screen and riser must be flush mount threaded, with no adhesive used in probe construction. A **1/2-inch diameter female adapter with 1/2"-1/4" brass bushing with 1/4" brass quick connect shutoff body (McMaster-Carr No. 5327K81)** shall be placed on the riser stick-up, using no adhesive. Each probe's 1/2-inch PVC pipe shall be clearly marked and tagged according to its depth as noted below.

0-5'	RED
5-10'	YELLOW
10-20'	BLUE
20-40'	GREEN

Stone shall be placed within the borehole, around the screen interval of each probe, extending from the bottom of the applicable depth interval to just above the perforated PVC probe. Geotextile filter fabric shall be placed on top of the gravel. A 6-inch backfill of bentonite chips shall be poured over the gravel. The chips shall be hydrated with distilled water. The next probe interval shall then be constructed, with #57 stone placed around the 1-foot perforated screen and extending above the perforated screen interval followed by geotextile, bentonite, etc.

The surface completion shall comprise a **12 1/2" diameter fiberglass irrigation valve box, Brooks Model 2200 or equivalent,** with locking lid, in a concrete foundation with a 1/2-inch PVC drain, as illustrated in Exhibit 1. Note: It will be necessary to remove approximately 8" of the bottom length of the valve box prior to installation. **An orange fiberglass fencepost with a minimum diameter of 2" and with metal I.D. tag shall be installed adjacent to a 2' x 2' concrete pad with minimum 8" thickness.**

C. Access to Borehole Drilling Locations

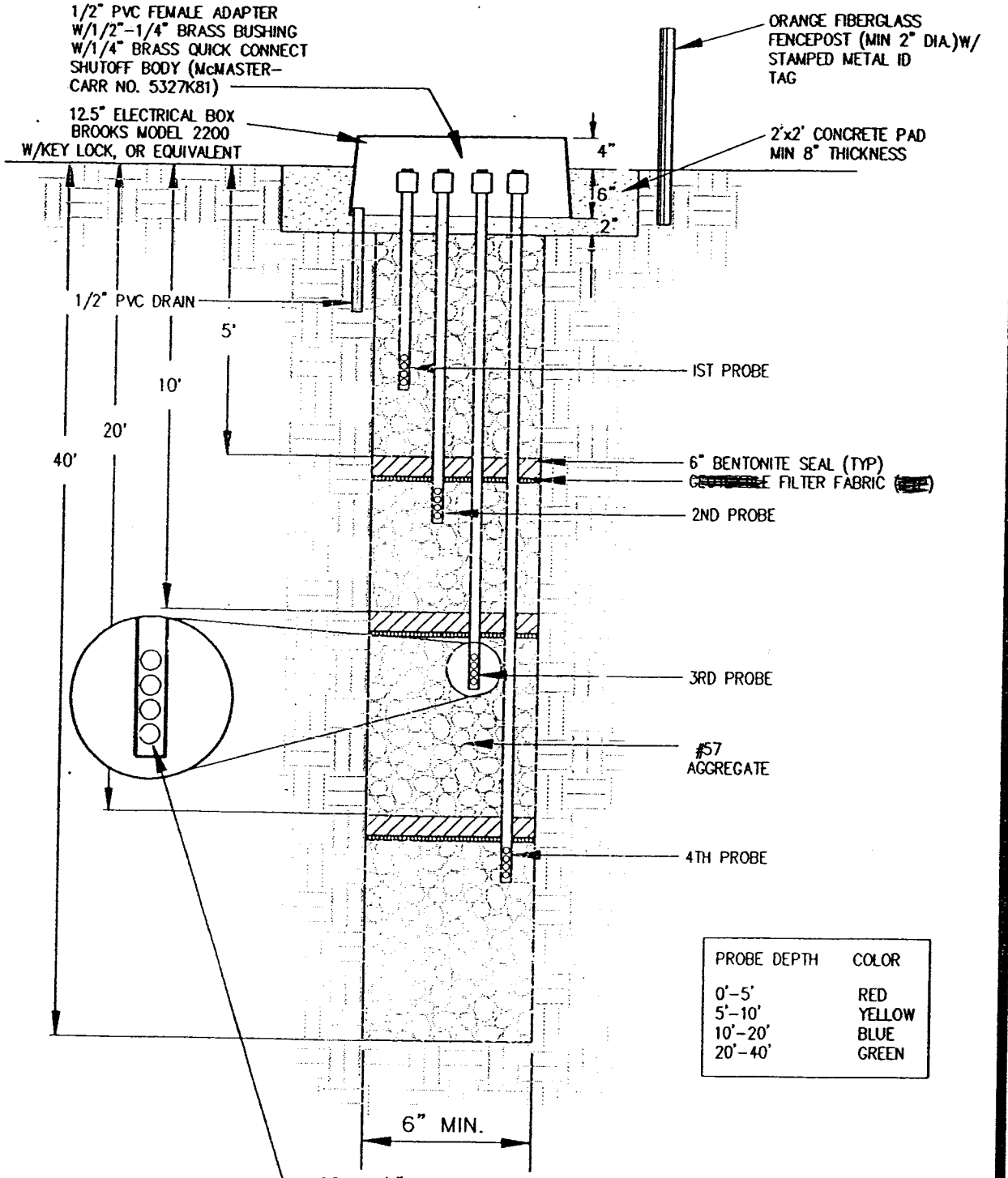
Aid in access to borehole drilling locations via a track loader will be provided by Watauga County, if necessary. However, it is the responsibility of the Driller to provide site equipment which will enable reasonable, timely access to drill locations. Mobilization time between holes greater than 1/2 hour may be charged as down-time. All drilling equipment shall arrive at the site decontaminated, and in good working order. Decontamination of drilling equipment is not necessary between borings.

IV. WORK SCHEDULE

Once the successful Bidder is chosen and the site investigation begins, all reasonable efforts to maintain progress will be expected. Equipment shall arrive at the work site in proper operating condition. Delays which are the result of mechanical failure and/or the Subcontractors failure to adequately plan and provide logistical support will not be billed to the client. Work shall be completed within 30 days of the Notice to Proceed or as approved by DAA.

V. GENERAL TERMS AND CONDITIONS

VENDOR: The general terms and conditions which follow, apply to all purchases and become an integral part of each formal Invitation to Bid, purchase orders and/or other award issued by the Consultant, unless otherwise specified. Drillers or their authorized representatives are expected to fully inform themselves as to the conditions, requirements, and specifications herein and included in the invitation for Bid before submitting Bids. Failure to do so will be at the Driller's own risk and relief cannot be secured on the plea of ignorance, subject to State,



PROBE DEPTH	COLOR
0'-5'	RED
5'-10'	YELLOW
10'-20'	BLUE
20'-40'	GREEN

TYPICAL GAS DETECTION PROBE-WATAUGA COUNTY

GPROBE7

Draper Aden Associates
CONSULTING ENGINEERS
Blacksburg, Virginia - Richmond, Virginia - Nashville, Tennessee

JOB No.	DATE:	SCALE:	FIGURE
6520-28	9-13-95	NONE	2

9:10 am – Meet Dewey Wright

9:30 am Meet Bob Frei and JV — discuss & inspect edge of waste & pit verification.

10:30 am – Dewey Wright Rig arrives on site. set on GP2

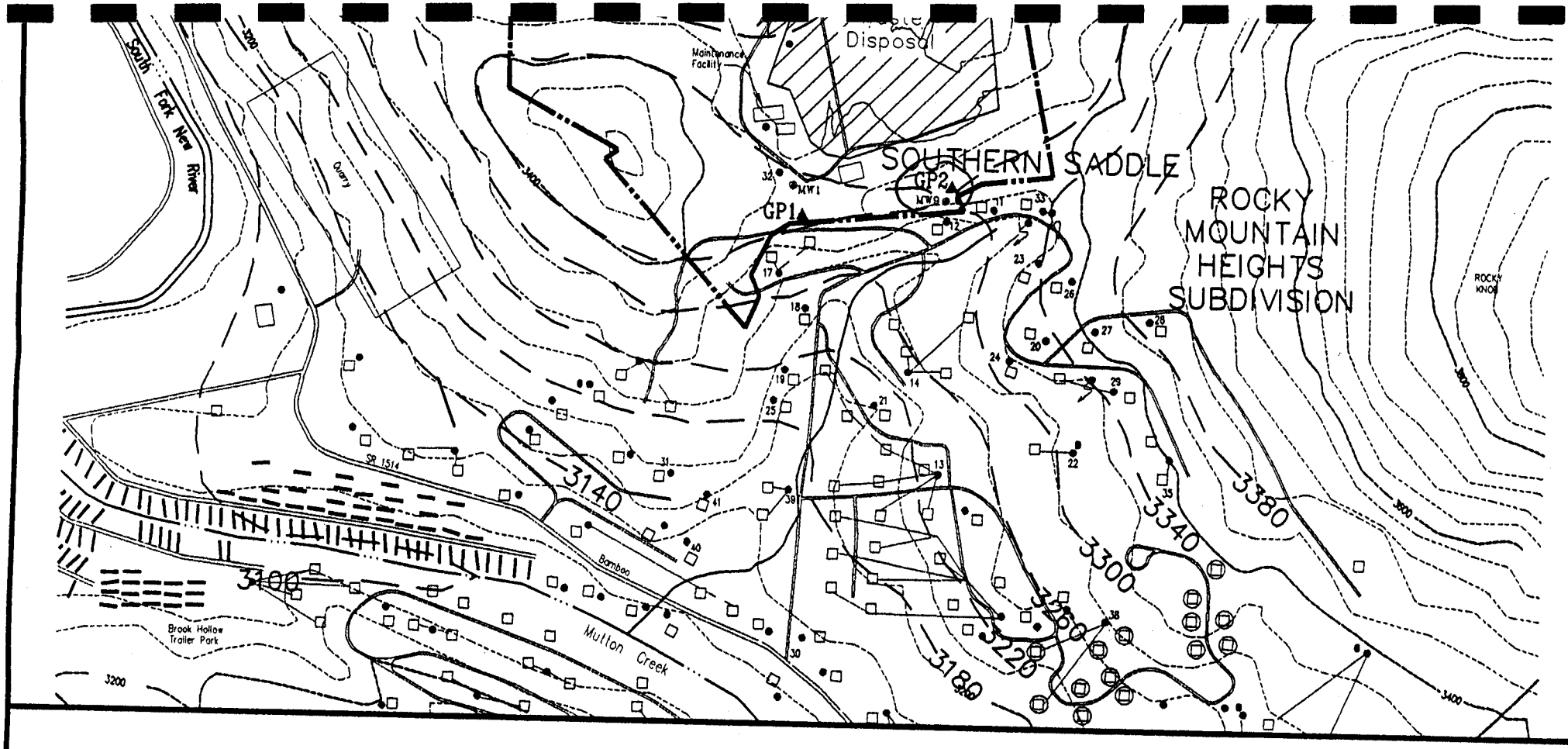
11:00 am – 40 ft – bedrock – GP2

12:30 pm – complete construction of GP2 per specs
– clean up on GP1

30.0	20.0	15.0	10.0	0.0
28.5	20.5	15.5	10.5	2.0
31.5	31.5	16.5	11.5	3.0
40.5	30.0	20.0	15.0	5.0

1.00 pm – 40 ft. – bedrock – GP1

Mileage 7[illegible]
11
12[illegible]745



LEGEND

- Existing Ground
- Overhead Power Line
- Stream
- Pond
- Existing Residence/Multi-unit Residence
- Existing Mobile Home
- Assessment Monitoring Wells
- Surface Water Sampling Locations
- SF1 Septic Field Monitoring Wells
- Spring
- S Spring Used as Potable Water Source
- 2 Existing Potable Well/ Sampled Well Ref. No.
- ▲GP1 Gas Monitoring Well

APPENDIX C

REPORTING FORMS

EXTERIOR GAS MONITORING REPORT FORM

LANDFILL NAME:_____

DATE:_____

MONITORING EQUIPMENT:_____

TEMPERATURE: (Arr.)_____

(Dep.)_____

BAR PRESSURE: (Arr.)_____

(Dep.)_____

SAMPLED BY:_____

WEATHER:_____

PROBE NO.	PROBE DEPTH	PROBE DIAMETER	MINIMUM PURGE TIME (SEC)	BEGIN SAMPLE TIME	METHANE						OXYGEN	RELATIVE PRESSURE
					(Peak Value)			(Steady State)			(Steady State)	
					TIME	% VOL	% LEL	TIME	%VOL	%LEL	%VOL	in H_2O

INTERIOR GAS MONITORING REPORT FORM

LANDFILL NAME:_____

DATE:_____

MONITORING EQUIPMENT:_____

TEMPERATURE:(Arr.)_____ SAMPLED BY:_____
(Dep.)_____

BAR PRESSURE: (Arr.)_____
(Dep.)_____ WEATHER:_____

Time	Sample Location Description (Bld. Type, Location On Site, etc.)	Methane		O_2
		(Peak) % LEL	(Peak) % Volume	Steady State

APPENDIX D

MONITORING DATA

WATAUGA COUNTY LANDFILL
Steady State Methane Concentrations (%vol)

Probe	Depth (ft.)	Methane Concentrations (in % by Volume)																					
		3/21/1996	3/26/1996	4/9/1996	4/30/1996	7/29/1996	########	4/9/1997	1/14/1998	5/1/1998	7/28/1998	10/8/1998	1/13/1999	4/29/1999	7/13/1999	########	1/12/2000	4/4/2000	7/3/2000	11/1/2000	2/15/2001	4/9/2001	7/16/2001
1R	0 - 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1Y	5 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1B	10 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1G	20 - 40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2R	0 - 5	41	42	30	43	0	27.8	45.5	39	41.3	0	0	24	19	22.7	22	31.4	32.9	6.2	0	29.5	32.3	14.8
2Y	5 - 10	44	45	30	41	11	24.2	50.4	46.5	50.4	14	8.1	31.3	38	32	30.4	44.6	50.7	20.2	10.1	39.1	47.1	39
2B	10 - 20	55	54	0	44	33	48.7	58.9	52.4	60.3	44.4	34.5	42	53	48.5	39.3	53.3		44.2	32.5	49	52.2	53.5
2G	20 - 40	59	57	1.25	56	51	60.4	62.9	62.7	62.7	63.3	60.1	58	67	62.1	52	62.1	63.1	60.2	55.4	61.3	54.1	69.5

WATAUGA COUNTY LANDFILL
Steady State Methane Concentrations (%vol)

Probe	Depth (ft.)	Methane Concentrations (in % by Volume)																					
		10/8/2001	2/14/2002	5/2/2002																			
1R	0 - 5	0	0	0																			
1Y	5 - 10	0	0	0																			
1B	10 - 20	0	0	0																			
1G	20 - 40	0	0	0																			
2R	0 - 5	4.1	42.2	28.3																			
2Y	5 - 10	24.8	51	47.1																			
2B	10 - 20	45	56.8	54.8																			
2G	20 - 40	60.1	63.9	60.6																			

APPENDIX E

GAS VENT LOCATION
AND
CONSTRUCTION LOG

Appendix E
DRILLING SUMMARY
WEEK OF 5-30 TO 6-2-96

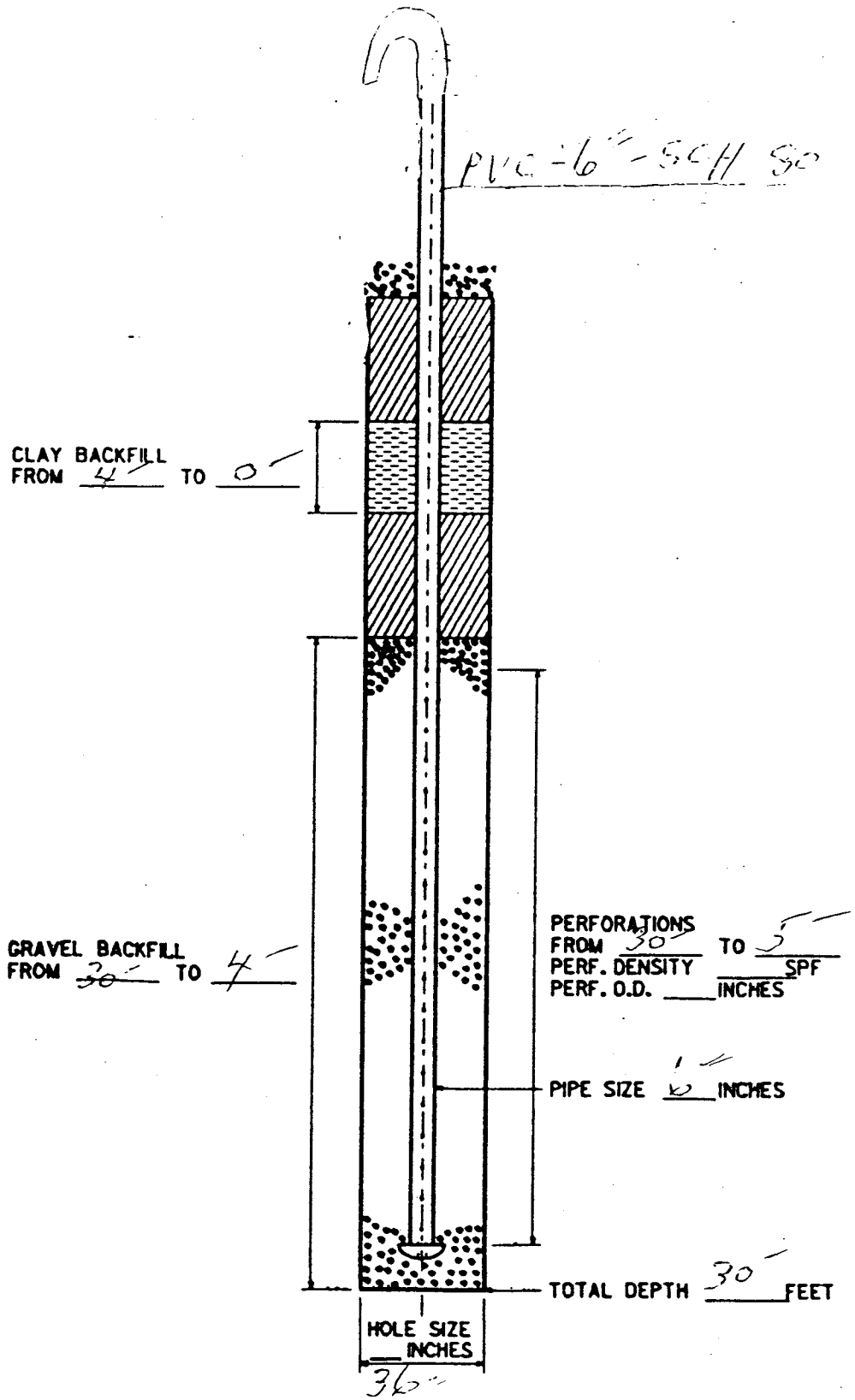
Well #	Date	Total Depth	Perf Pipe	Solid Pipe
W-1	6-5	30'	25'	10'
W-2	6-5	30'	25'	10'
W-3	6-6	30'	25'	10'
W-4	6-6	30'	25'	10'
W-5	6-6	30'	25'	10'
W-6	6-4	30'	25'	10'
W-7	5-31	30'	25'	10'
W-8	5-31	30'	25'	10'
W-9	5-31	30'	25'	10'
W-10	6-1	30'	25'	10'
W-11	6-1	25'	20'	10'
W-12	6-1	30'	25'	10'
W-13	5-30	18'	13'	10'
W-14	5-30	30'	25'	10'
W-15	5-30	25'	20'	10'
W-16	6-3	30'	25'	10'
W-17	6-3	30'	25'	10'
W-18	6-3	30'	25'	10'
W-19	6-4	30'	25'	10'
W-20	6-3	30'	25'	10'
W-21	6-5	30'	25'	10'
W-22	6-6	30'	25'	10'

