PIEDMONT LANDFILL AND RECYCLING CENTER

KERNERSVILLE, NORTH CAROLINA

PERMIT NO. 34-06

Carmen Johnson
Permit/Co ID# 34-06
Date 8/8/13
Doc ID#
DIN

A Division of Waste Management of Carolinas, Inc.

FINAL REPORT
LEACHATE RECIRCULATION TRIAL

AUGUST, 1998

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NORTH CAROLINA PROFESSIONAL SEAL 10975 ENGINEER MARK A. TAYLOR

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1. INTRODUCTION

In September, 1995, Piedmont Landfill and Recycling Center (PLFRC) submitted a proposal to conduct a leachate recirculation trial in Subcell 1 of Phase 3, Subcell 2 of the lined MSWLF. In a letter dated December 21, 1995, Mr. Jim Coffey of the Solid Waste Section of DSWM, NCDEHNR issued an approval letter for a 120-day recirculation trial, with attached requirements. In accordance with those requirements, an Interim Report summarizing the first 60 days of the trial and providing updated information on the operational procedures, leachate strength, and the expected engineering performance of the system was submitted to the Section on May 19,1997. This is the final report of the leachate recirculation trial.

The 120-day trial began on October 29, 1996. The first 60-day period ended on December 29, 1996. Attempts to recirculate leachate in late December were unsuccessful due to insufficient pump capacity as a result of raising the distribution manhole with the fill. The trial was then suspended to allow installation of a larger pump. The first 60 days of the trial period were successful in that no breakouts or seeps occurred and there were no indications of excessive head build-up on the liner based on remote, electronic liquid level monitoring.

The second 60-day period began on July 15,1997 and ended on September 12, 1997. The system was modified only by the addition of a new pump and incremental raising of the distribution manhole with the fill; no new distribution lines were added and no existing lines were abandoned. The second 60 days of the trial were also successful, as defined above.

2. LCRS DESIGN AND CONSTRUCTION

The leachate collection and recovery system (LCRS) throughout the landfill uses gravity, via the slope of the base liner, to direct leachate to high capacity collection lines, thence to sumps where the leachate is pumped out of the subcells by centrifugal submersible pumps to a force main which transports the leachate to on-site, above- ground storage tanks. The leachate must travel vertically through a 2-foot layer of protective soil and a geotextile filter, thence laterally through an HDPE drainage net ("geonet") above the geomembrane liner to the collection lines. The collection lines consist of 6-inch HDPE pipes encapsulated in a coarse aggregate which is wrapped in a geotextile filter. Details from the design (permit) drawings, showing the base liner profile and LCRS cross-section are included in Appendix 1.

The as-built conditions of the unit and the LCRS are documented in a report titled "Construction Quality Assurance Report" and dated December, 1995 by RUST

Environment and Infrastructure of Greenville, South Carolina. The following is a brief summary of the as-built conditions described in that report.

The protective soil layer is comprised of a "poorly graded washed sand" 2 feet thick and having a coefficient of permeability, k, equal to $2x10^{-2}$ cm/sec. Underlying the sand is a geotextile filter consisting of Synthetic Industries SI-1751, a 16 oz/sy non-woven polypropylene. The apparent opening size (AOS) of the geotextile is reported to be equal to the No. 100 U.S. standard sieve. According to published data, the permittivity of the fabric is 50 gal/min/sf. Beneath the geotextile and immediately overlying the geomembrane is a geonet consisting of a Tensar NS 1405, having an average thickness of 5.5 mm or 0.22 inches. According to published data, the transmissivity of the geonet is at least $4.5x10^{-3}$ m^2/sec under maximum landfill height. The geonet transmits leachate in planar flow to the leachate collection lines.

In the collection line trenches, leachate accumulation above the net is carried by the coarse aggregate and the HDPE pipes as needed. The coarse aggregate consists of a NCDOT #5 gradation, non-calcareous crushed rock. The reported coefficient of permeability, k, of the stone is $5x10^{-1}$ cm/sec. The pipes are reported to be 6-inch diameter, SDR 17, perforated HDPE 3408 and were butt-fusion welded. The pipe slopes as built are reported to range from a minimum of 1.1% to a maximum of 2.5%. The layout and grades of the leachate collection lines as built are shown on the record drawing by DS Atlantic included in Appendix 2.

The leachate collection lines transmit the leachate to Sump D in the southwest corner of the subcell. The sump has a reported depth of approximately 30 inches. The 18-inch HDPE leachate sump riser that extends from the sump to the perimeter berm rests on a piece of HDPE flat stock. The riser contains an EPG WSDPT 16-1 SurePump Wheeled Sump Drainer rated at 80 gpm at 32 feet TDH. The pump discharges into a force main running around the landfill perimeter, which carries the leachate from all subcells to a series of storage tanks having a combined capacity of 25,000 gallons.

The pump configuration is such that the intake is located approximately 6 inches above the sump bottom, or approximately 24 inches below the liner grade just outside the sump. The pump controls are set to turn the pump on when the leachate level in the sump reaches 18 inches and off when it drops to 12 inches. Thus, the pump maintains the leachate head on the liner at 12 inches in the sump and 0 inches in the subcell, except during periods of temporary mounding during which the pump is continuously running. A profile of the sump pump and riser and spec and performance data for the pump are included in Appendix 3.

3. LEACHATE RECIRCULATION SYSTEM

A schematic sketch of the recirculation system as designed by RUST E&I is shown in Appendix 4. The layout of the system in Subcell 1 and details of the system components are shown on RUST's design drawing included in Appendix 5.

Leachate is pumped from the storage tanks by a Goulds Model 3656 10-Hp pump. It and another, smaller pump are also used to load leachate into transport tankers for off-site disposal at HOH Corporation's treatment facility in Winston-Salem, North Carolina. A series of Spears gate valves are used to control leachate flow as shown in Appendix 4. Leachate flows back into the landfill via the force main and is directed to Subcell 1 by check valves that prevent the leachate from flowing upstream into any other subcells. The leachate is directed into Subcell 1 through a 3-inch ball valve and flow meter located inside a manhole on the south perimeter access road, hence through a 3-inch HDPE pipe (contained inside a 6-inch HDPE pipe from the manhole to inside the subcell) to a distribution riser (see Detail 4/2 in Appendix 5). The distribution riser is located in the north-central portion of the subcell, approximately 150 feet north-northeast of the location shown in Detail 1/2 in Appendix 5.

At the distribution riser, the leachate is transferred to a series of distribution lines, one at a time, by manually connecting a flexible hose to vertical riser pipes within the riser (see Detail 2/2 in Appendix 5 and Photographs). Three levels of distribution lines were in place during the 120-day trial. The first (lower) two levels of lines each contain seven (7) distribution lines oriented approximately as shown in Detail 1/2. Those levels are located at approximate elevations 780 and 790 feet. The bottom of the subcell (top of protective sand layer) varies from elevations 762 to 774 feet, and is at approximate elevation 770 feet at the distribution riser. The third level contains only four lines extending generally northward in order to reduce leachate breakout potential on the south slope of the subcell. It is located at approximate elevation 810 feet The lines were constructed in general accordance with Detail 3/2 in Appendix 5.

4. RECIRCULATION PROCEDURE

The recirculation procedure utilized during the 120-day trial is outlined in detail in Appendix 6. The one page summary shown in the appendix is printed on the back of the recirculation log used to record each recirculation event. A copy of the blank log is included in Appendix 7. The procedure is designed to be in strict accordance with the requirements and restrictions of the operating conditions provided in DSWM's approval letter dated December 21, 1995. Restrictions to recirculation include, 1) greater than 1 inch of rain in the preceding 24 hours, 2) a leachate level above the liner greater than 12 inches, and 3) the presence or evidence of leachate seeps on exterior slopes. It should be noted that the leachate level can only be

monitored at the collection sump; there is no mechanism for monitoring leachate level below the distribution lines (or in the "manhole" as called for in the operating conditions).

When sufficient leachate has accumulated in the storage tanks, and weather conditions are conducive to recirculation, site personnel implement the procedure, beginning with the pipe next in sequence following the prior event. The pipes are numbered sequentially starting with the lowest level, i.e., pipes 1-7 are in the first level (El. 780±), pipes 8-14 are in the second level (El. 790±), and pipes 15-18 are in the third level (El. 810±). The prescribed sequence is to go in order of pipe number while alternating levels, e.g., 1, 8, 15, 2, 9, 16, 3, 10, 17, etc. A sequence based on areal distribution as well as vertical distribution would be desirable to best distribute the leachate around the subcell and avoid loading one area heavily, but unfortunately the orientations of the pipes were not noted before the distribution riser was backfilled with crushed stone. A quick review of the rules of probability suggests, however, that the probability of one of seven randomly numbered pipes in one level being coincidental with the corresponding pipe in the level below is 1 in 7. Thus, the random numbering of the pipes should result in a 86% probability that vertically coincidental loading will not occur.

In addition to noting weather, subcell and site conditions that would preclude recirculation, and recording the time and/or quantity of recirculation per pipe, a record is kept of leachate generation from the subcell in order to develop a database which could be useful in assessing the response of the subcell to leachate loading from recirculation. Any problems, unusual conditions observed, and/or maintenance required are also recorded on the recirculation log.

The final step in the recirculation trial was to monitor leachate strength at prescribed stages. An initial sample was taken prior to beginning the trial, and samples were taken shortly after the first and second 60-day periods of recirculation. All samples were taken from the sump discharge of the subcell receiving the recirculated leachate (Subcell 2). The samples were tested for Appendix 1 solid waste constituents as well as pH and BOD.

5. SUMMARY OF TWO 60-DAY TRIAL RESULTS

First 60 Days

A total of approximately 112,350 gallons of leachate were recirculated in nine (9) events (days) during the first 60 days of the trial. The recirculation events are summarized in Table 1 below. Logs from the events are included in Appendix 8. Only the first two levels of distribution lines were in place during that period, and all lines were used at least once except for line 5 which was apparently blocked and non-functional.

The last event in the first 60 days, on December 16, 1996, was only marginally successful because the distribution riser had been raised and the pump was struggling to overcome the elevation differential. Flow through the meter was apparently insufficient to record an accurate reading, so the amount of leachate recirculated during that event was estimated from previous pumping rates (discounted for the head problem) and the time of pumping.

No other operational problems with the system were experienced, and the first half (60 days) of the trial was considered successful in that no breakouts of seeps occurred and there were no indications that the head exceeded one (1) foot on the liner. Records indicate that approximately 30,180 gallons of leachate were generated and removed from the subcell during the first 60-day period.

TABLE 1

SUMMARY OF LEACHATE RECIRCULATION
(FIRST 60 DAYS)

Date	Gals. Recirc.
10/29	9,070
11/4	12,130
11/11	14,800
11/13	7,500
11/21	15,400
12/5	15,800
12/10	10,400
12/11	16,000
12/16	11,250
TOTAL	**112,350**

The results of leachate strength testing prior to the trial and after the first 60 days are summarized in Table 2 below. Copies of the laboratory data reports are included in Appendix 9. Though the BOD increased 31% in the second sample, from 2880 to 3760 mg/l, a BOD sample taken 4 days after the initial sample had a BOD of 3300 mg/l, suggesting that BOD fluctuates greatly and may only be useful as an indicator of leachate strength after a large number of values are established and trends can be analyzed. Of the fifteen (15) metals analyzed, concentrations of five (5) increased, six (6) decreased, and four (4) remained below detection limits. Similarly, of the fifteen (15) detected organics, concentrations of four (4) increased, nine (9) decreased, and two (2) remained about the same.

TABLE 2

SUMMARY OF LEACHATE STRENGTH ANALYSES (FIRST 60 DAYS)

MISCELLANEOUS PARAMETERS

	Pre-Trial (10/24/96)	Interim (1/23/97)
pH	5.7	5.6
BOD	2880	3760

INORGANICS (METALS)

	Pre-Trial (10/24/96)	Interim (1/23/97)
Arsenic	<.010	.015
Antimony	.043	<.006
Barium	1.79	1.95
Beryllium	.004	<.002
Cadmium	.073	.032
Chromium	.021	.083
Cobalt	.210	.150
Copper	<.200	<.200
Lead	.047	.035
Nickel	.058	.109
Selenium	<.050	<.020
Silver	<.010	<.010
Thallium	<.050	<.002
Vanadium	.075	<.010
Zinc	.122	.450

ORGANICS

	Pre-Trial (10/24/96)	Interim (1/23/97)
Methylene Chloride	.672	.250
Trichlorofluoromethane	.035	<.020
1,1-Dichloroethane	.116	.082
Chloroform	.025	<.013
Trichloroethene	.019	<.013
Tetrachloroethene	.010	<.020
1,1,1-Trichloroethane	.038	<.013
Toluene	.420	.210
Ethyl Benzene	.027	.022
Acetone	1.98	6.70
2-Butanone	4.66	8.10
4-Methyl-2-Pentanone	.180	.270
Total Xylenes	.142	.064
Cis-1,2-Dichloroethene	.006	<.020
Chloroethane	<.010	.021

NOTE: All concentrations are expressed in units of mg/l or ppm.

Second 60 Days

A total of approximately 104,300 gallons of leachate were recirculated in fourteen (14) events during the second 60 days of the trial. The recirculation events are summarized in Table 3 below. Logs from the events are included in Appendix 8. All three levels of distribution lines were in place during the period, and most lines were used at least once. Lines not used include line 5 (blocked) and lines 4 through 9 and 18 which were reported to be slow to receive leachate (no reason given or known).

No other operational problems with the system were experienced, and the second half (60 days) of the trial was considered successful in that no breakouts of seeps occurred and there were no indications that the head exceeded one (1) foot on the liner. Records indicate that approximately 72,780 gallons of leachate were generated and removed from the subcell during the second 60-day period.

TABLE 3

SUMMARY OF LEACHATE RECIRCULATION
(SECOND 60 DAYS)

Date	Gals. Recirc.
7/15/97	2,800
7/17	1,600
7/21	9,700
8/7	12,700
8/11	9,200
8/12	9,300
8/19	2,000
8/20	10,000
9/1	12,300
9/2	8,400
9/4	6,000
9/8	6,800
9/9	6,500
9/12	7,000
TOTAL	**104,300**

The results of leachate strength testing prior to the trial, after the first 60 days, and after the second 60 days are summarized in Table 4 below. Copies of the laboratory data reports are included in Appendix 9. BOD increased noticeably (78%) in the third sample, from 3760 to 6710 mg/l, suggesting an increase in leachate strength. The pH also increased slightly, from 5.6 to 6.3. Of the fifteen (15) metals analyzed, concentrations of six (6) increased between the second and third samples, two (2) decreased, three (3) stayed about the same, and four (4) remained below detection limits. Similarly, of the fifteen (15) detected organics, concentrations of six (6) increased, none (0) decreased, four (4) stayed about the same, and five (5) remained below detection limits.

