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2

Construction and Demolition Landfill

for

Alexander County
North Carolina

December 1, 1997

APPROVED
DIVISION OF SOLID WASTE MANAGEMENT
DATE 12/31/97 BY JDB
CF copy

prepared by:

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE

12/2/97

By: _____

MUNICIPAL ENGINEERING SERVICES CO., PA
Garner • Boone, NC

TABLE OF CONTENTS

Section I	Facility Plan
Section II	Operation Plan
Section III	Closure Plan
Section IV	Post Closure Plan
Section V	Closure and Post Closure Cost Analysis and Summary
Section VI	Water Quality Monitoring Plan
Appendix A	Existing Conditions
Appendix B	Operation Plan
Appendix C	Final Contours
Appendix D	Closure Details

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Solid Waste
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Section 1

FACILITY PLAN

FACILITY PLAN

The Alexander County Construction and Demolition Landfill will be operated within an area covered under the Transition Plan. Groundwater and methane gas will be monitored according to Subtitle D through the existing monitoring systems.

The existing cap system is in place with a minimum of 2.0 feet of soil which was placed prior to October 9, 1991.

The total air space available for Phases 1-4 is approximately 156,184 cubic yards. The annual tonnage of construction and demolition material will be approximately 6,000 tons. Assuming a compacted density of 1,500 lbs./yd^3 and a soil to trash ratio of 10:1, the life expectancy of Phases 1-4 is approximately 17.7 years.

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Section 11

OPERATION PLAN

OPERATIONAL PLAN FOR THE ALEXANDER COUNTY CONSTRUCTION AND DEMOLITION LANDFILL

The County will operate a Construction and Demolition Landfill within the permitted boundaries and upon closed sections of the present municipal solid waste landfill. The sections are limited to areas that stopped receiving waste prior to October 9, 1991 and have an adequate two (2) feet of final cover. These areas are also part of the Transition Plan concerning monitoring under Subtitle D Rules.

The Construction and Demolition Landfill will receive the following solid waste:

1. Land clearing debris as defined in G. S. 130A-290, specifically, solid waste which is generated solely from land-clearing activities, such as stump, trees, etc.;

2. Inert debris defined as solid waste which consists solely of material that is virtually inert, such as brick, concrete, rock and clean soil;

3. Asphalt in accordance with G. S. 130-294 (m);

4. Construction and demolition debris defined as solid waste resulting solely from construction, remodeling, repair or demolition operations on pavement, buildings or other structures; and

5. Construction and demolition like waste from industrial sources within the County such as shingles from a manufacturer of shingles and mobile home debris from a manufacturer of mobile homes.

Operational soil cover of at least six (6") inches shall be placed at least once per week or when the active area reaches 1/2 acre in size or more often as necessitated by the nature of the waste so as to prevent the site from becoming a visual nuisance and to prevent fire, windblown materials, vectors or water infiltration.

Areas which will not have additional waste placed on them for 12 months or more, but where final termination of operations has not occurred, shall be covered with a minimum of one foot of soil cover.

The County will implement a program at the landfill for detecting and preventing the disposal of hazardous and liquid wastes. The program shall consist of random inspection of incoming loads at a minimum of 1% of the weekly traffic. Landfill personnel will be trained to recognize hazardous and liquid wastes. Records shall be kept on the training and the inspection. (See Appendix I).

The County shall monitor for explosive gases of landfill structures and property boundaries. The concentration of methane gases generated by the landfill cannot exceed 25 percent of the lower explosive limit for methane in the structures, and it cannot exceed the lower explosive limit for methane at the landfill property boundary. (See Appendix III.) If methane gas is found to exceed the acceptable limits at either the property boundary or landfill structures, the County shall do the following:

1. Immediately take all necessary steps to ensure protection of human health; i.e., no smoking, temporarily abandon the structure and notify the Division of Solid Waste Management.

2. 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

3. 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 of Solid Waste Management that the plan has been implemented. The plan shall describe the nature and extent of the problem and the proposed remedy.

Off and on site erosion shall be controlled through erosion control structures and devices. Provisions for a vegetative ground cover sufficient to restrain erosion shall be accomplished within 30 working days or 120 calendar days upon completion of any phase of landfill development.

The County will record and retain at the landfill an operating record of the following information:

1. Inspection records, waste determination records, and training procedures;

2. Amounts by weight of construction and demolition waste received at the landfill to include source of generation;

3. Gas monitoring results and any remediation plans;

4. Any demonstration, certification, findings, monitoring, testing or analytical data required for surface and groundwater monitoring;

5. Any monitoring, testing or analytical data required for closure or post-closure; and,

6. Any cost estimates and financial assurance documentation.

All information contained in the operating record will be furnished upon request to the Division of Solid Waste Management or be made available at all reasonable times for inspection by the Division.

Ground and surface water shall be sampled and analyzed according to Subtitle D Appendix I detection monitoring requirements. The monitoring frequency for all Appendix I detection monitoring constituents shall be at least semiannual during the life of the facility (including closure) and the post-closure period. At least one sample from each well (background and downgradient) shall be collected and analyzed during subsequent semiannual sampling events.

If the County determines that there is a statistically significant increase over background for one or more of the constituents listed in Appendix I at any monitoring well at the relevant point of compliance, the County shall, within 14 days of the finding, report to the Division of Solid Waste and place a notice in the operating record indicating which constituents have shown statistically significant changes from background levels. The County shall establish an assessment monitoring program within 90 days. The County may demonstrate that a source other than the landfill caused the contamination or that the statistically significant increase resulted from an error in sampling, analysis, statistical evaluation, or natural variation in ground-water quality. A report documenting these demonstrations shall be certified by a Licensed Geologist or Professional Engineer and approved by the Division of Solid Waste. A copy of this report shall be placed in the operating record. If a successful demonstration is made, documented, and approved by the Division, the County may continue detection monitoring. If after 90 days, a successful demonstration is not made, the County shall initiate an assessment monitoring program.

OPERATIONAL REQUIREMENTS

1. Waste Acceptance and Disposal Requirements

   a. The Construction and Demolition Landfill (C&DLF) will only accept those solid wastes which it is permitted to receive. The County will notify the Division within 24 hours of attempted disposal of any waste the landfill is not permitted to receive, including waste from outside the County area the landfill is permitted to serve.

   b. The following wastes are prohibited from disposal at the C&DLF:

      i. Hazardous waste as defined within 15A NCAC 13A, to also include hazardous waste from conditionally exempt small quantity generators.

      ii. Polychlorinated biphenyls (PCB) wastes as defined in 40 CFR 761.

      iii. Liquid wastes unless the container is a small container similar in size to that normally found in household waste; the container is designed to hold liquids for use other than storage; or the waste is household waste.

      iv. Municipal solid waste.

   c. Asbestos waste shall be managed in accordance with 40 CFR 61. The waste shall be covered immediately with soil in a manner that will not cause airborne conditions and must be disposed of separate and apart from other solid wastes.

      i. At the bottom of the working face or;

      ii. In an area not contiguous with other disposal areas. Separate areas shall be clearly designated so that asbestos is not exposed by future land disturbing activities.

   d. The County will implement a program at the landfill for detecting and preventing the disposal of hazardous and liquid wastes. (Appendix I). This program will include, at a minimum:

      i. Random inspections of incoming loads or other comparable procedures;

      ii. Records of any inspections;

iii. Training of facility personnel to recognize hazardous and liquid wastes.

iv. Development of a contingency plan to properly manage any identified hazardous and liquid wastes. The plan must address identification, removal, storage and final deposition of the waste.

e. Waste placement shall be within the areal limits of the actual waste boundary established prior to October 9, 1991 and in a manner consistent with the effective permit.

2. Cover material requirements

a. Except as in Part (b), the County must cover disposed solid waste with six inches of earthen material at the end of each week, or at more frequent intervals if necessary, to control disease vectors, fires, odors, blowing litter, and scavenging.

b. Areas which will not have additional wastes placed on them for 12 months or more, but where final termination of disposal operations has not occurred, shall be covered with a minimum of one foot of intermediate cover.

3. Disease vector control

a. The County will prevent or control on-site populations of disease vectors using techniques appropriate for protection of human health and the environment.

b. "Disease vectors" means any rodents, flies, mosquitoes, or other animals, including insects, capable of transmitting disease to humans.

4. Explosive gases control

a. The County must ensure that:

i. The concentration of methane gas generated by the landfill does not exceed 25 percent of the lower explosive limit for methane in landfill 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 landfill property boundary.

b. The County will implement a routine methane monitoring program to ensure that the standards of 4 (a) are met. (Appendix III)

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

I. Soil conditions;

II. The hydrogeologic conditions surrounding the facility;

III. The hydraulic conditions surrounding the facility;

IV. 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 will:

i. Immediately take all necessary steps to ensure protection of human health; i.e., no smoking, temporarily abandon the structure and notify the Division of Solid Waste Management.

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 of Solid Waste Management that the plan has been implemented. The plan shall describe the nature and extent of the problem and the proposed remedy.

d. "Lower explosive limit" means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at 25° C and atmospheric pressure.

5. Access and safety requirements

a. The landfill will be adequately secured by means of gates, chains, beams, fences and other security measures approved by the Division of Solid Waste Management to prevent unauthorized entry.

b. An attendant will be on duty at the site at all times while it is open for public use to ensure compliance with operational requirements.

c. The access road to the site will be of all-weather construction and maintained in good condition. The entrance will be gravel constructed to prevent the tracking of mud onto secondary roads.

d. Dust control measures will be implemented when necessary.

e. Signs providing information on tipping or disposal procedures, the hours during which the site is open for public use, the permit number and other pertinent information will be posted at the site entrance.

f. Signs will be posted stating that no hazardous, municipal or liquid waste can be received.

g. Traffic signs or markers will be provided as necessary to promote an orderly traffic pattern to and from the discharge area and to maintain efficient operating conditions.

h. The removal of solid waste from the landfill will be prohibited unless the County approves and the removal is not performed on the working face.

i. Barrels and drums will not be disposed of unless they are empty and perforated sufficiently to ensure that no liquid or hazardous waste is contained therein, except fiber drums containing asbestos.

6. Erosion and Sedimentation Control Requirements

a. Adequate sediment control measures (structures or devices), will be utilized to prevent silt from leaving the landfill.

b. Adequate sediment control measures (structures or devices), will be utilized to prevent excessive on-site erosion.

c. Provisions for a vegetative ground cover sufficient to restrain erosion will be accomplished within **30 working days** or **120 calendar days** upon completion of any phase of landfill development.

7. Drainage Control and Water Protection Requirements

a. Surface water will be diverted from the operational area.

b. Surface water will not be impounded over or in waste.

c. Solid waste will not be disposed of in water.

d. The landfill will not:

(i) Cause a discharge of pollutants into waters of the United States, including wetlands, that violates any requirements of the Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements pursuant to Section 402.

(ii) Cause the discharge of a nonpoint source of pollution to waters of the United States, including wetlands, that violates any requirements of an area-wide or state-wide water quality management plan that has been approved under Section 208 or 319 of the Clean Water Act, as amended.

8. Liquids Restriction

a. Bulk or non-containerized liquid waste will not be placed in the landfill.

b. Containers holding liquid wastes will not be placed in the landfill.

c. For the purpose of this paragraph:

(i) Liquid waste means any waste material that is determined to contain "free liquids" as defined by Method 9095 (Paint Filter Liquids Test), S. W. 846.

9. Recordkeeping Requirements

a. The County C&DLF will record and retain at the facility, or an alternative location near the facility approved by the Division of Solid Waste Management, in an operating record the following information as it becomes available.

(i) Inspection records, waste determination records, and training procedures;

(ii) Amounts by weight of solid waste received at the landfill to include source of generation.

(iii) Gas monitoring results and any remediation plans;

(iv) Any demonstration, certification, findings, monitoring, testing or analytical data required for surface and groundwater monitoring;

(v) Any monitoring, testing or analytical data required for closure or post-closure; and,

(vi) Any cost estimates and financial assurance documentation.

b. All information contained in the operating record will be furnished upon request to the Division of Solid Waste Management or be made available at all reasonable times for inspection by the Division.

c. The County will maintain a copy of the operation plan at the landfill.

10. Spreading and Compacting Requirements

a. The landfill will restrict solid waste into the smallest area feasible.

b. Solid waste will be compacted as densely as practical into cells.

c. Appropriate methods such as fencing and diking will be provided within the area to confine solid waste subject to be blown by the wind. At the conclusion of each day of operation, all windblown material resulting from the operation will be collected and returned to the area.

Section III

CLOSURE PLAN

CLOSURE PLAN

Alexander County will cap their landfill within 180 days after the final receipt of solid waste. The cap system will consist of 12 inches, bridging material (temporary cover), 18 inches of soil liner with a permeability no greater than 1 x 10^{-5} cm/sec, and 18 inches of erosive layer. (Figure 1) The cap system will also include the proper seeding and mulching of the erosive layer and other erosion control devices.

CONSTRUCTION MATERIALS

General

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Cohesive Soil Liner

The soil for the cohesive soil liner shall consist of the red, orange, clayey silt on site if the mica content is less than 0.5 percent by weight passing the No. 200 Sieve and a permeability of 1 x 10^{-5} cm/sec or less is achieved. Off-site cohesive soils may be used if approved by the Engineer and if it provides a permeability of 1 x 10^{-5} cm/sec or lower. Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

Erosive Layer

The soil for the erosive layer shall be the best topsoil that is available on the site.

Gas Venting System

#57 stone, Geotextile fabric, 8" pvc pipe will be used in the construction of the Gas Venting System. Figure 2.

CONSTRUCTION METHODS

Subbase

(a) Subbase shall be the one foot of bridging material that has been installed as the temporary cover.

Cohesive Soil Liner

(a) A test strip of compacted cohesive soil liner shall be prepared and tested for particle size distribution analysis, Atterberg limits, triaxial cell laboratory permeability, moisture content, percent bentonite admixed with soil, and the moisture-density-permeability relation to general installation of the cohesive soil liner. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 125 ft. The test strip shall consist of at least two compacted 6 inch lifts of cohesive soil liner. Placement and testing of the test strip shall be in conformance with the construction specifications and requirements for general installation of the cohesive soil liner. Test results from the test strip shall be used to guide placement and achievement of the required maximum permeability of 1×10^{-5} cm/sec of the cohesive soil liner. The test strip may be used as an integral part of the overall cohesive soil liner if it meets the required specification for the liner.

(b) The soils shall be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6 inch compacted lift at a moisture content between 0 to 3% above optimum moisture to 95% Standard Proctor maximum dry density (ASTM Test Designation D698). The soils for the cohesive soil liner must be compacted wet of optimum if the desired permeability is to be obtained. A sheepsfoot roller or approved alternative may be used to compact the soil liner provided the compaction and permeability requirements can be achieved. Each lift shall be tested for moisture content, density and permeability prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil liner shall be screened, disked, or prepared using any other, approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. After each lift, the surface shall be scarified prior to the placement of the next lift to provide good bonding from one lift to the next.

(c) The cohesive soil liner shall be tested to evaluate the coefficient of permeability. The coefficient of permeability of the soil liner shall be equal to or less than 1.0×10^{-5} cm/sec after placement and compaction.

(d) Laboratory falling head permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil liner after placement and compaction. Tests shall be performed in accordance with the U. S. Army Corps of Engineers' "Permeability Testing on Sampling Tubes", EM 1110-2-1906, Appendix VII, 30 Nov. 70, paragraph 5, page VII-16, or approved alternative.