90444-0

SITE LOCATION WATAUGA COUNTY DRILLING TIME
DATE 5-31
WELL NO. W-7 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-4'	SOIL COVER	NA	DRY	
4'-10'	HHT	MOD	DRY	
10-15'	HHT-WIRE	"	WET	
15'-20'	HHT-PAPER	"	WET	
20-25	HHT	"	WET	
25'-30'	TIRES DIRT	MOD	WET	
				TD-30'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 30' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE 6" INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
____ INCHES
36"

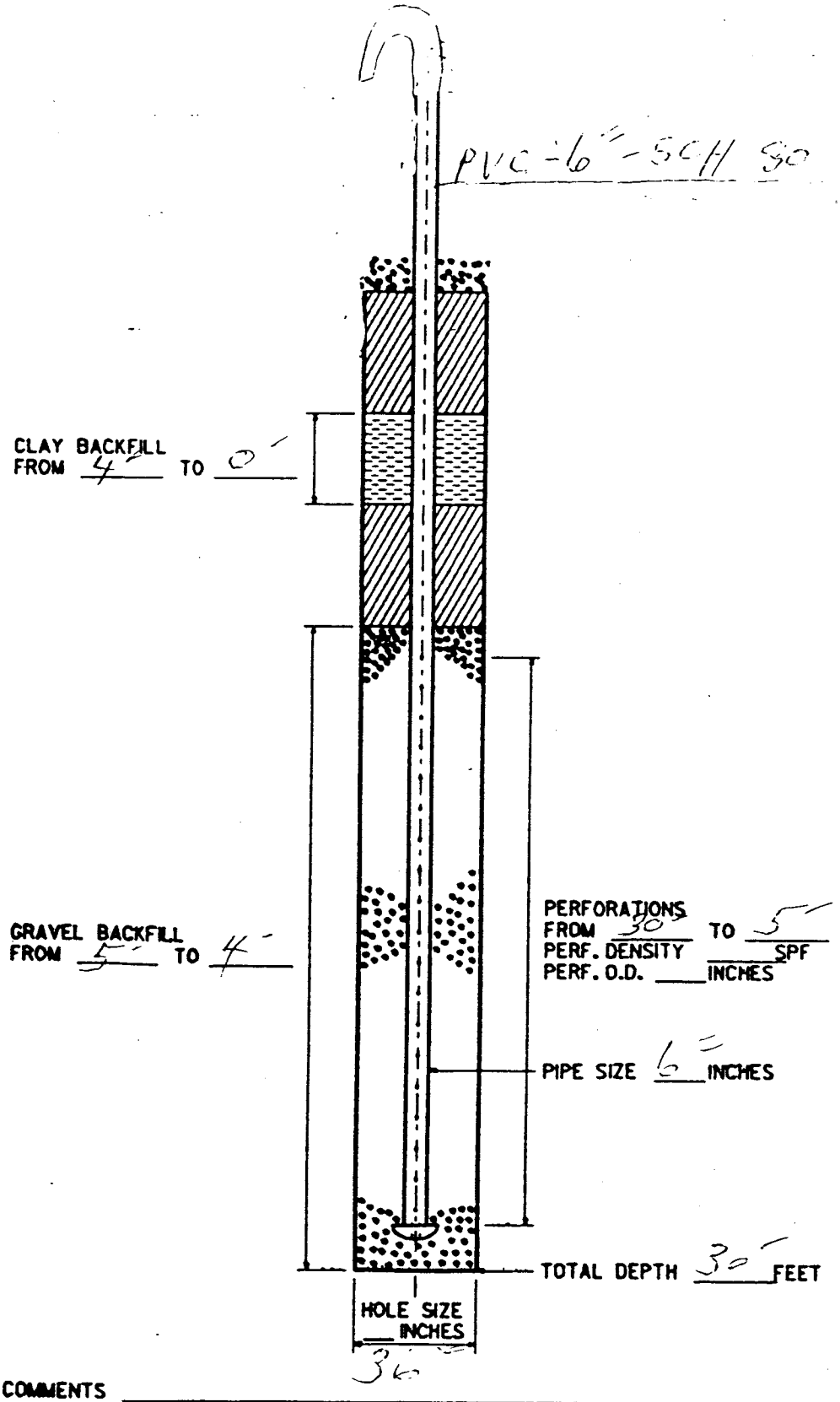
COMMENTS _____

90444-D

SITE LOCATION WATAUGA COUNTY DRILLING TIME _____
DATE 3-31-96
WELL NO. W-8 PAGE NO. _____

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-6'	SOIL COVER	N/A	DRY	
6-10'	HHT-ROCKS	MOD	"	
10'-15'	HHT-HPS	"	"	
15'-20'	HHT	"	"	
20'-25'	HHT-CARBT	"	"	
25-30'	HHT-DIRT	MOD	DRY	
				TD-30'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 5' TO 4'
PERFORATIONS
FROM 30' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE 6" INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
____ INCHES
36

COMMENTS _____

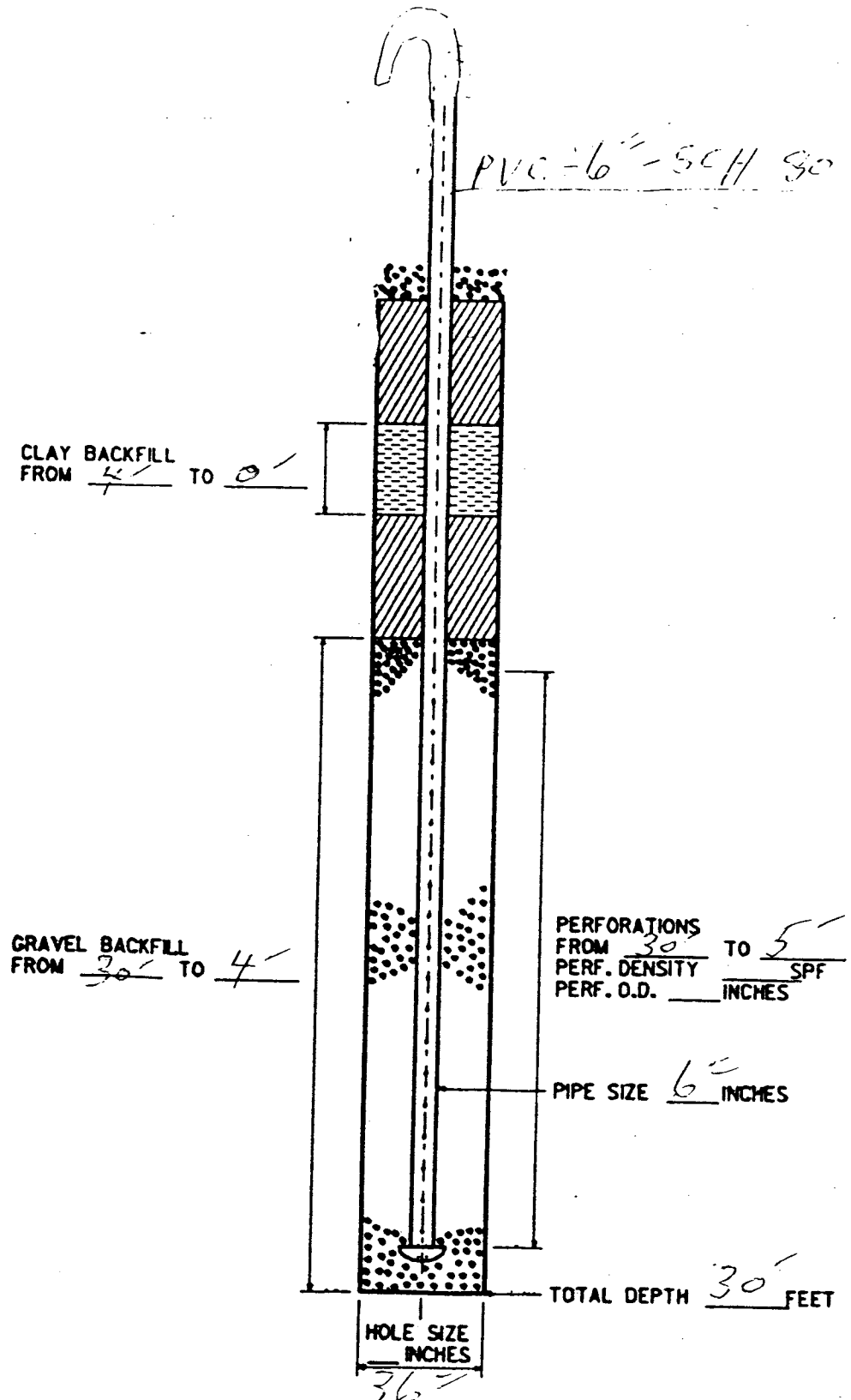
SITE LOCATION WATAUGA COUNTY DRILLING TIME _____

DATE 5-31-96

WELL NO. W-9 PAGE NO. _____

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0'-5'	Soil Cover	N/A	DRY	
5'-10'	HHT-PAPER	MOD	"	
10'-15'	HHT	"	"	
15'-20'	HHT-WIRE	"	"	
20'-25'	HHT-WOOD	"	"	
25'-30'	HHT-DIRT	MOD	DRY	
				TD-30'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 30' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE 6" INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
____ INCHES
36"

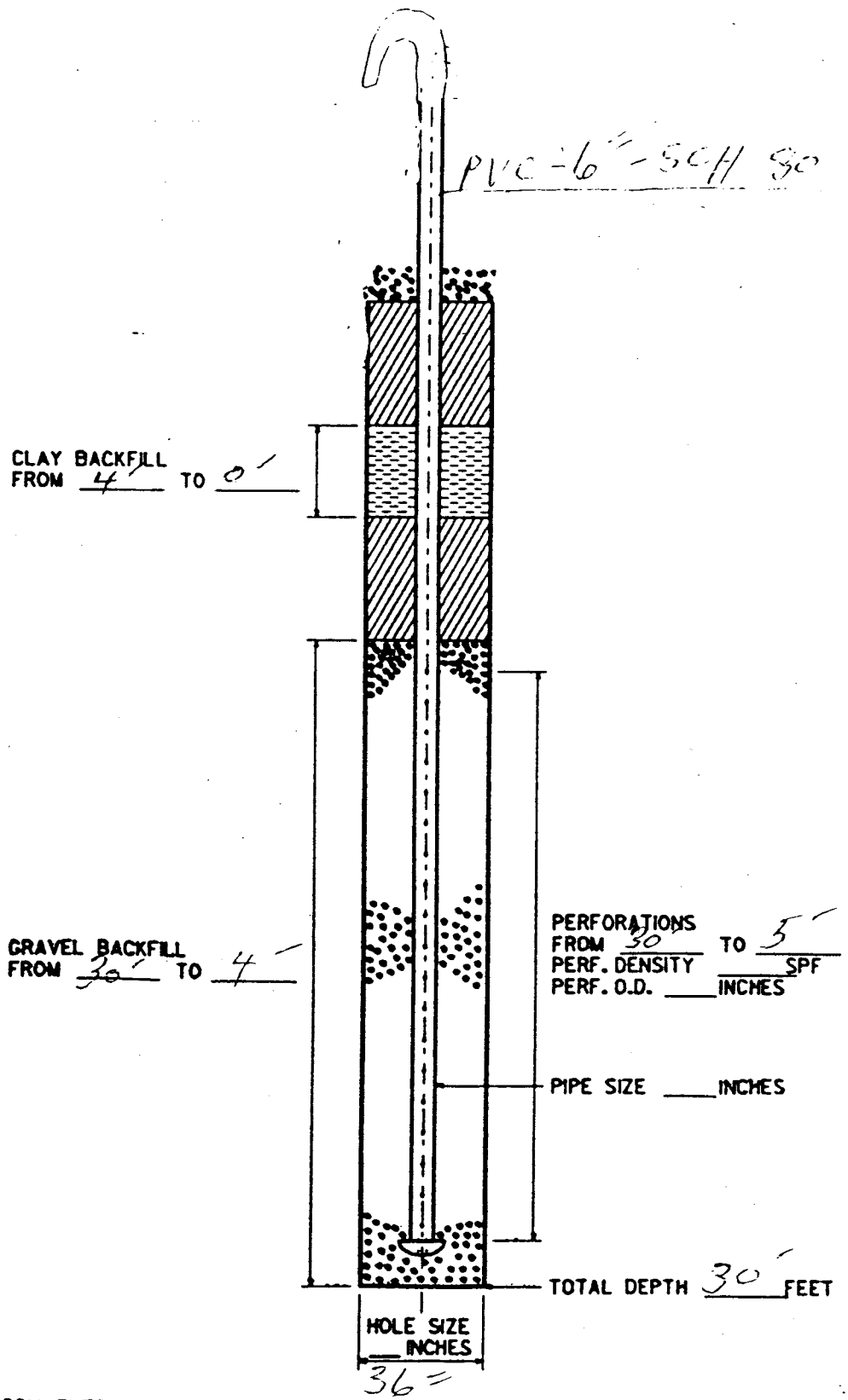
COMMENTS _____

90444-D

SITE LOCATION WATAUGA COUNTY DRILLING TIME
DATE 5-31-96
WELL NO. W-10 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-5'	SOIL COVER	NA	DRY	
5-10'	HHT-WOOD	MOD	DRY	
10-15'	WOOD-CARPET	"	WET	
15-20'	HHTTIRES	"	WET	
20-25'	HHT-DIRT	"	WET	
25-30'	HHT-DIRT	MOD	WET	
				TD-30'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 30' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE ____ INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
____ INCHES
36"

COMMENTS _____

90444-0

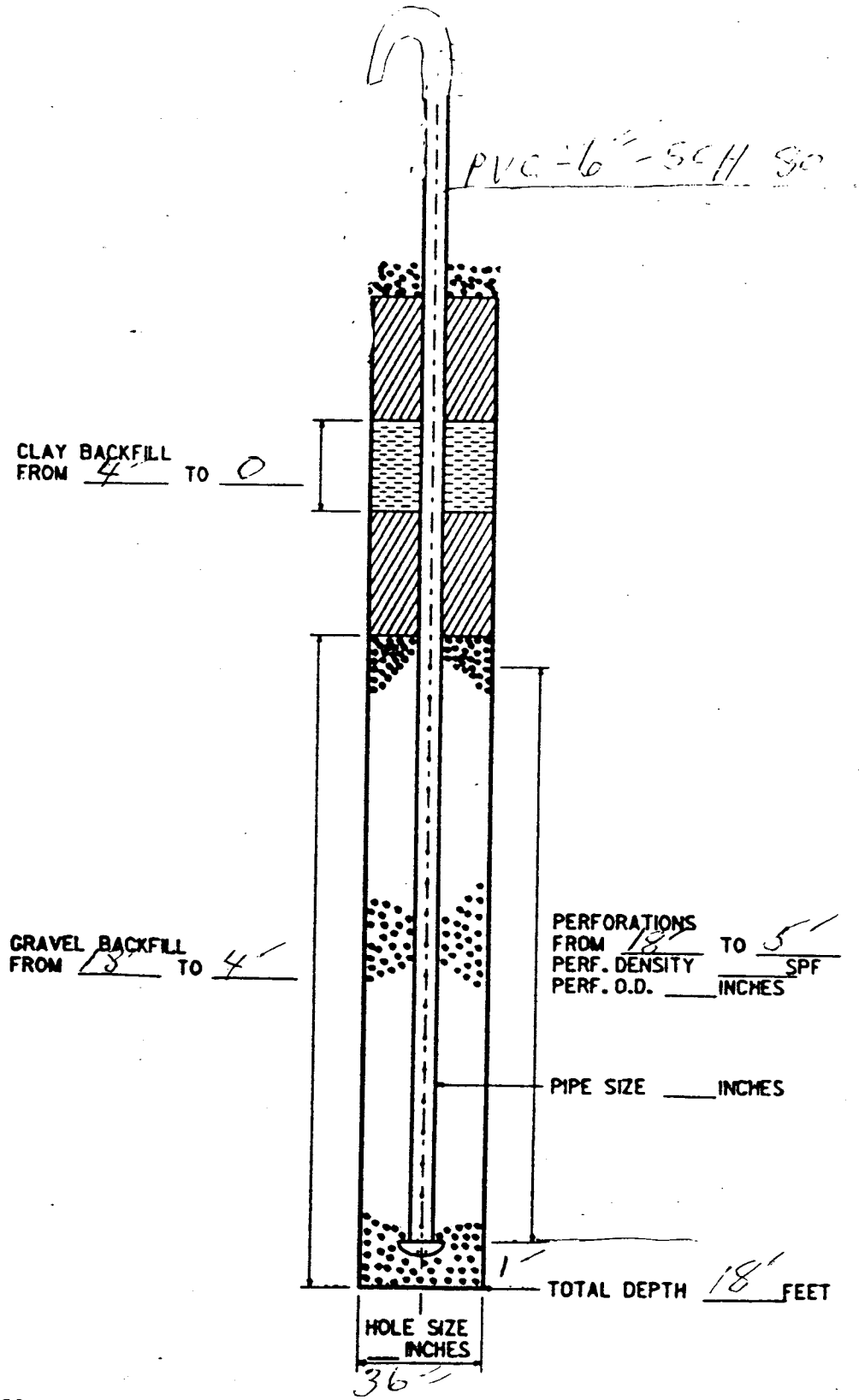
SITE LOCATION WATAUGA COUNTY DRILLING TIME