These findings suggest that leachate strength is gradually increasing as a result of recirculation, but the results are so variable and the changes so slight that verifiable trends and the significance of the changes remain to be determined.

TABLE 4

SUMMARY OF LEACHATE STRENGTH ANALYSES

MISCELLANEOUS PARAMETERS

Analyte	Pre-Trial (10/24/96)	Interim (1/23/97)	Final (10/15/97)
pH	5.7	5.6	6.3
BOD	2,880	3,760	6,710

INORGANICS (METALS)

Analyte	Pre-Trial (10/24/96)	Interim (1/23/97)	Final (10/15/97)
Antimony	.043	<.006	.109
Arsenic	<.010	.015	.048
Barium	1.79	1.95	1.83
Beryllium	.004	<.002	<.002
Cadmium	.073	.032	.024
Chromium	.021	.083	.194
Cobalt	.210	.150	.270
Copper	<.200	<.200	<.200
Lead	.047	.035	.015
Nickel	.058	.109	.333
Selenium	<.050	<.020	<.020
Silver	<.010	<.010	<.010
Thallium	<.050	<.002	.046
Vanadium	.075	<.010	.079
Zinc	.122	.450	.485

TABLE 4 (Cont.)

ORGANICS

Analyte	Pre-Trial (10/24/96)	Interim (1/23/97)	Final (10/15/97)
Methylene Chloride	.672	.250	.390
Trichlorofluoromethane	.035	<.020	<.033
1,1-Dichloroethane	.116	.082	.076
Chloroform	.025	<.013	<.022
Trichloroethene	.019	<.013	<.022
Tetrachloroethene	.010	<.020	<.033
1,1,1-Trichloroethane	.038	<.013	<.022
Toluene	.420	.210	.940
Ethyl Benzene	.027	.022	.070
Acetone	1.98	6.70	5.10
2-Butanone	4.66	8.10	13.00
4-Methyl-2-Pentanone	.180	.270	.620
Total Xylenes	.142	.064	.160
Cis-1,2-Dichloroethene	.006	<.020	.037
Chloroethane	<.010	.021	.049

NOTE: All concentrations are expressed in units of mg/l or ppm.

6. EXPECTED ENGINEERING PERFORMANCE

Based on the as-built conditions of the LCRS, as described in Section 2 of this report, the expected engineering performance of the system during recirculation has been evaluated. The items requested in DSWM's approval letter of December 21, 1995 have been addressed, including the expected maximum head on the liner, the hydraulic capacity of LCRS, a demonstration that the loading rate of the system due to recirculation is within the design specifications, and a demonstration that the head on the liner will not exceed one foot for a long period of time. Calculations showing that these criteria are met are included in Appendix 10. Calculations from RUST's "Transition Application and Permit Renewal" dated April, 1994 are also provided in Appendix 11 for easy reference to demonstrate the basis for the LCRS design.

The calculations show that the LCRS is capable of handling the level of recirculation proposed at this time without exceeding the design and performance specifications of the system. Leachate accumulation in the LCRS under extreme wet-weather conditions may occur depending on the rate of leachate release from the waste to the LCRS, which is difficult to predict, but the system is free-draining and the pump is capable of removing accumulated leachate rapidly. No indications of LCRS capacity exceedence have been observed in or around the subject subcell to date, but known indicators will be carefully monitored to further improve the

understanding of the response of the system to recirculation and other normal operating variables.

7. SUMMARY OF 120-DAY TRIAL RESULTS

As described in Section 5 above, the recirculation trial is considered to have been a success in that the affected subcell has shown no adverse effects from hydraulic loading due to recirculation. This is consistent with the expected engineering performance described in Section 6 above.

Table 5 shows the hydraulic loading of the subcell during the trial period, assuming 40 percent infiltration of rainfall, and the leachate generation response. Rainfall values shown in the table were measured on site by a 24-hour recording weather station, with readings recorded at 2-hour intervals. A few conclusions can be readily drawn from the table and the accompanying graph, as follows:

1) The quantity of leachate recirculated (being all of the leachate generated from the entire facility) is small in comparison to rainfall infiltration at this stage in the landfill's life (less than 50,000 gals/mo. versus 325,000 gals/mo., on average). The actual rainfall infiltration could be less than the 40 percent assumed, which would reduce this difference proportionately;

2) Most of the liquid infiltrating the cell is being absorbed by the waste and cover soil, as evidenced by the large difference in input versus output and the relatively constant leachate generation rate; and

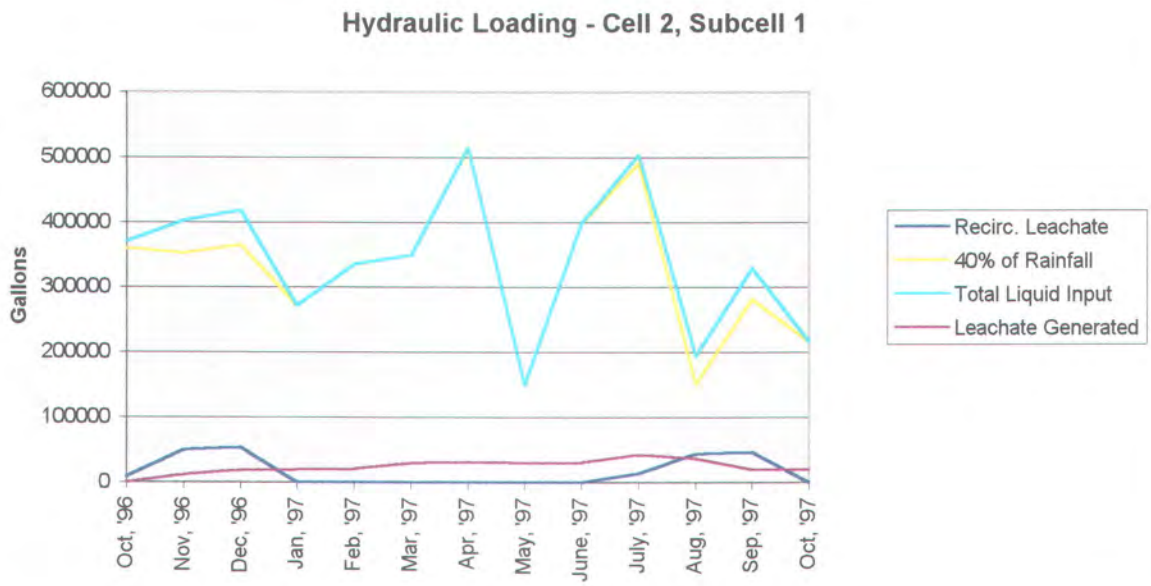
3) There is no noticeable leachate generation response to hydraulic loading from either rainfall or recirculation.

TABLE 5

Hydraulic Loading During Recirculation Trial Period

Date	Recirc. Leachate	40% of Rainfall	Total Liquid Input	Leachate Generated
Oct, '96	9070	360413	369483	Not Available
Nov, '96	49830	352245	402075	11550
Dec, '96	53450	364497	417947	18630
Jan, '97	0	271586	271586	20120
Feb, '97	0	334888	334888	20770
Mar, '97	0	349182	349182	29790
Apr, '97	0	514584	514584	31800
May, '97	0	150087	150087	30220
June, '97	0	398190	398190	30430
July, '97	14100	490080	504180	42850
Aug, '97	43200	151108	194308	36320
Sep, '97	47000	281796	328796	19440
Oct, '97	0	216452	216452	20170
Total	216650			

1. All units are Gallons.
2. Total Liquid Input based on 40% infiltration of rainfall.



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NORTH CAROLINA PROFESSIONAL SEAL 10975 ENGINEER MARK A. TAYLOR

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PHOTOGRAPHS

View of Distribution Riser During Recirculation
Close-up of Connections to Feeder and Distribution Lines

1. INTRODUCTION

In September, 1995, Piedmont Landfill and Recycling Center (PLFRC) submitted a proposal to conduct a leachate recirculation trial in Subcell 1 of Phase 3, Subcell 2 of the lined MSWLF. In a letter dated December 21, 1995, Mr. Jim Coffey of the Solid Waste Section of DSWM, NCDEHNR issued an approval letter for a 120-day recirculation trial, with attached requirements. One of those requirements is an Interim Report summarizing the first 60 days of the trial and providing updated information on the operational procedures, leachate strength, and the expected engineering performance of the system. This is that report.

The 120-day trial began on October 29, 1996. Leachate was last recirculated on December 16, 1996, completing recirculation during the first 60-day period (10/29/96 to 12/29/96). Further attempts to recirculate leachate in December were unsuccessful due to insufficient pump capacity as a result of raising the distribution manhole with the fill. The trial has thus been suspended pending installation of a larger pump. The first 60 days of the trial period were successful in that no breakouts or seeps occurred and there were no indications of excessive head build-up on the liner based on remote, electronic liquid level monitoring.

2. LCRS DESIGN AND CONSTRUCTION

The leachate collection and recovery system (LCRS) throughout the landfill uses gravity, via the slope of the base liner, to direct leachate to high capacity collection lines, thence to sumps where the leachate is pumped out of the subcells by centrifugal submersible pumps to a force main which transports the leachate to on-site, above- ground storage tanks. The leachate must travel vertically through a 2-foot layer of protective soil and a geotextile filter, thence laterally through an HDPE drainage net ("geonet") above the geomembrane liner to the collection lines. The collection lines consist of 6-inch HDPE pipes encapsulated in a coarse aggregate which is wrapped in a geotextile filter. Details from the design (permit) drawings, showing the base liner profile and LCRS cross-section are included in Appendix 1.

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The protective soil layer is comprised of a "poorly graded washed sand" 2 feet thick and having a coefficient of permeability, k, equal to $2x10^{-2}$ cm/sec. Underlying the

sand is a geotextile filter consisting of Synthetic Industries SI-1751, a 16 oz/sy non-woven polypropylene. The apparent opening size (AOS) of the geotextile is reported to be equal to the No. 100 U.S. standard sieve. According to published data, the permittivity of the fabric is 50 gal/min/sf. Beneath the geotextile and immediately overlying the geomembrane is a geonet consisting of a Tensar NS 1405, having an average thickness of 5.5 mm or 0.22 inches. According to published data, the transmissivity of the geonet is at least 4.5×10^{-3} m^2/sec under maximum landfill height. The geonet transmits leachate in planar flow to the leachate collection lines.

In the collection line trenches, leachate accumulation above the net is carried by the coarse aggregate and the HDPE pipes as needed. The coarse aggregate consists of a NCDOT #5 gradation, non-calcareous crushed rock. The reported coefficient of permeability, k, of the stone is 5×10^{-1} cm/sec. The pipes are reported to be 6-inch diameter, SDR 17, perforated HDPE 3408 and were butt-fusion welded. The pipe slopes as built are reported to range from a minimum of 1.1% to a maximum of 2.5%. The layout and grades of the leachate collection lines as built are shown on the record drawing by DS Atlantic included in Appendix 2.

The leachate collection lines transmit the leachate to Sump D in the southwest corner of the subcell. The sump has a reported depth of approximately 30 inches. The 18-inch HDPE leachate sump riser that extends from the sump to the perimeter berm rests on a piece of HDPE flat stock. The riser contains an EPG WSDPT 16-1 SurePump Wheeled Sump Drainer rated at 80 gpm at 32 feet TDH. The pump discharges into a force main running around the landfill perimeter, which carries the leachate from all subcells to a series of storage tanks having a combined capacity of 25,000 gallons.

The pump configuration is such that the intake is located approximately 6 inches above the sump bottom, or approximately 24 inches below the liner grade just outside the sump. The pump controls are set to turn the pump on when the leachate level in the sump reaches 18 inches and off when it drops to 12 inches. Thus, the pump maintains the leachate head on the liner at 12 inches in the sump and 0 inches in the subcell, except during periods of temporary mounding during which the pump is continuously running. A profile of the sump pump and riser and spec and performance data for the pump are included in Appendix 3.

3. LEACHATE RECIRCULATION SYSTEM

A schematic sketch of the recirculation system as designed by RUST E&I is shown in Appendix 4. The layout of the system in Subcell 1 and details of the system components are shown on RUST's design drawing included in Appendix 5.

Leachate is pumped from the storage tanks by one of two Burks 7.5 Hp pumps. These are the same pumps used to load leachate into transport tankers for off-site disposal at HOH Corporation's treatment facility in Winston-Salem, North Carolina. Two pumps are provided so that a back-up is available during maintenance. A series of Spears gate valves are used to control leachate flow as shown in Appendix 4. Leachate flows back into the landfill via the force main and is directed to Subcell 1 by check valves that prevent the leachate from flowing upstream into any other subcells. The leachate is directed into Subcell 1 through a 3-inch ball valve and flow meter located inside a manhole on the south perimeter access road, hence through a 3-inch HDPE pipe (contained inside a 6-inch HDPE pipe from the manhole to inside the subcell) to a distribution riser (see Detail 4/2 in Appendix 5). The distribution riser is located in the north-central portion of the subcell, approximately 150 feet north-northeast of the location shown in Detail 1/2 in Appendix 5.

At the distribution riser, the leachate is transferred to a series of distribution lines, one at a time, by manually connecting a flexible hose to vertical riser pipes within the riser (see Detail 2/2 in Appendix 5 and Photographs). Three levels of distribution lines were in place during the first 60 days of the trial. The first (lower) two levels of lines each contain seven (7) distribution lines oriented approximately as shown in Detail 1/2. Those levels are located at approximate elevations 780 and 790 feet. The bottom of the subcell (top of protective sand layer) varies from elevations 762 to 774 feet, and is at approximate elevation 770 feet at the distribution riser. The third level contains only four lines extending generally northward in order to reduce leachate breakout potential on the south slope of the subcell. It is located at approximate elevation 810 feet The lines were constructed in general accordance with Detail 3/2 in Appendix 5.

4. RECIRCULATION PROCEDURE

The recirculation procedure utilized for the first 60 days of the trial and planned for continued use is outlined in detail in Appendix 6. The one page summary shown in the appendix is printed on the back of the recirculation log used to record each recirculation event. A copy of the blank log is included in Appendix 7. The

procedure is designed to be in strict accordance with the requirements and restrictions of the operating conditions provided in DSWM's approval letter dated December 21, 1995. Restrictions to recirculation include greater than 1 inch of rain in the preceding 24 hours, a leachate level above the liner greater than 12 inches, and the presence or evidence of leachate seeps on exterior slopes. It should be noted that leachate level can only be monitored at the collection sump; there is no mechanism for monitoring leachate level below the distribution lines (or in the "manhole" as called for in the operating conditions).