(e) A minimum of four soil samples each, per lift, per acre, of cohesive soil liner shall be secured for permeability testing. All permeability testing shall be on random samples judged by the Engineer to be representative of the most permeable soil conditions for the area being tested. Where tests do not indicate satisfactory permeability, the failing area shall be reworked and retested. If tests still do not indicate the desired permeability is being achieved, the compaction procedure or soil must be adjusted to achieve the desired permeability.

(f) A minimum of two (2) inches of soil shall be removed prior to securing each sample for permeability testing. The sampling tube shall be advanced vertically into the soil with as little soil disturbance as possible and should be pushed using a uniform pressure. The sampling tube (Shelby tube), when extracted, shall be free of dents, and the ends shall not be distorted. A back hoe or approved alternative should be used to advance the sampling tube (Shelby tube) as long as disturbance is minimized. Drive tube samples of the liner may be obtained for permeability testings. If the Engineer judges the sample to be too disturbed, another sample shall be taken. Once an acceptable sample has been secured and properly prepared, all sample excavations shall be backfilled to grade with similar soils in maximum 3-inch loose lifts and hand tamped with a blunt tool to achieve a tight seal equivalent to the original density.

(g) No additional construction shall proceed on the soil layers at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved.

(h) As a minimum, sufficient visual classifications (ASTM Test Designation D2488) and Atterberg limits (ASTM Test Designation D4318) shall be conducted in association with each permeability test to verify that the construction materials meet specifications. Where

mica content is in question, sufficient gradation analyses (ASTM Test Designation D422) shall be conducted to verify the mica content meets the required limit.

(i) If the soil for the cohesive soil liner is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory. Where additives are required, the soil shall be placed in maximum 8-inch thick loose lifts and compacted between 0 to +3% optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698) for the soil-additive mixture. All other compaction procedures for the soil apply.

(j) The cohesive soil liner shall be protected from desiccation, flooding and freezing. Protection, if required, may consists of a thin plastic protective cover, (or other material as approved by the engineer) installed over the completed cohesive soil liner until such time as the placement of the erosive layer begins. Areas found to have desiccation cracks or which exhibit swelling, heaving or other similar conditions shall be replaced or reworked by the contractor to remove these defects.

(k) The project engineer shall include a discussion of all quality control testing required in the construction quality assurance report. The results of all testing shall be included in the construction quality assurance report including documentation of any failed test results, descriptions of the procedures used to correct the improperly installed material, and statements of all retesting performed in accordance with the Division approved plans.

(l) The project engineer shall certify that the liner was constructed using the methods and acceptance criteria consistent with test pad construction and tested according to the Division approved plans.

(m) A Construction quality assurance (CQA) report shall be submitted after completing construction of the cap system. The CQA report shall include, at a minimum, results of all construction quality assurance and construction quality control testing required, including documentation of any failed test results, descriptions of procedures used to correct the improperly installed material and results of all retesting performed. The CQA report shall contain as-built drawings noting any deviation from the approved engineering plans and shall also contain a comprehensive narrative including but not limited to

daily reports from the project engineer and a series of color photographs of major project features.

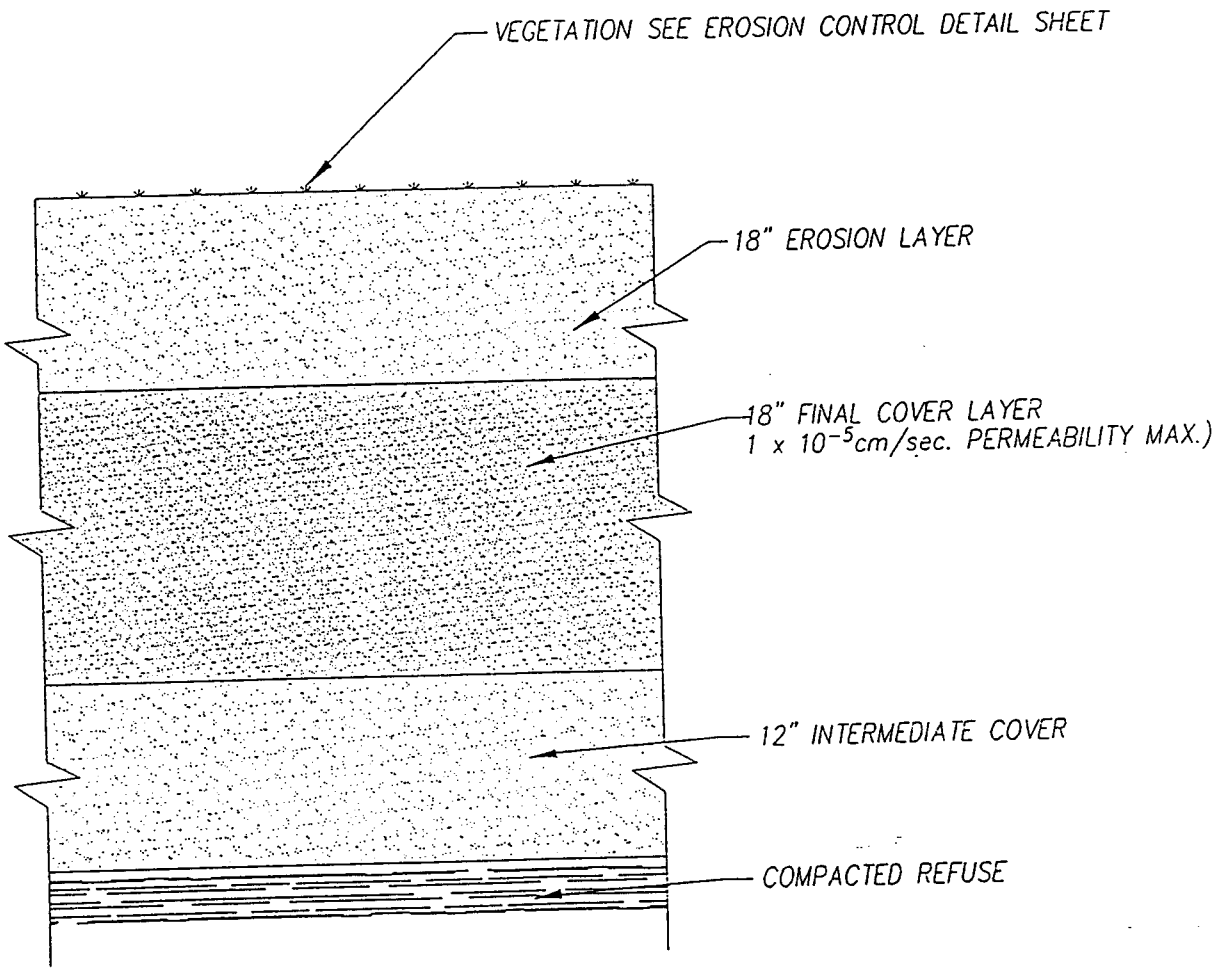
(n) The CQA report shall bear the seal of the project engineer and a certification was completed in accordance with the CQA plan, conditions of the permit to construct, the requirements of this section, and acceptable engineering practices.

Prior to beginning closure, Alexander County shall notify the Division of Solid Waste that a notice of the intent to close the unit has been placed in the operating record. The County shall begin closure activities no later than 30 days after the date on which the landfill receives the final wastes; or if the landfill has remaining capacity and there is a reasonable likelihood that the landfill will receive additional wastes, no later than one year after the most recent receipt of wastes. Extensions beyond the one-year deadline for beginning closure may be granted by the Division of Solid Waste if the County demonstrates that the landfill has the capacity to receive additional waste and the County has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the closed landfill.

The County shall complete closure activities in accordance with the closure plan within 180 days following the final receipt of waste. Extensions of the closure period may be granted by the Division of Solid Waste if the County demonstrates that closure will, of necessity, take longer than 180 days and the County has taken and will continue to take all steps to prevent threats of human health and environment from the enclosed landfill.

Following closure of each MSWLF unit, Alexander County shall notify the Division of Solid Waste that a certification, signed by the project engineer verifying that closure has been completed in accordance with the closure plan, and has been placed in the operating record.

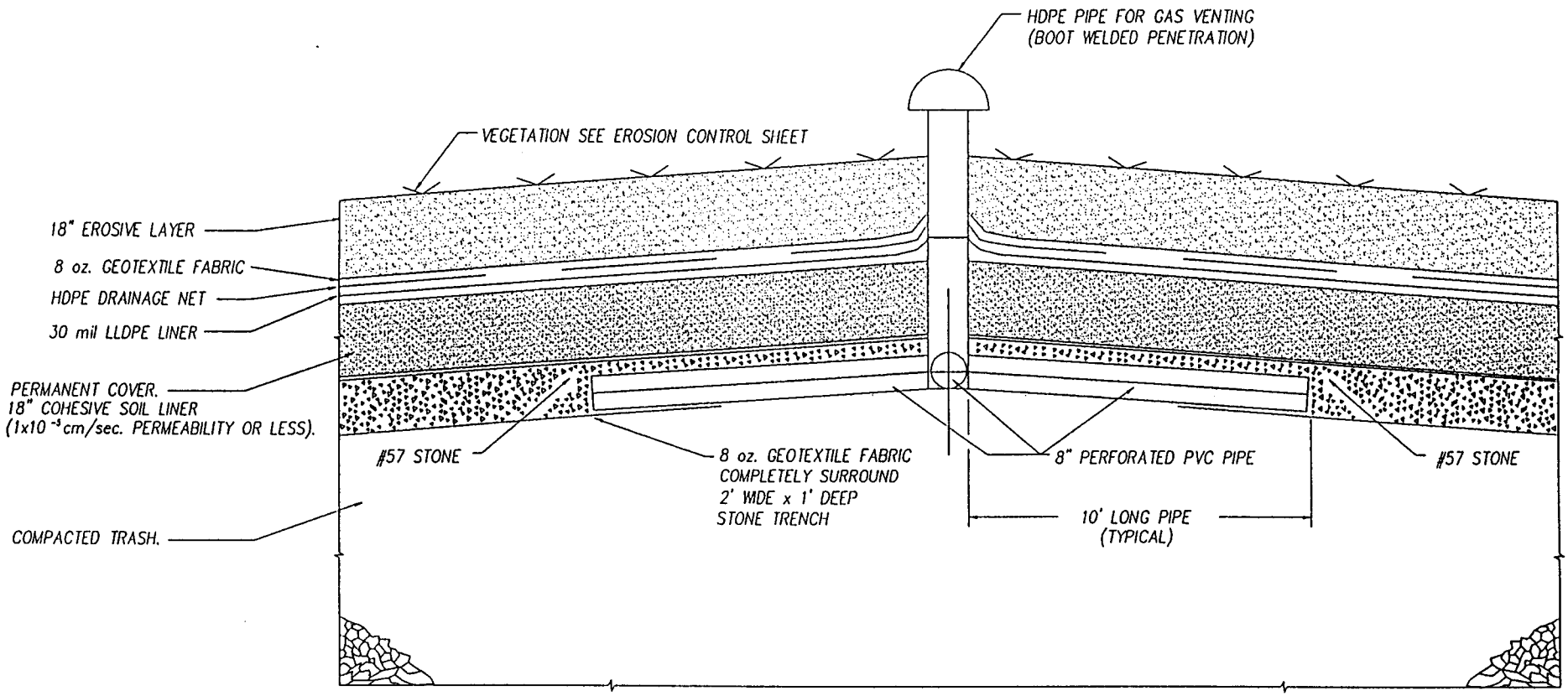
Following closure of all MSWLF units, the County shall record a notation on the deed to the landfill property and notify the Division of Solid Waste that the notation has been recorded and a copy has been placed in the operating record. The notation on the deed shall in perpetuity notify any potential purchaser of the property that the land has been used as a landfill and its use is restricted under the closure plan approved by the Division of Solid Waste. The County may request permission from the Division to remove the notation from the deed if all wastes are removed from the landfill.



FINAL COVER DETAIL

SCALE: NTS

Figure I



TYPICAL METHANE GAS COLLECTION TRENCH DETAIL

NOT TO SCALE

FILENAME: LFCLOSE2.DWG

Figure 2

SLOPE STABILITY ANALYSIS

ALEXANDER COUNTY LANDFILL

gai

GAI CONSULTANTS

GAI Consultants-NC, In

3812-H Tarheel Drive
Raleigh, NC 27609
919/878-4478
FAX: 919/878-4032

November 3, 1994

Mr. Wayne Sullivan
Municipal Engineering Services Company
Post Office Box 97
Garner, North Carolina 27529

Re: Stability Analyses
Various Existing Landfills

Dear Mr. Sullivan:

Slope stability analyses were conducted on existing landfills for Alexander, Caldwell, Cherokee, Granville, Greene, Lenoir, Scotland, Surry (2), Transylvania, and Wayne Counties and City of Albemarle for Transition Plans prepared and submitted in April 1994. The stability analyses were based on existing site conditions and closure plans for the landfills, which included a 6-inch erosive layer over the landfill cover. Closure plans for the landfills have been changed to include a 18-inch erosive layer over the cover. The impact of such a change to the landfill cover configuration is considered to be minimal to the stability analyses previously submitted. Additional erosive material will slightly increase shear resistance without appreciably increasing driving forces. Therefore, the impact, however slight, with all other things equal, will be an increase in the factor of safety against slope instability.

Sincerely,

GAI Consultants-NC, Inc.

Wendell W. Parker

Wendell W. Parker, Ph.D., P.E.
Vice President

WWP/tjt

NORTH CAROLINA PROFESSIONAL SEAL 15945 ENGINEER WENDELL W. PARKER

Slope Stability Analysis

Circular slip surface analyses were conducted on a selected critical section of the landfill closure configuration to evaluate factors of safety against stability failures. A cross section of the landfill closure considered to be critical was plotted based on available subsurface information and subgrade and final landfill configuration contours. Subsurface information was obtained from the report dated March 11, 1994 entitled, "Ground and Surface Water Monitoring System, Alexander County Landfill, Taylorsville, North Carolina" by GAI Consultants.

Materials composing the closure of the landfill consist of subgrade soil, refuse, and soil cover. The soil cover consists of 1 foot of bridging soil directly over the refuse, 1.5 feet of soil having a coefficient of permeability of 1×10^{-5} cm/sec, and 6 inches of erosion soil cover.

The landfill is in a seismic impact zone,defined as any area having a 10 percent or greater probability that the maximum expected horizontal acceleration in hard rock, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10g in 250 years. The landfill lies in the area of a seismic coefficient of 0.13g as defined by Algermissen, et al, 1990. The stability was evaluated for both the static case and seismic conditions using a seismic coefficient of 0.13g.

The thickness of the subgrade soil which may affect the stability of the landfill slopes was estimated to be about 20 ± feet thick. The subgrade soil was considered to have an angle of internal friction of 25 degrees, a cohesion of 0 pounds per square feet (psf), and a unit weight of 120 pounds per cubic feet (pcf).

Engineering properties of the refuse were estimated based on a conservative approach. It has been observed that high strains are required to mobilize the peak strength of refuse. Researchers at West Virginia University have performed triaxial tests on paper waste, and they report the angle of internal friction ranges from 40 to 45 degrees. The inclusion of debris other than paper would not tend to decrease the friction angle, and the debris and general refuse will be compacted by rollers into layers or lifts. Refuse buried at a significant depth will tend to develop high strains due to overburden pressures. Therefore, an angle of internal friction of 25 degrees for refuse was conservatively used in the stability analysis. In reality, the angle of internal friction may be higher than was used but for purposes of assessing the factors of safety for landfill stability, 25 degrees is considered appropriate and conservative. The unit weight of refuse used is 40 pcf from NAVFACS Design Manual 7.3 (April 1983), for a non-shredded landfill with good compaction. No cohesion of the refuse was considered.