DATE 5-30-96

WELL NO. W-13 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-5''	SOIL COVER	NA	DRY	
5-10	HHT WIRE	MOD	DRY	
10-15	TIRES PAPER	MOD	DRY	
15-18	HHT-DIRT	MOD	MOIST	
				TD 18'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0
GRAVEL BACKFILL
FROM 18' TO 4'
PERFORATIONS
FROM 18' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE ____ INCHES
1'
TOTAL DEPTH 18' FEET
HOLE SIZE
____ INCHES
36"

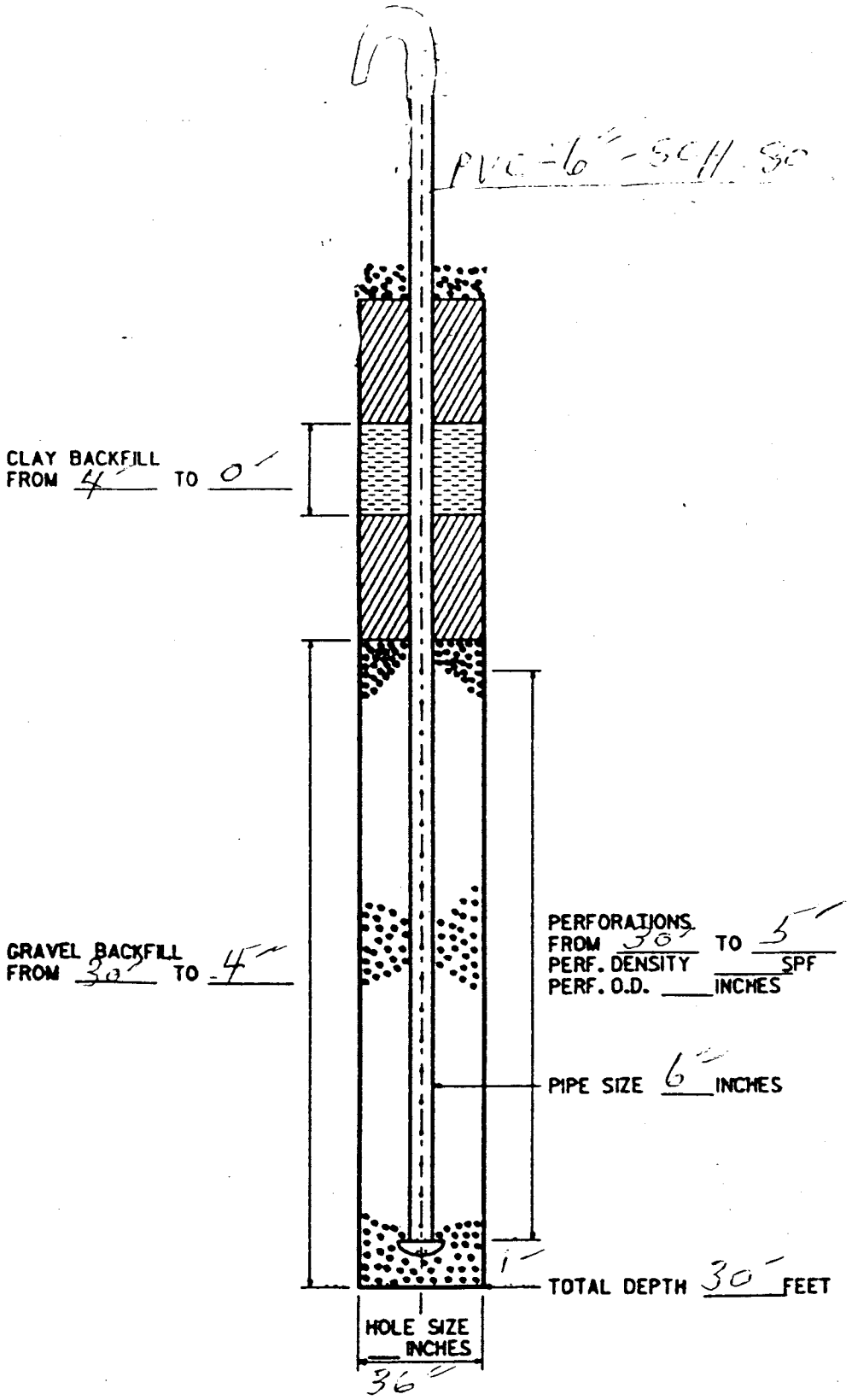
COMMENTS _____

90444-0

SITE LOCATION WATAUGA COUNTY DRILLING TIME _____
DATE 5-30-96
WELL NO. W-14 PAGE NO. _____

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0'-5'	SOIL COVER	NA	DRY	
5'-10'	HHT CEMENT	MOD.	DRY	
10'-15'	WIRE TIRES	"	WET	
15'-20'	HHT-DIRT	"	WET	
20'-25'	HHT-HPS	"	WET	
25'-30'	HHT DIRT	MOD	WET	
				TD-30'


PVC-6"-SCH. 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 30' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE 6" INCHES
1'
TOTAL DEPTH 30' FEET
HOLE SIZE
INCHES
36"

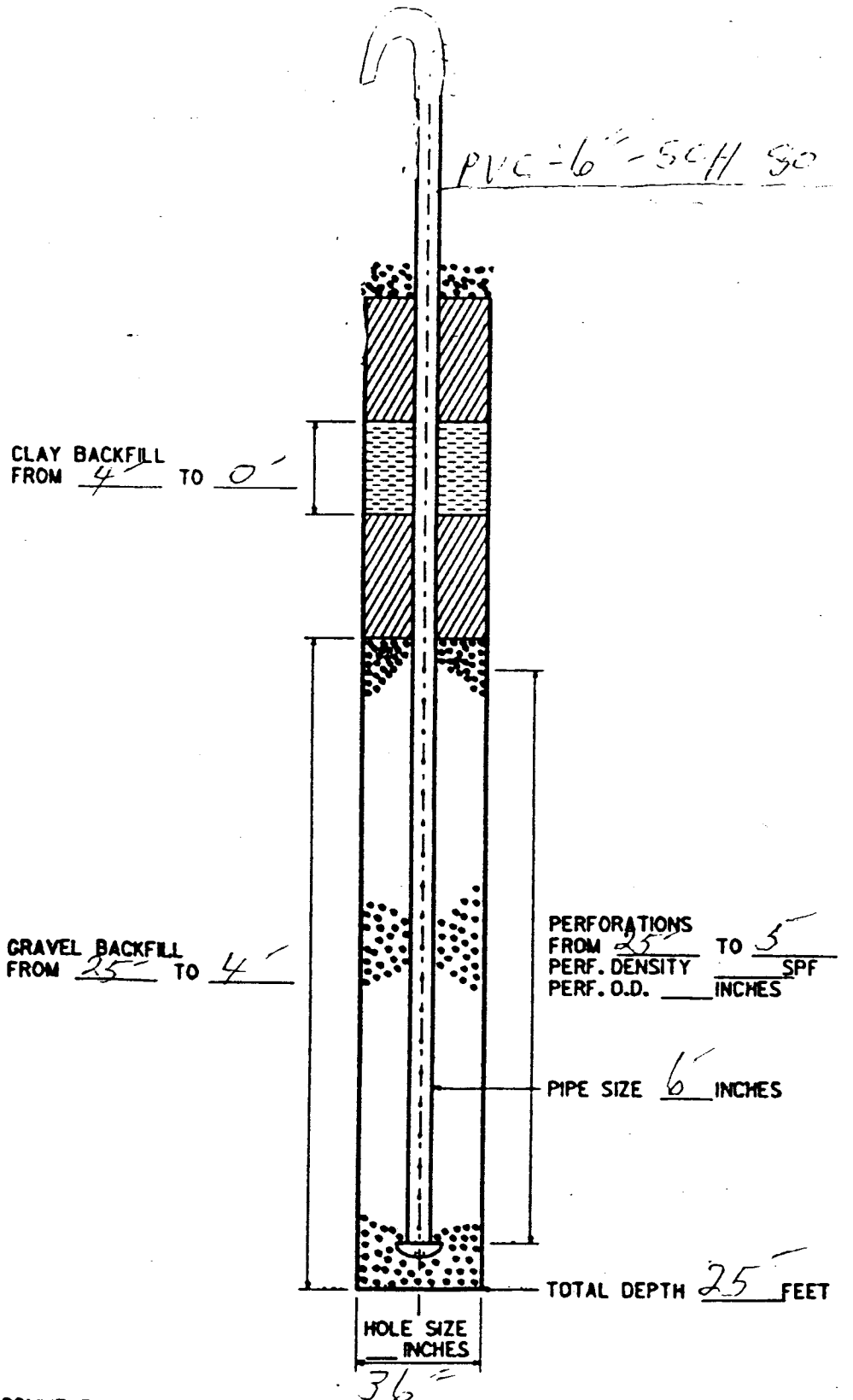
COMMENTS _____

90444-0

SITE LOCATION WATAGA COUNTY DRILLING TIME
DATE 5-30-96
WELL NO. W-13 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-6'	SOIL COVER	n-A	DRY	
6-10	HHT WOOD	MOD	"	
10-15	PAPER WOOD	"	"	
15-20	WIRE ROCKS	"	"	
20-25	TIRES DIRT	MOD	DRY	
				TD-25'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 25' TO 4'
PERFORATIONS
FROM 25' TO 5'
PERF. DENSITY ___ SPF
PERF. O.D. ___ INCHES
PIPE SIZE 6 INCHES
TOTAL DEPTH 25' FEET
HOLE SIZE
___ INCHES
36"

COMMENTS _____

90444-D

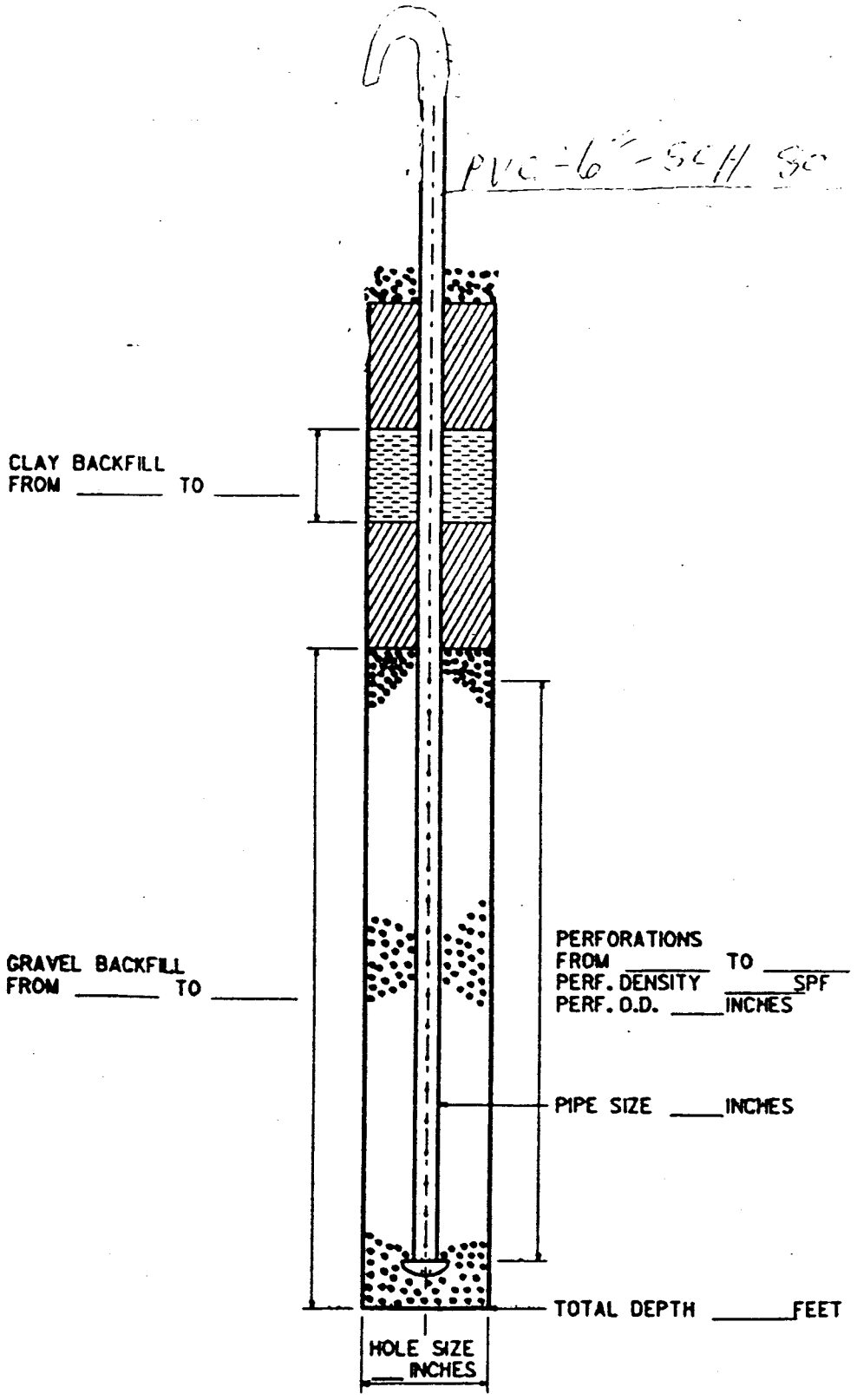
SITE LOCATION WATAUGA COUNTY DRILLING TIME _____

DATE 6-1-96

WELL NO. W-11 PAGE NO. _____

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0'-3'	SOIL COVER	N/A	DRY	
3'-5'	HHT DIRT	MOD	"	
5'-10'	HHT-TIRE	"	"	
10'-15'	TIRE-WOOD	"	"	
15'-20'	WIRE-HHT	"	"	
20'-25'	WIRE-HHT	"	"	
25'-30'	WIRE-DIRT	MOD	DRY	


PVC - 6" - SCH 80
CLAY BACKFILL
FROM _____ TO _____
GRAVEL BACKFILL
FROM _____ TO _____
PERFORATIONS
FROM _____ TO _____
PERF. DENSITY _____SPF
PERF. O.D. ____INCHES
PIPE SIZE ____INCHES
TOTAL DEPTH _____FEET
HOLE SIZE
____INCHES