When sufficient leachate has accumulated in the storage tanks, and weather conditions are conducive to recirculation, site personnel implement the procedure, beginning with the pipe next in sequence following the prior event. The pipes are numbered sequentially starting with the lowest level, i.e., pipes 1-7 are in the first level (El. 780±), pipes 8-14 are in the second level (El. 790±), and pipes 15-18 are in the third level (El. 810±). The prescribed sequence is to go in order of pipe number while alternating levels, e.g., 1, 8, 15, 2, 9, 16, 3, 10, 17, etc. A sequence based on areal distribution as well as vertical distribution would be desirable to best distribute the leachate around the subcell and avoid loading one area heavily, but unfortunately the orientations of the pipes were not noted before the distribution riser was backfilled with crushed stone. A quick review of the rules of probability suggests, however, that the probability of one of seven randomly numbered pipes in one level being coincidental with the corresponding pipe in the level below is 1 in 7. Thus, the random numbering of the pipes should result in a 86% probability that vertically coincidental loading will not occur.

In addition to noting weather, subcell and site conditions that would preclude recirculation, and recording the time and/or quantity of recirculation per pipe, a record is kept of leachate generation from the subcell in order to develop a database which could be useful in assessing the response of the subcell to leachate loading from recirculation. Any problems, unusual conditions observed, and/or maintenance required are also recorded on the recirculation log.

The final step in the recirculation trial is to monitor leachate strength at prescribed stages. An initial sample was taken prior to beginning the trial, and a sample was taken shortly after the first 60 days. All samples are taken from the sump discharge of the subcell receiving the recirculated leachate (Subcell 2). The samples are tested for Appendix 1 solid waste constituents as well as pH and BOD.

5. SUMMARY OF 60-DAY TRIAL RESULTS

A total of approximately 112,350 gallons of leachate were recirculated in nine events (days) during the first 60 days of the trial. The recirculation events are summarized in Table 1 below. Logs from the events are included in Appendix 8. Only the first two levels of distribution lines were in place during that period, and all lines were used at least once except for line 5 which is apparently blocked and non-functional. Future events will not include line 5.

The last event, on December 16, 1996, was only marginally successful because the distribution riser had been raised and the pump was struggling to overcome the elevation differential. Flow through the meter was apparently insufficient to record an accurate reading, so the amount of leachate recirculated during that event was estimated from previous pumping rates (discounted for the head problem) and the time of pumping.

No other operational problems with the system were experienced, and the first half (60 days) of the trial is considered successful in that no breakouts of seeps occurred and there were no indications that the head exceeded one (1) foot on the liner. Records indicate that approximately 35,500 gallons of leachate were generated and removed from the subcell during the subject 60-day period.

TABLE 1

SUMMARY OF LEACHATE RECIRCULATION
(FIRST 60 DAYS)

Date	Gals. Recirc.
10/29	9,070
11/4	12,130
11/11	14,800
11/13	7,500
11/21	15,400
12/5	15,800
12/10	10,400
12/11	16,000
12/16	11,250
TOTAL	**112,350**

The results of leachate strength testing prior to the trial and after the first 60 days are summarized in Table 2 below. Copies of the laboratory data reports are included in Appendix 9. Though the BOD increased 31% in the second sample, from 2880 to 3760 mg/l, a BOD sample taken 4 days after the initial sample had a BOD of 3300 mg/l, suggesting that BOD fluctuates greatly and may only be useful as an indicator of leachate strength after a large number of values are established and trends can be analyzed. Of the fifteen (15) metals analyzed, concentrations of five (5) increased (none dramatically), six (6) decreased, and four (4) remained below detection limits. Similarly, of the fifteen (15) detected organics, concentrations of four (4) increased (none dramatically), nine (9) decreased, and two (2) remained about the same. These findings suggest that it is too early to detect any noticeable change in leachate strength as a result of recirculation. This makes sense considering the large volume of leachate that will likely be absorbed by the waste before saturated, steady state flow and leaching of solid waste constituents occurs.

TABLE 2

SUMMARY OF LEACHATE STRENGTH ANALYSES

MISCELLANEOUS PARAMETERS

	Pre-Trial (10/24/96)	Interim (1/23/97)
pH	5.7	5.6
BOD	2880	3760

INORGANICS (METALS)

	Pre-Trial (10/24/96)	Interim (1/23/97)
Arsenic	<.010	.015
Antimony	.043	<.006
Barium	1.79	1.95
Beryllium	.004	<.002
Cadmium	.073	.032
Chromium	.021	.083
Cobalt	.210	.150
Copper	<.200	<.200
Lead	.047	.035
Nickel	.058	.109
Selenium	<.050	<.020
Silver	<.010	<.010
Thallium	<.050	<.002
Vanadium	.075	<.010
Zinc	.122	.450

TABLE 2 (Cont.)

ORGANICS

	Pre-Trial (10/24/96)	Interim (1/23/97)
Methylene Chloride	.672	.250
Trichlorofluoromethane	.035	<.020
1,1-Dichloroethane	.116	.082
Chloroform	.025	<.013
Trichloroethene	.019	<.013
Tetrachloroethene	.010	<.020
1,1,1-Trichloroethane	.038	<.013
Toluene	.420	.210
Ethyl Benzene	.027	.022
Acetone	1.98	6.70
2-Butanone	4.66	8.10
4-Methyl-2-Pentanone	.180	.270
Total Xylenes	.142	.064
Cis-1,2-Dichloroethene	.006	<.020
Chloroethane	<.010	.021

NOTE: All concentrations are expressed in units of mg/l or ppm.

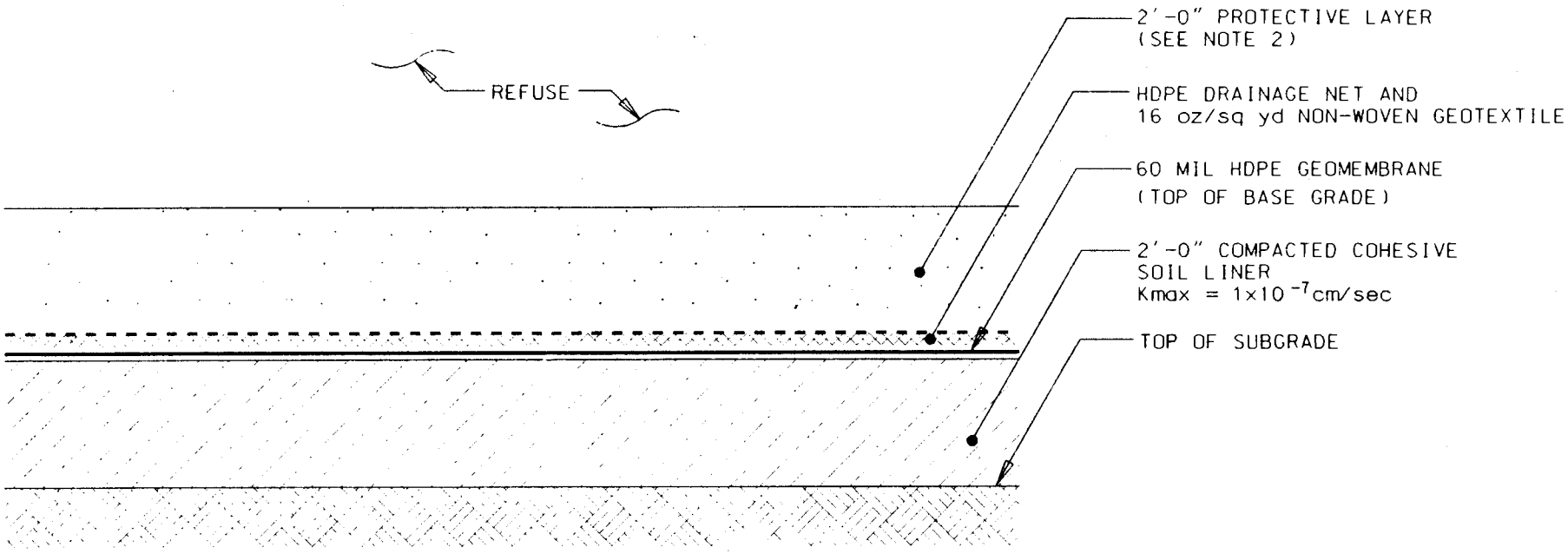
6. EXPECTED ENGINEERING PERFORMANCE

Based on the as-built conditions of the LCRS, as described in Section 2 of this report, the expected engineering performance of the system during recirculation has been evaluated. The items requested in DSWM's approval letter of December 21, 1995 have been addressed, including the expected maximum head on the liner, the hydraulic capacity of LCRS, a demonstration that the loading rate of the system due to recirculation is within the design specifications, and a demonstration that the head on the liner will not exceed one foot for a long period of time. Calculations showing that these criteria are met are included in Appendix 10. Calculations from RUST's "Transition Application and Permit Renewal" dated April, 1994 are also provided in Appendix 11 for easy reference to demonstrate the basis for the LCRS design.

The calculations show that the LCRS is capable of handling the level of recirculation proposed at this time without exceeding the design and performance specifications of the system. Leachate accumulation in the LCRS under extreme wet-weather conditions may occur depending on the rate of leachate release from the waste to the LCRS, which is difficult to predict, but the system is free-draining and the pump is capable of removing accumulated leachate rapidly. No indications of LCRS capacity exceedence have been observed in or around the subject subcell to date, but it will be carefully monitored as the recirculation trial proceeds to further improve the understanding of the response of the system to recirculation and other normal operating variables.

7. PROPOSED MODIFICATIONS

The trial was suspended after the first 60-day period due to insufficient pump capacity resulting from raising the distribution riser with the fill. A larger pump has been installed to enable the resumption of recirculation in the near future. No other modifications to the system or procedure are planned for the final 60 days of the trial. Further modifications will be considered after the trial is complete and all relevant data has been collected and reviewed. As called for in the trial approval letter, the leachate strength will be analyzed following the 120-day trial completion and a final report will be issued within 30 days.



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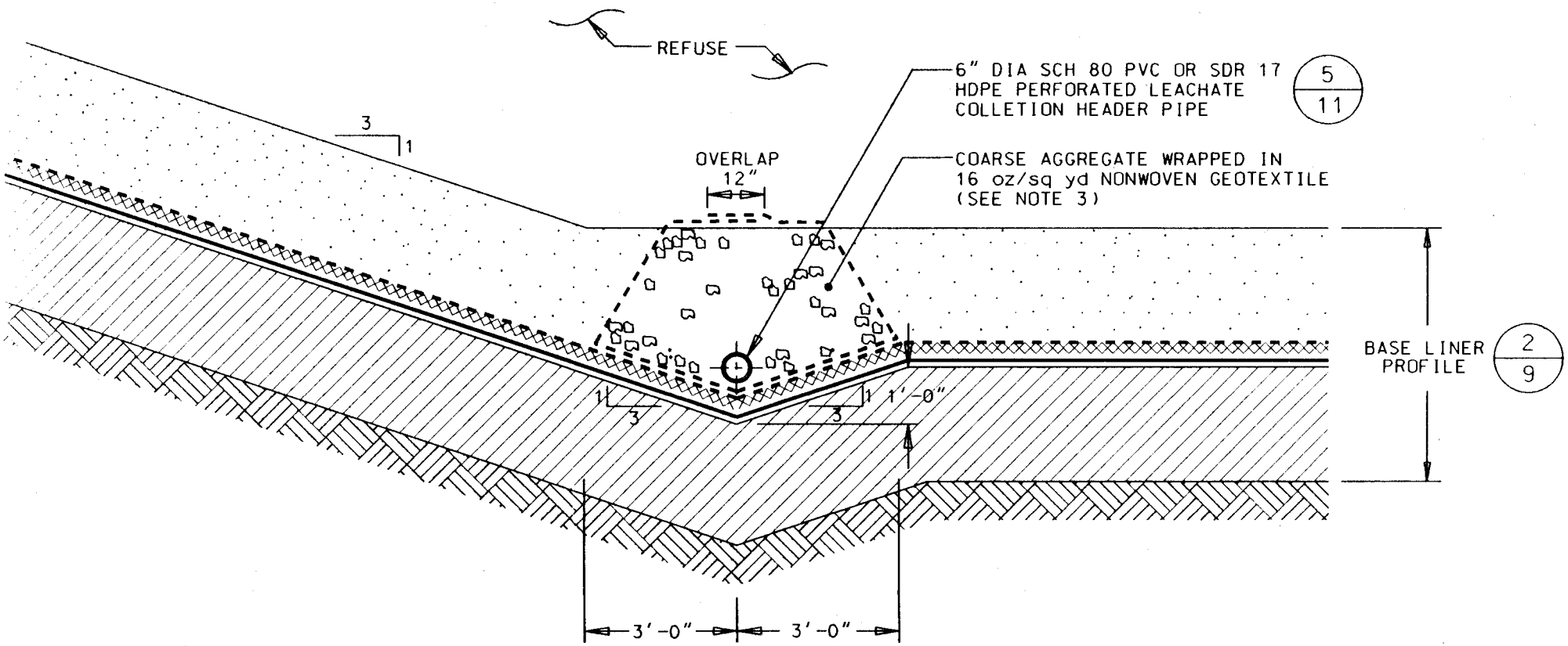
BASE LINER PROFILE



LEACHATE COLLECTION SYSTEM TRENCH CROSS SECTION F–F'

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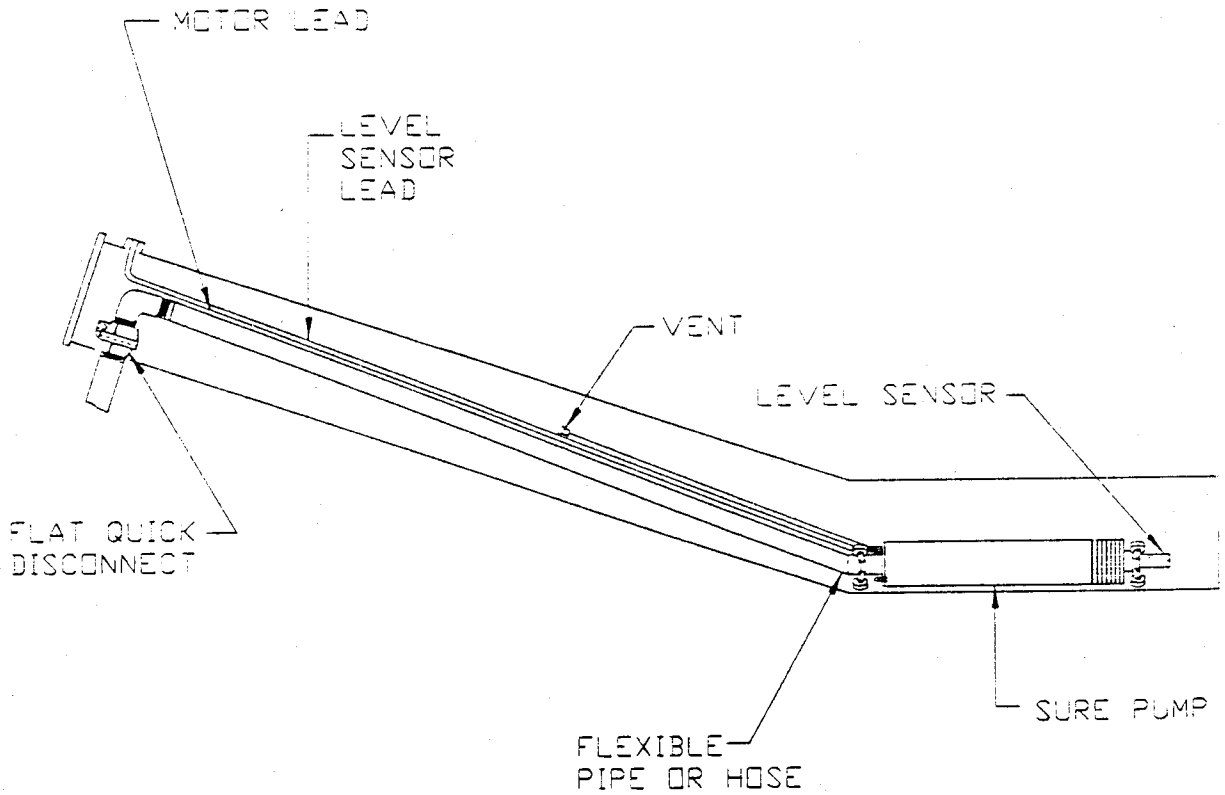
1

Appendix 2

-Drawing-

Appendix 3

SIDE SLOPE RISER
SUREPUMP APPLICATION



EPG Companies Inc.