The soil cover materials were considered and are specified to be or equivalent to an angle of internal friction of 25 degrees and cohesion of 250 psf. The unit weight for the soil cover was considered to be 125 pcf. These data should be achieved or exceeded by the soil cover and verified.

Groundwater was not considered to impact stability. State regulations require groundwater to be maintained four feet or more below the base of the landfill. Adequate drainage and seepage controls are requirements for landfills to maintain the groundwater below the required levels; therefore, groundwater is not considered to affect stability.

A critical section was selected based on the relationship between the slopes of the subgrade and the final landfill configuration. Only circular slip surface failures were considered since the critical section has a broad base and would not tend to fail in a wedge configuration. Circular failure surfaces were analyzed using the computer program REAME (Rotational Equilibrium Analysis of a Multi-layered Embankment). This method is based on the simplified Bishop method of stability analysis. A series of circles specified along a grid were analyzed. Once a circle with a minimum factor of safety has been determined within the grid, the program searches around the center to find the circle with the lowest computed factor of safety.

Based on the material properties and the geometry of the landfill, the minimum factors of safety computed against a deep seated failure are 1.7 for the static case and 1.2 for the seismic case. These minimum factors of safety meet or exceed the requirements as set forth in the US EPA Technical Manual for Solid Waste Disposal Facility Criteria, November 1993. Computations on the stability analyses are attached. Documentation on the computer program, REAME, was previously provided to the Solid Waste Section.

REAME.BASIC, MAY 1, 1991 VERSION
COPYRIGHT, CIVIL ENGINEERING SOFTWARE CENTER
UNIVERSITY OF KENTUCKY, LEXINGTON, KY 40506

FILE NAME -ALEXAND

INPUT FROM FILE (NINPUT)?(ENTER 1 WHEN INPUT FROM FILE & 0 WHEN NOT) 1

TITLE -ALEXANDER COUNTY LANDFILL CLOSURE

NO. OF STATIC AND SEISMIC CASES- 2

CASE NO. 1 SEISMIC COEFFICIENT= 0

NO. OF BOUNDARY LINES= 4

NO. OF POINTS ON BOUNDARY LINE 1 = 6
1 X COORD.= 0 Y COORD.= 970
2 X COORD.= 121 Y COORD.= 990
3 X COORD.= 135 Y COORD.= 1000
4 X COORD.= 290 Y COORD.= 1020
5 X COORD.= 330 Y COORD.= 1030
6 X COORD.= 430 Y COORD.= 1035

NO. OF POINTS ON BOUNDARY LINE 2 = 5
1 X COORD.= 148 Y COORD.= 1021
2 X COORD.= 220 Y COORD.= 1030
3 X COORD.= 290 Y COORD.= 1040
4 X COORD.= 330 Y COORD.= 1050
5 X COORD.= 430 Y COORD.= 1055

NO. OF POINTS ON BOUNDARY LINE 3 = 4
1 X COORD.= 135 Y COORD.= 1020
2 X COORD.= 148 Y COORD.= 1021
3 X COORD.= 296 Y COORD.= 1071
4 X COORD.= 430 Y COORD.= 1077

NO. OF POINTS ON BOUNDARY LINE 4 = 7
1 X COORD.= 0 Y COORD.= 990
2 X COORD.= 68 Y COORD.= 1000
3 X COORD.= 121 Y COORD.= 1010
4 X COORD.= 135 Y COORD.= 1020
5 X COORD.= 140 Y COORD.= 1022
6 X COORD.= 296 Y COORD.= 1074
7 X COORD.= 430 Y COORD.= 1080

LINE NO. AND SLOPE OF EACH SEGMENT ARE:

1	+0.165	+0.714	+0.129	+0.250	+0.050	
2	+0.125	+0.143	+0.250	+0.050		
3	+0.077	+0.338	+0.045			
4	+0.147	+0.189	+0.714	+0.400	+0.333	+0.045

MIN. DEPTH OF TALLEST SLICE= 5
NO. OF RADIUS CONTROL ZONES= 1

RADIUS DECREMENT FOR ZONE 1 = 0
NO. OF CIRCLES FOR ZONE 1 = 5
ID NO. FOR FIRST CIRCLE FOR ZONE 1 = 1
NO. OF BOTTOM LINES FOR ZONE 1 = 1

FOR ZONE 1 LINE SEQUENCE 1
LINE NO.= 1 BEG. NO.= 1 END NO.= 6

SOIL NO.	COHESION	FRIC. ANGLE	UNIT WEIGHT
1	0	25	120
2	0	25	40
3	250	25	125

USE PHREATIC SURFACE
UNIT WEIGHT OF WATER= 62.4
USE GRID
NO. OF SLICES= 10 NO. OF ADD. RADII= 3

NO. OF POINTS ON WATER TABLE= 6
1 X COORD.= 0 Y COORD.= 970
2 X COORD.= 121 Y COORD.= 990
3 X COORD.= 135 Y COORD.= 1000
4 X COORD.= 290 Y COORD.= 1020
5 X COORD.= 330 Y COORD.= 1030
6 X COORD.= 430 Y COORD.= 1035

NO. OF SOILS WITH DIFFERENT WATER TABLE= 0
NO. OF SOILS WITH DIFFERENT PORE PRESSURE RATIO= 0

INPUT COORD. OF GRID POINTS 1,2,AND 3

POINT 1 X COORD.= 160 Y COORD.= 1180
POINT 2 X COORD.= 160 Y COORD.= 1080
POINT 3 X COORD.= 260 Y COORD.= 1080

X INCREMENT= 8 Y INCREMENT= 8
NO. OF DIVISIONS BETWEEN POINTS 1 AND 2= 5
NO. OF DIVISIONS BETWEEN POINTS 2 AND 3= 5
ONLY F. S. AT EACH CENTER WILL BE PRINTED
SLICES WILL BE SUBDIVIDED

AUTOMATIC SEARCH WILL FOLLOW AFTER GRID

WARNING IN THE FOLLOWING TABLE INDICATES HOW MANY TIMES THE MAXIMUM RADIUS IS LIMITED BY THE END POINTS OF GROUND LINES

CENTER X COORDINATE	CENTER Y COORDINATE	NO. OF CIRCLE TOTAL	CRITIC.	RADIUS	LOWEST F.S.	WARNING
160	1180	11	4	156.269	1.745	0

160	1160	11	4	136.950	1.782	0
160	1140	11	4	117.632	1.832	0
160	1120	11	9	96.855	1.884	0
160	1100	11	9	77.580	1.964	0
160	1080	11	9	58.304	2.088	0
180	1180	11	8	153.226	1.724	0
180	1160	11	8	133.865	1.754	0
180	1140	11	8	114.503	1.797	0
180	1120	11	4	93.495	1.854	0
180	1100	11	4	74.177	1.933	0
180	1080	11	4	54.858	2.076	0
200	1180	11	9	144.668	1.732	0
200	1160	11	8	129.234	1.760	0
200	1140	11	4	107.995	1.807	0
200	1120	11	4	88.676	1.869	0
200	1100	11	9	67.566	1.967	0
200	1080	11	9	48.291	2.143	0
220	1180	6	5	133.204	1.849	0
220	1160	11	10	118.276	1.797	0
220	1140	11	9	101.110	1.820	0
220	1120	11	9	81.835	1.893	0
220	1100	11	10	60.579	2.009	0
220	1080	6	5	37.473	2.277	0
240	1180	6	5	127.632	2.083	0
240	1160	6	5	108.486	1.988	0
240	1140	6	5	89.340	1.913	0
240	1120	6	5	70.194	1.985	0

240	1100	6	5	51.048	2.100	0
240	1080	6	5	31.902	2.369	0
260	1180	11	10	127.111	2.492	0
260	1160	7	5	102.914	2.405	0
260	1140	7	5	83.768	2.263	0
260	1120	7	5	64.622	2.146	0
260	1100	6	5	45.476	2.133	0
260	1080	6	5	26.330	2.564	0

AT POINT (180 1180)RADIUS 153.226

THE MINIMUM FACTOR OF SAFETY IS 1.724

WARNING IN THE FOLLOWING TABLE INDICATES HOW MANY TIMES THE MAXIMUM RADIUS IS LIMITED BY THE END POINTS OF GROUND LINES

CENTER X COORDINATE	CENTER Y COORDINATE	NO. OF TOTAL	CIRCLE CRITIC.	LOWEST RADIUS	WARNING F.S.
180	1180	11	8	153.226	1.724	0
188	1180	11	7	153.225	1.722	0
196	1180	11	4	147.595	1.722	0
188	1188	11	8	159.119	1.707	0
188	1196	11	4	164.978	1.702	0
188	1204	11	9	170.802	1.707	0
196	1196	11	9	161.089	1.724	0
180	1196	11	8	168.715	1.702	0
190	1196	11	4	164.496	1.707	0
186	1196	11	8	167.326	1.703	0
188	1198	11	4	166.909	1.701	0
188	1200	11	4	168.841	1.703	0

190	1198	11	4	166.428	1.709	0
186	1198	11	4	167.391	1.701	0
184	1198	11	8	169.725	1.697	0
182	1198	11	8	170.189	1.694	0
180	1198	11	8	170.652	1.698	0
182	1200	11	8	172.125	1.691	0
182	1202	11	8	174.061	1.693	0
184	1200	11	8	171.662	1.699	0
180	1200	11	8	172.588	1.693	0

AT POINT (182 1200)RADIUS 172.125

THE MINIMUM FACTOR OF SAFETY IS 1.691

CASE NO. 2 SEISMIC COEFFICIENT= .13

AUTOMATIC SEARCH WILL FOLLOW AFTER GRID

WARNING IN THE FOLLOWING TABLE INDICATES HOW MANY TIMES THE MAXIMUM RADIUS IS LIMITED BY THE END POINTS OF GROUND LINES

CENTER X COORDINATE	CENTER Y COORDINATE	NO. OF TOTAL	CIRCLE CRITIC.	LOWEST RADIUS	WARNING F.S.
160	1180	11	4	156.269	1.211	0
160	1160	11	4	136.950	1.235	0
160	1140	11	4	117.632	1.267	0
160	1120	11	7	101.230	1.308	0
160	1100	11	7	81.826	1.361	0
160	1080	11	9	58.304	1.445	0
180	1180	11	8	153.226	1.196	0
180	1160	11	8	133.865	1.218	0

180	1140	11	8	114.503	1.248	0
180	1120	11	4	93.495	1.290	0
180	1100	11	4	74.177	1.348	0
180	1080	11	4	54.858	1.450	0
200	1180	11	9	144.668	1.201	0
200	1160	11	8	129.234	1.222	0
200	1140	11	4	107.995	1.256	0
200	1120	11	4	88.676	1.302	0
200	1100	11	9	67.566	1.372	0
200	1080	11	9	48.291	1.500	0
220	1180	11	10	137.508	1.257	0
220	1160	11	10	118.276	1.243	0
220	1140	11	9	101.110	1.265	0
220	1120	11	9	81.835	1.319	0
220	1100	11	10	60.579	1.402	0
220	1080	6	5	37.473	1.597	0
240	1180	11	10	132.313	1.371	0
240	1160	6	5	108.486	1.356	0
240	1140	6	5	89.340	1.326	0
240	1120	11	10	74.617	1.334	0
240	1100	6	5	51.048	1.468	0
240	1080	6	5	31.902	1.663	0
260	1180	11	9	129.639	1.554	0
260	1160	11	10	107.886	1.522	0
260	1140	7	5	83.768	1.500	0
260	1120	7	5	64.622	1.462	0
260	1100	6	5	45.476	1.490	0

260	1080	6	5	26.330	1.802	0

AT POINT (180 1180)RADIUS 153.226

THE MINIMUM FACTOR OF SAFETY IS 1.196

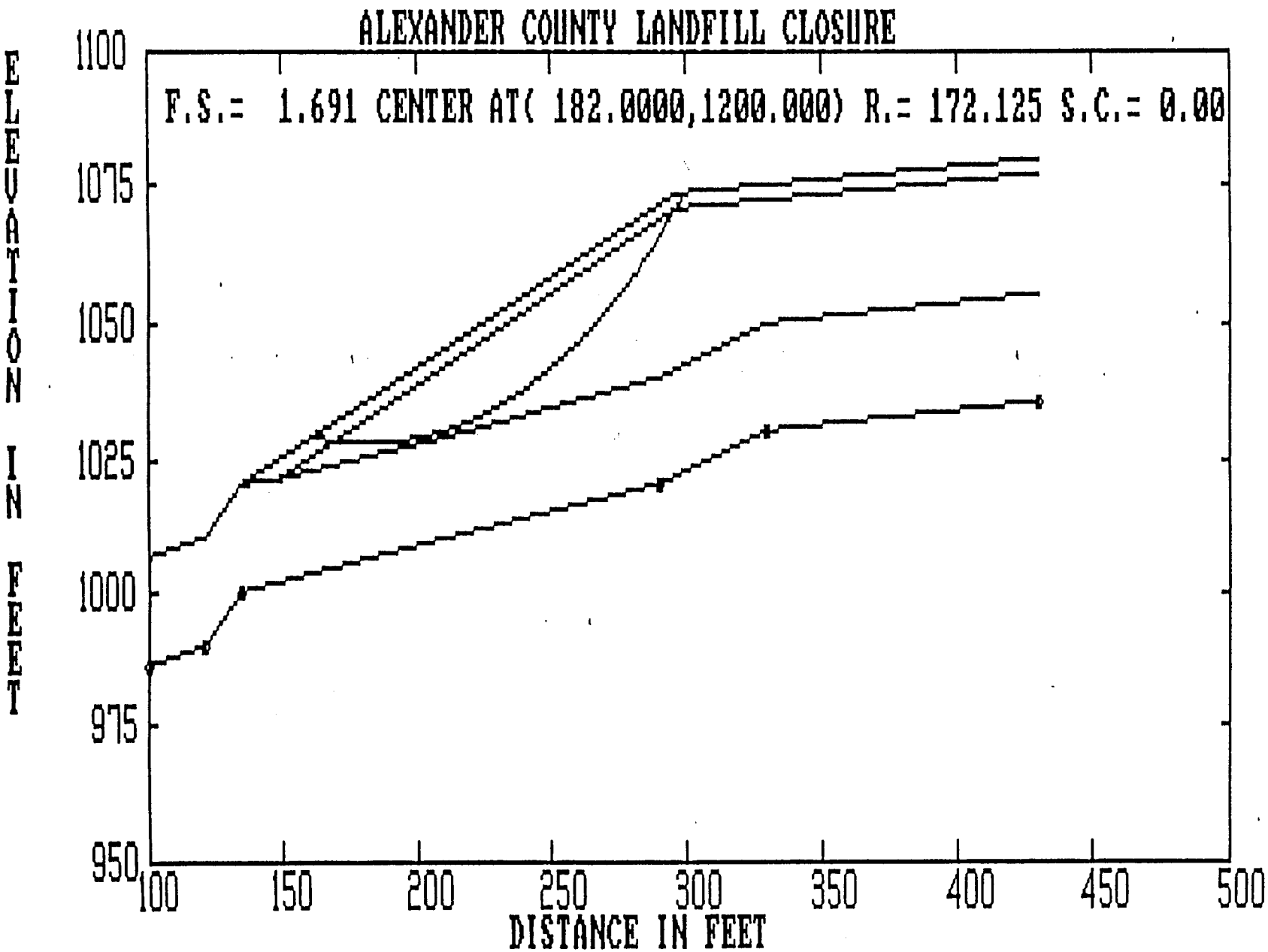
WARNING IN THE FOLLOWING TABLE INDICATES HOW MANY TIMES THE MAXIMUM RADIUS IS LIMITED BY THE END POINTS OF GROUND LINES