COMMENTS _____

9044490

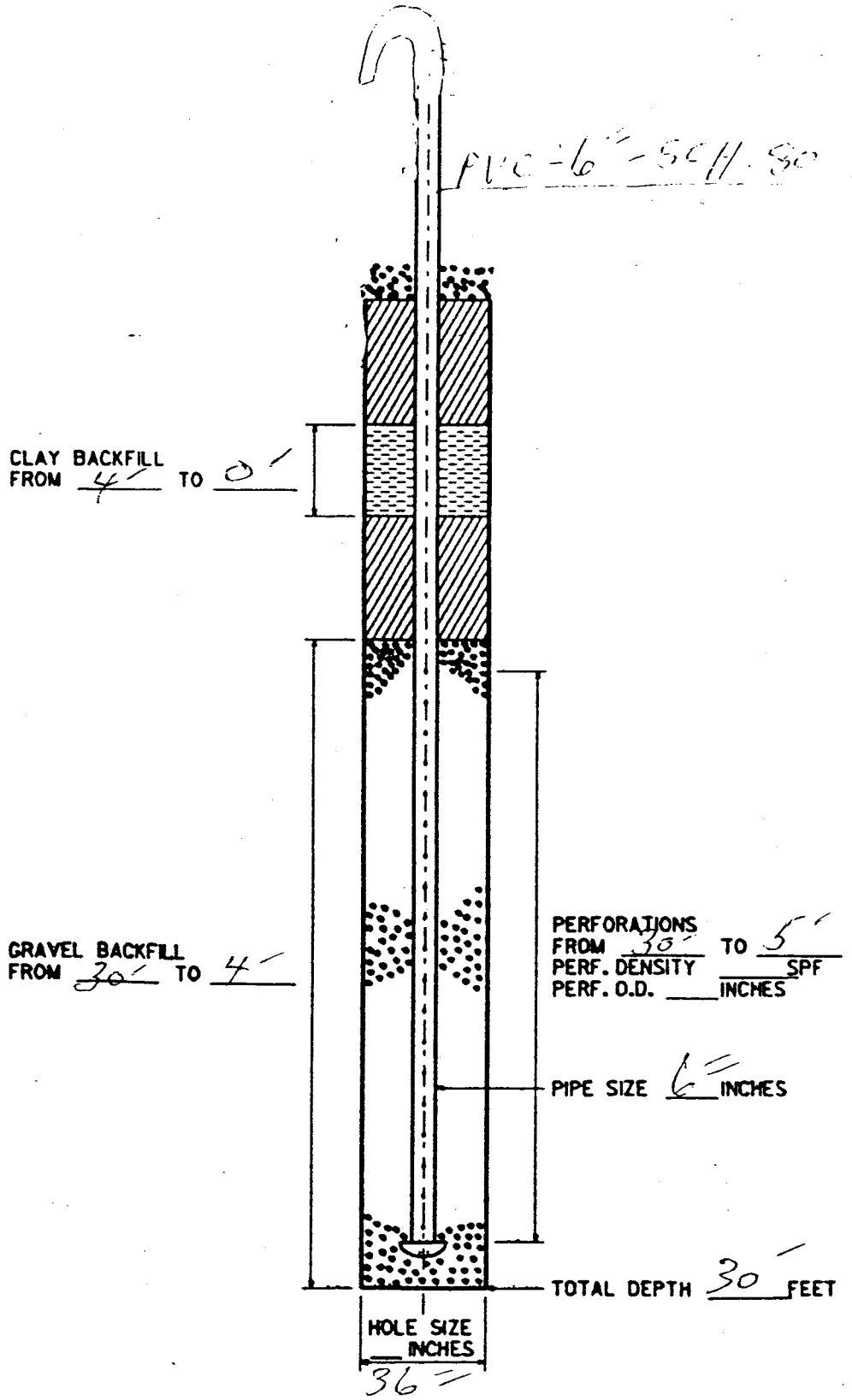
SITE LOCATION WATAUGA COUNTY DRILLING TIME _____

DATE 6-1-96

WELL NO. W-12 PAGE NO. _____

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-5'	SOIL COVER	NA	DRY	
5-10'	HHT	MOD	"	
10-15'	HHT - PAPER	"	"	
15'-20'	CARPET - WIRE	"	"	
20-25'	HHT - WOOD	"	"	
25'-30'	HHT - DIRT	MOD	DRY	
				TD-30'


PVC - 6" - SCH. 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 30' TO 5'
PERF. DENSITY ___ SPF
PERF. O.D. ___ INCHES
PIPE SIZE 6" INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
___ INCHES
36"

COMMENTS _____

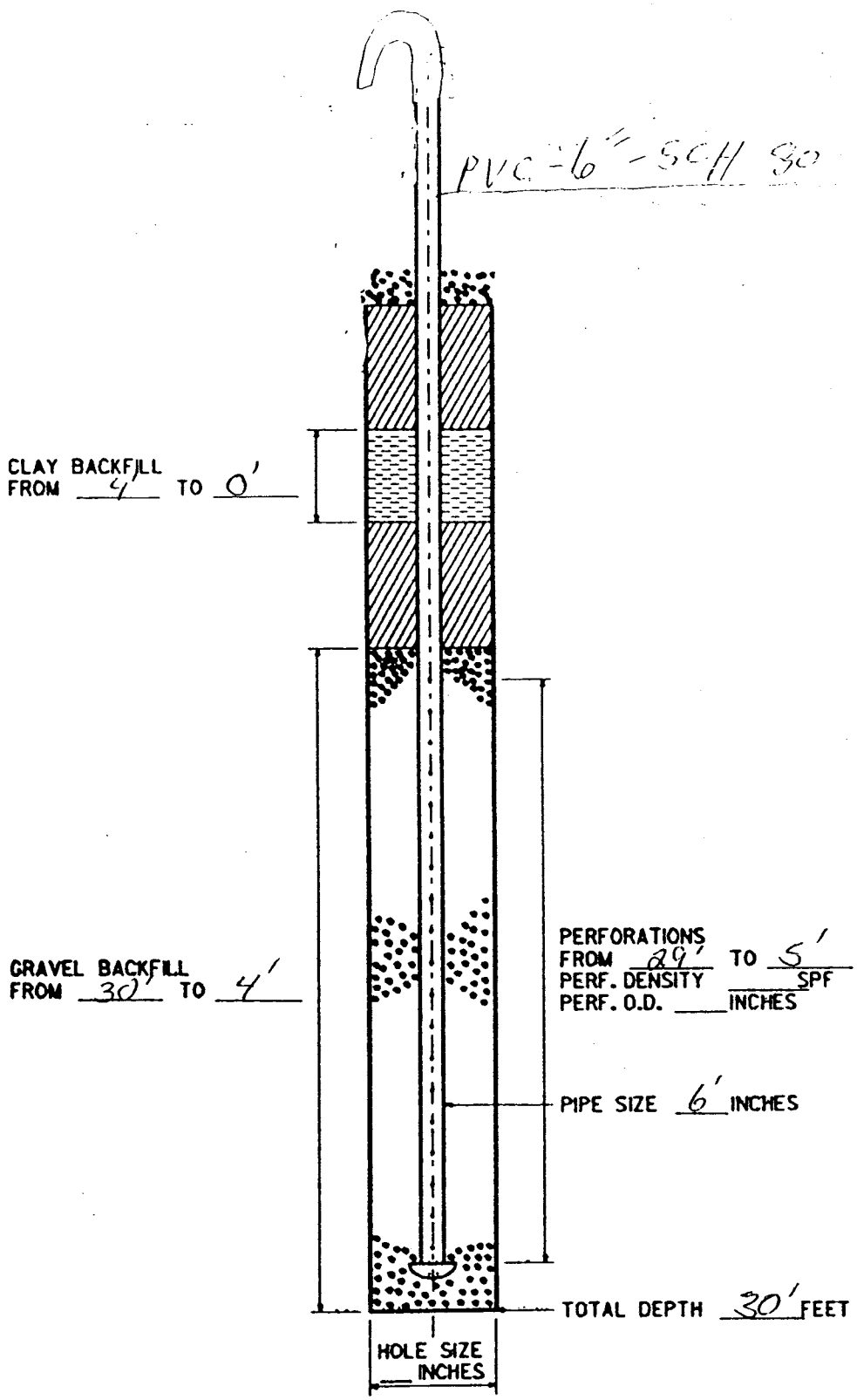
SITE LOCATION Watauga County DRILLING TIME

DATE 6-3-96

WELL NO. EW 16 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
05	Cover Rock	Moderate	Dry	
5-10	HHT	Moderate	Dry	
10-15	HHT Dirt	Moderate	Dry	
15-20	Tires Wire	Moderate	Dry	
20-25	HHT Paper	Moderate	Dry	
25-30	Dirt Rock	Moderate	Dry	
				Total Depth 30'

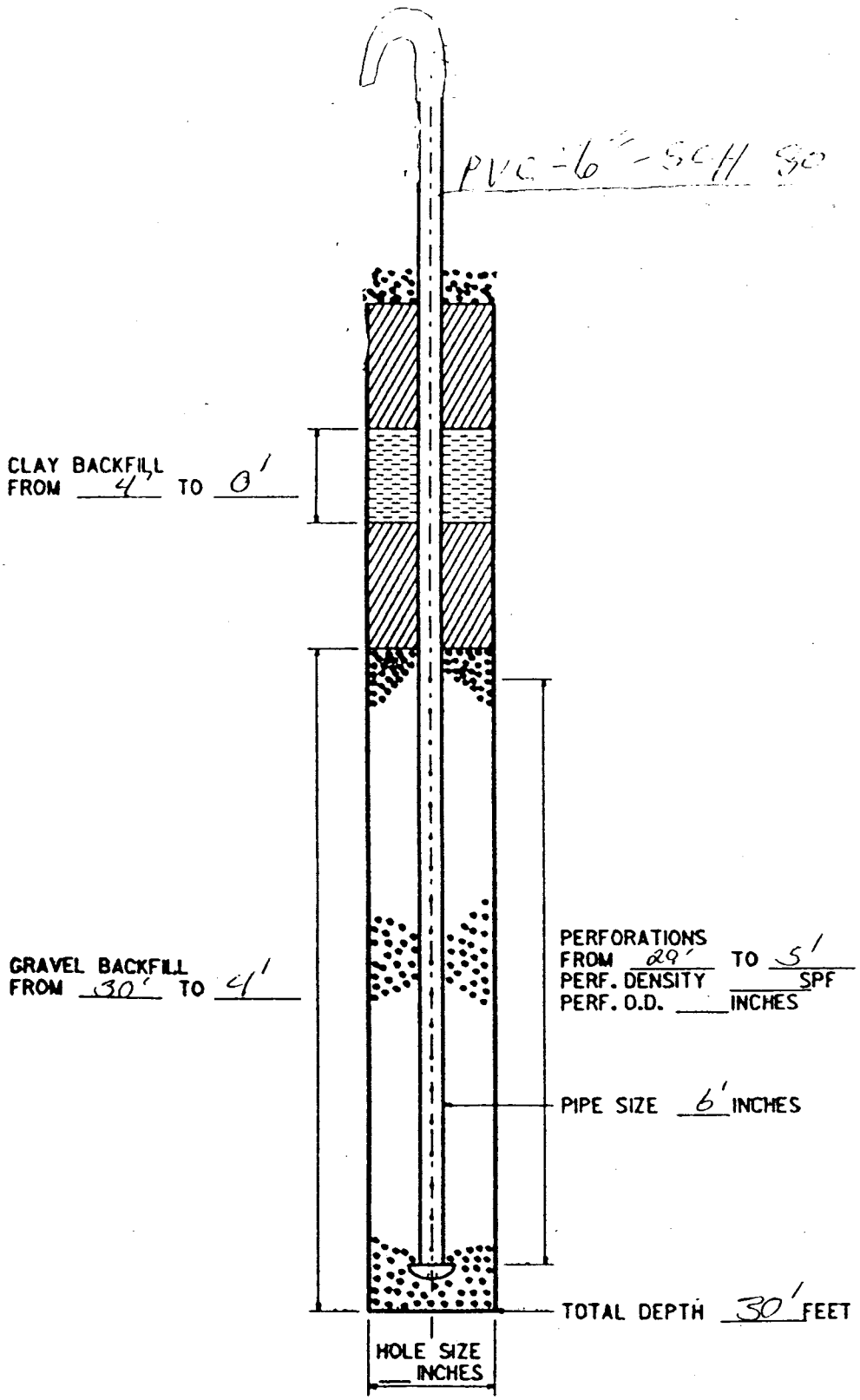

PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 29' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE 6' INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
____ INCHES

COMMENTS _____

SITE LOCATION Watauga County DRILLING TIME
DATE 6-3-96
WELL NO. RW 17 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-5	Cover Plastic	Moderate	Dry	
5-10	HHT Wood	Moderate	Dry	
10-15	HHT Plastic	Moderate	Dry	
15-20	Tire Paper	Moderate	Dry	
20-25	HHT Dirt	Moderate	Dry	
25-30	Rock Paper	Moderate	Dry	
				Total Depth 30'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 29' TO 5'
PERF. DENSITY ___ SPF
PERF. O.D. ___ INCHES
PIPE SIZE 6' INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
___ INCHES

COMMENTS _____

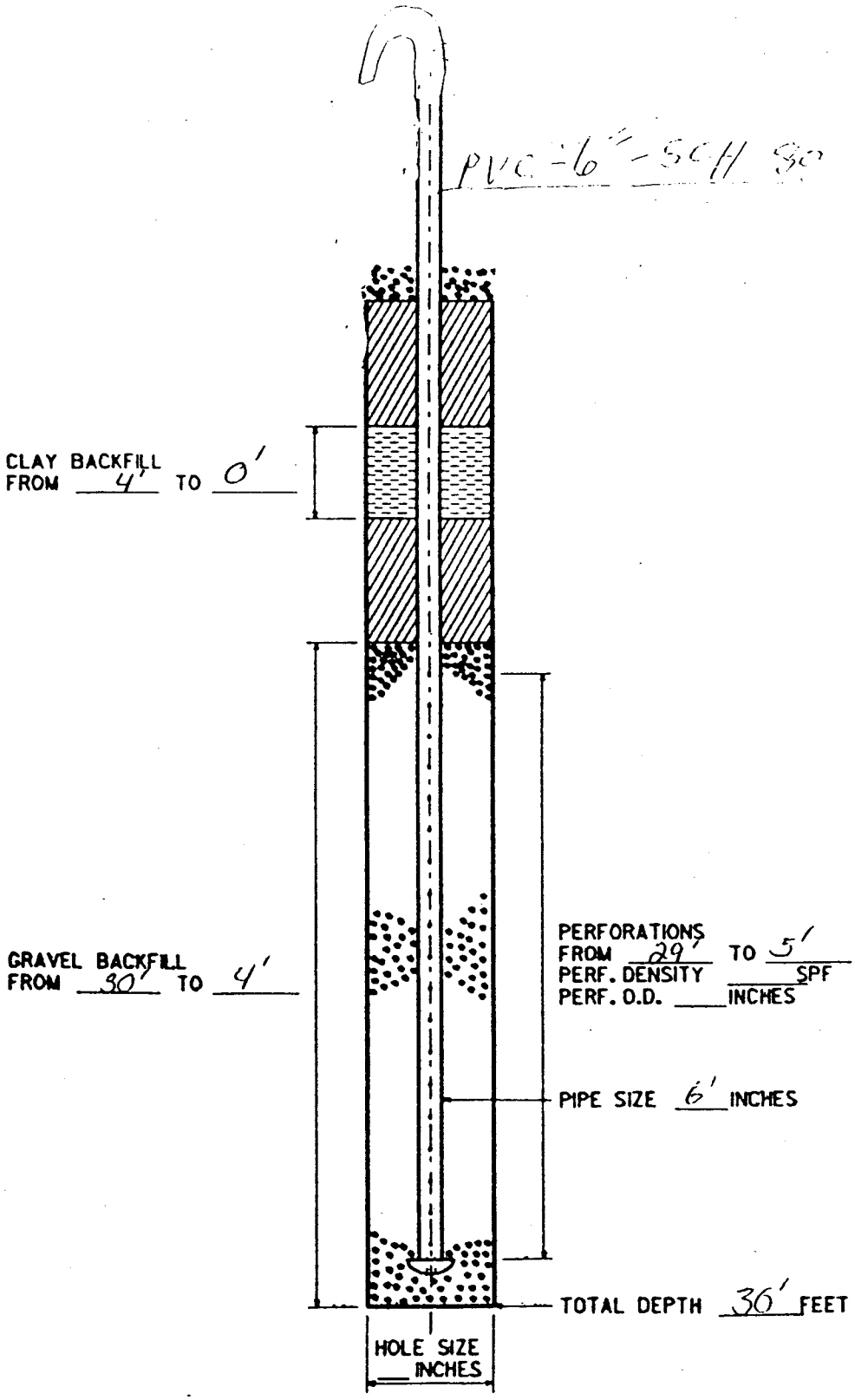
SITE LOCATION Watauga County DRILLING TIME

DATE 6-3-98

WELL NO. EW-18 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-5	Cover Paper	Moderate	Dry	
5-10	Plastic Wire	Moderate	Dry	
10-15	Tire Steel	Moderate	Dry	
15-20	Paper Dirt	Moderate	Dry	
20-25	Rock Plastic	Moderate	Dry	
25-30	Dirt Steel	Moderate	Dry	
				Total Depth 30'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 29' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE 6' INCHES
TOTAL DEPTH 36' FEET
HOLE SIZE
____ INCHES

COMMENTS _____

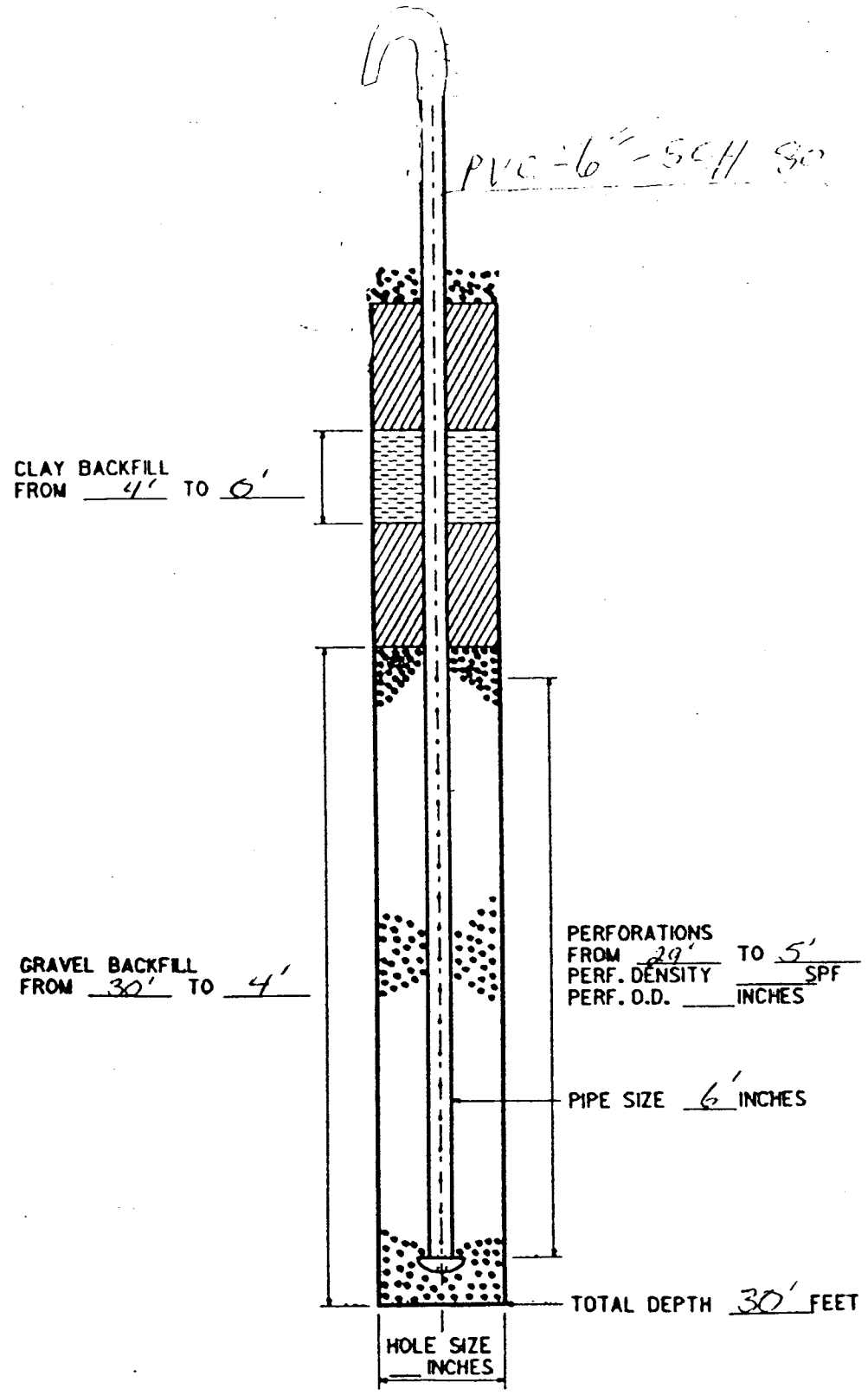
SITE LOCATION Watauga County DRILLING TIME