List of Equipment

Piedmont RDF

Job # 95-3014

1 ea.	EPG WSDPT 16-1 SurePump wheeled SS sump drainer with 1.5HP 230VAC 1Ø motor. Includes 50' jacketed motor lead, submersible level sensor with 50' lead and 50' length of 3/16" SS cable with clamps.
1 ea.	EPG L925PT PumpMaster to operate 1.5HP 230VAC 1Ø motor. Includes LevelMaster, flow meter, top mounted alarm light, power on light and panel mounted low level alarm light.
1 ea.	EPG 3" PVC flow sensor with flanged ends and paddlewheel type flow sensor
1 ea.	50' length of 3" PVC type F hose with SS disconnects and hose clamps

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ENGINEER'S SPECIFICATION

EPG SurePump™ Wheeled Sump Drainer for Side Slope Riser Installations

Furnish and install __1__ centrifugal submersible EPG SurePump Wheeled Sump Drainer(s) (U.S. patented), Model WSD __16__-__1__ with __1__ impeller stages. Each unit shall be suitable for side slope riser installation. Each unit shall come with a __1.50__HP, submersible electric motor for operation on __230__volts, __1__ phase, 60 hertz service with __50__ feet of power cable. Each SurePump Wheeled Sump Drainer shall have a __3__ inch threaded discharge nozzle and be capable of delivering __80__ GPM at __32__ feet of TDH. Each unit shall be fitted with __50__ feet of stainless steel lifting cable of sufficient strength to permit removal of the unit.

DESIGN

Each SurePump Wheeled Sump Drainer shall be capable of pumping contaminated groundwater for spill recovery, leachate, purge and sampling applications. A transmitter mount shall be welded at the center bottom of the Sump Drainer for liquid level control. The Sump Drainer shall permit the unit to "pump down" to within __10__ inches of the sump bottom without any loss of performance or damage to the pump. The Sump Drainer shall be equipped with a vent valve to assist with the evacuation of air from the Sump Drainer.

MATERIALS

Major components shall be made of 304 stainless steel, seal rings are to be made of Teflon™, and bearings are to be Eglide™. In addition, all fasteners shall be 304 stainless steel.

CHECK VALVE

Each unit shall include a built-in check valve, with housing and disc of 304 stainless steel and check valve seat of Teflon.

SHAFT

The shaft shall be of 304 stainless steel and rotate on Eglide bearings which are product lubricated.

DIFFUSER CHAMBER

The diffuser chambers for each impeller shall be of 304 stainless steel. Further, they shall be fitted with Teflon impeller seal rings.

IMPELLERS

The impeller(s) shall be closed and consist of 304 stainless steel.

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MOTOR

The motor shall be a submersible, hermetically sealed Franklin motor in __Pollution Recovery__ construction. The motor shall be designed for continuous duty, capable of sustaining up to __100__ starts per day. The motor shall be connected to the pump via a motor adaptor and coupling in 304 stainless steel. Single phase motors shall have thermal protection in the motor windings to protect the windings from over-load. The unit will restart automatically after the motor cools down. Three phase motors shall have thermal protection located in the control panel which is to be manually reset.

MOTOR LEAD WIRE

The lead wire shall be no-splice with EPG's "CP" water proof and chemically resistant insulation and be of the length specified.

WARRANTY

See EPG Bulletin 0200b.

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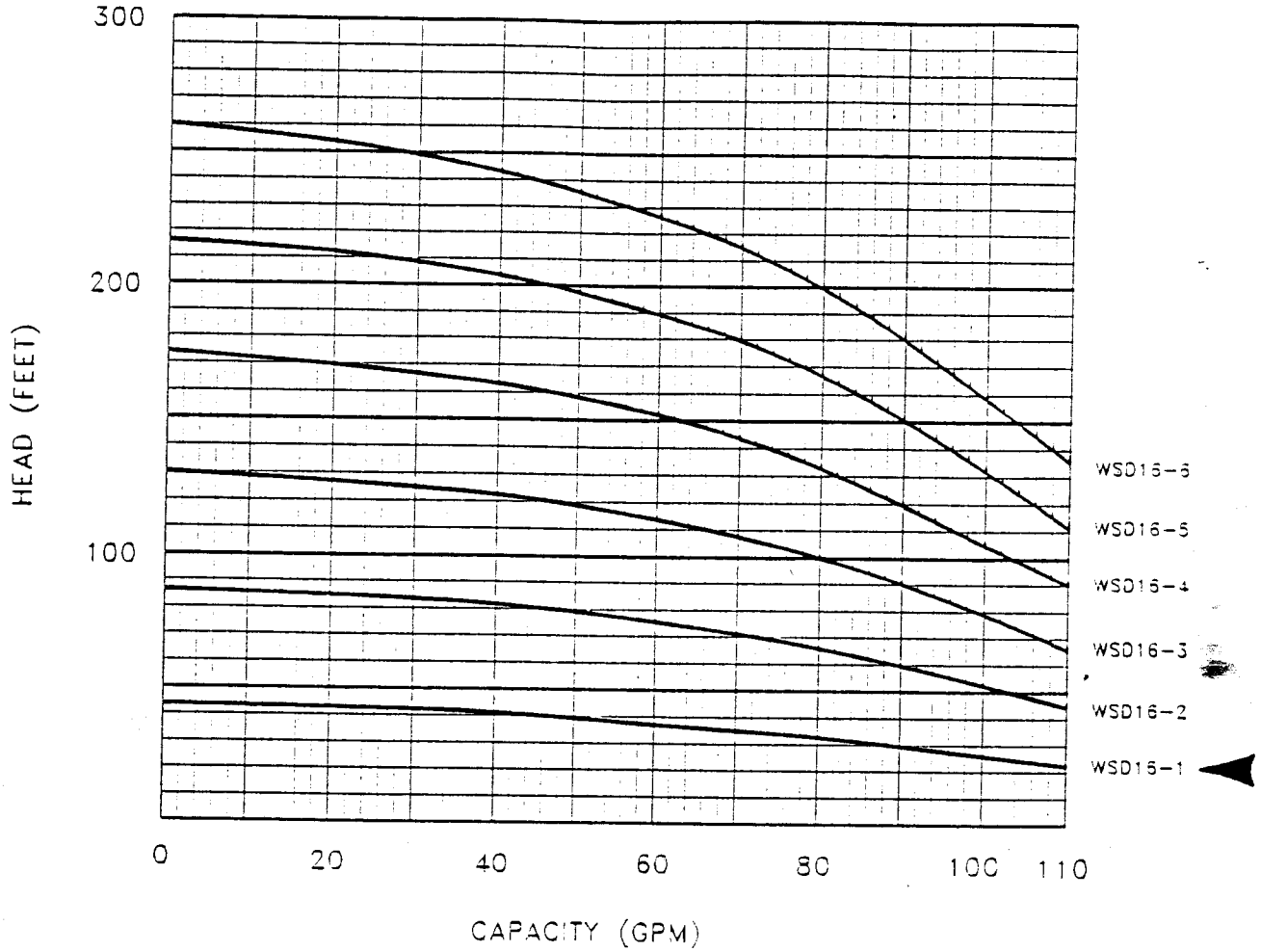
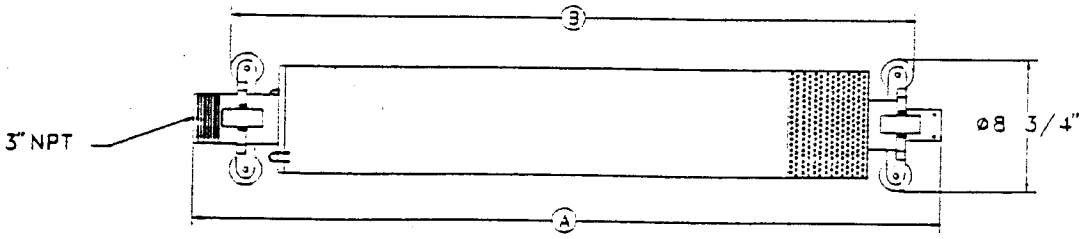
WSD16 SurePump™
WHEELED SUMP DRAINER





PUMP MODEL	SINGLE PHASE			THREE PHASE			SHIPPING WEIGHT (LBS)	
	MOTOR HP	A (in)	B (in)	MOTOR HP	A (in)	B (in)	1Ø	3Ø
WSD16-1	1.5	42.50	39.50	1.5	41.25	38.25	81.8	77.1
WSD16-2	2.0	45.75	42.75	2.0	44.25	41.25	89.0	84.0
WSD16-3	3.0	55.75	52.75	3.0	53.00	50.00	117.4	106.6
WSD16-4	5.0	63.50	60.50	5.0	57.75	54.75	141.3	121.5
WSD16-5	5.0	65.25	62.25	5.0	59.25	56.25	144.4	124.6
WSD16-6	7.5	67.75	64.75	7.5	62.00	59.00	197.0	170.4

SEE 0578-2 FOR HIGH HEAD MODELS.

Appendix 4

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE 1 OF 1

PROJECT NO. 3302.100

CLIENT WM OF CAROLINAS

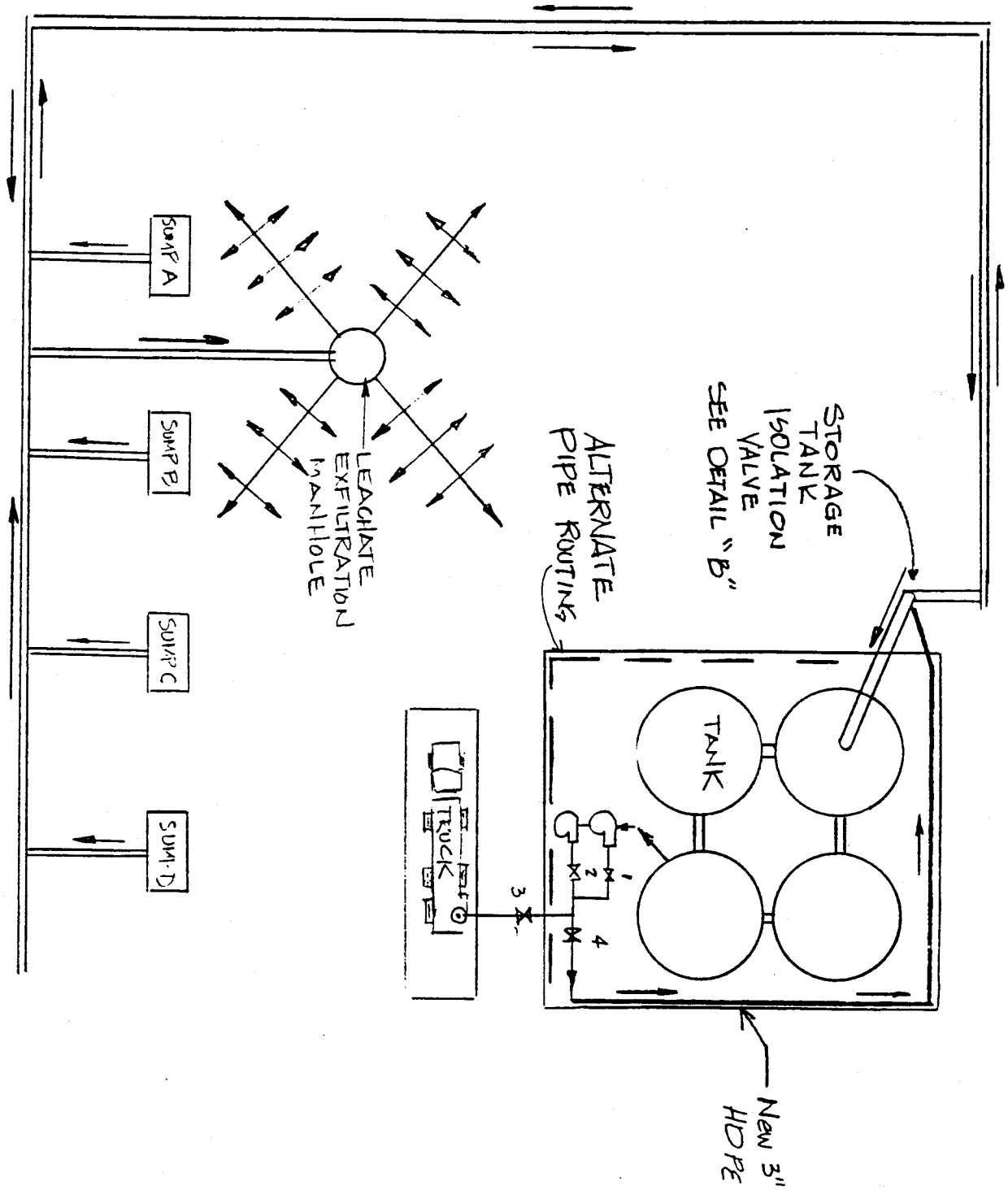
PROJECT Piedmont L/F

SUBJECT Leachate Tank Isolation Valve

Prepared By KEENER Date

Reviewed By Date

Approved By Date



Appendix 5

-Drawing-

Appendix 6

LEACHATE RECIRCULATION PROCEDURE

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

IMPORTANT! Follow this procedure carefully and record all required data.