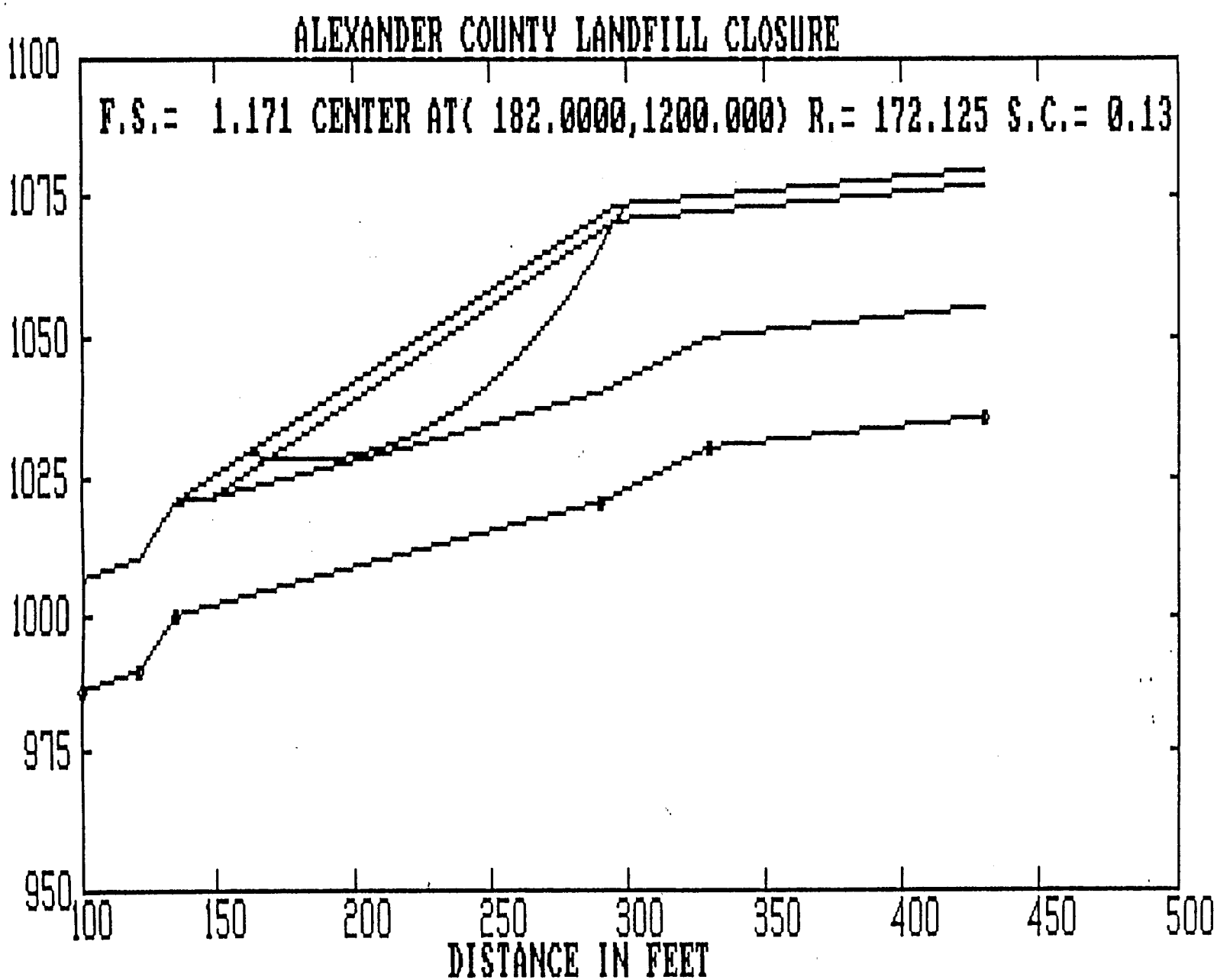
CENTER X COORDINATE	CENTER Y COORDINATE	NO. OF CIRCLE TOTAL	CRITIC.	LOWEST RADIUS	WARNING F.S.
180	1180	11	8	153.226	1.196	0
188	1180	11	7	153.225	1.193	0
196	1180	11	4	147.595	1.194	0
188	1188	11	8	159.119	1.182	0
188	1196	11	4	164.978	1.179	0
188	1204	11	4	172.705	1.179	0
196	1196	11	9	161.089	1.192	0
180	1196	11	7	170.526	1.179	0
190	1196	11	4	164.496	1.181	0
186	1196	11	8	167.326	1.178	0
184	1196	11	8	167.789	1.175	0
182	1196	11	8	168.252	1.177	0
184	1198	11	8	169.725	1.175	0
184	1200	11	8	171.662	1.175	0
186	1198	11	4	167.391	1.178	0
182	1198	11	8	170.189	1.174	0
180	1198	11	8	170.652	1.176	0
182	1200	11	8	172.125	1.171	0
182	1202	11	8	174.061	1.171	0

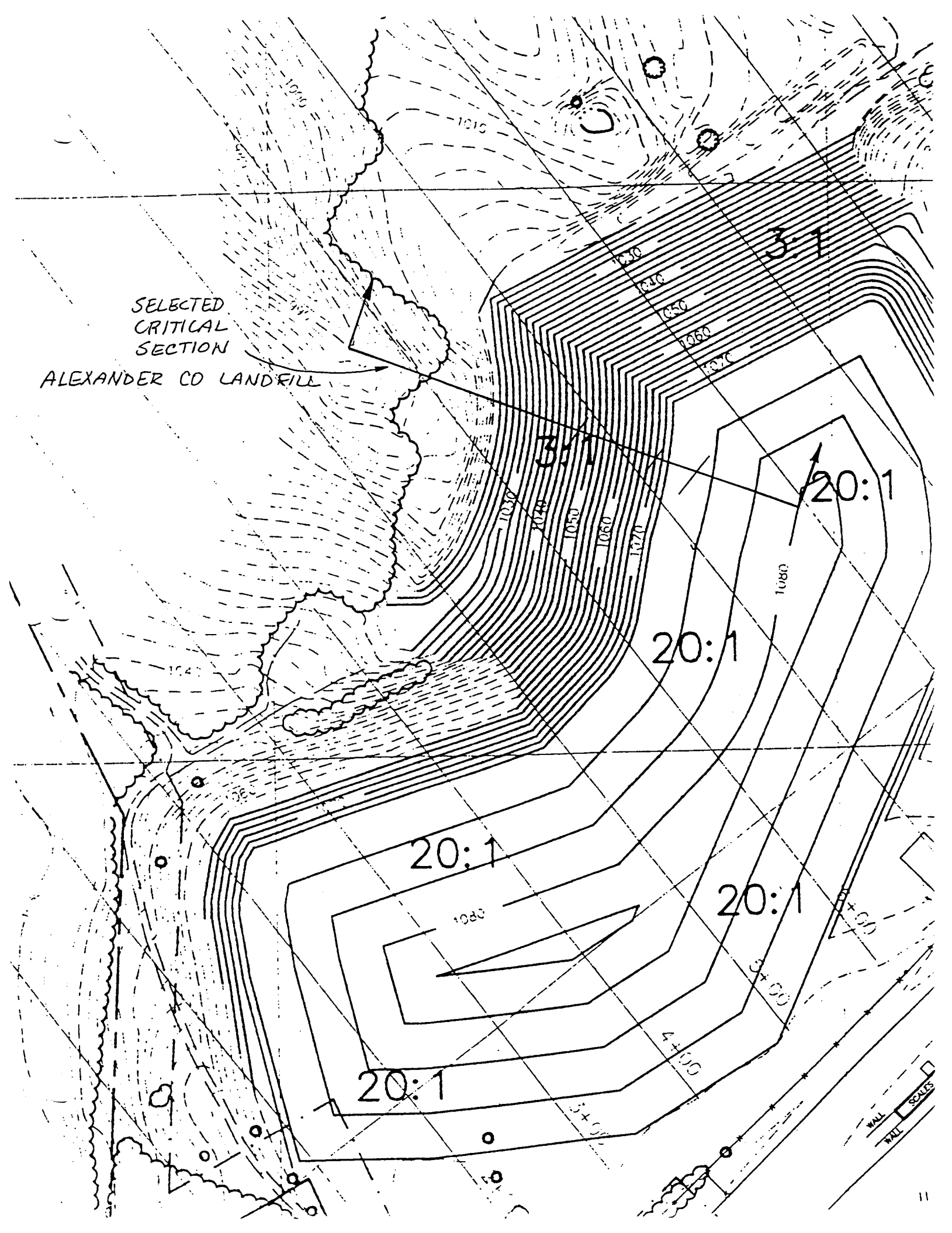
184	1200	11	8	171.662	1.175	0
180	1200	11	8	172.588	1.173	0

AT POINT (182 1200)RADIUS 172.125

THE MINIMUM FACTOR OF SAFETY IS 1.171


ALEXANDER COUNTY LANDFILL CLOSURE
F.S.= 1.691 CENTER AT(182.0000,1200.000) R.= 172.125 S.C.= 0.00
ELEVATION IN FEET
1100
1075
1050
1025
1000
975
950
100
150
200
250
300
350
400
450
500
DISTANCE IN FEET


ALEXANDER COUNTY LANDFILL CLOSURE
F.S.= 1.171 CENTER AT(182.0000,1200.000) R.= 172.125 S.C.= 0.13
1100
1075
1050
1025
1000
975
950
100
150
200
250
300
350
400
450
500
DISTANCE IN FEET


SELECTED
CRITICAL
SECTION
ALEXANDER CO LANDFILL
3:1
3:1
20:1
20:1
20:1
20:1
20:1
1010
1030
1040
1050
1060
1070
1080
3+00
4+00
WALL
SCALES

Section IV

POST-CLOSURE PLAN

POST CLOSURE PLAN FOR ALEXANDER COUNTY

CONTACTS:

Name:	Charles Mashburn
Title:	County Manager
Phone No.:	(704) 632-9332
Address:	255 Liledoun Road Taylorsville, N.C. 28681

DESCRIPTION OF USE:

Alexander County has no future use planned for their landfill at this time.

DESCRIPTION OF MAINTENANCE ACTIVITIES:

The Alexander County Landfill shall be monitored semiannually for evidence of settlement, subsidence and ponding in the cap system. The entire site shall be monitored semiannually for evidence and effects of erosion. The erosion control plan will be preserved. Annually in the Spring, the vegetative cover will be monitored to assure a good stand of vegetation, and where needed, it shall be reseeded. These maintenance activities shall take place over the entire post closure period of thirty years.

DESCRIPTION OF MONITORING ACTIVITIES:

The Alexander County Landfill shall monitor and analyze ground and surface water semi-annually for (Subtitle D Appendix I) constituents for a period of thirty years. The County shall also monitor methane gas at landfill structures and the boundary quarterly for the thirty-year period.

COMPLETION OF POST-CLOSURE CARE

Following completion of the post-closure care period for each MSWLF unit, the owner or operator shall notify the Division of Solid Waste that a certification, signed by a registered professional engineer, verifying that post-closure care has been completed in accordance with the post-closure plan, has been placed in the operating record.

Alexander County Sanitary Landfill Closure and Post Closure Costs

The largest area to be closed within the permitted life will be 6.5 acres. Post Closure will be 30 years after closure.

Closure Costs:

Closure will consist of the following which costs are estimated as being done by a third party.

1. 18" of 1×10^{-5} cm/sec. soil cover;
2. Erosion control devices;
3. 18" Erosive layer;
4. Seeding and mulching;
5. Mobilization/demobilization;
6. Labor costs;
7. Stone for methane gas collection;
8. Geotextile for methane gas collection;
9. Vent pipes for methane gas collection; and
10. Engineering costs.

Estimate of Probable Costs:

1. **18" of 1×10^{-5} cm/sec. soil cover for 6.5 acres:**

   Total yardage + 15% = 18,090 yd^3 @ a cost of \$3.15/yd^3

   ∴ Cost = \$56,984.00

2. **Erosion Control Devices**

   Estimated costs @ \$21,000.00

   ∴ Cost = \$21,000.00

3. **18" Erosive soil layer for 16 acres.**

   Total yardage + 15% = 18,090 yd^3 @ a cost of \$1.05 yd^3

   ∴ Cost (2) = \$18,995.00

4. **Seeding and Mulching for 16 acres.**

Estimated cost of $1,365.00/acre

∴ Cost = $8,873.00

5. **Mobilization/Demobilization.**

Estimated cost of $10,500.00

∴ Cost = $10,500.00

6. **Labor Costs.**

Estimated cost of $66,479.00

∴ Cost = $66,479.00

7. **Stone for methane gas collection.**

Total estimated linear feet = 1,900 feet
Total estimated volume for a 2' x 1' trench = 3,600 ft^3
with a density of 120 lbs/ft^3 total weight = 216 tons @ a cost of $15.75/ton

∴ Cost = $3,402.00

8. **Geotextile for methane gas collection.**

Total estimated linear feet = 1,900 feet
Total estimated perimeter for a 2' x 1' trench = 6 feet @ a cost of $0.18/$ft^2$

∴ Cost = $2,052.00

9. **Vent pipes for methane gas collection.**

Estimated cost @ $525.00

∴ Cost (2) = $1,050.00

10. **Engineering Costs for QA/QC of the soil liner and certification of closure.**

Estimated cost = $78,750.00

∴ Cost = $78,750.00

Total of Estimated Probable Costs:

1. $56,984.00
2. 21,000.00
3. 18,995.00
4. 8,873.00
5. 10,500.00
6. 66,479.00
7. 3,402.00
8. 2,052.00
9. 1,050.00
10. 78,750.00

Total: $268,085.00

Post Closure Costs:

Methane gas and ground and surface water will be monitored for 30 years after closure. The cap will also have to be monitored for the 30 year period.

1. **Ground and Surface Water monitoring semiannually for 30 years for Appendix I constituents and statistical analysis.**

   Estimated cost/sample = $735.00/sample
   Total annual samples = 2 (9 wells+5 surface) = 28 samples/year
   Estimated cost = 30 years x 28 samples/year x $735.00/sample
   = $617,400.00

   ∴ Cost = $617,400.00

2. **Methane Gas monitoring quarterly for 30 years.**

   Estimate $525.00/quarter = $2,100.00/year
   Estimated cost = 30 years x $2,100.00 = $63,000.00

   ∴ Cost = $63,000.00

3. **Cap Monitoring and repairing any problems.**

   Estimate $105,000.00 for the 30 years.