DATE 6-3-96

WELL NO. EW-20 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-5	Cover HHT	Moderate	Dry	
5-10	HHT Wire	Moderate	Dry	
10-15	Dirt Cloth	Moderate	Dry	
15-20	Rock Paper	Moderate	Dry	
20-25	Cloth Wire Tire	Moderate	Dry	
25-30	Dirt Paper	Moderate	Dry	
				Total Depth 30'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 29' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE 6' INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
____ INCHES

COMMENTS _____

90444-D

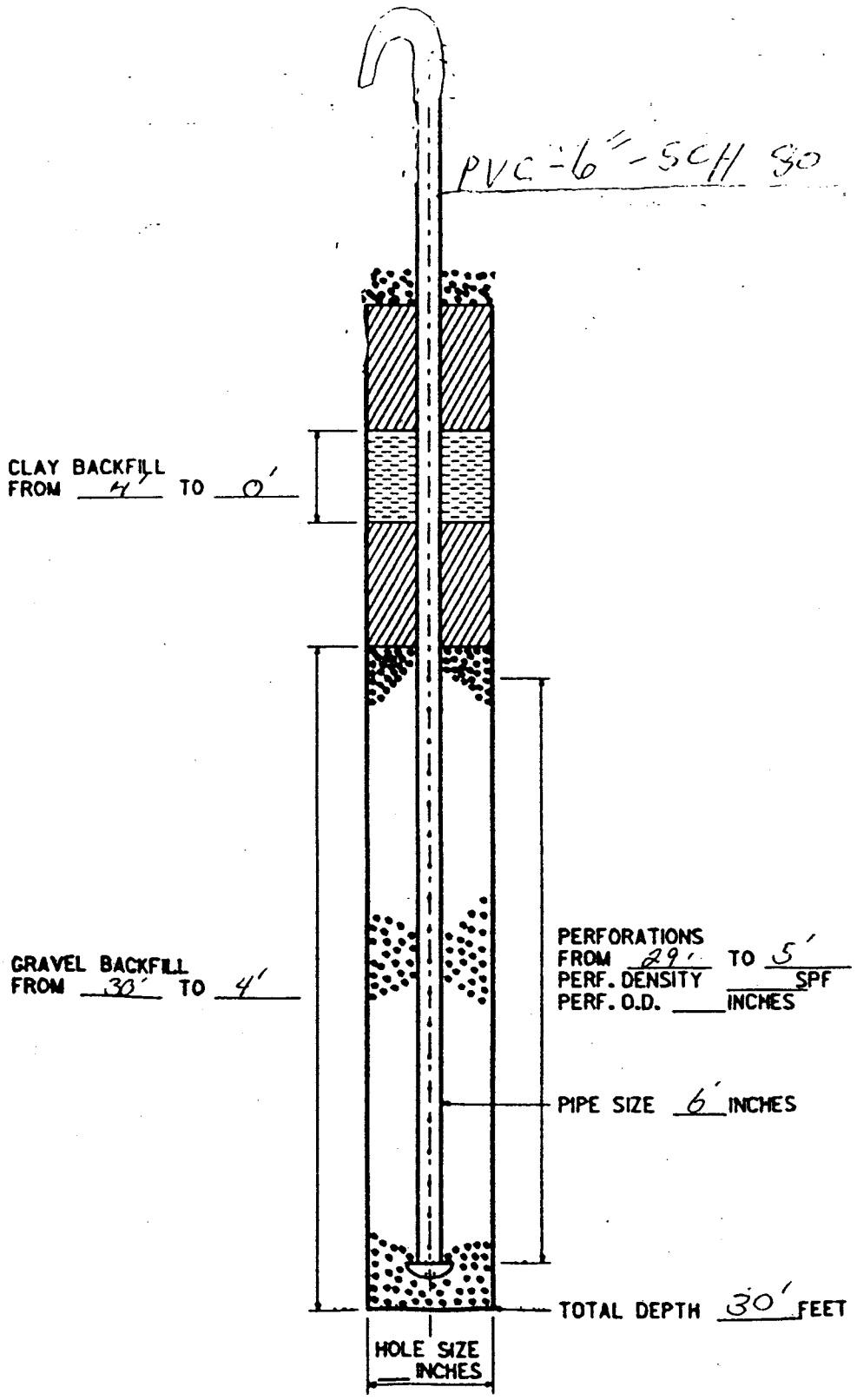
SITE LOCATION WATAUGA COUNTY DRILLING TIME _____

DATE 6-4-96

WELL NO. W-6 PAGE NO. _____

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-3'	SOIL COVER	NA	DRY	
3-5'	HHT-WOOD	MOD	"	
5-10'	HHT-HPS	MOD	"	
10-15'	TIRES	HEAVY	"	
15-20	TIRES-WOOD	HEAVY	"	
20-25'	STEEL-WOOD	MOD	"	
25-30	HHT-PAPER	MOD	DRY	
				TD-30'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 29' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE 6' INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
____ INCHES

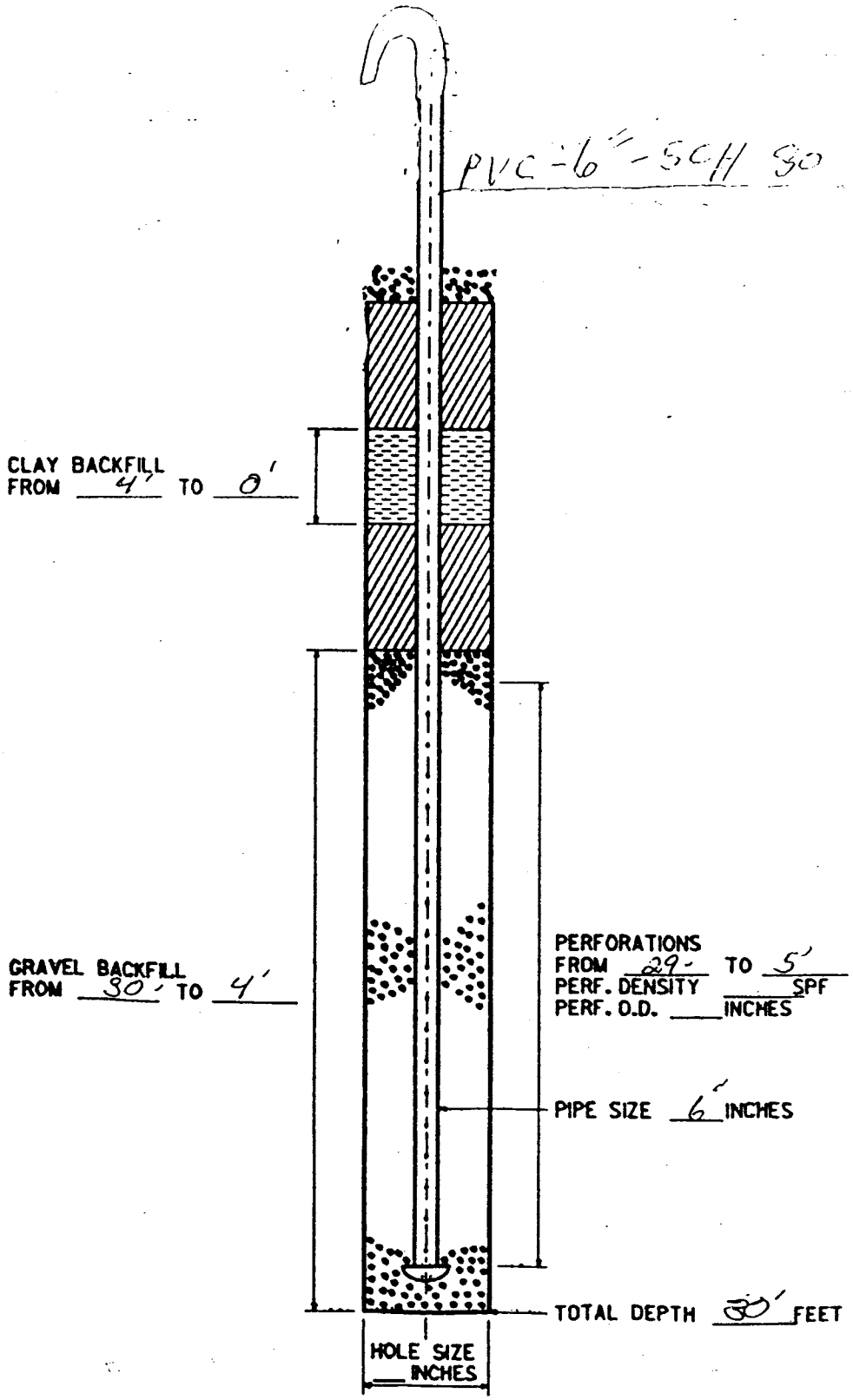
COMMENTS _____

90444-D

SITE LOCATION WATAUGA COUNTY DRILLING TIME
DATE 6-4-96
WELL NO. MW-19 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-4'	Soil Cover	NA	DRY	
4-5	HHT	MODERATE	DRY	
5-10	WIRE HOS	"	DAMP	
10-15	HHT PAPER	"	WET	
15-20	WOOD TIRE	"	WET	
20-25	PAPER DIRT	"	WET	
25-30'	CEMENT DIRT	MODERATE	WET	
				TD-30'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 29' TO 5'
PERF. DENSITY ___ SPF
PERF. O.D. ___ INCHES
PIPE SIZE 6" INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
___ INCHES

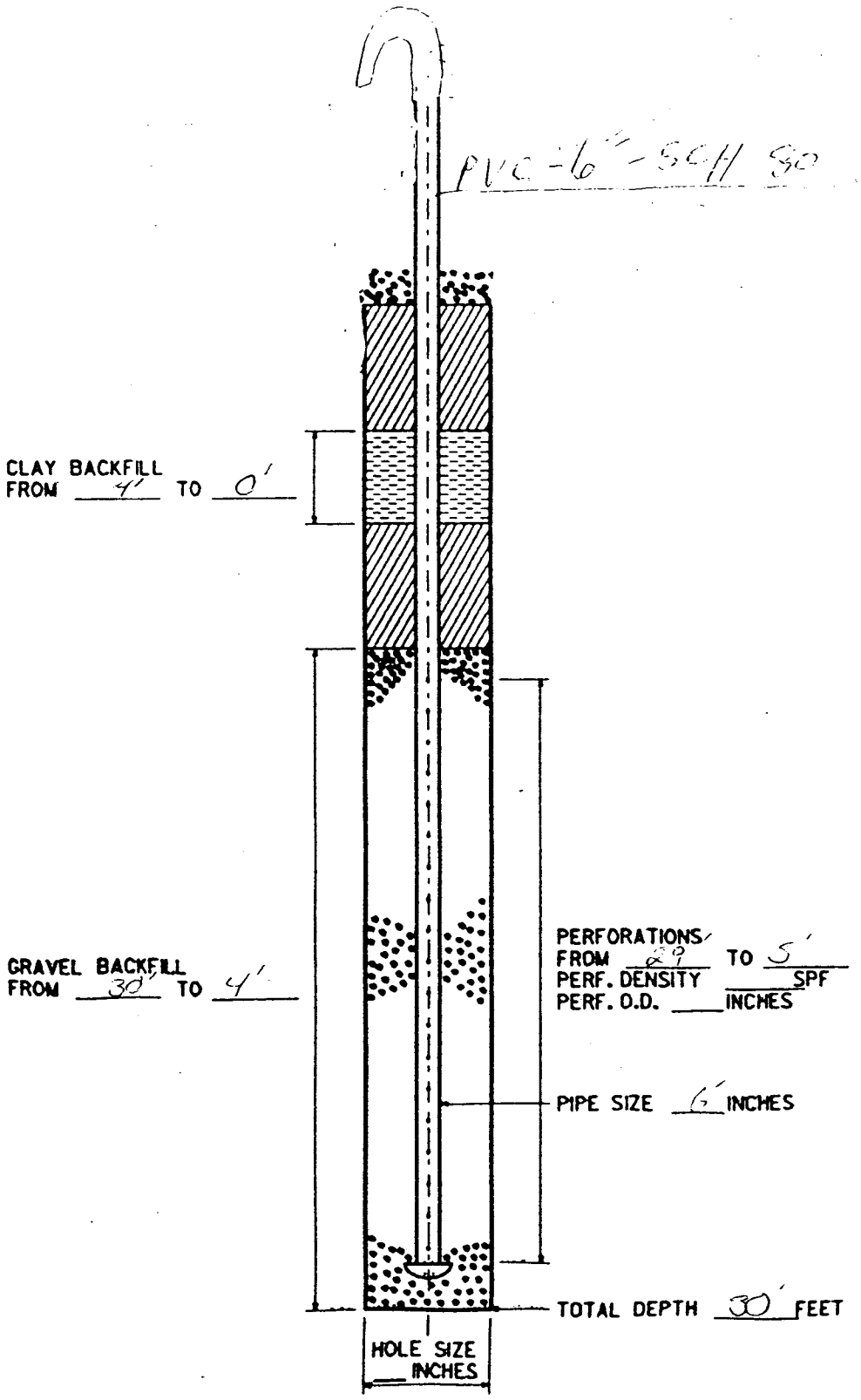
COMMENTS _____

90444-D

SITE LOCATION WATAUGA COUNTY DRILLING TIME
DATE 6-5
WELL NO. W-1 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-2'	SOIL COVER	NA	DRY	
2-5'	HHT	NA	DRY	
5-10'	HHT - WOOD	MOD	WET	
10-15'	WIRE CARPET	"	"	
15-20'	HHT	"	"	
20-25'	HHT	"	"	
25-30'	HHT	MOD	WET	
				TD-30'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 29' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE 6" INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
____ INCHES

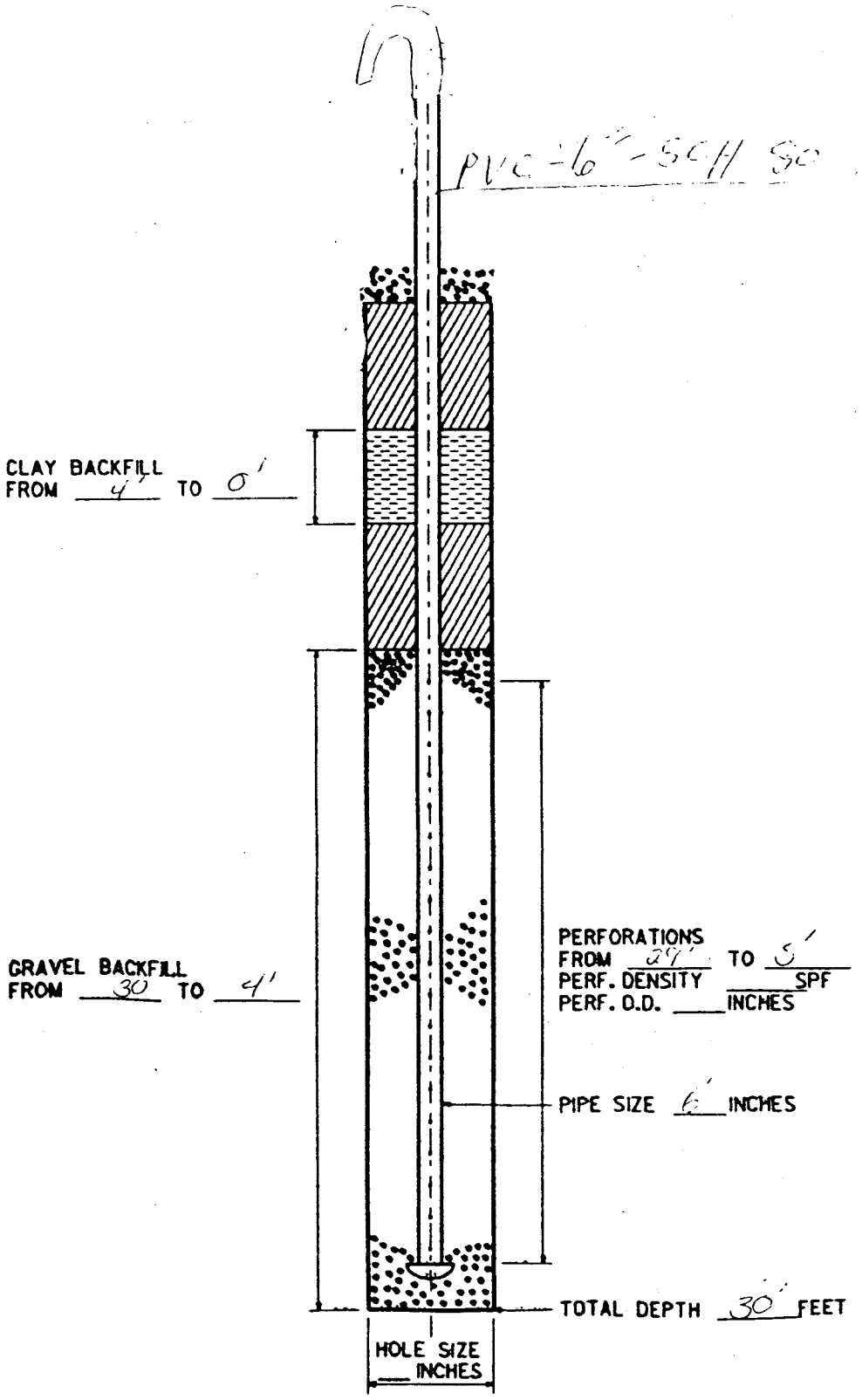
COMMENTS _____

90444-D

SITE LOCATION WATAUGA COUNTY DRILLING TIME
DATE 6-5
WELL NO. W-2 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-5'	Soil COVER	N/A	DRY	
5'-10'	FINE GRAVEL	MED	DRY	
10-15'	FINE-"	"	WET	
15-20'	FINE-"	"	"	
20-25	MED-COARSE	"	"	
25-30'	MED-DIRT	MED	WET	
				TD-30'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30 TO 4'
PERFORATIONS
FROM 29' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE 6" INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
____ INCHES