1. Go to weather station. a) Record current temperature, b) Record high and low temp. last 24 hrs., c) Record rainfall last 24 hrs. - If ≥ 1", Do not recirculate!*, d) Look for rainfall events since last recirculation where cumulative rainfall ≥ 1", Record yes or no - If yes, record date and time it ended and total rainfall from that event; if it ended within the last 24 hrs., Do not recirculate!*

2. Inspect slopes of subcell for seeps - If present, or evidence of recent seeps is present, Do not recirculate!*

3. Go to sump of subcell to receive leachate. a) Record meter reading of leachate output from subcell, b) Record leachate level in sump, c) Subtract sump depth for the subcell, d) Record leachate level above liner (If < 0, record 0) - If ≥ 12", Do not recirculate!*

4. Go to distribution riser. a) Connect recirculation hose to pipe next in sequence, b) Record pipe # in "Record of Recirculation" table, c) Open valve on recirculation riser.

5. Go to recirculation manhole. a) record start meter reading on same line as starting pipe #.

6. Go to storage tanks. a) Close valve to load-out station and open valve to recirculation system, b) Close inflow valve to tanks, c) Start pump and record start time at top of log and on same line as starting pipe #.

7. Go to distribution riser. a) Observe pipe until pipe is full, b) Close valve on recirculation riser, c) Record stop time on same line as pipe # just filled, d) Move hose to next pipe in sequence, e) Open valve to start filling pipe, f) Record pipe # and start time on next line of table, g) Repeat steps (a) through (f) until last pipe in sequence has begun filling, h) When last pipe is full, go to Step 8.

8. Go to storage tanks. a) Stop pump, b) Close valve to recirculation system and open valve to load-out station, c) Record stop time on same line as last pipe # filled and at top of log, d) Open inflow valve to tanks.

9. Go to recirculation manhole. a) Record stop meter reading on same line as last pipe #.

10. Complete log by entering information in any blanks left unfilled and noting any observations or problems concerning system performance, slope conditions, odors, etc. Note any maintenance performed and/or any corrective actions taken to remedy problems.

11. Without delay, submit completed log to Operations Supervisor and report any problems.

* Note the reason under "Observations/Problems/Maintenance" and go to Step 10.

EcoLogic Associates, P.C.

Appendix 7

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE:_____TIME STARTED:_____TIME STOPPED:_____

LOCATION: Phase:_____Cell:_____Subcell:_____
TECHNICIAN:_____ASSISTANT:_____
WEATHER:_____CURRENT TEMP._____°F
LAST 24 HRS.: HIGH TEMP._____°F LOW TEMP._____°F RAINFALL*_____IN.

DATE OF LAST RECIRCULATION EVENT:_____
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes O No
If yes, when did it end? Date:_____ Time:_____* How much rain fell? _____IN.

LEACHATE GENERATION: METER READING_____GALS.
LEACHATE LEVEL: IN SUMP_____IN. ABOVE LINER*_____IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* O No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

- DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

EcoLogic Associates, P.C.

Appendix 8

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 10-29-96 TIME STARTED: 10:30 am TIME STOPPED: 3:00 pm

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: J. Brooks ASSISTANT: Andy / MARK T.
WEATHER: Sunny, warm CURRENT TEMP. 60-84 °F (am-pm)
LAST 24 HRS.: HIGH TEMP. 80 °F LOW TEMP. 49 °F RAINFALL* 0.01 IN.

DATE OF LAST RECIRCULATION EVENT: N.A.
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ⊙ No
If yes, when did it end? Date: — Time: — * How much rain fell? — IN.

→ LEACHATE GENERATION: METER READING METER BROKEN GALS.
LEACHATE LEVEL: IN SUMP 19.8 IN. ABOVE LINER* 0 IN. *
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ⊙ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
1	10:30	— 0 —	11:45	1,700	1,700
8	11:20	1,700	12:00	3,420	1,720
2	1:20	3,420	3:00	9,070	5650

OBSERVATIONS / PROBLEMS / MAINTENANCE:

* Sump depth is 24". (Actual is more like 30", but pump does not sit flush on bottom. 24" is conservative.)

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 11-4-96 TIME STARTED: 9:55 am TIME STOPPED: 1:55 pm

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: JOHN BROOKS ASSISTANT: PHIL BALL
WEATHER: Partly Cloudy CURRENT TEMP. 52 °F
LAST 24 HRS.: HIGH TEMP. 73 °F LOW TEMP. 28.5 °F RAINFALL* 0 IN.

DATE OF LAST RECIRCULATION EVENT: 10-29-96
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ~~O~~ No
If yes, when did it end? Date:_____ Time:_____* How much rain fell? _____IN.

LEACHATE GENERATION: METER READING 1357638 GALS.
LEACHATE LEVEL: IN SUMP 22 IN. ABOVE LINER* 0 IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ~~O~~ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
9	9:55	9070	12:10	17,050	7,980
3	12:50	17,050	1:55	21,200	4,150

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 11-11-96 TIME STARTED: 10:15 TIME STOPPED: 2:00

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: JOHN BROOKS ASSISTANT:
WEATHER: Over cast / Cloudy CURRENT TEMP. 41 °F
LAST 24 HRS.: HIGH TEMP. 47 °F LOW TEMP. 25 °F RAINFALL* 0.02 IN.

DATE OF LAST RECIRCULATION EVENT: 11-4-96
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ~~O~~ No
If yes, when did it end? Date:_____ Time:_____* How much rain fell? _____IN.

LEACHATE GENERATION: METER READING 1359970 GALS.
LEACHATE LEVEL: IN SUMP 12.9 IN. ABOVE LINER* 60 IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ~~O~~ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
4	10:15	21,200	11:50	29,461	8261
10	12:00	29,461	2:00	36,000	6539

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 11-13-96 TIME STARTED: 11:00 TIME STOPPED: 12:30

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: John Brooks ASSISTANT: _____
WEATHER: Sunny CURRENT TEMP. ~~56~~ 52 °F
LAST 24 HRS.: HIGH TEMP. ~~59~~ 52 °F LOW TEMP. ~~35~~ 28 °F RAINFALL* 0 IN.

DATE OF LAST RECIRCULATION EVENT: 11-11-96
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ✓ No
If yes, when did it end? Date: _____ Time: _____ * How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1360902 GALS.
LEACHATE LEVEL: IN SUMP 17.9 IN. ABOVE LINER* Ø IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ✓ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
6	11:00	36,000	12:30	43,500	7,500

OBSERVATIONS / PROBLEMS / MAINTENANCE:

Pipe #5 will not take / must be crushed??

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 11-21-96 TIME STARTED: 8:45 TIME STOPPED: 12:00

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: John Brooks ASSISTANT: _____
WEATHER: Mostly Cloudy CURRENT TEMP. 46 °F
LAST 24 HRS.: HIGH TEMP. 67 °F LOW TEMP. 46 °F RAINFALL* Ø IN.

DATE OF LAST RECIRCULATION EVENT: 11-13-96
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ~~O~~ No
If yes, when did it end? Date: _____ Time: _____ * How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1263725 GALS.
LEACHATE LEVEL: IN SUMP 17.8 IN. ABOVE LINER* Ø IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ~~O~~ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
11	8:45	43,500	10:15		
7	10:15		12:00	58,900	15,400

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 12-5-96 TIME STARTED: 8:15 TIME STOPPED: 11:30

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: JOHN BROOKS ASSISTANT:
WEATHER: CLOUDY CURRENT TEMP. ~~70~~-38°F
LAST 24 HRS.: HIGH TEMP. 62 °F LOW TEMP. 29 °F RAINFALL* Ø IN.

DATE OF LAST RECIRCULATION EVENT: 11-21-96
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? ☑ Yes O No
If yes, when did it end? Date: 12-1-96 Time: night * How much rain fell? 1 1/2 IN.

LEACHATE GENERATION: METER READING 1368439 GALS.
LEACHATE LEVEL: IN SUMP 17.7 IN. ABOVE LINER* Ø IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ☑ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
12	8:15	58,900	10:15		
13	10:30		11:30	74,700	15,800

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 12-10-96 TIME STARTED: 12:10 TIME STOPPED: 2:20

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: JOHN BROOKS ASSISTANT: _____
WEATHER: Sunny CURRENT TEMP. 45 °F
LAST 24 HRS.: HIGH TEMP. 45 °F LOW TEMP. 22 °F RAINFALL* Ø IN.

DATE OF LAST RECIRCULATION EVENT: 12-5-96
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ~~O~~ No
If yes, when did it end? Date: _____ Time: _____ * How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1372632 GALS.
LEACHATE LEVEL: IN SUMP 17.9 IN. ABOVE LINER* Ø IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ~~O~~ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
14	12:10	74,700	1:10		
14	1:20		2:20	85100	10,400

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 12-11-96 TIME STARTED: 12:50 TIME STOPPED: 2:55

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: John Brown ASSISTANT: _____
WEATHER: Mostly Cloudy CURRENT TEMP. 54 °F
LAST 24 HRS.: HIGH TEMP. 54 °F LOW TEMP. 35 °F RAINFALL* Ø IN.

DATE OF LAST RECIRCULATION EVENT: 12-10-96
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ~~O~~ No
If yes, when did it end? Date: _____ Time: _____ * How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1372341 ? GALS.
LEACHATE LEVEL: IN SUMP 17.9 IN. ABOVE LINER* Ø IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ~~O No*~~

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
#1	12:50	85,100	1:50		
#2	1:55		2:55		
#3	3:00		4:00	101,100	16,000

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 12-16-96 TIME STARTED: 10:10 TIME STOPPED: _____

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: John Brooks ASSISTANT: _____
WEATHER: Overcast CURRENT TEMP. 40 °F
LAST 24 HRS.: HIGH TEMP. _____ °F LOW TEMP. _____ °F RAINFALL* _____ IN.

DATE OF LAST RECIRCULATION EVENT: 12-10-96
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes O No
If yes, when did it end? Date: _____ Time: _____* How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1375568 GALS.
LEACHATE LEVEL: IN SUMP 20.4 IN. ABOVE LINER* Ø IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* O No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
4	10:10	101,100	12:10		
6	12:20		1:20		
7	1:25		2:25		
8	2:40		3:40		
10	3:45		4:45	101,500*	
Estimate Qty. Recirc. = 300 min.			x 75 gpm (low avg. rate)	x 50% = (Pump efficiency factor)	11,250 ±

OBSERVATIONS / PROBLEMS / MAINTENANCE:

shipped #9 by mistake will pick up next date

* Meter malfunctioned

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 7/15/97 TIME STARTED: 11:30 AM TIME STOPPED: 3:50 P.M

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: L.J. Burgin ASSISTANT: _____
WEATHER: Clear – Hot CURRENT TEMP. 94
LAST 24 HRS.: HIGH TEMP. 94 °F LOW TEMP. 63 °F RAINFALL* 0 IN.

DATE OF LAST RECIRCULATION EVENT: 1-14/97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ~~O~~ No
If yes, when did it end? Date: _____ Time: _____ * How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1566103 GALS.
LEACHATE LEVEL: IN SUMP 17.8 IN. ABOVE LINER* 0 IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ~~O~~ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
#1	11:30 AM	1030 00~~0~~	12:35 P.M	1036 ~~000~~	600
#2	12:52 PM	1036 00~~0~~	1:50 P.M	1048 ~~000~~	1200
#3	2:50 P.M	1048 00~~0~~	3:50 P.M	1058 ~~000~~	1000

OBSERVATIONS / PROBLEMS / MAINTENANCE:

no RAIN in LAST 6 weeks

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 7/17/97 TIME STARTED: 6:24 TIME STOPPED: 4:00 pm

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: L. J. Burgess ASSISTANT: _____
WEATHER: Clear - [illegible] CURRENT: 97 °F
LAST 24 HRS.: HIGH TEMP. 97 °F LOW TEMP. 65 °F RAINFALL* .75 IN.

DATE OF LAST RECIRCULATION EVENT: 7/15/97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ● No
If yes, when did it end? Date: _____ Time: _____ * How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1567378 GALS.
LEACHATE LEVEL: IN SUMP 27.5 IN. ABOVE LINER* 0 IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ● No* 3.5

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
16	1:00 pm	1058	2:30 pm	1064	600
17	3:00 pm	1064	4:00 pm	1074	1000

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

EcoLogic Associates, P.C.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 7/21/97 TIME STARTED: 8:15 A.M. TIME STOPPED: 5:30 P.M.

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: L. J. Burgess ASSISTANT: _____
WEATHER: Clear CURRENT TEMP. 74 °F
LAST 24 HRS.: HIGH TEMP. 97 °F LOW TEMP. 72 °F RAINFALL* 0 IN.

DATE OF LAST RECIRCULATION EVENT: 7/17/97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ⊘ No
If yes, when did it end? Date: _____ Time: _____ * How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1578489 GALS.
LEACHATE LEVEL: IN SUMP 19.5 IN. ABOVE LINER* 0 IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ⊘ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
15	8:15 am	1074	9:15 AM	1084	1,000
14	9:45 AM	1084	10:50 AM	1100	1,600
13	11:00 am	1100	12:00 pm.	1118	1,800
12	12:50 P.M.	1118	2:50 P.M.	1144	2,600
11	4:40 P.M.	1144	5:30 P.M.	1171	2,700

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 8-7-97 TIME STARTED: 8:30 TIME STOPPED: 4:00 PM

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: JACK LONG ASSISTANT: _____
WEATHER: CLEAR CURRENT TEMP. 68 °F
LAST 24 HRS.: HIGH TEMP. 79 °F LOW TEMP. 59 °F RAINFALL* 0 IN.

DATE OF LAST RECIRCULATION EVENT: 7-21-97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ● No
If yes, when did it end? Date: _____ Time: _____ * How much rain fell? 0 IN.

LEACHATE GENERATION: METER READING 1609867 GALS.
LEACHATE LEVEL: IN SUMP 18.2 IN. ABOVE LINER* NO IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ● No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
17	8:30	1171	9:30	1197	2600
16	9:30	1197	10:30	1211	1400
15	10:30	1211	1:30	1251	4000
13	1:30	1251	2:30	1268	1700
12	2:30	1268	4:00	1298	3000

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 8-11-97 TIME STARTED: 7:30 TIME STOPPED: 4:00

LOCATION: Phase: 3 Cell: 7 Subcell: 1
TECHNICIAN: JACK LONG ASSISTANT: _____
WEATHER: CLEAR CURRENT TEMP. 67
LAST 24 HRS.: HIGH TEMP. 87 °F LOW TEMP. 58 °F RAINFALL* NO IN.