   ∴ Cost = $105,000.00

Total of Estimated Post Closure Costs:

1.	$617,400.00
2.	63,000.00
3.	105,000.00
Total	**$785,400.00**

Total Financial Assurances:

Total of Closure Costs	=	$268,085.00
Total of Post Closure Costs	=	785,400.00
TOTAL		**$1,053,485.00**

Section VI

WATER QUALITY MONITORING PLAN

GAI CONSULTANTS

GROUND AND SURFACE WATER SAMPLING AND ANALYSIS PLAN

FOR INCLUSION IN

EXISTING MUNICIPAL SANITARY LANDFILL TRANSITIONS PLANS
NORTH CAROLINA

NOVEMBER 1995

GROUND AND SURFACE WATER SAMPLING AND ANALYSIS PLAN

INTRODUCTION

The objective of the ground and surface water sampling and analysis plan is to provide clear guidelines and procedures to be followed by field and laboratory personnel when obtaining and testing ground and surface water samples.

The goal of the sampling plan is to obtain the desired sample while neither adding nor subtracting any constituent to or from the sample or the monitoring well. The plan details described below, when followed, are considered adequate to eliminate any cross-contamination or contamination from external sources of the wells sampled. These guidelines are drawn, in part, directly from and are intended to be used in conjunction with the N.C. Water Quality Monitoring Guidance Document for Solid Waste Facilities (Guidance Document); a copy is in Appendix A.

The goal of the analysis plan is to test and detect, if present, selected chemical constituents (Appendix I constituents) in the ground and surface water. Testing will be conducted to the desired detection levels with accuracy and precision under controlled sampling and testing procedures such that chemical constituents not present are neither added to the water nor detected.

SAMPLING EQUIPMENT

Groundwater samples will be obtained in the field using a dedicated, laboratory-cleaned, stainless steel bailer. Each bailer will be cleaned in a laboratory controlled environment prior to sampling in accordance with the following steps.

1. Completely disassemble bailer.
2. Phosphate-free, laboratory grade soap and distilled water wash.
3. Distilled water rinse.
4. Isopropyl alcohol rinse.
5. Distilled water rinse.
6. Air dry.
7. Wrap bailer in aluminum foil, shiny side out.
8. Wrap bailer in plastic.

In addition to laboratory cleaned bailers for each well sampled, standard equipment necessary to conduct the sampling includes sample containers, including trip blanks and equipment blanks, wide-mouth container, at least two 600-ft spools of ¼-inch nylon rope, at least two boxes of latex gloves, one box of large plastic bags, temperature indicator, pH indicator, conductivity indicator, water level indicator, storage coolers, and ice. In case of emergency, supplies to clean bailers as described above may also be brought to the site. If the total depth of all

wells to be sampled exceeds 1200 feet, additional spools of rope will be obtained to complete the sampling. If the number of wells to be sampled exceeds one third of the number of pairs of gloves in stock, additional boxes of gloves will be obtained.

The bailers, wrapped in foil and plastic, will be transported between pieces of peaked foam rubber to prevent damage to the wrappings. Other equipment subject to damage and contamination will be transported in sealed, plastic bags. The water level indicator will be cleaned in accordance with Steps 2 and 3 described above prior to placement in a clean plastic bag.

SAMPLE CONTAINERS

Various sample containers are required for a complete sampling and analysis effort. Routine groundwater and surface water monitoring may include the following:

- Volatile organic analysis (VOA),
- Total organic halogens (TOX), and
- Inorganic analysis, such as heavy metals or general chemistry.

Samples will be collected for the various analyses in the containers described below in the order listed.

Samples to be analyzed for VOA and/or TOX will be collected first in four 40-ml glass vials with teflon caps. The sample vials will be completely filled with no air left in the vials.

Samples to be analyzed for inorganic contamination will be collected next in two 1-quart/1-liter plastic containers.

Samples to be analyzed for complete organics, including acid-base neutrals, will be collected in a ½-gallon/2-liter glass jar with aluminum foil or teflon-lined caps.

Samples to be analyzed for radiologic parameters will be collected next in 1-gallon/4-liter plastic containers.

Samples to be analyzed for bacteriological parameters will be collected in one 120-ml plastic vial.

All sample containers will be obtained from an independent laboratory in a sterilized condition. Some of the containers will have a premeasured amount of preservative in them as necessary. In this event, care will be taken not to rinse the container or allow the preservative to wash out during sampling.

GROUNDWATER SAMPLING

Preparation. Sampling a groundwater monitoring well begins with unlocking and opening the locking cap and removing the PVC well cap. The depth to water will be determined using the water level indicator. Before storage and/or reuse, the water level indicator will be cleaned in accordance with Steps 2 and 3 described above and replaced in a clean plastic bag.

The total well depth read from the well tag and the measured depth to water will be used to compute the depth of water in the well. The total well depth will be measured and compared to the depth indicated on the well tag as a check for siltation or blockage at depth. Using the chart in the Guidance Document, the volume of water in the well will be determined. For example, if a two-inch well is 29 feet deep and has a measured depth to water of 10 feet, there are 19 feet of standing water or 3.3 gallons in the well. Each well will be purged three to five well volumes (quantity of water in the well), or until dry, prior to sampling. In the example, 10 gallons would be adequate. Purged water will be measured in 5-gallon buckets until the desired amount is purged. Care will be taken not to bring the bailer into contact with the bucket during purging.

Based on the number of wells to be sampled and their proximity to each other, all the wells may be purged one after another with sampling to follow. In this manner, if a well is purged dry, it will have time to recharge prior to sampling.

Purging. After the amount of water to be purged from a well is determined, the equipment necessary for purging will be assembled at the well including rope, 5-gallon bucket, bailer, and gloves. With the wrapped bailer maintained in a stable, upright position, the top portion of aluminum foil will be pulled away exposing only the eyelet used for securing the rope to the bailer. After the rope has been secured to the bailer with gloved hands, the bailer will be suspended as the aluminum foil and plastic are removed. The gloved hand used to remove the aluminum foil and plastic will be considered contaminated and may not come into contact with the bailer or rope. The bailer will be lowered slowly into the well using the uncontaminated, gloved hand that suspended the bailer until the bailer contacts the water. The rope will be cut to an adequate length and secured to prevent losing the bailer in the well. The gloves will be discarded and a new pair used during the purging.

In order not to allow the rope to touch the ground during purging, the rope will be gathered when raising the bailer either by gathering in loops in one hand or by the wind mill method. The wind mill method requires hooking the rope with alternating thumbs as the rope is pulled from the well. When purging deep wells, the ground around the well head may be covered with a clean plastic bag or sheet of plastic with a slit cut to allow the plastic to slide over the well head. The plastic will be placed over the sampler's boots to allow the rope to fall on the plastic without contamination. Alternatively, the rope may be lowered into an open bag placed in a 5-gallon bucket beside the well head. In any case, the rope will not contact anything considered contaminated including ground, boots, dirtied plastic, etc.

If purging and sampling of a well is performed at separate times, the bailer will be left suspended in the well above the water table and the rope secured. The remaining rope will be doubled and grasped in a tight loop in one hand. With the free hand, the glove on the hand holding the rope will be removed by pulling away from the hand and over the rope in an inside-out position until rope is encased in the glove. The rope will be transferred to the opposite hand and the procedure repeated to cover any portion of rope remaining uncovered. The glove-encased rope will be set on top of the well head until time to sample. Alternatively, the rope remaining after securing may be gathered in a tight loop and pushed into the 2-inch PVC well pipe and left. If sampling immediately follows purging, new gloves will not be necessary.

Equipment Blank. Prior to sampling the wells, an equipment blank will be prepared using a representative bailer. This procedure entails removing the top and bottom portions of the aluminum foil while sustaining the bailer in one hand, removing the lid of the bailer and filling with distilled water, and replacing the lid. The distilled water is then dispensed through the small holes at the top of the bailer into the appropriately labeled equipment blank containers.

Sampling. Prior to sampling the well, the necessary equipment will be assembled at the well, including pH, conductivity, and temperature indicators, sampling jars, a thoroughly cleansed wide mouthed container, and a box of latex gloves.

With gloves on, the bailer will be lowered into the well slowly. To avoid releasing any volatiles from the groundwater, care will be exercised while the bailer is lowered so that it does not splash or smack the water surface. Once full, the bailer will be retrieved and containers filled in the order described above. The containers will be filled by inverting the bailer until water issues from the small holes at the top of the bailer. In addition to collecting the samples, water will be collected in the wide-mouth container for pH, temperature, and conductivity measurements. The pH, temperature, and conductivity indicators and wide-mouth container will be rinsed with

distilled water after sampling each monitoring well and will be cleaned in accordance with Steps 2 through 5 above at the completion of the project.

Following completion of the sampling, the containers, including the equipment blank and trip blank, will be stored and transported on ice. The used latex gloves and rope will be discarded.

SURFACE WATER SAMPLING

Surface water samples will be obtained from adjacent rivers, streams, or brooks upstream and downstream of the landfill at designated surface water sampling sites. Actual collection points for surface water sampling will be selected with consideration given to minimal turbulence and aeration.

Surface water sample containers will be handled with one hand near the base. The container will be rinsed with the water to be sampled prior to filling the container unless the container contains a premeasured amount of preservative. When collecting surface water samples, sample containers will be dipped at location points with extreme caution in order to avoid contamination at the mouth of the container. The container will be pushed rapidly into the water to a depth of about six inches, mouth down, and tilted towards the stream current to fill. Care will be taken not to let the mouth of the container breech the surface while filling. If there is little current movement, the container will be moved slowly through the water laterally. During times of drought, if the water is not deep enough to allow submersion of the container, a pool may be scooped out of the bottom of the stream to obtain a sample. The pool will be allowed to clear before sampling. The container will be lifted from the water and sealed with the cap, leaving an airspace at the top of about ½ inch. Glass vial containers collected for VOA and TOX analyses will be filled completely as described above. The samples will be stored and transported on ice.

SAMPLE TRANSPORT AND CHAIN-OF-CUSTODY

Sample containers will be clearly labeled as the samples are obtained and stored on ice along with the equipment blanks and trip blanks. Trip blanks will remain in the condition they are received from the laboratory and will not be opened or tampered with during the sampling. A chain-of-custody record will be completed for each day's samples, indicating the date and time, sample location, sample matrix (soil, water, etc.), and laboratory analyses to be conducted. In addition, a field sampling data sheet will be completed indicating the depth to water measured in each well sampled and the pH, temperature, and specific conductivity of the sample measured in the field. Sample copies of the chain-of-custody record and field sampling data sheet are in Appendix B.

GROUND AND SURFACE WATER ANALYSIS

Water samples obtained in the field will be maintained in the sample containers on ice and transported to an approved laboratory for analysis. If the individual transporting the samples is different from the individual that did the sampling, the chain of custody forms will be used to document the transfer of custody from the water sampler to the water transporter. When the water samples reach the laboratory, they will be transferred to a sample custodian who will sign the chain of custody documentation for receipt of the samples. Internal control of the water samples in the laboratory will be in accordance with QA/QC procedures for the laboratory. Copies of QA/QC manuals for approved laboratories are on file with the Division of Solid Waste.

Ground and surface water samples will be analyzed for Subtitle D Appendix I constituents. Table 1 contains a list of the Appendix I constituents as well as a list of EPA methods to be utilized in detection of the constituents. References where these test methods are documented are also presented in Table 1. In addition, practical quantitation limits for each of the constituents and a list of the equipment that will be used in the laboratory testing are presented in Table 1. QA/QC procedures utilized during the testing will be in conformance with the laboratory QA/QC manual.

TABLE

TABLE 1
GROUND AND SURFACE WATER ANALYSES METHODOLOGY

Inorganic Constituent	Test Method	Equipment	PQL, µg/L
Antimony	EPA[1] 7041	GF/AA	30
Arsenic	EPA 7060A	GF/AA	10
Barium	EPA 6010A	ICP	500
Beryllium	EPA 7091	GF/AA	2
Cadmium	EPA 7131A	GF/AA	1
Chromium	EPA 7191	GF/AA	10
Cobalt	EPA 7201	GF/AA	10
Copper	EPA 6010A	ICP	200
Lead	EPA 7421	GF/AA	10
Nickel	EPA 6010A	ICP	50
Selenium	EPA 7740	GF/AA	20
Silver	EPA 7761	GF/AA	10
Thallium	EPA 7841	GF/AA	10
Vanadium	EPA 7911	GF/AA	40
Zinc	EPA 6010A	ICP	50
Organic Constituent			
Acetone	EPA 8260	GC/MS	100
Acrylonitrile	EPA 8260	GC/MS	200
Benzene	EPA 8260	GC/MS	5
Bromochloromethane	EPA 8260	GC/MS	5
Bromodichloromethane	EPA 8260	GC/MS	5
Bromoform	EPA 8260	GC/MS	5
Carbon disulfide	EPA 8260	GC/MS	100
Carbon tetrachloride	EPA 8260	GC/MS	10
Chlorobenzene	EPA 8260	GC/MS	5
Chloroethane	EPA 8260	GC/MS	10
Chloroform	EPA 8260	GC/MS	5
Dibromochloromethane	EPA 8260	GC/MS	5
1,2-Dibromo-3-chloropropane	EPA 8260	GC/MS	25

TABLE 1
(continued)

Organic Constituent	Test Method	Equipment	PQL, µg/L
1,2-Dibromoethane (Ethylene dibromide)	EPA 8260	GC/MS	5
1,2-Dichlorobenzene	EPA 8260	GC/MS	5
1,4-Dichlorobenzene	EPA 8260	GC/MS	5
trans-1,4-Dichloro-2-butene	EPA 8260	GC/MS	100
1,1-Dichloroethane	EPA 8260	GC/MS	5
1,2-Dichloroethane	EPA 8260	GC/MS	5
1,1-Dichloroethylene	EPA 8260	GC/MS	5
cis-1,2-Dichloroethylene	EPA 8260	GC/MS	5
trans-1,2-Dichloroethylene	EPA 8260	GC/MS	5
1,2-Dichloropropane	EPA 8260	GC/MS	5
cis-1,3-Dichloropropene	EPA 8260	GC/MS	10
trans-1,3-Dichloropropene	EPA 8260	GC/MS	10
Ethylbenzene	EPA 8260	GC/MS	5
2-Hexanone	EPA 8260	GC/MS	50
Methyl bromide	EPA 8260	GC/MS	10
Methyl chloride	EPA 8260	GC/MS	10
Methylene bromide	EPA 8260	GC/MS	10
Methylene chloride	EPA 8260	GC/MS	10
Methyl ethyl ketone	EPA 8260	GC/MS	100
Methyl iodide	EPA 8260	GC/MS	10
4-Methyl-2-pentanone	EPA 8260	GC/MS	100
Styrene	EPA 8260	GC/MS	10
1,1,1,2-Tetrachloroethane	EPA 8260	GC/MS	5
1,1,2,2-Tetrachloroethane	EPA 8260	GC/MS	5
Tetrachloroethylene	EPA 8260	GC/MS	5
Toluene	EPA 8260	GC/MS	5
1,1,1-Trichloroethane	EPA 8260	GC/MS	5
1,1,2-Trichloroethane	EPA 8260	GC/MS	5
Trichloroethylene	EPA 8260	GC/MS	5
Trichlorofluoromethane	EPA 8260	GC/MS	5

TABLE 1
(continued)

Organic Constituent	Test Method	Equipment	PQL, µg/L
1,2,3-Trichloropropane	EPA 8260	GC/MS	15
Vinyl acetate	EPA 8260	GC/MS	50
Vinyl chloride (Chloroethylene)	EPA 8260	GC/MS	10
Xylenes	EPA 8260	GC/MS	5