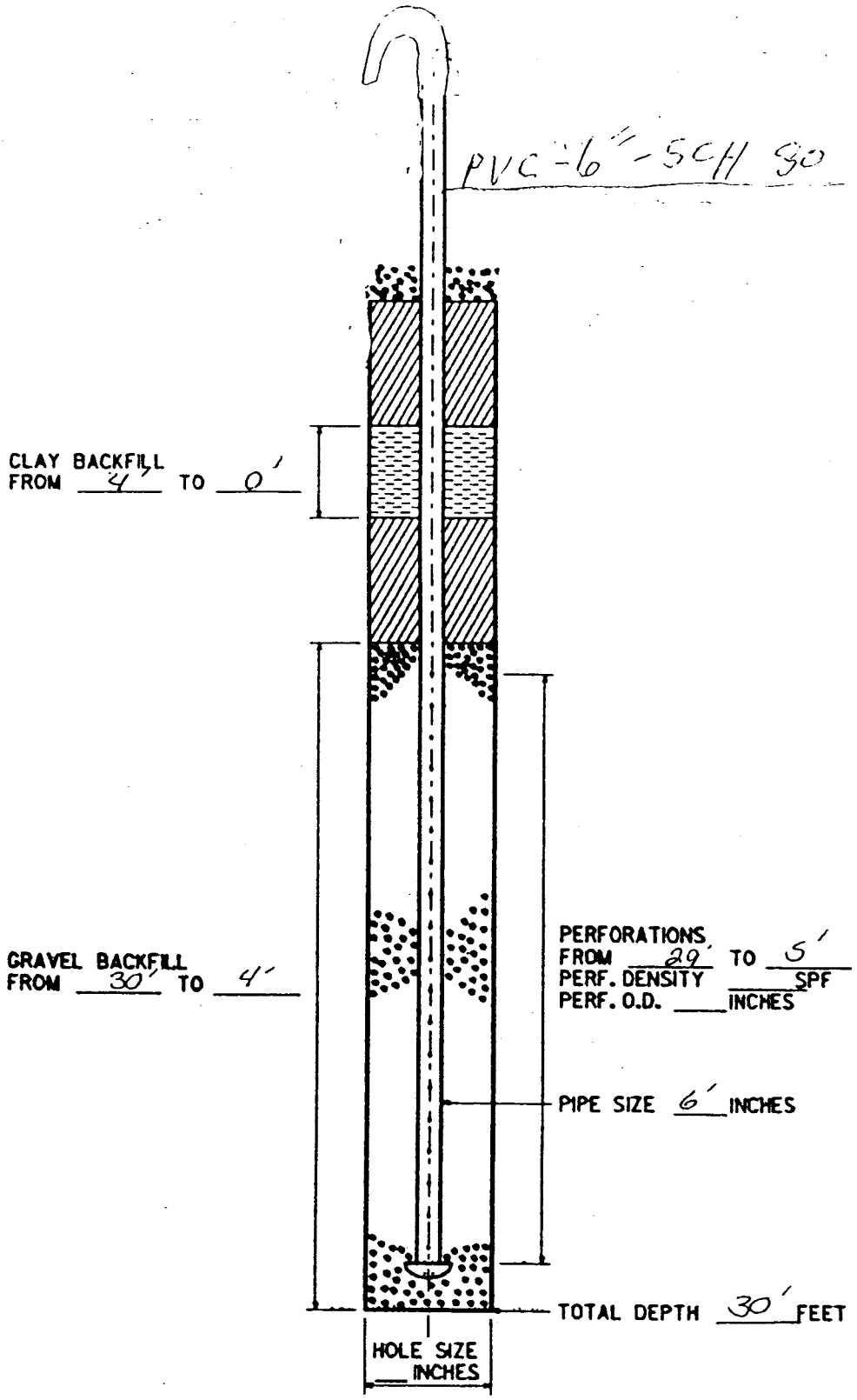
COMMENTS _____

90444-D

SITE LOCATION WATAUGA COUNTY DRILLING TIME
DATE 6-5-96
WELL NO. W-21 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-6'	Soil Cover	NA	DRY	
6-10'	HHT wire	MOD	"	
10-15	CARPET-HHT	HEAVY	"	
15-20	WOOD-HHT	MOD	"	
20-25	PAPER WOOD	HEAVY	"	
25-30'	HHT-ROCKS	MOD	DRY	
				TD-30'


PVC-6"-SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 29' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE 6' INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
____ INCHES

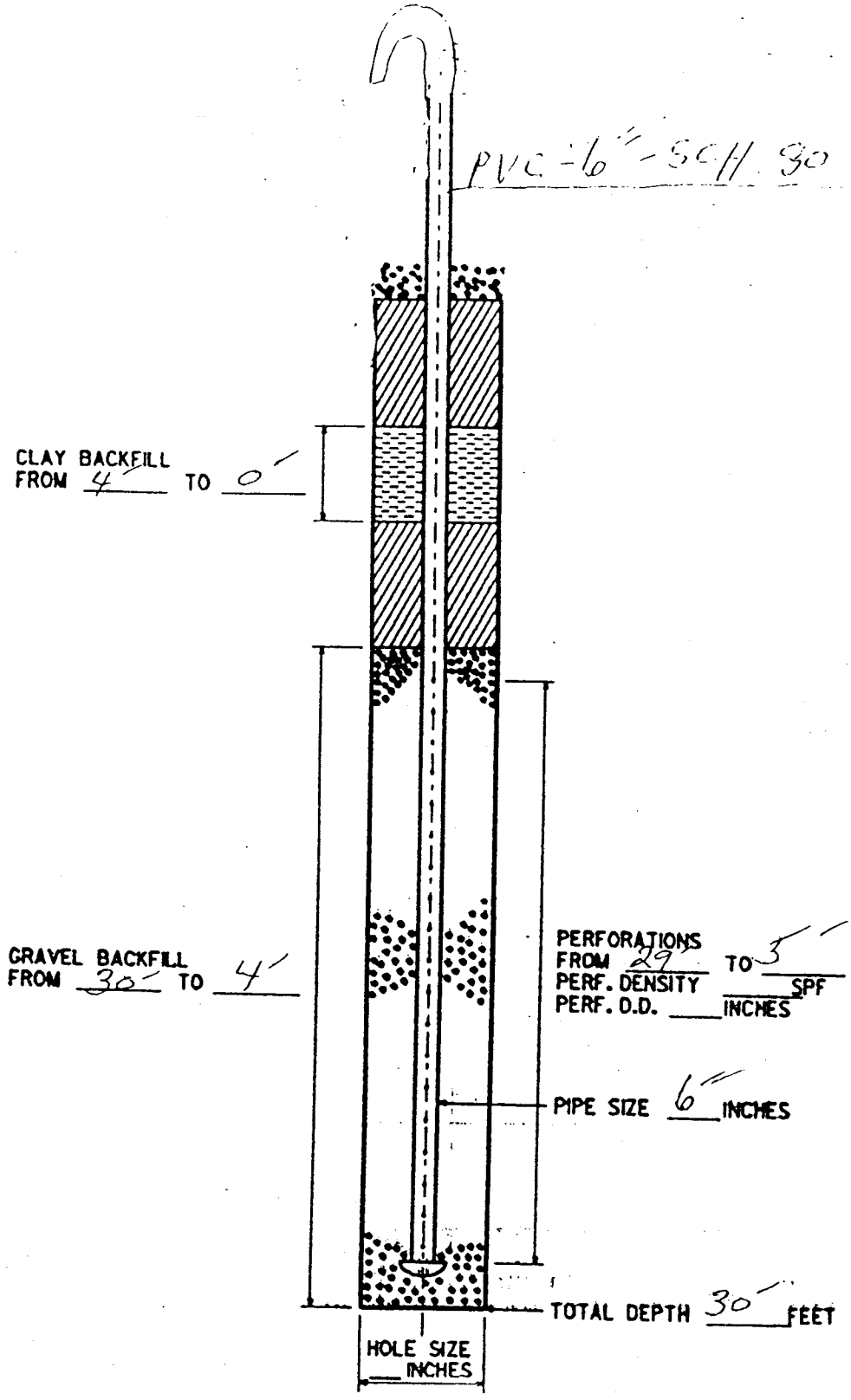
COMMENTS _____

90444-D

SITE LOCATION WATAUGA COUNTY DRILLING TIME
DATE 6-6-96
WELL NO. W-3 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-7'	Soil Cover	NA	DRY	
7-10'	Tire Rocks	NA	"	
10-15'	HHT-Rocks	MOD	"	
15-20'	HHT-Dirt	MOD	DAMP	
20-25'	HHT-Dirt	MOD	DAMP	
25-30'	HHT-Plastic	MOD	DRY	
				TD-30'


PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 29' TO 5'
PERF. DENSITY ____ SPF
PERF. O.D. ____ INCHES
PIPE SIZE 6" INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
____ INCHES

COMMENTS _____

90444-D

SITE LOCATION WATAUGA COUNTY DRILLING TIME
DATE 6-6-96
WELL NO. W-4 PAGE NO.

RECOVERY WELL BORING LOG

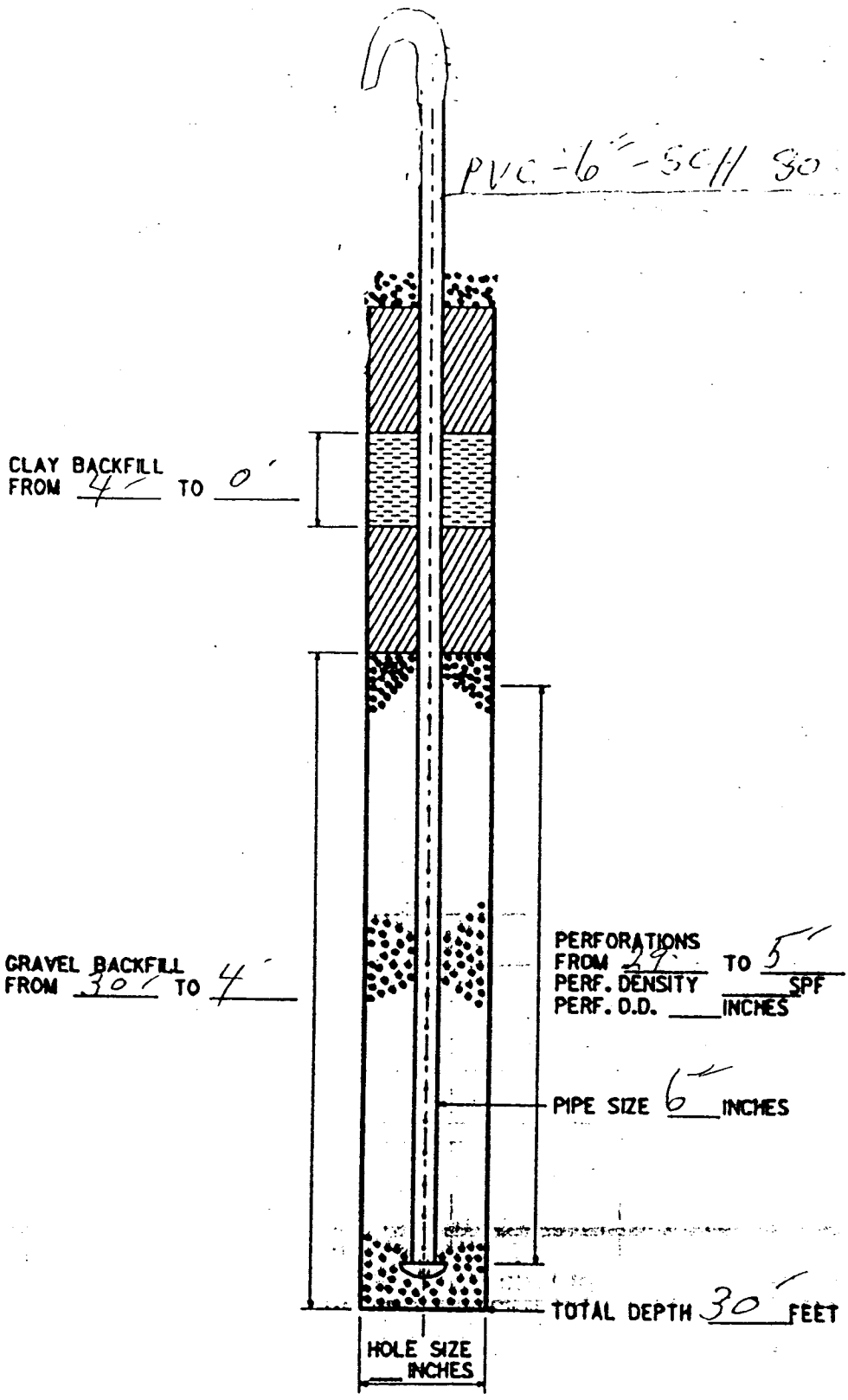
DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-1'	Soil Cover	~A'	DRY	
1-5'	HHT	11	wet	
5-10'	HHT	11	11	
10-15'	HHT Tires	11	11	
15-20'	HHT	11	11	
20-25'	HHT wire	11	11	
25-30'	wire	~A'	wet	
				TD-30'

90444-D

SITE LOCATION WATAUGA COUNTY DRILLING TIME
DATE 6-6-96
WELL NO. W-22 PAGE NO.

RECOVERY WELL BORING LOG

DEPTH	COMPOSITION	DEGREE OF COMPOSITION	MOISTURE	COMMENTS
0-5'	SOIL COVER	MOD	DRY	
5-10'	HHT-WOOD	"	"	
10-15'	HHT TIRE	"	"	
15-20	TIRES WOOD	"	"	
20-25'	HHT	"	"	
25-30'	HHT	MOD	DRY	
				TD-30'

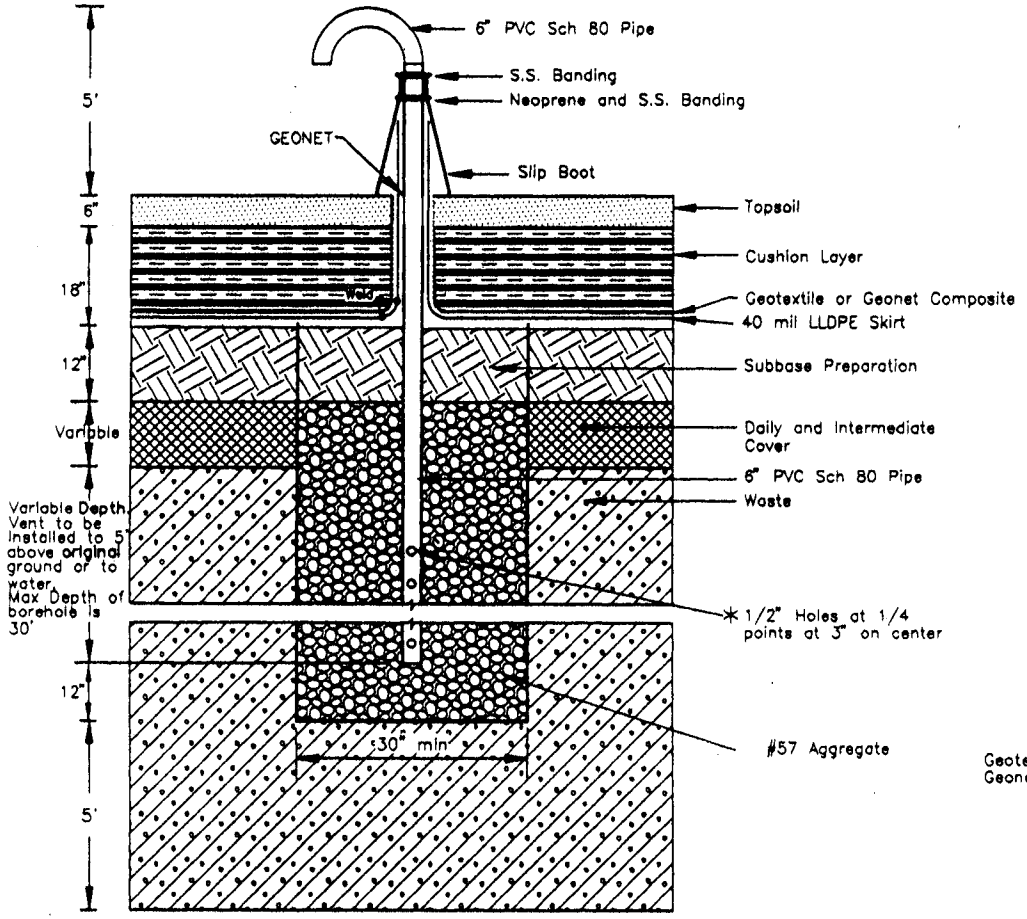

PVC - 6" - SCH 80
CLAY BACKFILL
FROM 4' TO 0'
GRAVEL BACKFILL
FROM 30' TO 4'
PERFORATIONS
FROM 25' TO 5'
PERF. DENSITY ___ SPF
PERF. O.D. ___ INCHES
PIPE SIZE 6" INCHES
TOTAL DEPTH 30' FEET
HOLE SIZE
___ INCHES