DATE OF LAST RECIRCULATION EVENT: 8-7-97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ● No
If yes, when did it end? Date: _____ Time: _____ * How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1613068 GALS.
LEACHATE LEVEL: IN SUMP 2 ft IN. ABOVE LINER* NO IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ● No* 3.2"

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
12	7:30	1298	9:30	1319	2100
11	9:30	1319	11:30	1353	3400
10	2:00	1353	3:00	1372	1900
17	3:00	1372	4:00	1390	1800

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 8-12-97 TIME STARTED: 7:30 TIME STOPPED: 3:30

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: JACK LONG ASSISTANT: ~~[illegible]~~
WEATHER: CLEAR CURRENT TEMP. 72 °F
LAST 24 HRS.: HIGH TEMP. 90 °F LOW TEMP. 68 °F RAINFALL* 0 IN.

DATE OF LAST RECIRCULATION EVENT: 8-11-97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ● No
If yes, when did it end? Date:_____ Time:_____* How much rain fell? _____IN.

LEACHATE GENERATION: METER READING 1613230 GALS.
LEACHATE LEVEL: IN SUMP 25.1 IN. ABOVE LINER* ~~40~~ IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ● No* 1.1"

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
17	7:30	1390	9:30	1416	2600
16	9:30	1416	10:45	1436	2000
15	10:45	1436	12:30	1465	2900
14	12:30	1465	3:30	1483	1800

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

EcoLogic Associates, P.C.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 8-19-97 TIME STARTED: 8:00 TIME STOPPED: _____

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: JACK LONG ASSISTANT: _____
WEATHER: CLEAR CURRENT TEMP. _____ °F
LAST 24 HRS.: HIGH TEMP. 94 °F LOW TEMP. 75 °F RAINFALL* 0 IN.

DATE OF LAST RECIRCULATION EVENT: 8-12-97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ● No
If yes, when did it end? Date: _____ Time: _____* How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1621784 GALS.
LEACHATE LEVEL: IN SUMP 17.6 IN. ABOVE LINER* 0 IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ● No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
14	8:00	1484	10:30	1491	700
16	10:30	1491	1:30	1504	1300
13	1:30	1504	3:30	1504	
	PUMP NOT PUMPING.				

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 8-20-97 TIME STARTED: 6:30 TIME STOPPED: 10:30

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: JACK LONG ASSISTANT: _____
WEATHER: _____ CURRENT TEMP. 74
LAST 24 HRS.: HIGH TEMP. 85 °F LOW TEMP. 68 °F RAINFALL* _____ IN.

DATE OF LAST RECIRCULATION EVENT: 8-19-97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ● No
If yes, when did it end? Date: _____ Time: _____ * How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1622627 GALS.
LEACHATE LEVEL: IN SUMP 17.7 IN. ABOVE LINER* NO IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ● No*

RECORD OF RECIRCULATION

STARTED TO RAIN AT 10:30

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
14	6:30 ONE	TANK	8:30		5000± *
13	8:30	ONE TANK	10:30		"

OBSERVATIONS / PROBLEMS / MAINTENANCE:

STARTED TO RAIN AT 10:30
METER NOT WORKING

* NOTE: "ONE TANK" = 5500 gals. full

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 9/1/97 TIME STARTED: 9:45 AM TIME STOPPED: 5:00 P.M.

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: _____ ASSISTANT: L.J. Burgess
WEATHER: Sunny CURRENT TEMP. 87 °F
LAST 24 HRS.: HIGH TEMP. 90 °F LOW TEMP. 68 °F RAINFALL* 0 IN.

DATE OF LAST RECIRCULATION EVENT: 8/20/97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ☑ No
If yes, when did it end? Date: _____ Time: _____ * How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1632188 GALS.
LEACHATE LEVEL: IN SUMP 17.9 IN. ABOVE LINER* 0 IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ☑ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
13	9:45 AM.	not working	11:45	1535	4,000
14	12:10 pm.	1535	2:00 PM	1568	3,300
15	2:00 PM	1568	4:00 P.M.	1603	3,500
16	4:00 PM	1603	5:00 P.M	1618	1,500

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 9/2/97 TIME STARTED: 8:20 AM TIME STOPPED: 1:30 PM

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: _____ ASSISTANT: L. J. Burgess
WEATHER: sunny CURRENT TEMP. 84 °F
LAST 24 HRS.: HIGH TEMP. 90 °F LOW TEMP. 75 °F RAINFALL* _____ IN.

DATE OF LAST RECIRCULATION EVENT: 9/1/97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ~~O~~ No
If yes, when did it end? Date: _____ Time: _____ * How much rain fell? _____ IN.

LEACHATE GENERATION: METER READING 1632821 GALS.
LEACHATE LEVEL: IN SUMP 17.9 IN. ABOVE LINER* 0 IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ~~O~~ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
16	8:20 AM	1618	9:20	1639	2,100
17	9:30	1639	11:30	1666	2,700
12	11:40	1666	1:30	1702	3,600

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 9/4/97 TIME STARTED: 8:55 A.M. TIME STOPPED: 2:30 P.M.

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: ASSISTANT: L. J. Burgess
WEATHER: Clear CURRENT TEMP. 75 °F
LAST 24 HRS.: HIGH TEMP. 90 °F LOW TEMP. 49 °F RAINFALL* 0 IN.

DATE OF LAST RECIRCULATION EVENT: 9/1/97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ~~O~~ No
If yes, when did it end? Date: — Time: — * How much rain fell? — IN.

LEACHATE GENERATION: METER READING 1634177 GALS.
LEACHATE LEVEL: IN SUMP 17.9 IN. ABOVE LINER* 0 IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ~~O~~ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
12	8:55 A.M.	not working	10:55	—	2,800
11	12:30 P.M.	not working	2:30 P.M.	—	3,200

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 9/8/97 TIME STARTED: 7:40 A.M. TIME STOPPED: 3:00 P.M.

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: _____ ASSISTANT: E.J. Burgess
WEATHER: Clear CURRENT TEMP. 80 °F
LAST 24 HRS.: HIGH TEMP. 85 °F LOW TEMP. 50 °F RAINFALL* 0 IN.

DATE OF LAST RECIRCULATION EVENT: 9/4/97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ~~O No~~
If yes, when did it end? Date: — Time: — * How much rain fell? 0 IN.

LEACHATE GENERATION: METER READING 1636698 GALS.
LEACHATE LEVEL: IN SUMP 17.8 IN. ABOVE LINER* 0 IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ~~O No*~~

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
11	7:40 AM	1747	9:40 AM	—	3,200
17	9:50 AM.	[redacted]	11:50	[redacted]	2,200
16	2:00 P.M.	1791	3:00 P.M.	1805	1,400

OBSERVATIONS / PROBLEMS / MAINTENANCE:

meter not working, taking gallons from scale off tanks

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 9/9/97 TIME STARTED: 6:50 AM TIME STOPPED: 12:15

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: ASSISTANT: L. J. Burgess
WEATHER: Cloudy CURRENT TEMP. 72 °F
LAST 24 HRS.: HIGH TEMP. 87 °F LOW TEMP. 68 °F RAINFALL* 0 IN.

DATE OF LAST RECIRCULATION EVENT: 9/8/97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? O Yes ● No
If yes, when did it end? Date: — Time: — * How much rain fell? — IN.

LEACHATE GENERATION: METER READING 1637159 GALS.
LEACHATE LEVEL: IN SUMP 17.8 IN. ABOVE LINER* 0 IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ● No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
16	6:50 A.M.	1805	7:50 AM	1820	1,500
15	8:00 AM.	1820	10:15	1844	2,400
14	10:15 AM	1844	12:15	1870	2,600
13					

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

LEACHATE RECIRCULATION LOG

PIEDMONT LANDFILL & RECYCLING CENTER
Kernersville, North Carolina

DATE: 9-12-97 TIME STARTED: 6:45 A.M. TIME STOPPED: 10:35 A.M.

LOCATION: Phase: 3 Cell: 2 Subcell: 1
TECHNICIAN: ASSISTANT: L. J. Burgess
WEATHER: Clear CURRENT TEMP. 65 °F
LAST 24 HRS.: HIGH TEMP. 72 °F LOW TEMP. 61 °F RAINFALL* 0 IN.

DATE OF LAST RECIRCULATION EVENT: 9-9-97
Since last event, has there been a rainfall event with a cumulative rainfall ≥ 1 inch? ✓ Yes ~~O~~ No
If yes, when did it end? Date: 9/10/97 Time: 12:00 PM* How much rain fell? 1.17 IN.

LEACHATE GENERATION: METER READING 1638912 GALS.
LEACHATE LEVEL: IN SUMP 17.7 IN. ABOVE LINER* 0 IN.
EVIDENCE OF LEACHATE SEEPS ON SLOPES? O Yes* ~~O~~ No*

RECORD OF RECIRCULATION

PIPE #	START TIME	START METER RDG.	STOP TIME	STOP METER RDG.	GALLONS INTRODUCED
13	6:45 AM.	1870	7:45	NOT correct	2,500
12	7:50 Am.	—	8:50	—	2,000
11	9:35 Am		10:35 A.M.		2,500

OBSERVATIONS / PROBLEMS / MAINTENANCE:

CORRECTIVE ACTIONS (DATE: BY:):

* DO NOT RECIRCULATE IF: a) ≥ 1" of rain within last 24 hrs., b) Leachate level above liner is ≥ 12", or c) Seeps are present or have occurred within last 24 hrs.

Appendix 9

RESEARCH & ANALYTICAL LABORATORIES, INC.

Analytical/Process Consultations

RESEARCH & ANALYTICAL LABS. SIDNEY L. CHAMPION NC #34 DIRECTOR CERTIFIED ANALYSIS

Appendix 1 - Subtitle D Groundwater Monitoring - Inorganic Analysis From Selected Sampling Locations From Piedmont Landfill and Recycling Center, Kernersville, NC, 24 October 1996)

Inorganics Parameter	Quantitation Limit(mg/l)	Leachate (mg/l)
Arsenic	0.010	BQL
Antimony	0.030	0.043
Barium	0.500	1.79
Beryllium	0.002	0.004
Cadmium	0.001	0.073
Chromium	0.010	0.021
Cobalt	0.010	0.210
Copper	0.200	BQL
Lead	0.010	0.047
Nickel	0.050	0.058
Selenium	0.050	BQL
Silver	0.010	BQL
Thallium	0.050	BQL
Zinc	0.050	0.122
Vanadium	0.040	0.075
Biochemical Oxygen Demand (BOD)	2.0	2,880

Sample Number	284425
Sample Date	10/24/96
Sample Time	1000

mg/l = milligrams per liter = parts per million
BQL = Below Quantitation Limit

P.O. Box 473 • 106 Short Street • Kernersville, North Carolina 27284 • 910/996-2841

RESEARCH & ANALYTICAL LABORATORIES, INC.

Analytical/Process Consultations

RESEARCH & ANALYTICAL LABS. SIDNEY L. CHAMPION NC #34 DIRECTOR CERTIFIED ANALYSIS

Appendix 1 - Subtitle D Groundwater Monitoring - Volatile Organic Analysis From Selected Sampling Locations From Piedmont Landfill and Recycling Center, Kernersville, NC, 24 October 1996

Volatile Organics EPA Method 8260 Parameter	Quantitation Limit(mg/l)	Leachate (mg/l)
Methylene Chloride	0.010	0.872
Trichlorofluoromethane	0.005	0.035
1,1-Dichloroethene	0.005	BQL
1,1-Dichloroethane	0.005	0.116
Chloroform	0.005	0.025
Carbon Tetrachloride	0.010	BQL
1,2-Dichloropropane	0.005	BQL
Trichloroethene	0.005	0.019
Dibromochloromethane	0.005	BQL
1,1,2-Trichloroethane	0.005	BQL
Tetrachloroethene	0.005	0.010
Chlorobenzene	0.005	BQL
Trans-1,2-Dichloroethene	0.005	BQL
1,2-Dichloroethane	0.005	BQL
1,1,1-Trichloroethane	0.005	0.038
Bromodichloromethane	0.005	BQL
Cis-1,3-Dichloropropene	0.010	BQL
Benzene	0.005	BQL
Trans-1,3-Dichloropropene	0.010	BQL
Bromoform	0.005	BQL
1,1,2,2-Tetrachloroethane	0.005	BQL
Toluene	0.005	0.420
Ethyl Benzene	0.005	0.027
Chloromethane	0.010	BQL
Bromomethane	0.010	BQL
Vinyl Chloride	0.010	BQL
Chloroethane	0.010	BQL
Acetone	0.100	1.98
Carbon Disulfide	0.100	BQL
Vinyl Acetate	0.050	BQL
2-Butanone	0.100	4.66
4-Methyl-2-Pentanone	0.100	0.180
2-Hexanone	0.050	BQL
Styrene	0.010	BQL
Total Xylenes	0.005	0.142
Acrylonitrile	0.200	BQL
1,2-Dichlorobenzene	0.005	BQL
1,4-Dichlorobenzene	0.005	BQL
Trans-1,4-Dichloro-2-butene	0.100	BQL
Cis-1,2-Dichloroethene	0.005	0.006
Methyl Iodide	0.010	BQL
Bromochloromethane	0.005	BQL
Dibromomethane	0.010	BQL
1,1,1,2-Tetrachloropropane	0.005	BQL
1,2,3-Trichloropropane	0.015	BQL
1,2-Dibromo-3-Chloropropane(DBCP)	0.025	BQL
1,2-Dibromethane(EDB)	0.005	BQL

Sample Number	284425
Sample Date	10/24/96
Sample Time (hrs)	1000

mg/l = milligrams per liter = parts per million
BQL = Below Quantitation Limit

P.O. Box 473 • 106 Short Street • Kernersville, North Carolina 27284 • 910/996-2841

RESEARCH & ANALYTICAL LABORATORIES, INC.
Analytical/Process Consultations
Phone (910) 996-2841

CHAIN OF CUSTODY RECORD

JOB NO.

PROJECT NAME: PIEDMONT LANDFILL

SAMPLERS (SIGNATURE): Michael N. McFeeley

SAMPLE NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	2L G (BNA, Herb./Pest.)	40ml Vials (VOA)	250ml G (TOX)	250ml P (TOC)	1L PG (BOD, TSS, Unpreserved, etc)	1L G (Phenol, Oil & Grease)	1L PG (COD, N,P)	1L PG (Metals, Hardness)	1L PG (CYANIDE)	Sterile PG (Coliform)	REQUESTED ANALYSIS
SUMP D	961024	10:00		X	LEACHATE SUMP D	6		X			X			X			APPENDIX I CONST. AND BOD
2841/25																	

WATER/WASTEWATER | MISC.