Legend

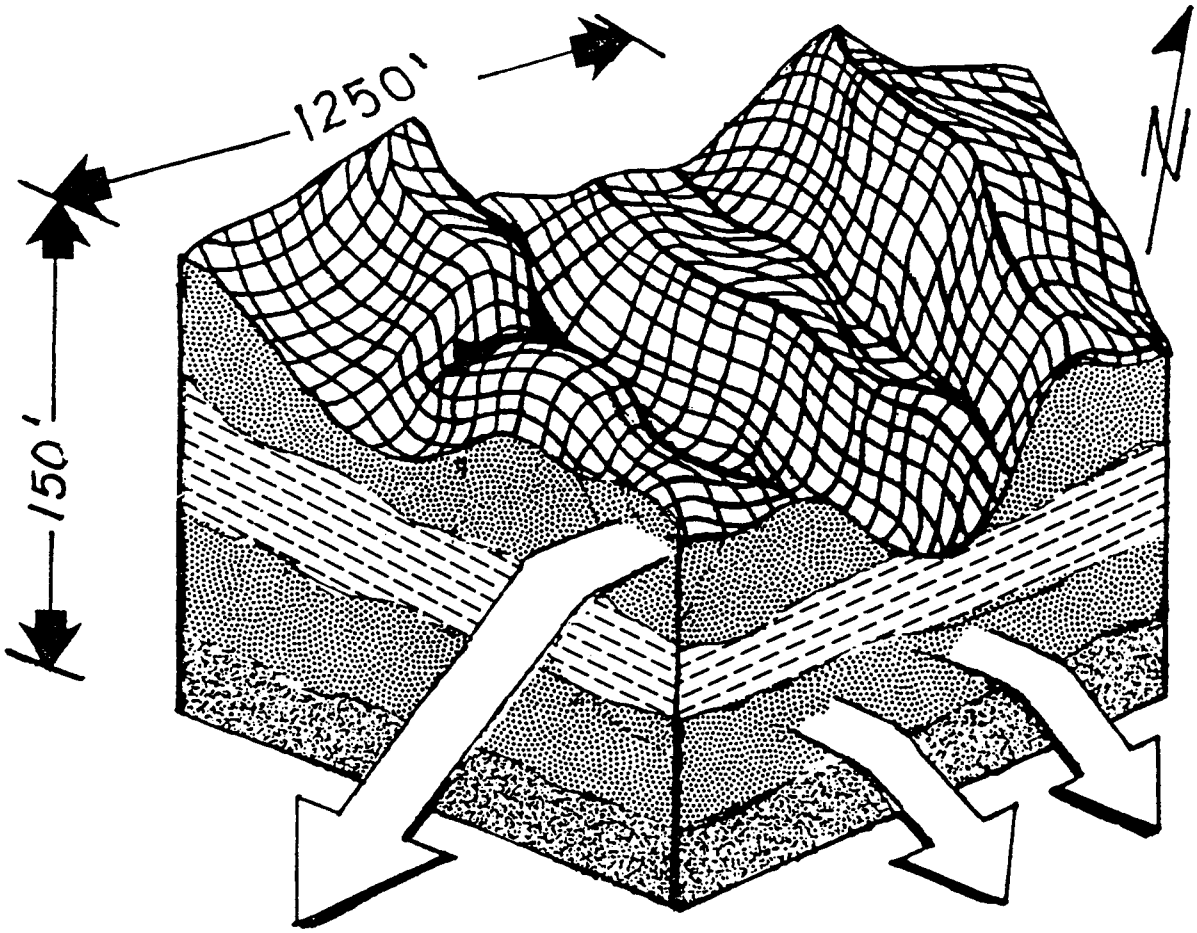
PQL	Practical Quantitation Limit
ICP	Inductively Coupled Plasma - Atomic Emission Spectrophotometer
GF/AA	Graphite Furnace - Atomic Absorption Spectrophotometer
GC/MS	Gas Chromatograph - Mass Spectrometer

Note: 1. EPA Test Methods from "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," U.S. EPA Publication SW-846, 3rd Edition, September 1986, Amended by Update I, July 1992. Update I methods are designated with the letter "A" on the end of the method numbers. Update I was promulgated by 58 FR, August 31, 1993.

APPENDIX A

N.C. WATER QUALITY MONITORING GUIDANCE DOCUMENT

NORTH CAROLINA WATER QUALITY
MONITORING GUIDANCE DOCUMENT FOR SOLID WASTE FACILITIES



GROUND-WATER FLOW
DIRECTION OF UPPER
AQUIFER

GROUND-WATER FLOW
DIRECTION OF LOWER
AQUIFER

Prepared by the
SOLID & HAZARDOUS WASTE MANAGEMENT BRANCH
ENVIRONMENTAL HEALTH SECTION
DIVISION of HEALTH SERVICES
DEPARTMENT of HUMAN RESOURCES
1987
SW-1001-87

NORTH CAROLINA WATER QUALITY
MONITORING GUIDANCE DOCUMENT FOR SOLID WASTE FACILITIES

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1987

SW-1001-87

LIST OF FIGURES

FIGURE PAGE

1. Typical Ground-Water Monitoring Well Schematic Diagram 2
2. Graphical Plot of Standing Water Volumes 4
3. Laboratory Analysis Request Sheet 9
4. Chain of Custody Form 10
5. Typical Ground-Water Monitoring Well Nest Schematic 14

TABLE OF CONTENTS

	PAGE
ACKNOWLEDGEMENTS	i
DEFINITIONS	ii
GENERAL INTRODUCTION	iii
INTRODUCTION	1
SPECIFIC MONITORING WELL CONSTRUCTION REQUIREMENTS	1
GROUND-WATER MONITORING	5
PORTABLE MONITORING	5
PURGING METHODS	5
SAMPLING METHODS	6
DEDICATED MONITORING	7
EQUIPMENT CLEANING PROCEDURES	7
SAMPLE CONTAINERS	8
TRANSPORT AND STORAGE OF SAMPLES	11
ADMINISTRATIVE PROCEDURES	11
SURFACE WATER MONITORING	12
FRACTURED WATER MONITORING	13
REFERENCES CITED	16

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Michael L. Babuin, 1987

DEFINITIONS

Monitoring Well - any well constructed for the primary or incidental purpose of obtaining subsurface samples of water or other liquids. This definition excludes lysimeters, tensiometers, and other devices used to investigate the characteristics of the unsaturated zone.

Observation Well - any well constructed for the purpose of obtaining ground-water level information only

Permittee - an individual, corporation, company, association, partnership, unit of local government, State agency, Federal agency or other legal entity upon which a permit to operate a sanitary landfill has been issued.

Water Table - the upper limit of the portion of the ground wholly saturated with water.

GENERAL INTRODUCTION

The purpose of this report is to provide a simple, clear and thorough overview of acceptable methods regarding ground and surface-water monitoring at solid waste facilities. The procedures and techniques outlined in this report have been compiled in response to the need for reliable, accurate and consistent data for ground-water and surface-water quality evaluation of sanitary landfills. The standardization of these methods of data collection will undoubtedly clarify proper ground-water monitoring techniques required by the State for all solid waste facilities, and subsequently, minimize much of the subjectivity associated with landfill evaluation. Clearly, it is in the best interests of each facility to utilize these guidelines whereas the probability of contamination is significantly reduced by following the steps outlined in this document.

INTRODUCTION

In order to fully acknowledge the scope and purpose of ground-water monitoring, it is of the utmost importance to fully understand and define the difference between a ground-water monitoring well and a public water supply well. This distinction is very obvious when comparing well construction techniques characteristic of various geologic formations throughout the State. For instance, the western part of North Carolina is dominated by a series of crystalline and metamorfic rocks. Subsequently, water supply wells in these regions typically are constructed by drilling through the saprolite (weathered rock) and into very hard, resistant rock bodies below the true water table. Because of the resistant lithologic character of these units, many well drillers feel that it is unnecessary to case a well characteristic of these type of conditions. This rationale may hold true for drinking water supply wells but is clearly unacceptable for ground-water monitoring purposes due to contamination problems associated with uncased or partially-cased holes and to possible logistic problems. For instance, monitoring equipment may become entangled on the bottom of a well casing which does not span the entire depth of the borehole. Subsequently, this office requires completely cased boreholes in all ground-water monitoring wells.

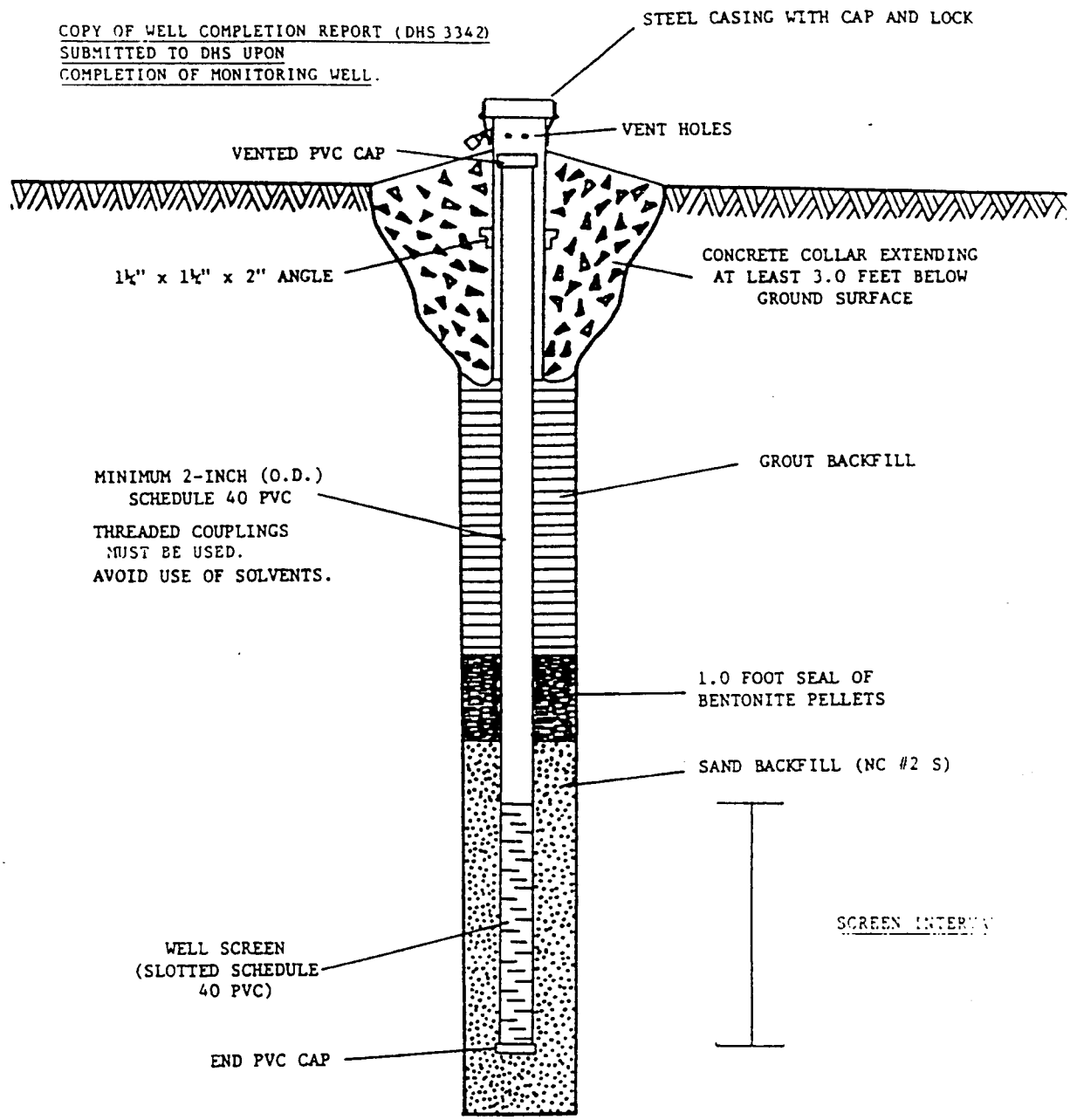
This office strongly urges all contractors and consultants to become familiar with well construction techniques and specifications illustrated on the ground-water monitoring well schematic (Figure 1). Further information regarding construction standards of other types of wells may be found in 15 NCAC 2C "Well Construction Standards: Criteria and Standards Applicable to Water Supply and Certain Other Types of Wells".

A. Specific Monitoring Well Construction Requirements

Because the location of ground-water monitoring wells at the proposed landfill is one of the most crucial phases of site development, the importance of a thorough hydrogeologic evaluation which clearly delineates ground water elevation and flow characteristics is of the highest significance. In order to assure consistent and thorough installation techniques which are in accordance with EPA regulations, all deviations to the following methods, or questions regarding materials, monitoring well locations or other techniques, should be directed to the Solid Waste Hydrogeologist at (919) 733-2178, c/o the Solid and Hazardous Waste Management Branch P.O. Box 2091 Raleigh, North Carolina 27602-2091. Additionally, the Solid and Hazardous Waste Management Branch reserves the right to evaluate in the field, the actual well installation techniques and procedures.

Drilling through the unsaturated soil mantle to the water bearing formation is a standard procedure with most consulting and well-drilling firms. Utmost caution and discretion in minimizing the use of drilling fluids (bentonite-gel mixture), flocculants (mixtures of sodium pyrophosphate) and excessive use of lubricants is highly recommended. If any of these products, or related products, are used in the drilling process the hole should be flushed to remove as much of the contaminants as possible.

Installation of the monitoring well and subsequent placement of the well screen is critical to assure that the ground water sample represents the



Rev. 5/86

Figure 1. Typical ground-water monitoring well schematic diagram.

portion of the aquifer where contaminants may migrate. The minimum length of the screened interval is 10 feet and will be placed at a depth specified as a condition of the permit based upon hydrogeologic data collected during the site investigation. Recommended screen depths will be submitted by the applicant under the heading "proposed comprehensive ground-water monitoring plan" as part of the site plan application as per section .0504 (1)(G)(iv). Well-sorted sand used as a pre-screening of influent ground water should be washed to remove all fines and prevent clogging of the well screen. Finally, in connecting sections of PVC pipe, clamps or threaded pipe fittings are required whereas various types of epoxy cement and other PVC glues have the potential for contaminating the ground-water reservoirs. For these reasons they are not authorized for construction of ground-water monitoring wells.

Various drilling methods and casing sizes are available for installation of monitoring wells. Generally, the most common size bore holes include those which are drilled with an eight inch hollow-stem auger. The casings which are placed in these holes are typically 4" or 2" I.D., and composed of PVC, stainless steel or teflon materials. For reasons which are discussed later under the "Ground-Water Monitoring" heading, this office recommends the use of 2" I.D. casings for wells drilled 100' or less. Ground-water monitoring wells drilled to depths exceeding 100' such as wells designed to monitor water quality through possible fracture patterns, should be cased with a 4" or 6" I.D. casing to readily promote rapid purging via jet pumps. Casings and screens may be composed of PVC or stainless steel. Teflon casings and screens are relatively maleable and may not hold-up under various conditions.

As mentioned above, this office recommends the installation of 2" I.D. cased wells for shallow and semi-shallow ground-water monitoring purposes. The use of 2" I.D. casings readily promotes rapid purging via teflon bailers. For example, a 2" I.D, cased well drilled 20 feet deep may contain up to approximately 3.3 gallons of standing water. Because three to five times the volume must be purged to avoid contamination (EPA, 1977), it is foreseeable that 9.9 to 16.5 gallons of water must be purged prior to sampling (Figure 2) in the above example. Assuming a purging minimum of 9.9 gallons of water, and also assuming that a 3' long bailer (which holds 1-liter of water) will be used for purging of the wells, it will take approximately 40 bails of water to adequately purge this well. Comparatively, a 4" I.D. cased well drilled to an extremely shallow depth of 16' will contain approximately 10.5 gallons of water, and subsequently, require between 31.5 and 52.5 gallons of purged water. Attempts to purge 52.5 gallons of water with a 1-liter bailer will require 210 bails of water-- which will undoubtly displease the field personnel and more importantly, occupy additional hours of expensive and needless labor as well.