COMMENTS _____

Drawing Under Seperate Cover

APPENDIX F

GAS VENT CONSTRUCTION AND FLARE INFORMATION

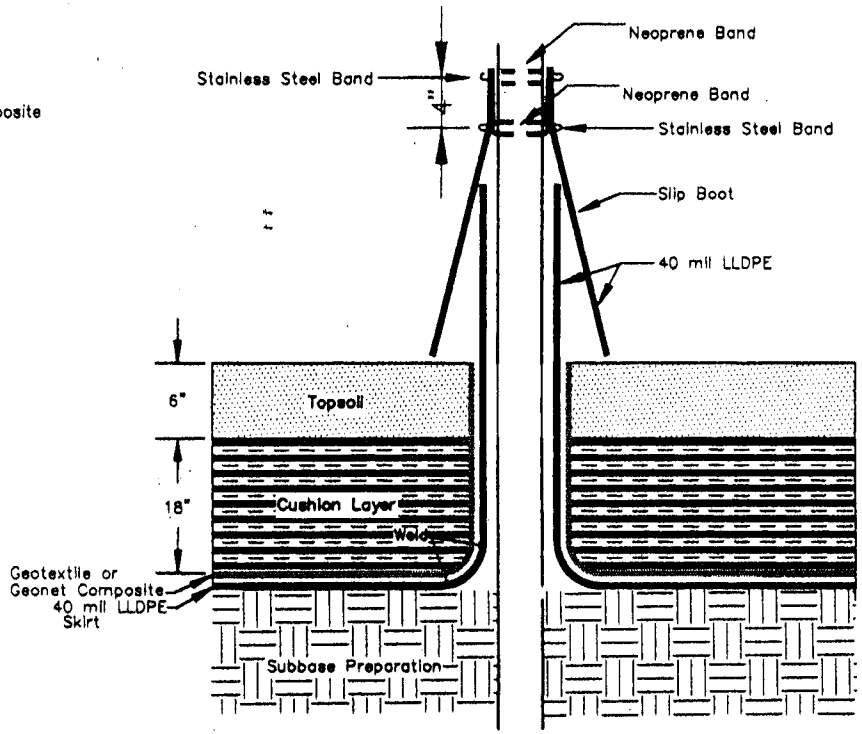


* PVC Pipe to be perforated from 5' below grade to the bottom.

9.5

GAS VENT

NO SCALE



SLIP BOOT DETAIL

SECTION 13320

GAS VENTS

PART 1 GENERAL

1.01 GENERAL

A. This section sets forth the specifications and requirements for the construction of drilled gas vents.

B. The Contractor shall furnish all materials, equipment and labor required to construct the proposed gas vents as specified herein and as shown on the drawings. The Contractor or subcontractor who will be performing the drilling operations shall have a strong prior experience in landfill drilling projects and knowledge of safety procedures and possible hazards involved. A log of well depths and as-built drawings of the interior configuration of each well shall be provided to the Engineer at the completion of the final gas vents well installations.

C. Boreholes shall be covered with a solid, rigid material any time work has stopped (lunch, breaks, etc.). Upon completion of the drilling operation, the Contractor shall install the PVC casing and piping and complete the backfilling as shown on the drawings. The Contractor shall complete backfilling by the end of the same working day.

1.02 QUALITY CONTROL

Comply with all applicable codes and regulations as required by regulatory agencies having jurisdiction over this work. Comply with pertinent sections of the following standards.

ASTM - American Society of Testing Materials
ANSI - American National Standards Institute
DEHNR - Department of Environment, Health and Natural Resources
OSHA - Occupational Safety and Health Administration

1.03 SUBMITTALS

A. Submit to the Engineer Certificates of Compliance on materials furnished, and manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, installation, and inspection of pipe and appurtenances furnished.

B. The Contractor shall submit for approval any changes of materials or installations procedures from that specified or detailed on the drawings.

C. The Contractor shall submit to the Engineer samples of any well backfill materials furnished from off-site.

D. The Contractor shall keep detailed well logs and construction diagrams for all wells drilled, including the total depth of the well, the static water level, depth, thickness, and description of soil or waste strata and the occurrence of any water bearing zones. Well logs shall be submitted to the Engineer.

E. The Contractor shall submit as-built drawings of the interior configuration of the vents to the Engineer.

1.04 WARRANTY

All materials and workmanship shall be guaranteed in writing for a period of one year after substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

The Contractor shall furnish all materials required to construct the gas extraction wells as shown on the drawings and as specified herein. Native soil required for capping the wells will be supplied by the Contractor.

2.02 GRAVEL

A. The gravel used to backfill the gas wells shall be washed clean subject to the approval of the Engineer and shall be size specified on Drawings.

B. The gravel shall be a product having rounded surfaces. Flat or elongated shapes will not be accepted unless the thickness of individual pieces is at least one third of the length. The gravel shall be sound, durable, resistant to abrasion, free from laminations and weak cleavage planes and shall be of such characteristics that it will not disintegrate from conditions to be met in handling and placing. All materials shall be washed clean and shall be free from impurities including earth, clay, refuse and adherent coatings.

2.03 PIPING

A. Plastic Pipe Compounds

The rigid unplasticized compound from which PVC pipe, fittings, and appurtenances shall be made to conform to ASTM D-1784, Class PVC 12454-B for polyvinyl chloride.

B. Pipe

The Schedule 80 PVC pipe shall conform to ASTM D-1785, PVC 1120. All 6-inch and smaller PVC pipe shall be Schedule 80 pipe and shall be socket type joint unless otherwise specified on the drawings.

C. Fittings

Schedule 80 PVC fittings shall conform to requirements of ASTM D-2466 for socket type joints and shall have a minimum pressure rating of 100 psig at 73°F.

D. Solvent Primer.

Socket type connections shall be primed with purple primer furnished by the supplier of the PVC pipe and fittings.

E. Solvent Cement

Socket type connections shall only be joined by heavy bodied PVC solvent cement furnished by the supplier of the PVC pipe and fittings, and shall conform to ASTM D-2564.

F. Solvent Welded Joints

All PVC well pipe shall be solvent welded and lag bolted. Solvent welded joints shall be made in accordance with ASTM D-2885.

The ends of the plastic pipe shall be cut square and smooth, beveled, and wiped clean. Primer shall first be applied to the outside of the pipe and the inside of the fitting socket with a small paint brush. After priming, solvent cement shall be applied to the outside of the pipe and the inside of the fitting socket with a small paint brush. Solvent shall be applied in such a manner that no material is deposited on the interior surface of the pipe or extruded into the interior to the pipe during joining. The coated surfaces shall be immediately pushed snugly together and the pipe rotated approximately 1/4 turn to ensure uniform distribution of cement. Excess cement on the exterior of the joint shall be wiped clean immediately after assembly.

Care shall be exercised in assembling a pipeline with solvent welded joints so that stress on previously made joints is avoided. Handling of the pipe following jointing, such as lowering the assembled pipeline into the trench, shall not occur until after the cure time recommended by the cement manufacturer has elapsed.

PART 3 EXECUTION

3.01 DRILLING

A. Drilling shall be done by an experienced driller. Wells are to be a minimum of 30" in diameter. Drilling shall be done with a bucket or auger drill, capable of leaving a clean hole. Contractor must use dry drilling equipment, wet rotary drilling equipment may not be used. After drilling, the vent shall be cleaned of loose debris before filling with stone and the vent piping.

B. The maximum depth of each vent is 30 feet. Each vent will be drilled to 30 feet unless water or original ground is encountered first as discussed below.

1. If water is encountered in a boring, the Contractor may be directed to drill beyond the point at which it was encountered. If wet conditions remain, the boring may be terminated and the length of perforated pipe adjusted by the Engineer, or the well may be relocated. If wet conditions cease (e.g. due to trapped water layer), then drilling will continue to the design depth. See paragraph 3.03 for well abandonment requirements.

2. Since base grades of the landfill are not well known, the depth of drilling may be impacted by the actual depth to the original ground. When within 10 feet of estimated base grade, advance bucket with care noting drilling torque and pressure.

C. Soil required for drill rig leveling or for gas vent backfilling may be excavated from on site borrow areas designated by the Engineer.

D. As soon as drilling is completed, a safety screen shall be placed over the top of the bore. This screen shall stay in place until backfilling is within 4 feet of the surface. Safety screen size should be large enough to accommodate all backfill materials and any tools used during backfill yet not large enough for any human to accidentally fall through.

3.02 INSTALLATION PROCEDURES

A. The vents shall be constructed as shown on the Drawings and as specified herein.

B. The bore for the well shall be straight and the well pipe shall be installed in the center of the bore hole. The Contractor will take all tension off of the pipe by mechanical means and center the pipe in the middle of the bore hole before starting to backfill.

C. The top end of the PVC casing shall be capped prior to backfilling. Backfilling shall be as shown by detail on the Drawings.

D. The Contractor shall install the soil backfill in 1 foot lifts. The top of each lift shall be wetted as appropriate with water. Soil backfill shall be rodded in the boring to provide even distribution and compaction.

E. The well will be inspected by the Engineer during construction. Any damage of the well casing or improper filling of the gravel will be cause for redrilling of the well at no cost to the Owner.

F. Install the boot as shown by the detail on the Drawings.

G. The Contractor will be responsible for collecting all solid waste removed from the boreholes and transporting it to the on-site transfer station. It is the Contractor's responsibility to ensure that all drilling debris and solid waste has been removed from the vent area and that all soil layers have been properly cleaned and smoothed as necessary for geotextile or geomembrane installation.

3.03 INCOMPLETE AND ABANDONED WELLS

Each of the proposed gas vents shall be drilled to the full designated depth as shown on the contract drawings. When drilling through refuse, the contractor is cautioned that liquid layers, or underground obstructions including reinforced concrete, wood and metal, etc., may be encountered. These materials may stop or delay the drilling operations and would require the Contractor to employ special construction methods and utilize special drilling equipment. Should the Contractor encounter liquid layers, the Contractor shall consider drilling past the liquid layers to a dryer zone below without removing spoils until in the dryer zone, thereby allowing the liquids to drain.

The Contractor shall also consider introducing dry soil to the borehole and mixing with the drill auger in the borehole to absorb the liquid. All costs associated with the above mentioned work necessary to overcome the possible obstructions and liquid layers encountered shall be at the Contractor's expense. The Contractor shall be allowed to abandon installation of a gas extraction well only after the Engineer has reviewed the Contractor's request and has issued authorization to abandon an incomplete gas extraction well. In abandoning a gas well, the Contractor shall completely backfill the borehole with native soil up to the bottom of the subbase preparation layer. From the subbase preparation layer to grade, the borehole shall be backfilled according to the cap section detail. The Contractor shall complete backfilling of abandoned boreholes on the same working day, unless otherwise authorized by the Engineer. Any vents not meeting specification or wells damaged or destroyed during construction shall be abandoned and redone at a new location as designated by the Engineer. The above mentioned rework, which includes drilling and backfilling, shall not be considered as extra work and shall be done at no additional cost to the Owner. However, if the Contractor has adequately drilled any gas well up to 90% of the designated depth and has made in the judgement of the Engineer every possible effort to penetrate to the full depth required, the Engineer shall accept the well depth as complete and the Contractor shall finish the well installation as shown on the drawings.

3.04 SAFETY

A. Background

There have been accidents resulting from landfill gas migration. Gas migration, in particular, poses a hazard and has been responsible for some deaths and serious injuries. Therefore, it makes good sense to take more than routine safety precautions when working in or near a landfill. The Contractor is solely responsible for worker safety. The following section is provided as suggestions only. The Contractor shall provide his own Health and Safety Plan.

B. General

Hazards that might occur include but are not limited to the following:

1. Fires may start from exposed and/or decomposing solid waste.

2. Fires and explosions may occur from the presence of methane gas. Methane gas (CH_4) is also known as marsh gas and/or methyl hydride; is a flammable, colorless, odorless and tasteless gas; and is the major constituent of natural gas.

3. Landfill gas may cause an oxygen deficiency in underground trenches, vaults, conduits and structures.

4. Hydrogen sulfide (H_2S) may also be present. H_2S is a colorless, very flammable gas which, in low concentrations, has an offensive odor described as that of rotten eggs. H_2S can be highly toxic. Although the odor of H_2S is recognizable (unless masked) at 1/400 of the lowest possible amount that can cause injurious effects, sense of smell is lost within 2-15 minutes of exposure.

At higher concentrations, it will instantly deaden the sense of smell and can cause death within seconds by terminating the function of the nerve and motor control center in the brain.

C. Site Work Safety Conditions

Workers should be protected from the dangers from hazardous gases through the use of safeguard measures, for example:

- Test the atmosphere
- Ventilate confined spaces
- Use appropriate safety equipment
- Provide back-up safety personnel

1. Test the Atmosphere

Before entering or nearing confined space, the atmosphere should be tested to detect any adverse environmental condition. The confined space should be tested for oxygen deficiency, toxic gases, and combustible gases with a gas detector instrument. Test instruments must be properly maintained and calibrated.

When testing, the presence of explosive gases should be checked first. If this test indicates non-explosive conditions, asphyxiating (toxic) gases and oxygen deficiency conditions should be determined. An oxygen deficiency condition indicates that gases or vapors undetected in the toxic gas test are probably present. Because carbon monoxide, carbon dioxide, hydrogen sulfide, or other vapors may have accumulated in the lower levels of the confined space, their presence would not have been detected in the upper portions of the manhole.

2. Ventilate Confined Spaces

To mitigate against toxic gases or oxygen deficiency, the affected area should be thoroughly ventilated before entry and during the entire time workers are in the area. Forced ventilation is best. Start by blowing air in the affected area until the atmosphere is suitable for entry.

Blower equipment should be placed upwind so that emerging gases will not be ignited by the blower equipment or recycled to the work area. Blower equipment should also be located away from the exhaust of nearby motor vehicles so that the exhaust fumes are not introduced into the manhole. Gas engine blowers, if used, should also be situated so that their exhaust is not introduced into the manhole.

The hose from the blower unit should be set and inspected periodically to assure that it is not bent to kinked to guarantee that air flow to the manhole will not be reduced or restricted.

D. Worker Safety Precautions

In addition to providing safe work conditions, the work force should obey the following safety procedures. Some of the more important procedures are:

1. No smoking while on a landfill (active or closed).

2. No drinking of alcoholic beverages, or being under the influence of drugs while working on a landfill.

3. Hard hats should be worn when working in construction areas, near drilling equipment, or in excavations.

4. Any cut or abrasion should be treated immediately as the chance of infection is high when working on a landfill. A tetanus shot is recommended, prior to working on a landfill.

5. Inhalation of landfill gases should be avoided as far as practicable. Such gases may cause nausea and dizziness, which could lead to accidents.

E. Safety Equipment

Organizations working on landfill gas projects should be certain that prior to commencement of the construction of a landfill gas facility, that certain safety equipment as a minimum be provided and in proper working order. The following equipment should be available at the construction location:

1. Hard hats and work gloves for all personnel (rubber gloves may be advisable if working with wet solid waste or where exposure to leachate/condensate is expected).

2. Appropriate work shoes/boots.

3. First aid kit.

4. Fire extinguishers: Multi-purpose dry UL Class 10A-20B; C for extinguishing Class A, B and C fires shall be kept within 20 feet of all excavations.

5. No smoking signs.

6. Full-face acid/gas/organic vapor masks for all personnel (with prescription lens when appropriate).

7. Parachute type harnesses (2) and safety lines (for use in excavation, manholes, etc.)

8. Ladders for easy ingress and egress from excavations, structures, etc.

9. Fans with hoses for forced air to provide ventilation in closed excavations, structures, etc.

10. Methane/oxygen detector.

11. Hydrogen sulfide detector.

12. Barricades.

13. Covers for excavations which would otherwise remain open at end of working day. These covers should be sufficient to support weight and if at all possible, gas tight.

14. Construction equipment should be equipped with vertical exhaust and spark arresters.

F. Safety Precautions for Well Construction

Safety precautions which should be followed during vent/well construction include:

1. One person should be present at all times during the construction, with the sole responsibility of assuring the observance of all safety procedures. This person should be trained in the use of all recommended safety equipment.

2. Smoking should be prohibited within 50 feet of the drilling area. No smoking on the landfill is preferred.

3. Any personnel working within 5 feet of the edge of the vent/well under construction should wear a parachute-type harness.

4. No worker should be allowed to work alone at any time near the edge of the vent/well under construction. Another worker should be present beyond the area considered subject to the possible effects of landfill gas.

5. No worker should handle excavated solid waste without wearing work gloves.

6. At all times during the vent/well construction, the work area should be monitored for levels of methane and hydrogen sulfide.