RELINQUISHED BY	DATE/TIME	RECEIVED BY
M. McFeeley	961024 11:00	1315
RELINQUISHED BY	DATE/TIME	RECEIVED BY

REMARKS: NUT OFFICE
- ALLOW SOLIDS TO SETTLE OUT OF SAMPLES BEFORE ALIQUOT.

RESEARCH & ANALYTICAL LABORATORIES, INC.

Analytical/Process Consultations

RESEARCH & ANALYTICAL LABS. SIDNEY L. CHAMPION NC #34 DIRECTOR CERTIFIED ANALYSIS

Waste Management of Carolinas, Inc.
9900 Freeman Road
Kernersville, NC 27284
Attn: Edward L. Gibson

Date Sample Collected : 10/28/96
Date Sample Received : 10/28/96
Date Sample Analyzed : 10/28/96
Date of Report : 11/06/96
Analyses Performed by : DT

Lab Sample Number

284642

Parameter	Storet #	Results
BOD-5	(00310)	3,300 mg/l

Clients Sample Source : LEACHATE TANKS
Number :
Time Collected (Hrs) : 1300

RESEARCH & ANALYTICAL LABORATORIES, INC.
Analytical/Process Consultations
Phone (910) 996-2841

CHAIN OF CUSTODY RECORD

JOB NO.	PROJECT NAME
	PIEDMONT LANDFILL

SAMPLERS (SIGNATURE): [signature]

SAMPLE NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	2L G (BNA, Herb./Pest.)	2 40ml Vials (VOA)	250ml G (TOX)	250ml P (TOC)	1L PG (BOD, TSS, Unpreserved, etc.)	1L G (Phenol, Oil & Grease)	1L PG (COD, N,P)	1L PG (Metals, Hardness)	1L PG (CYANIDE)	Sterile PG (Coliform)	REQUESTED ANALYSIS
LEACHATE	961028	13:00		X	LEACHATE TANKS 284642					X							BOD

RELINQUISHED BY	DATE/TIME	RECEIVED BY
M. McFarley	961028 14:00	[signature]
RELINQUISHED BY	DATE/TIME	RECEIVED BY

REMARKS: on ice

WMX Technology Center, Inc.
Analytical Report Transmittal Memorandum

Enclosed are the analytical results for samples received from your facility. The results in the Client Report are for a single ENS (Event Notification System) number only. The sampling event at your facility may include multiple ENS numbers. A separate Client Report will be generated for each one.

It is the goal of the WMX Technology Center to provide analytical data in a timely fashion, formatted in a way that our clients will find most useful.

If you have any questions concerning the form or content of this report, please contact the WMX-TC Customer Operations Department:

Main Number (708) 208-3100
FAX Number (708) 208-1175

Note: Two designations may appear in the results column of your Client Report: NA or ND.

The designation NA (for "Not Analyzed") is used to identify analytes which were requested in the monitoring program, but for which no suitable testing methodology exists. NA may also indicate a dry well, broken sample bottle, insufficient sample volume, or other condition which precludes analysis for a sample.

The designation ND (for "Not Detected") is used to indicate that the analyte of interest was not found at or above the concentration listed under the EMLRL (EML Reporting Limit) heading.

Unless otherwise indicated, all analytes meet the requirements of holding time as specified in the method.

Roy S. Gall

Roy S. Gall, Ph.D.
President
WMX Technology Center

WMX TECHNOLOGY CENTER, INC.

EVENT SUMMARY REPORT

Site: 134 - Piedmont Landfill
Disposal Facility
9900 Freeman Road
Kernersville NC 27284

ENS: 97-10524
MP: 134972
Rev / Task: 00 / 02
Sample Type: LEACHATE
Reported: 31-JAN-1997

Analyte	Sample Point: 134-SUMD Sample Number: AQ8060 Sampled: 23-JAN-1997		EML RL					Units
FIELD DATA:								
DEPTH TO LEACHATE	NA							FT
LEACHATE ELEVATION	NA							FT MSL
PH FIELD	5.60							PH UNITS
SAMPLING EQUIPMENT	NA							
SAMPLING MATERIAL	NA							
SPECIFIC CONDUCTANCE FIELD	NA							UMHOS/CM
WATER TEMPERATURE IN DEG. CELSIUS FIELD	15.2							DEGREES C
INORGANICS:								
ANTIMONY-TOTAL	ND		6.00					UG/L
ARSENIC-TOTAL	15.2		10.0					UG/L
BARIUM-TOTAL	1950		500.					UG/L
BIOCHEMICAL OXYGEN DEMAND	3760		1200					MG/L
CADMIUM-TOTAL	32.1		1.00					UG/L
CHROMIUM-TOTAL	82.9		10.0					UG/L
COPPER-TOTAL	ND		200.					UG/L
LEAD-TOTAL	35.0		10.0					UG/L
NICKEL-TOTAL	109		50.0					UG/L
SELENIUM-TOTAL	ND		20.0					UG/L
SILVER-TOTAL	ND		10.0					UG/L
THALLIUM-TOTAL	ND		2.00					UG/L
ZINC-TOTAL	450.		50.0					UG/L
SUB-CONTRACT DATA:								
BERYLLIUM-TOTAL	ND	s	2.00					UG/L
COBALT-TOTAL	150	s	5.00					UG/L
VANADIUM-TOTAL	ND	s	10.0					UG/L
VOLATILE ORGANICS:								
1,1,1,2-TETRACHLOROETHANE	ND		13					UG/L
1,1,1-TRICHLOROETHANE	ND		13					UG/L
1,1,2,2-TETRACHLOROETHANE	ND		20.					UG/L
1,1,2-TRICHLOROETHANE	ND		13					UG/L
1,1-DICHLOROETHANE	82		13					UG/L
1,1-DICHLOROETHENE	ND		20.					UG/L
1,2,3-TRICHLOROPROPANE	ND		40.1					UG/L
1,2-DIBROMO-3-CHLOROPROPANE	ND		40.1					UG/L
1,2-DIBROMOETHANE	ND		13.4					UG/L
1,2-DICHLOROBENZENE	ND		13.4					UG/L
1,2-DICHLOROETHANE	ND		13					UG/L
1,2-DICHLOROPROPANE	ND		13					UG/L
1,4-DICHLOROBENZENE	ND		13.4					UG/L
2-BUTANONE	8100		334					UG/L
2-HEXANONE	ND		60.1					UG/L
4-METHYL-2-PENTANONE	270		100.					UG/L
ACETONE	6700		334					UG/L
ACRYLONITRILE	ND		200.					UG/L
BENZENE	ND		13					UG/L

NA = Not Analyzed ND = Not Detected TBK = Trip Blank s = EML Subcontract Data

WMX TECHNOLOGY CENTER, INC.

EVENT SUMMARY REPORT

Site: 134 - Piedmont Landfill
Disposal Facility
9900 Freeman Road
Kernersville NC 27284

ENS: 97-10524
MP: 134972
Rev / Task: 00 / 02
Sample Type: LEACHATE
Reported: 31-JAN-1997

Analyte	Sample Point: 134-SUMD Sample Number: AQ8060 Sampled: 23-JAN-1997	EML RL					Units
BROMOCHLOROMETHANE	ND	13.4					UG/L
BROMODICHLOROMETHANE	ND	13					UG/L
BROMOFORM	ND	13					UG/L
BROMOMETHANE	ND	20.					UG/L
CARBON DISULFIDE	ND	100.					UG/L
CARBON TETRACHLORIDE	ND	20.0					UG/L
CHLOROBENZENE	ND	13					UG/L
CHLOROETHANE	21	20.					UG/L
CHLOROFORM	ND	13					UG/L
CHLOROMETHANE	ND	27					UG/L
CIS-1,2-DICHLOROETHENE	ND	20.0					UG/L
CIS-1,3-DICHLOROPROPENE	ND	13.4					UG/L
DIBROMOCHLOROMETHANE	ND	7					UG/L
DIBROMOMETHANE	ND	13					UG/L
ETHYLBENZENE	22	13					UG/L
IODOMETHANE	ND	20.					UG/L
METHYLENE CHLORIDE	250	20.0					UG/L
STYRENE	ND	13.4					UG/L
TETRACHLOROETHENE	ND	20.					UG/L
TOLUENE	210	13					UG/L
TRANS-1,2-DICHLOROETHENE	ND	20.0					UG/L
TRANS-1,3-DICHLOROPROPENE	ND	13.4					UG/L
TRANS-1,4-DICHLORO-2-BUTENE	ND	100.					UG/L
TRICHLOROETHENE	ND	13					UG/L
TRICHLOROFLUOROMETHANE	ND	20.0					UG/L
VINYL ACETATE	ND	50.0					UG/L
VINYL CHLORIDE	ND	20.					UG/L
XYLENE(TOTAL)	64	40.1					UG/L

NA = Not Analyzed **ND = Not Detected** **TBK = Trip Blank** **s = EML Subcontract Data**

WMX TECHNOLOGY CENTER, INC.

DATA QUALIFIER REPORT

Site: 134 - Piedmont Landfill

ENS: 97-10524

Report Date: 31-JAN-1997

Sample Pt	Samp Date	Analyte	Method	Comment	Additional Comments Explanations (NQ/DL)
SUMD	23-JAN-1997	EVERY ANALYTE FOR THIS METHOD	VOMSBAA004	DL,PX	Dilution factor 16.7 applied.
SUMD	23-JAN-1997	ACRYLONITRILE	VOMSBAA004	NQ	Analyzed by approved screen methodology per EPA Method 624 or analyzed quantitatively per SW-846 methods.
SUMD	23-JAN-1997	EVERY ANALYTE FOR THIS METHOD	VOMSBAX423	DL,PX	Dilution factor 16.7 applied.
SUMD	23-JAN-1997	EVERY ANALYTE FOR THIS METHOD	SBGFAATOBE	SB,NQ	SAVANNAH G
SUMD	23-JAN-1997	EVERY ANALYTE FOR THIS METHOD	SBGFAATONC	SB,NQ	SAVANNAH G
SUMD	23-JAN-1997	BIOCHEMICAL OXYGEN DEMAND	INBODXXX01	DL,NQ	Dilution factor 600 applied. A GGA standard was outside of the control limits required by the method (167.5-228.5 mg/L). However, the GGA standard was within the laboratory historical limits. THE SEED CORRECTION FACTOR WAS OUTSIDE THE RANGE OF 0.6 - 1.0.

WMX TECHNOLOGY CENTER, INC.

DATA QUALIFIER REPORT

Site: 134 – Piedmont Landfill

ENS: 97-10524

Report Date: 31-JAN-1997

Code	Data Qualifier Comment Code Definition
DL	Sample diluted; reporting limits have been adjusted where necessary.
NQ	No standard qualifier code is in use for this qualification. See the associated comment.
PX	This sample required preservation in the field to a pH of less than 2. The pH was checked before analysis and did not have a pH of less than 2.
SB	The analysis of this sample was performed by an approved subcontract laboratory.

Subcontract To: _____

WMX Technology Center, Inc.

FIELD CHAIN-OF-CUSTODY RECORD

AquaPak™ PREP
AquaPak™ # 2129
Date Sealed 9 7 0 1 2 1 (YY / MM / DD)
Seal # 112985
By: SW

SITE/FACILITY # 134 SITE NAME: Piedmont Landfill

Sample Point: C SUMD (Source Code)

SAMPLE DATE: - 9 7 0 1 2 3 (YY / MM / DD)

SAMPLE TIME: 1 5 : 4 5 (2400 HR.)

MATRIX CODE: C

WMX TECHNOLOGY CENTER, INC.
SAMPLE POINT LABEL
Sample Team: Attach this label to CC form when sampling begins at the Sample Point specified.

*134-SUMD *

Water ..... (W) Leachate ..... (C)
Soil ..... (S) Other ..... (X)

Source Codes:
Well ..... (W) Leachate System ... (C) Pretreatment Facility ... (P) River/Stream/Brook ... (R) Soil ..... (S) Generation Pt ..... (G)
Dewatering/Pressure Relief .... (D) Gas Condensate ... (M) Influent ..... (U) Lake or Ocean ..... (L) Bottom Sediment ... (B) Other ..... (X)
Surface Water Impoundment ... (I) Air ..... (A) Effluent ..... (T) Outfall ..... (O) Noise ..... (N) Specify _____

ENS # *97-10524 AquaPak™ CONTENT 07 Day TAT

SAMPLE I.D.	# OF BOTTLES	BOTTLE TYPE	PRESERVATIVE TYPE	ANALYTES/LAB GROUPS	FILTER Y — N	FIELD COMMENTS	E.M.L. COMMENTS
AQ8060-A	01	P	HNO3	IN 12 METHODS	Y / N	EML	
AQ8060-B	04	G	HCL 4C	VO 02 METHODS	Y / N	EML	
AQ8060-C	01	P	HNO3	SB 02 METHODS	Y / N	SAVANNAH G	
AQ8060-D	01	G	HCL 4C	VO 02 METHODS	Y / N	EML BBLD@6<mm	TBK
					Y / N	1/24/97	
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		

CHAIN OF CUSTODY CHRONICLE

1. AquaPak™ Opened By: (print) EDWARD GIBSON Date: 1/23/97 Time: 13:15 (2400 HR.)
Signature: [signature] Seal #: 112985 Intact: yes

I have received these materials in good condition from the above person.

2. Name: _____ Signature: _____
Date: / / Time: : (2400 HR.) Remarks: _____

I have received these materials in good condition from the above person.

3. Name: _____ Signature: _____
Date: / / Time: : (2400 HR.) Remarks: _____

4. AquaPak™/Sub Contr. # AP0502 Sealed By: ED GIBSON (Print) Date: 1/23/97 Time: 16:30 (2400 HR.)
Signature: [signature] Seal #: 116220 Intact: yes

LAB USE ONLY
Opened By: (Signature) [signature] Date: 1/24/97 Time: 10:44 (2400 HR.)
AquaPak™/Sub. Contr. # SO2 Temp.°C 3 Seal # 116220 Intact. Y

ORIGINAL LAB

EML FF-1A 12/

WMX Environmental Monitoring Laboratories, Inc.