An obvious difference shown on the schematic of a typical ground-water monitoring well (Figure 1), compared to other types of wells, is the concrete collar surrounding the stick-up (or outer casing) above the ground surface. This collar should contain small angle-irons attached to the outer casing as outlined on the diagram (Figure 1). The purpose of this set-up is to prevent accidental (or willfull) damage to the well whereas the stick-up could otherwise be pulled loose at the surface without the use of angle-irons to support the collar.

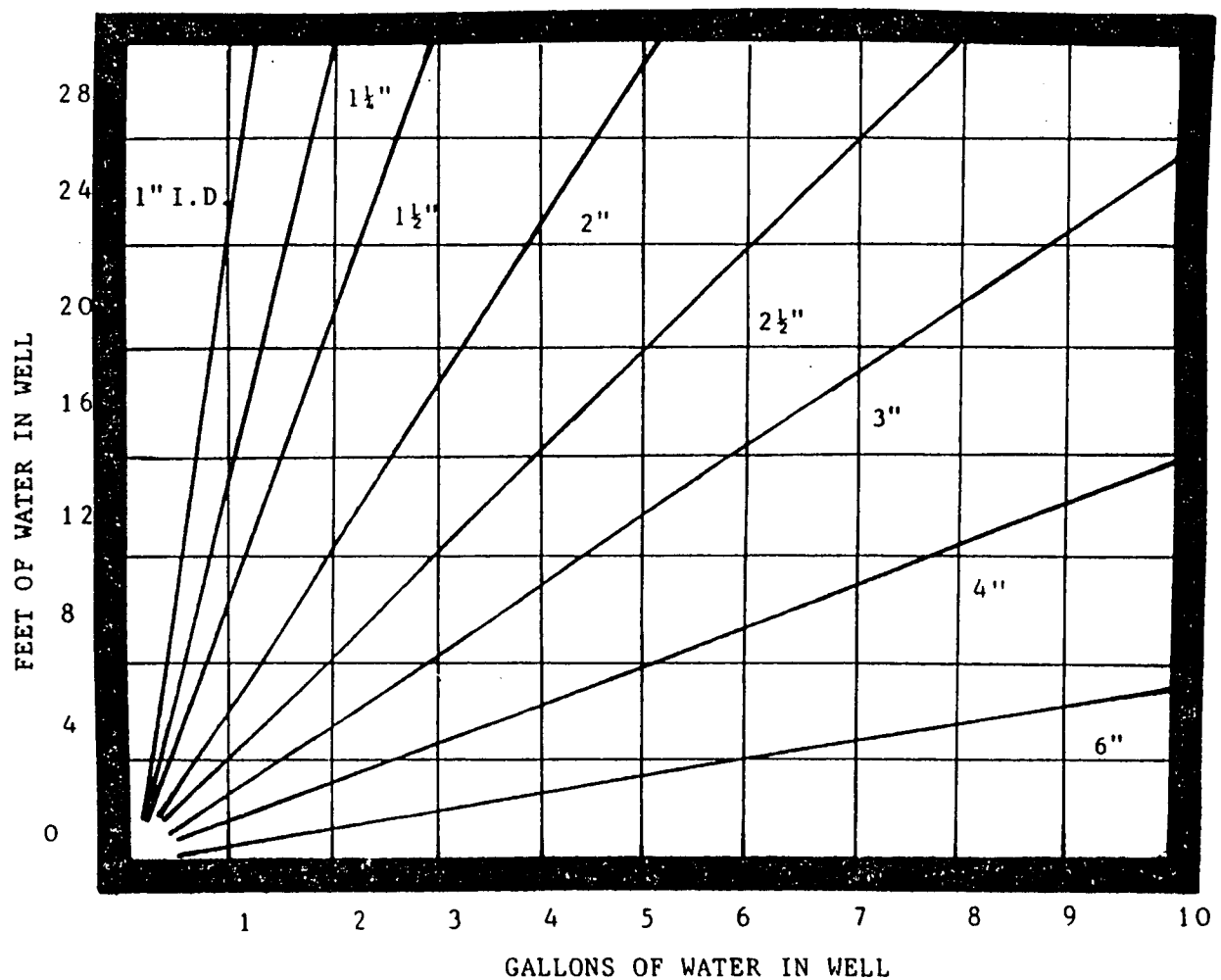


Figure 2. Graphical plot of standing volumes of water.

Because accidental or natural events may influence the status and condition of pre-existing ground-water monitoring wells, an on-going well inspection program is being conducted by personnel of the Solid andHazardous Waste Management Branch. Some of the items which must be regularily maintained by the facility after the wells are installed include: 1) ensuring that all caps are rust-free and locked at all times, 2) ensuring that all inner casings are securely fit with a threaded cap, 3) ensuring that the outer casing is upright and undamaged from equipment or vehicles which may inadvertently back-up into the well, 4) ensuring that a clear unobstructed path, free from dense vegetation exists leading to each well. These maintenance factors are critical to the implementation of proper ground-water monitoring.

B. Ground-Water Monitoring

Because a tremendous liability is associated with water quality data obtained from analytical laboratory results, it is of the utmost importance to ensure the validity and integrity of sampling techniques and methodology. Two distinct monitoring systems exist which may be used to purge and subsequently sample a monitoring well. These systems include the portable monitoring system and the dedicated monitoring system.

Portable Monitoring

The portable monitoring system is by far the most common method of monitoring ground-water quality. This method includes purging the total standing water within the well and subsequent sampling of a representative portion of the aquifer. Purging is required in all instances in order to avoid sampling of stagnant, possibly stratified water above the well screen. In many cases, however, the recharge rate may meet or exceed the purging rate. For these instances three to five times the volume of standing water must be purged prior to sampling. Several methods exist for removing the standing water within a well. Among these methods are various types of automated pumps, compressed air, hand pumps and bailers, each of which has several advantages and disadvantages which will be discussed below.

In some instances dependant upon the hydrogeologic setting, the recharge rate may be exceptionally slow (EPA, 1977), subsequently, sampling may not be possible until the next day when the well is recharged. Generally however, all attempts should be made to purge the wells dry or purge until the necessary three to five times the well volume is extracted. In other settings where the soils are relatively permeable purging and subsequent sampling may be possible in the same day.

1. Purging Methods

Depending upon time constraints and spatial variability of the monitoring wells, the decision whether to purge and sample a facility on the same day must be made by the field personnel performing the monitoring operation. Additional concerns regarding the depth of the well, water volumes, well access and inclement weather are all important in determining which type of device to use in purging the well. For instance, if fully automated, effortless purging is desired and time is not a major concern, the use of an automated pump may be in order. The major disadvantage of

these pumps, however, include slow pumping rates (typically a maximum of 0.5 gallons/minute) and the potential for cross contamination from well to well.

The hand pump is another type of purging device which is available invarious lengths and pumping rates (typically 2.75 gallons/minute). This device has the advantage of easy assembly, low cost and relatively high pumping rates. An obvious disadvantage, however, is the need for a thorough cleaning in the field before purging from one well to the next.

Another popular purging device is the teflon bailer. Teflon is considered to be the preferred material to use for ground water monitoring because of its relatively inert chemical character. Stainless steel is also an acceptable purging/sampling mechanism for similar reasons. Regardless of the composition, bailers are available in various lengths, the most popular being the 3' bailer which holds a volume of water equal to 1 liter or 0.26 gallons.

2. Sampling Methods

Thus far the focus of this discussion has primarily been upon purging techniques, subseqently, a short discussion which addresses sampling procedures is now in order. The use of automated pumps for sampling purposes requires considerable effort to avoid contamination. Many automated pumps are designed to remain on the ground surface while a specified length of flexible tubing is placed into the well. For sampling purposes if this technique is to be used, it is mandatory that the flexible tubing be composed of teflon and adequately cleaned prior to sampling from one well to another. The inevitable question arises, however, whether or not adequate cleaning is possible in the field for these types of automated pumps.

Because laboratory analyses evaluate water quality in terms of parts per million and parts per billion, it is not recommended to clean and prepare sampling devices in the field when a laboratory cleaning will undoubtedly produce a higher quality final product. Other types of automated pumps (called bladder pumps) are designed to fit down the borehole and are typically composed of teflon and stainless steel. One inherent difficulty associated with some bladder pumps in addition to possible sample contamination problems is the inability of many bladder pumps to adequately control and regulate the rate at which the flow of water leaves the flexible tubing. This is critical for samples to be analyzed for volatile organic analysis (VOA) whereas a rapid flow rate will cause aeration which subsequently volatilizes certain chemicals. For these reasons this office urges that the utmost consideration and thought be given to the feasibility of whether or not to utilize traditional automated pumps for sampling purposes.

Hand pumps are useful tools for purging wells in a relatively short period of time but, unfortunately, are highly unsuitable for sampling. The main reason being the likelihood of contamination and the unavailability of teflon or stainless steel hand-pumps in the commercial market. Additionally, no present technology exists for regulating the effluent discharge of water from a hand pump which, as mentioned before, presents a volatilization problem for certain samples.

The overall preferred method of acquiring ground-water samples via portable monitoring is by the use of telfon bailers. In a properly established and equipped laboratory setting, a standardized cleaning and preparation procedure may be followed. The obvious advantage of laboratorycleaning includes minimal generation of contaminants and consistency in preparatory procedures.

Dedicated Monitoring

Thus far the previous discussions have all focused upon techniques and procedures related to portable ground-water monitoring systems. At this time, a short overview of dedicated systems is in order. Dedicated well monitoring differs from portable monitoring primarily by the permanency of the set-up and the higher initial cost. Because portable systems require the use of much of the same equipment from well to well, great care must be exercised in avoiding cross contamination. Dedicated systems, however, require no between-well cleaning procedures. These systems offer permanently affixed down-well and well-head components which are capped after initial set-up.

Because ground water is not in contact with incompatible constituents that otherwise may enter the well from the surface, virtually no contamination is possible from an extrinsic source during times between sampling intervals. As with all sampling methods the competency and integrety of the individual extracting the sample is of the utmost importance. For instance, a great deal of manual dexterity must be exercised in regulating the flow of water leaving the flexible tubing from dedicated systems when collecting VOA samples in order to avoid unnecessary volatilization. In conclusion, dedicated systems have the potential for accurate and reliable ground-water monitoring and are therefore recommended for consideration.

In contrast to this, many individuals are under the false impression that bailers which are initially cleaned in a laboratory and permanently placed in monitoring wells are considered dedicated systems and subsequently are acceptable for ground-water monitoring purposes. Unfortunately, this is not true due to the possibility of extrinsic contamination during sampling intervals, such as decomposition of the bailer line, airborne dirt and dust, or other accidentally induced contaminants. Because the detection limits for the various parameters are measured in terms of parts per million and parts per billion, the utmost discretion is required in selecting sampling procedures which will accomodate these analyses.

1. Equipment Cleaning Procedures

If automatic pumps and flexible tubing are used, a minimum field cleaning procedure will entail using a phosphate-free soap/deionized water solution followed by a deionized water rinse. This method constitutes an absolute minimum field cleaning procedure and should only be used if sampling one G.W. monitoring well. These pumps are not recommended or authorized for sampling more than one well due to probable contamination problems.

Stainless steel bailers require the following minimum cleaning techniques prior to groundwater sample collection:

1. Phosphate-free soap and tap water wash
2. Tap-water rinse
3. Deionized or distilled water rinse
4. Isopropyl alcohol rinse
5. Deionized or distilled water rinse
6. Air dry
7. Wrap bailer to prevent contamination before use (specify the material used for wrapping the bailer, example: aluminum foil shiny side out).

Teflon bailers require the following minimum cleaning techniques prior to ground water sample collection:

1. Phosphate-free soap and tap water wash
2. Tap water rinse
3. 10% nitric or 10% hydrochloric acid rinse
4. Deoinized or distilled water rinse
5. Isopropyl alcohol rinse
6. Deionized or distilled water rinse
7. Air dry
8. Wrap to prevent contamination before use (specify material used for wrapping for wrapping the bailer, example: aluminum foil, shiny side out).

The bailer line which attaches to the teflon or stainless steel bailers should consist of either 1) teflon coated wire, 2) single-strand stainless-steel wire, 3) other monofilament line or 4) nylon rope. In order to avoid contamination, a new segment of one of the above approved types of line should be used at each well. Reusing old line will increase the probability of cross contamination (even if the line is cleaned) and therefore is not approved. Any variation to the above cleaning procedures should be submitted to this office for approval.

Condition

The above cleaning procedures were obtained from EPA Region IV. If changes occur in any procedure specified above, the facility will be notified and be requested to make the necessary ammendments to the sampling and analysis plan.

Sample Containers

Because water samples are analyzed for various parameters, several types of containers are required for a complete sampling scheme. Routine ground-water monitoring should include (in the following order as extracted from the well): 1) VOA samples (for TOX analysis), and 2) heavy metal (inorganic) analysis. If additional analyses are required, the samples should be collected in the order listed below.

For instance, samples which are analyzed for volatile organic analysis (VOA) and/or total organic halogens (TOX) should be collected first in 40 ml glass vials with teflon caps. Two full vials per sample are required.

N. C. Department of Human Resources
Division of Health Services

SAMPLE ANALYSES REQUEST

State Laboratory of Public Health
P. O. Box 28047
306 N. Wilmington Street
Raleigh, 27611

Site Number _____ Field Sample Number _____

Name of Site _____ Site Location _____

Collected By _____ ID# _____ Date Collected _____ Time _____

Type of Sample:

Environmental	Concentrate	Comments
____ Groundwater (1)	____ Solid (5)	_____
____ Surface Water (2)	____ Liquid (6)	_____
____ Soil (3)	____ Sludge (7)	_____
____ Other (4)	____ Other (8)	_____

INORGANIC CHEMISTRY

Extractables		Total			
Parameter	Results mg/l	Parameter	Results mg/l	Parameter	Results mg/l
____ Arsenic	_____	____ Arsenic	_____	____ Silver	_____
____ Barium	_____	____ Barium	_____	____ Sulfates	_____
____ Cadmium	_____	____ Cadmium	_____	____ Zinc	_____
____ Chromium	_____	____ Chloride	_____	____ Ph	_____
____ Lead	_____	____ Chromium	_____	____ Conductivity	_____
____ Mercury	_____	____ Copper	_____	____ TDS	_____
____ Selenium	_____	____ Fluoride	_____	____ TOC	_____
____ Silver	_____	____ Iron	_____	____ _____	_____
____ _____	_____	____ Lead	_____	____ _____	_____
____ _____	_____	____ Manganese	_____	____ _____	_____
____ _____	_____	____ Mercury	_____	____ _____	_____
____ _____	_____	____ Nitrate	_____	____ _____	_____
____ _____	_____	____ Selenium	_____	____ _____	_____

ORGANIC CHEMISTRY

Parameter	Results mg/l	Parameter	Results mg/l	Parameter	Results mg/l
____ P&T:GC/MS	_____	____ EDB	_____	____ Methoxychlor	_____
____ Acid:B/N Ext.	_____	____ PCB's	_____	____ Toxaphene	_____
____ TOX	_____	____ Petroleum	_____	____ 2,4-D	_____
____ _____	_____	____ Endrin	_____	____ 2,4,5-TP (silvex)	_____
____ _____	_____	____ Lindane	_____	____ _____	_____

MICROBIOLOGY

Parameter
____ (MF) Coliform Colonies/100mls
____ (MPN) Coliform Colonies/100mls
____ _____
____ _____

RADIOCHEMISTRY

Parameter	Results PCi/l
____ Gross Alpha	_____
____ Gross Beta	_____
____ _____	_____
____ _____	_____

Date Received _____ Date Reported _____

Date Extracted _____ Date Analyzed _____

Reported By _____ Lab Number _____

DHS 3191 (Revised 7/85)
Solid and Hazardous Waste (Review 7/87)

Figure 3. Laboratory analysis request sheet.