7. If the vent/well construction is not completed by the end of the working day, the hole should be covered with a plate of sufficient overlap to prevent access to the hole and to support expected loads. The edges of the plate should be covered with sufficient depth of dirt. Barricades should be placed around the covered hole.

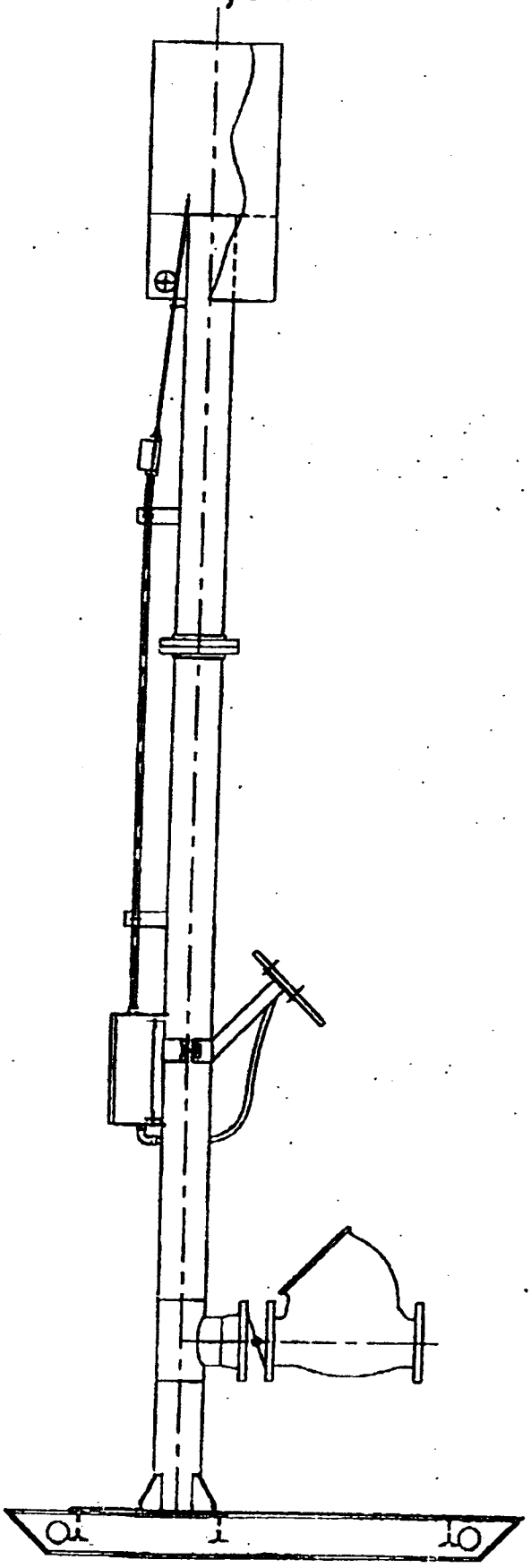
8. Construction equipment should be located upwind of open wells to minimize ignition hazards.

9. A water truck should be provided in a standby mode to quench possible fires.

10. There is a strong possibility of caving during drilling and vent/well installation operations. Anyone working near the edge of the drilling borehole should be secured with a safety belt and life line to preclude the possibility of falling into the opening. No more than 4 feet of slack should be allowed in the tether line. In lieu of safety belt and lifeline, a construction platform over the borehole of the vent/well will be acceptable. The platform should be designed for the anticipated load.

END OF SECTION

LFG SPECIALTIES, INC.



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LFG SPECIALTIES, INC.

LANDFILL GAS VENT FLARE INSTALLATION

FLARE STACK INSTALLATION:

LFG Specialties vent gas flares are designed to be installed directly on the vent well casing by means of a 150# ANSI flange fabricated to the flare stack inlet tee. The inlet tee provides a full bore access port to the well casing for inspection, leachate removal, etc. The flare stack is mounted to the side outlet port of the inlet tee and a manual valve is provided to control and/or shut off the landfill gas flow to the flare tip.

To install the vent flare stack, simply bolt the inlet tee lower flange to the compatible flange on the well bore casing. Stainless steel capscrews and a suitable gasket are recommended. Next install the flare stack and the manual valve to the inlet tee in the same manner (if flare is not shipped pre-assembled). Guy wires typically are not required on vent flare installations, but may be desired in some instances. This determination, based on size, rigidity of construction(PVC, HDPE, etc.) and height (above grade) of the well bore casing, is left to the installing contractor. Small diameter galvanized aircraft cable and screw-in or mushroom anchors are recommended if guy wires are utilized.

For proper operation of the automatic igniter system, the vent flare stack must be sufficiently grounded to earth. A minimum of 6 foot copper ground rod, #4 copper ground wire and suitable copper ground lugs are required. A copper lug is provided on the vent flare stack for this purpose.

Note: The position of the solar panel mounting plate should face due south in the northern hemisphere and due north in the southern hemisphere.

IGNITER SYSTEM INSTALLATION:

The automatic igniter system is enclosed in a NEMA.4 weatherproof enclosure and factory mounted to the flare stack. Due to the fragility of the solar panel and the igniter rod, they are shipped loose for field installation.

The igniter rod furnished with the LFG vent flare is an incon sheathed, ceramic insulated, inconel rod. The lower end of t igniter rod has a spark plug type terminal for attaching t igniter cable. One-half inch conduit with an explosion pro junction box is factory installed for mounting the igniter rod.

The conduit is pre-bent at the proper angle to obtain the corre position of the igniter tip. Mount the igniter rod by sliding t tube compression fitting over the rod with the thread end towa the terminal end. Do not tighten the compression nut. Slide t igniter rod through the guide tab at the flare tip and insert t bottom of the rod into the junction box and position the ignit rod so that the spark plug connector is centered in the juncti box. Tighten the compression fitting to hold the igniter rod place. Do not overtighten the compression nut as damage to t ceramic insulator may result. Next remove the cover of the juncti box and connect the silicone igniter cable to the igniter rod a replace the cover. Be sure the panel is in the off position avoid any potential shock from the transformer lead.

Note: Extreme caution should be used at all time when handli the igniter rod as the ceramic insulator is easi damaged and a slight crack will render the r inoperable.

Install the solar panel to the solar panel mounting plate with t screws provided being sure the panel is facing south in t northern hemisphere as noted. Run lead wire through grommet fitti in the bottom of the flare control panel mounted on the flare sta and connect to corresponding color on the two pole terminal str mounted in the control box. Tighten the grommet fitting to assu no moisture is allowed in the control panel.

Note: System is equipped with a 12 volt Gel battery which charged at the factory. If the battery should loo charge during transport or storage, the flare controll must be turned off and the battery allowed to recharg The battery will be fully charged by the solar panel wi two days of sunlight.

VENT FLARE START-UP AND OPERATION

The LFG Specialties 12 volt vent flare controller operates intermittently by means of an ON/OFF (recycling) timer. This timer has an "ON" range of 0 to 100 seconds and an "OFF" range of 0 to 100 minutes. These times are adjusted by a dial potentiometer on the timer face. The "ON" time may be set with the dial on the left side and the "OFF" time is set with the dial on the right side of the timer face with zero being completely counterclockwise and 100 being completely clockwise. Factory time settings are 30 seconds "ON" and 30 minutes "OFF" unless otherwise specified. Use care when adjusting this timer and avoid exerting any excessive force on the potentiometer dials.

To start the flare simply open the flow control valve and turn the selector switch on the controller face to "ON". The igniter will begin to arc and continue for 30 seconds at which time the "OFF" time begins. After 30 minutes of "OFF" time, the igniter will again arc for 30 seconds. This process will continue indefinitely or until the controller is turned off. The recycle timer is an "ON" first timer which means to reset the timer and begin the sequence again, simply turn the flare controller OFF and back ON.

The flow control valve is installed primarily to provide a shutdown of the flare. To turn the flare off for well inspection or serving, first turn the panel main switch to the off position then close the manual valve; this will extinguish the flame. After allowing a short cool-down period (5-10 min.), the valve may be reopened to allow passive venting. To reignite the flare simply open the valve and turn on the main switch in the controller. The igniter will spark and relight the venting gas.

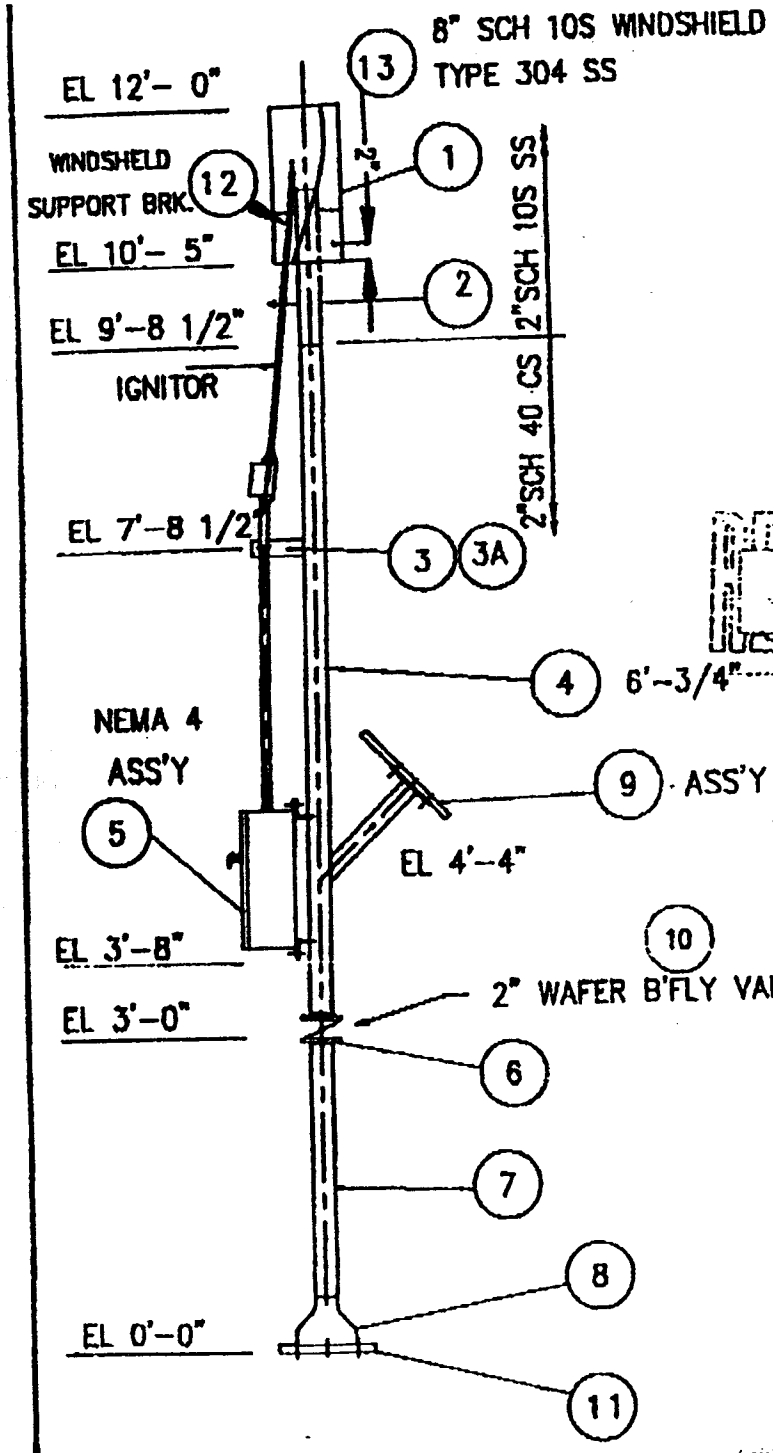
If any problems arise in the operation of your LFG Specialties vent flare and controller that cannot be easily remedied, please notify us immediately for service advice. If the problem cannot be corrected via phone conversation, a service representative can be sent to the site to fully investigate and resolve the problem.

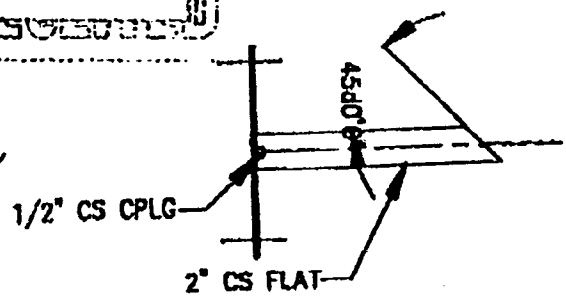
All LFG Specialties products are guaranteed for material, workmanship and performance as outlined in the standard "Terms and Conditions of Sales". The standard warranty period is eighteen (18) months from date of shipment or twelve (12) months from date of start-up, whichever occurs first.

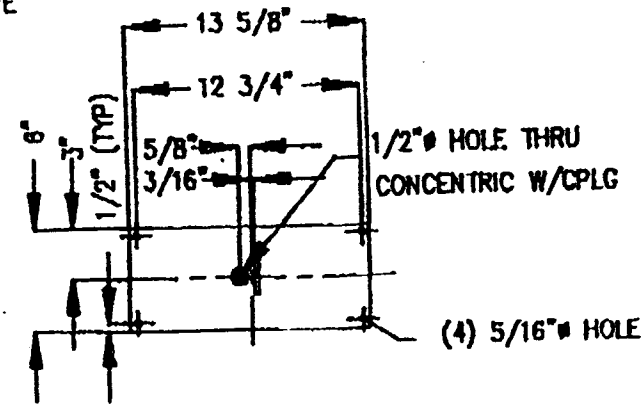
Note: Do not alter the design and/or operation of the LFG Specialties flare and controller system without consulting with us, as this could result in the voiding of the warranty on the equipment.

Post-it® Fax Note 7671	Date 8-22-96	# of pages ▶ 4
To JOHN	From TIM JEWETT	
Co./Dept. DR. PHILLIPS	Co. UFG SPECIALTIES	
Phone # 704-264-5305	Phone # 216-891-0305	
Fax # -1702	Fax # -8288	

PART	QTY	UFG PART	DESCRIPTION







APPENDIX G

GAS MODELING DATA

Watauga County Landfill
Estimation of Methane Emission Rate

Model Parameters

Lo : 169.90 m^3 / Mg ***** User Mode Selection *****
k : 0.0500 1/yr ***** User Mode Selection *****
NMOC : 164.00 ppmv ***** User Mode Selection *****
Methane : 50.0000 % volume
Carbon Dioxide : 50.0000 % volume

Landfill Parameters

Year Opened : 1972 Current Year : 2002 Year Closed: 1993
Capacity : 495,330 Mg = 546,000 tons

Model Results

Year	Refuse In Place (Mg)	Methane Emission Rate (Mg/yr)	Methane Emission Rate (Cubic m/yr)
1973	2.252E+04	1.276E+02	1.913E+05
1974	4.503E+04	2.490E+02	3.732E+05
1975	6.754E+04	3.644E+02	5.463E+05
1976	9.006E+04	4.743E+02	7.109E+05
1977	1.126E+05	5.787E+02	8.675E+05
1978	1.351E+05	6.781E+02	1.016E+06
1979	1.576E+05	7.726E+02	1.158E+06
1980	1.801E+05	8.626E+02	1.293E+06
1981	2.026E+05	9.481E+02	1.421E+06
1982	2.252E+05	1.029E+03	1.543E+06
1983	2.477E+05	1.107E+03	1.659E+06
1984	2.702E+05	1.180E+03	1.769E+06
1985	2.927E+05	1.251E+03	1.874E+06
1986	3.152E+05	1.317E+03	1.974E+06
1987	3.377E+05	1.380E+03	2.069E+06
1988	3.602E+05	1.441E+03	2.160E+06
1989	3.828E+05	1.498E+03	2.246E+06
1990	4.053E+05	1.553E+03	2.327E+06
1991	4.278E+05	1.605E+03	2.405E+06
1992	4.503E+05	1.654E+03	2.479E+06
1993	4.728E+05	1.701E+03	2.549E+06
1994	4.953E+05	1.745E+03	2.616E+06 = 176 CSm of methane
1995	4.953E+05	1.660E+03	2.489E+06
1996	4.953E+05	1.579E+03	2.367E+06
1997	4.953E+05	1.502E+03	2.252E+06
1998	4.953E+05	1.429E+03	2.142E+06
1999	4.953E+05	1.359E+03	2.038E+06
2000	4.953E+05	1.293E+03	1.938E+06
2001	4.953E+05	1.230E+03	1.844E+06
2002	4.953E+05	1.170E+03	1.754E+06
2003	4.953E+05	1.113E+03	1.668E+06
2004	4.953E+05	1.059E+03	1.587E+06
2005	4.953E+05	1.007E+03	1.509E+06
2006	4.953E+05	9.579E+02	1.436E+06
2007	4.953E+05	9.112E+02	1.366E+06
2008	4.953E+05	8.668E+02	1.299E+06
2009	4.953E+05	8.245E+02	1.236E+06

2010	4.953E+05	7.843E+02	1.176E+06
2011	4.953E+05	7.460E+02	1.118E+06
2012	4.953E+05	7.097E+02	1.064E+06
2013	4.953E+05	6.750E+02	1.012E+06
2014	4.953E+05	6.421E+02	9.625E+05
2015	4.953E+05	6.108E+02	9.155E+05
2016	4.953E+05	5.810E+02	8.709E+05
2017	4.953E+05	5.527E+02	8.284E+05
2018	4.953E+05	5.257E+02	7.880E+05
2019	4.953E+05	5.001E+02	7.496E+05
2020	4.953E+05	4.757E+02	7.130E+05
2021	4.953E+05	4.525E+02	6.782E+05
2022	4.953E+05	4.304E+02	6.452E+05
2023	4.953E+05	4.094E+02	6.137E+05
2024	4.953E+05	3.895E+02	5.838E+05
2025	4.953E+05	3.705E+02	5.553E+05
2026	4.953E+05	3.524E+02	5.282E+05