Chain of Custody Record

Solid & Hazardous Waste Materials

Location of Sampling: _____Generator _____Transporter _____Treatment Facility

_____Storage Facility _____Disposal Facility _____Landfill

_____Other:_____

Company's Name_____Telephone(_____)_____

Address_____

Collector's Name_____Telephone(_____)_____
signature

Date Sampled_____Time Sampled_____

Type of Process Generating Waste_____

Field Information

_____

_____

Field Sample No. _____ _____ _____ _____ _____ _____ _____

_____ _____ _____ _____ _____ _____ _____

Chain of Possession:

1. _____ _____ _____
signature title inclusive dates

2. _____ _____ _____
signature title inclusive dates

3. _____ _____ _____
signature title inclusive dates

Results reported

_____ _____ _____
signature title date

Instuctions: Complete all applicable information including signature, and submit with analysis request forms.

Figure 4. Chain of custody record.

Samples which will be analyzed for inorganic constituents such as heavy metals should be collected following the VOA samples. These samples are collected in small, disposable, 1-quart/1-liter plastic cubes. Two full cubes per sample are required. Depending upon the source of the sample containers, particularly, containers which hold water to be analyzed for heavy metals, some containers may have a pre-measured amount of acid placed in the container to act as a preservative. In these instances do not rinse the sample container prior to use, if uncertain, consult the laboratory where the containers were purchased.

If organic contamination is suspected it may be necessary to undergo a complete organic analysis. In this event, samples which will be analyzed for organics such as an acid-base neutral analysis should be collected in one half gallon/2-liter glass jars with aluminum foil or teflon lined caps. Samples to be tested via acid-base neutral analysis require one full jar of water per sample.

Water samples to be analyzed for radiologic parameters should be collected following acid-base neutral collection. These samples must be collected in the large 1-gallon/4-liter plastic cubes.

Finally, samples which will be analyzed for bacteriological parameters should be collected last in 120ml plastic vials containing a pre-measured amount of sodium thyosulphate. One vial per sample is required to perform the analysis.

Transport and Storage of Samples

Upon completion of water sample collecting all samples will be stored and subsequently transported on ice or in a refrigerated state to the laboratory performing the analyses (APHA, 1985; EPA, 1977). The samples should be stored in such a manner as to inhibit breakage or accidental spills. Unless unusually extraordinary circumstances prevent otherwise, all samples should be delivered to the laboratory on the same day.

Administrative procedures

Samples are to be delivered to a State Certified Drinking Water Laboratory and need to be accompanied by two administrative forms. The first form is a laboratory analysis request sheet (Figure 3). This form stipulates which constituents are to be analyzed for a given sample. The other form is a chain of custody record sheet (Figure 4). This form documents who handled the sample from collection time to lab delivery. These forms (or equivalents) will be submitted to the solid waste hydrogeologist within 15 days of receipt of the analytical results.

Per 10 NCAC 10G section .0601 (a), routine ground-water monitoring shall be the responsibility of the permittee and may be State supervised at the discretion of the Division of Health Services. An exception to this being the initial sampling of newly constructed wells by personnel of the Division of Health Services. Additionally, the State may request "split" or replicate samples from the facility during any of the routine sampling intervals.

Routine ground-water monitoring which encompasses the parameters listed below shall be conducted twice during the first year of operation (for newly-permitted sites) and annually thereafter. Newly-permitted facilities are required to properly install all proposed ground-water monitoring wells and subsequently notify the State within 30 days upon completion, so that the Division of Health Services may schedule a date to initially sample the wells. As mentioned above, subsequent sampling is the responsibility of the facility. All pre-existing (permitted) facilities as of July 1, 1987 are responsible for annual ground-water monitoring activities, and shall forward a copy of the analytical laboratory results within 15 days upon receipt to the solid waste hydrogeologist P.O. Box 2091, Raleigh, North Carolina 27602-2091 c/o the Solid and Hazardous Waste Management Branch.

All facilities (newly-permitted and pre-existing) shall send written notice by July 1, 1987 designating a tentative, annual sampling date for their facility. The purpose of which is to inform State personnel as to a specific date that they may expect the annual water quality results and to accomodate scheduling purposes by State personnel.

The following total inorganic parameters will be included for routine, annual ground-water quality analysis: arsenic, barium, cadmium, chloride,chromium, copper, fluoride, iron, lead, manganese, mercury, nitrate, selenium, silver, sulphates and zinc. The following indicators should be included in all routine, annual ground-water analysis : TOX (total organic halogens), TOC (total organic carbon, TDS (total dissolved solids), BOD (biological oxygen demand), COD (chemical oxygen demand), conductivity and PH. In the event that a contaminant plume is indicated by routine analysis of the monitoring wells, further analysis may be required to adequately assess contaminant migration and extent. Such anaysis may include purge and trap analysis (utilizing the gas chromatograph and mass spectrometer) and acid base-neutral extraction. Finally, a broad level of consistency should be exercised in listing the various quanities of chemical constituents. For instance, units should be PPM (parts per million) or PPB (parts per billion) not both. It is suggested tht parts per million (PPM) be used whenever possible.

C. Surface-Water Monitoring

Sites which contain and/or border small rivers, streams or branches should include within the site plan application, a prospective surface water monitoring plan. This plan will be used to gauge the effect of the landfill upon surficial flow at a given point. A simple procedure for selecting surface-water monitoring sites is to locate a point on the stream where drainage leaves the site. This promulgates detection of contamination through, and possibly downstream, of the site via discharge of surface waters. The sampling points selected should be downstream from any new, old or proposed areas which may be disturbed, including borrow and rubble areas (Babb and Glaser, 1985). An upstream surface water sample should be obtained in order to determine the water quality upstream of the influence of the sanitary landfill.

The following procedure is recommended regarding sample collection of surface water samples. Prior to collecting the sample in the appropriate

container, specific collection points should be determined. Generally, automated or semi-automated samplers or other manual devices accessible from the banks of a stream should be used whenever possible. If logistic or naturally occurring conditions inhibit this method of sample collection, the samples may be obtained manually by wading up-current (and down-stream) of the sample station. The sample should be collected in an area representative of minimal turbulence and aeration (Babb and Glaser, 1985). Because sample containers may be dipped by hand into the stream, extreme caution must be employed in avoiding contamination into the mouth of the container. The following procedures extracted from the "approved RCRA Ground-Water Sampling and Analysis Plan" (Babb and Glaser, 1985) are recommended for extraction and subsequent collection of surface water samples.

1. Hold the bottle near the base with one hand, and with the other, remove the cap.

2. Rinse the sample container with the water to be sampled prior to filling the container. One exception to this is the coliform sample bottle. This bottle may have a pre-measured amount of sodium thyosulphate to neutralize any chlorine present in the water, therefore, this container should not be rinsed prior to sampling.

3. Push the sample container rapidly into the water (mouth down) and tilt-up towards the current to fill. A depth of about six inches is satisfactory. Great care should be taken to avoid breaching the surface while filling the container.

4. During times of little current movement move the container slowly through the water laterally.

5. During times of extreme drought when stream depths are to shallow to allow submersion of the sample container, a pool may be scooped-out of the channel bottom and allowed to clear prior to sampling.

6. Lift the container from the water, and leave one-half inch of air space, and place the uncontaminated cap back-on the container.

7. Place the samples in styrofoam shipping cartons (on ice) for courier transport to the laboratory.

8. A completed Division of Health Services Form 2887 or equivalent (Figure 3) must be submitted along with the samples to the appropriate certified laboratory performing the analysis.

For additional details and further information on how to properly collect, store and transport stream samples, see N.R.C.D. draft on physical and chemical monitoring (in preparation).

D. Fractured Rock Monitoring

Many portions of Western and Central North Carolina are dominated by fractured cystalline rock. These fractures may be expressed on the surface, but more typically, are characteristic of subsurface environments. Areas

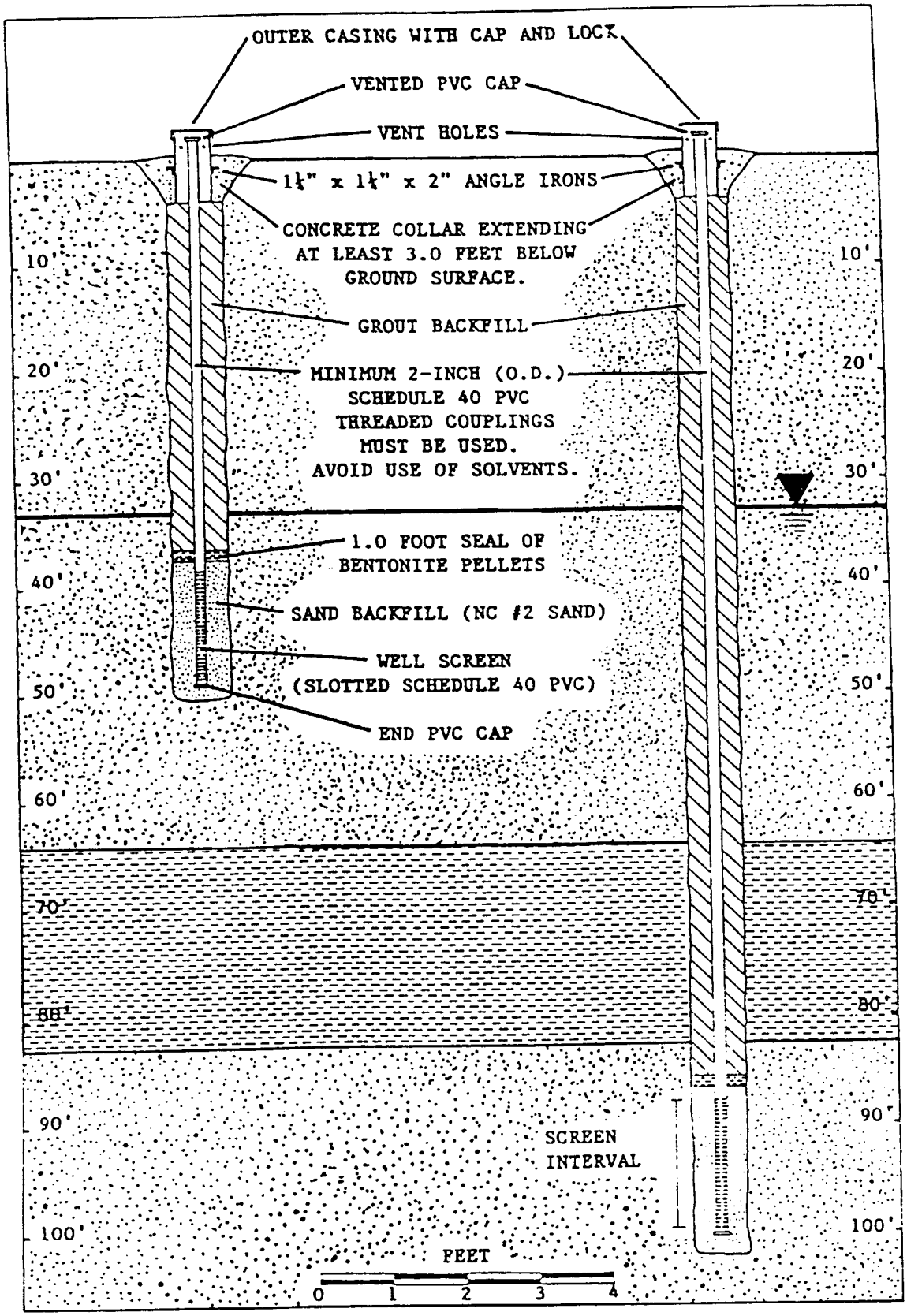


Figure 5. Typical ground-water monitoring well nest schematic.

such as these present inherent technical problems with landfill design and subsequently challenge the effectiveness and integrity of a ground-water monitoring system. The main reason being that fractured rock aquifers offer less predictability and certainty in estimating ground water flow patterns (EPA, 1977).

In order to overcome these difficulties the extent and inclination at depth of these fractures must be ascertained. The most common methods which are available to determine these factors include remote sensing and geophysical surveys. Consultants and engineering firms, may however, specifically utilize and employ these techniques as they see fit in order to adequately address the question of inclination and depth of fracture patterns.

Upon completion of a fracture trace analysis the consulting engineering firm which is responsible for submitting the site plan application will include as part of the proposed ground-water monitoring plan, tentative deep ground-water monitoring well locations at points where fractures intersect and/or at localities characteristic of pronounced lineations which may border or disect the prospective site. As with all proposed well sites, the borehole depths, screen depths and screened intervals will be defined in the report and confirmed with the Division of Health Services prior to drilling. If two aquifers exist beneath a site, a well nest (Figure 5) may be required to adequately assess the migration of potentially contaminanted ground water in both hydrologic regimes..

In most instances, fracture monitoring requires drilling 100 to 200 feet below the surface. This presents a problem for conventional purging methods as described previously in this document. For these wells, a jet pump or equivalent pump which offers a rapid displacement of water will be required for purging. Sampling is performed as described earlier via teflon bailers. A dedicated monitoring system may be used in lui of bailers if depths are not considered a major problem. Consult your industrial representative before purchasing dedicated systems to evaluate the effectiveness of the dedicated device as applied to your specific well requirements.

REFERENCES

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Environmental Protection Agency, 1977. Procedures Manual for Ground-Water Monitoring at Solid Waste Disposal Facilities, 269p.

APPENDIX B

CHAIN OF CUSTODY AND FIELD SAMPLING DATA SHEET

Sampling Field Data Sheet

GSI CONSULTANTS, INC.

PROJECT: _____ SAMPLERS: _____

FIELD DATA SHEET _____

MONITORING PT. NUMBER	SAMPLE NUMBER	DATE OF COLLECT.	TIME SAMPLED	SAMPLING PARAMETERS					WATER QUALITY PARAMETERS				
				DTH-G.W.	REF. PT.	VOL. PUR.	SAMP. TY.	SAMP.DTH	pH	TEMP.	SP. COND		

COMMENTS

CHAIN OF CUSTODY RECORD

Date: _____

Customer Name _____

Address _____

_____

Person to Contact _____ Telephone _____

Billing Address _____

_____

Sample Collection Information

Sampling Site _____

Project # _____ Sampler _____

Date of Sample Shipment _____ How Shipped _____

SAMPLE LOG AND ANALYSES REQUEST

Turnaround Requirements

_____ Regular

_____ Rush

_____ FAX Results

Sample ID	Containers # and Type	Date	Time	Matrix	Grab / Comp.	Analysis Requested						Remarks

Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*

Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)*	Date / Time	Condition on Arrival:

Comments _____

_____

Possible Interfering Compounds _____

Requested by _____