FIELD INFORMATION FORM

Site # 0134

Bottle Set: AQ8060

Sample Point: C SUMD (Source Code)

PURG INFO

PURGE DATE (YY MM DD)	START PURGE (2400 Hr Clock)	ELAPSED HRS	WATER VOL IN CASING (Gallons)	ACTUAL VOLUME PURGED (Gallons)
970123	N/A	N/A	N/A	N/A

PURG & SAMPLING EQUIP

Purging Equipment ..... Dedicated | Y | | N | (circle one)

Sampling Equipment ..... Dedicated | Y | | N | (circle one)

Purging Device		A-Submersible Pump	D-Gas Lift Pump	G-Bailer	X- PURGING OTHER (SPECIFY)
Sampling Device		B-Peristaltic Pump	E-Venturi Pump	H-Scoop/Shovel	X- SAMPLING OTHER (SPECIFY)
		C-Bladder Pump	F-Dipper/Bottle	I-Piston Pump	
Purging Material		A-Teflon	C-Polypropylene	E-Polyethylene	X- PURGING OTHER (SPECIFY)
Sampling Material		B-Stainless Steel	D-PVC		X- SAMPLING OTHER (SPECIFY)
Tubing-Purging		A-Teflon	D-Polypropylene	F-Silicon	X- PURGING OTHER (SPECIFY)
Tubing-Sampling		B-Tygon	E-Polyethylene	G-Combination teflon/ Polypropylene	X- SAMPLING OTHER (SPECIFY)
		C-Rope X- (SPECIFY)			
Filtering Devices 0.45 μ:	A	A-In-line Disposable	B-Pressure	C-Vacuum	

FIELD MEASUREMENT

Well Elevation	(ft/msl)	Land Surface Elevation	(ft/msl)
Depth to water From top of well casing	(ft)	Depth to water From land surface	(ft)
Groundwater Elevation	(ft/msl)	Groundwater Elevation	(ft/msl)
Well Depth	(ft)	Stickup	(ft)

	ph		spec cond		Other parameter	Value	Units
1st	5.60 (STD)	1st	UNK	μm/cm at 25° C			
2nd	(STD)	2nd		μm/cm at 25° C			
3rd	(STD)	3rd		μm/cm at 25° C			
4th	(STD)	4th		μm/cm at 25° C			

Sample Temp. 15.2 (° C)

COMMENTS

Sample Appearance: GREEN/GRAY (if applicable) Odor: SEPTIC Color: GRAY/GREEN Turbidity: Heavy

Weather Conditions: Wind Speed 5-10 mph Direction _____ Precipitation Y/N Outlook Sunny

Specific Comments: _____

I certify that sampling procedures were in accordance with applicable EPA, State and WMI protocols.

1/23/97 (Date) [signature] (Signature) Employer: Piedmont L/F

EML FF-2A 11/94

ORIGINAL LAB

WMX TECHNOLOGY CENTER, INC.

CLIENT REPORT

Site: 134 - Piedmont Landfill
Disposal Facility
9900 Freeman Road
Kernersville NC 27284

Sample Point: SUMD
Sample Type: LEACHATE
Sample Number: AS4058

ENS: 97-13908
MP: 134972
REV: 00

Sampled: 15-OCT-1997
Received: 16-OCT-1997
Reported: 23-JUL-1998

Analyte	Result	EML RL	Units	Comments	Method
FIELD DATA:					
PH FIELD	6.29		PH UNITS		FDPHSING01
SPECIFIC CONDUCTANCE FIELD	6800		UMHOS/CM		FDSPCOND01
WATER TEMPERATURE IN DEG. CELSIUS FIELD	18.6		DEGREES C		FDXTEMPC01
CHEMICAL METHODS & ROBOTICS:					
CHEMICAL OXYGEN DEMAND	12100	250.	MG/L	DL	CRCODXXX01
NITROGEN, NITRATE	0.050	0.050	MG/L	NQ	CRNO3HYD01
PH	6.39	0.05	PH UNITS		CRXPHXXX01
PHOSPHOROUS, TOTAL	ND	0.20	MG/L	PX	CRTPXXXX02
INORGANICS:					
ANTIMONY-TOTAL	109	30.0	UG/L	PX	INTJATOTSB
ARSENIC-TOTAL	48.2	10.0	UG/L	BL,PX	INTJATOTAS
BARIUM-TOTAL	1830	500.	UG/L	PX	INICPTOTBA
BERYLLIUM-TOTAL	ND	2.00	UG/L	PX	INTJATOTBE
BIOCHEMICAL OXYGEN DEMAND	6710	6000	MG/L	DL,NQ	INBODXXX01
CADMIUM-TOTAL	23.7	1.00	UG/L	PX	INTJATOTCD
CHROMIUM-TOTAL	194	10.0	UG/L	PX	INTJATOTCR
COBALT-TOTAL	270.	10.0	UG/L	PX	INTJATOTCO
COPPER-TOTAL	ND	200.	UG/L	PX	INICPTOTCU
LEAD-TOTAL	14.8	10.0	UG/L	BL,PX	INTJATOTPB
NICKEL-TOTAL	333	50.0	UG/L	PX	INICPTOTNI
SELENIUM-TOTAL	ND	20.0	UG/L	PX	INTJATOTSE
SILVER-TOTAL	ND	10.0	UG/L	PX	INTJATOTAG
SULFATE	87.9	12.0	MG/L	DL	INICXXSO4X
THALLIUM-TOTAL	45.6	2.00	UG/L	PX	INTJATOTTL
VANADIUM-TOTAL	78.5	40.0	UG/L	PX	INTJATOTXV
ZINC-TOTAL	485	50.0	UG/L	PX	INICPTOTZN
VOLATILE ORGANICS:					
1,1,1,2-TETRACHLOROETHANE	ND	22	UG/L	DL,PX	VOMSBAX435
1,1,1-TRICHLOROETHANE	ND	22	UG/L	DL,PX	VOMSBAX435
1,1,2,2-TETRACHLOROETHANE	ND	33	UG/L	DL,PX	VOMSBAX435
1,1,2-TRICHLOROETHANE	ND	22	UG/L	DL,PX	VOMSBAX435
1,1-DICHLOROETHANE	76	22	UG/L	DL,PX	VOMSBAX435
1,1-DICHLOROETHENE	ND	33	UG/L	DL,PX	VOMSBAX435
1,2,3-TRICHLOROPROPANE	ND	67	UG/L	DL,PX	VOMSBAX435
1,2-DIBROMO-3-CHLOROPROPANE	ND	1	UG/L		VOGCEAN104
1,2-DIBROMOETHANE	ND	1	UG/L		VOGCEAN104
1,2-DICHLOROBENZENE	ND	22	UG/L	DL,PX	VOMSBAX435
1,2-DICHLOROETHANE	ND	22	UG/L	DL,PX	VOMSBAX435
1,2-DICHLOROPROPANE	ND	22	UG/L	DL,PX	VOMSBAX435
1,4-DICHLOROBENZENE	ND	22	UG/L	DL,PX	VOMSBAX435
2-BUTANONE	13000	280	UG/L	DL,PX	VOMSBAX435
2-HEXANONE	ND	100	UG/L	DL,PX	VOMSBAX435
4-METHYL-2-PENTANONE	620	89	UG/L	DL,PX	VOMSBAX435
ACETONE	5100	560	UG/L	DL,PX	VOMSBAX435
ACRYLONITRILE	ND	222	UG/L	DL,PX,NQ	VOMSBAA004

NA = Not Analyzed **ND = Not Detected** **TBK = Trip Blank**

Item	Additional Comment Explanations (NQ/DL)
CHEMICAL OXYGEN DEMAND	Dilution factor 25 applied.
NITROGEN, NITRATE	The sample was filtered due to particulates.
BIOCHEMICAL OXYGEN DEMAND	A GGA standard was outside of the control limits required by the method (167.5-228.5 mg/L). However, the GGA standard was within the laboratory historical limits. THE SEED CORRECTION FACTOR WAS OUTSIDE THE RANGE OF .6-10. Dilution factor 3000 applied. RESULTS CONFIRMED ON YS200 W/PASSING GGA'S.
SULFATE	Dilution factor 10 applied.
VOMSBAA004	Dilution factor 27.778 applied.
VOMSBAX435	Dilution factor 27.778 applied.
ACRYLONITRILE	Analyzed by approved screen methodology per EPA Method 624 or analyzed quantitatively per SW-846 methods.

WMX TECHNOLOGY CENTER, INC.

C L I E N T R E P O R T

Site: 134 - Piedmont Landfill
Disposal Facility
9900 Freeman Road
Kernersville NC 27284

Sample Point: SUMD
Sample Type: LEACHATE
Sample Number: AS4058

ENS: 97-13908
MP: 134972
REV: 00

Sampled: 15-OCT-1997
Received: 16-OCT-1997
Reported: 23-JUL-1998

Analyte	Result	EML RL	Units	Comments	Method
BENZENE	ND	22	UG/L	DL,PX	VOMSBAX435
BROMOCHLOROMETHANE	ND	22	UG/L	DL,PX	VOMSBAX435
BROMODICHLOROMETHANE	ND	22	UG/L	DL,PX	VOMSBAX435
BROMOFORM	ND	22	UG/L	DL,PX	VOMSBAX435
BROMOMETHANE	ND	33	UG/L	DL,PX	VOMSBAX435
CARBON DISULFIDE	ND	22	UG/L	DL,PX	VOMSBAX435
CARBON TETRACHLORIDE	ND	33	UG/L	DL,PX	VOMSBAX435
CHLOROBENZENE	ND	22	UG/L	DL,PX	VOMSBAX435
CHLOROETHANE	49	33	UG/L	DL,PX	VOMSBAX435
CHLOROFORM	ND	22	UG/L	DL,PX	VOMSBAX435
CHLOROMETHANE	ND	44	UG/L	DL,PX	VOMSBAX435
CIS-1,2-DICHLOROETHENE	37	33	UG/L	DL,PX	VOMSBAX435
CIS-1,3-DICHLOROPROPENE	ND	22	UG/L	DL,PX	VOMSBAX435
DIBROMOCHLOROMETHANE	ND	11	UG/L	DL,PX	VOMSBAX435
DIBROMOMETHANE	ND	22	UG/L	DL,PX	VOMSBAX435
ETHYLBENZENE	70.	22	UG/L	DL,PX	VOMSBAX435
IODOMETHANE	ND	33	UG/L	DL,PX	VOMSBAX435
METHYLENE CHLORIDE	390	33	UG/L	DL,PX	VOMSBAX435
STYRENE	ND	22	UG/L	DL,PX	VOMSBAX435
TETRACHLOROETHENE	ND	33	UG/L	DL,PX	VOMSBAX435
TOLUENE	940	22	UG/L	DL,PX	VOMSBAX435
TRANS-1,2-DICHLOROETHENE	ND	33	UG/L	DL,PX	VOMSBAX435
TRANS-1,3-DICHLOROPROPENE	ND	22	UG/L	DL,PX	VOMSBAX435
TRANS-1,4-DICHLORO-2-BUTENE	ND	56	UG/L	DL,PX	VOMSBAX435
TRICHLOROETHENE	ND	22	UG/L	DL,PX	VOMSBAX435
TRICHLOROFLUOROMETHANE	ND	33	UG/L	DL,PX	VOMSBAX435
VINYL ACETATE	ND	78	UG/L	DL,PX	VOMSBAX435
VINYL CHLORIDE	ND	33	UG/L	DL,PX	VOMSBAX435
XYLENE(TOTAL)	160	67	UG/L	DL,PX	VOMSBAX435

NA = Not Analyzed **ND = Not Detected** **TBK = Trip Blank**

WMX TECHNOLOGY CENTER, INC.

CLIENT REPORT

Site: 134 - Piedmont Landfill
Disposal Facility
9900 Freeman Road
Kernersville NC 27284

Sample Point: TBK-SUMD
Sample Type: LEACHATE
Sample Number: AS4058

ENS: 97-13908
MP: 134972
REV: 00

Sampled: 15-OCT-1997
Received: 16-OCT-1997
Reported: 23-JUL-1998

Analyte	Result	EML RL	Units	Comments	Method
VOLATILE ORGANICS:					
1,1,1,2-TETRACHLOROETHANE	ND	5	UG/L		VOMSBAX435
1,1,1-TRICHLOROETHANE	ND	5	UG/L		VOMSBAX435
1,1,2,2-TETRACHLOROETHANE	ND	5	UG/L		VOMSBAX435
1,1,2-TRICHLOROETHANE	ND	5	UG/L		VOMSBAX435
1,1-DICHLOROETHANE	ND	5	UG/L		VOMSBAX435
1,1-DICHLOROETHENE	ND	5	UG/L		VOMSBAX435
1,2,3-TRICHLOROPROPANE	ND	10.	UG/L		VOMSBAX435
1,2-DICHLOROBENZENE	ND	10.	UG/L		VOMSBAX435
1,2-DICHLOROETHANE	ND	5	UG/L		VOMSBAX435
1,2-DICHLOROPROPANE	ND	5	UG/L		VOMSBAX435
1,4-DICHLOROBENZENE	ND	10.	UG/L		VOMSBAX435
2-BUTANONE	ND	10.	UG/L		VOMSBAX435
2-HEXANONE	ND	10.	UG/L		VOMSBAX435
4-METHYL-2-PENTANONE	ND	10.	UG/L		VOMSBAX435
ACETONE	ND	34	UG/L		VOMSBAX435
ACRYLONITRILE	ND	200.	UG/L	NQ	VOMSBAA004
BENZENE	ND	5	UG/L		VOMSBAX435
BROMOCHLOROMETHANE	ND	10.	UG/L		VOMSBAX435
BROMODICHLOROMETHANE	ND	5	UG/L		VOMSBAX435
BROMOFORM	ND	5	UG/L		VOMSBAX435
BROMOMETHANE	ND	10.	UG/L		VOMSBAX435
CARBON DISULFIDE	ND	5	UG/L		VOMSBAX435
CARBON TETRACHLORIDE	ND	5	UG/L		VOMSBAX435
CHLOROBENZENE	ND	5	UG/L		VOMSBAX435
CHLOROETHANE	ND	10.	UG/L		VOMSBAX435
CHLOROFORM	ND	5	UG/L		VOMSBAX435
CHLOROMETHANE	ND	10.	UG/L		VOMSBAX435
CIS-1,2-DICHLOROETHENE	ND	10.	UG/L		VOMSBAX435
CIS-1,3-DICHLOROPROPENE	ND	5	UG/L		VOMSBAX435
DIBROMOCHLOROMETHANE	ND	5	UG/L		VOMSBAX435
DIBROMOMETHANE	ND	10.	UG/L		VOMSBAX435
ETHYLBENZENE	ND	5	UG/L		VOMSBAX435
IODOMETHANE	ND	10.	UG/L		VOMSBAX435
METHYLENE CHLORIDE	ND	5	UG/L		VOMSBAX435
STYRENE	ND	5	UG/L		VOMSBAX435
TETRACHLOROETHENE	ND	5	UG/L		VOMSBAX435
TOLUENE	ND	5	UG/L		VOMSBAX435
TRANS-1,2-DICHLOROETHENE	ND	10.	UG/L		VOMSBAX435
TRANS-1,3-DICHLOROPROPENE	ND	5	UG/L		VOMSBAX435
TRANS-1,4-DICHLORO-2-BUTENE	ND	10.	UG/L		VOMSBAX435
TRICHLOROETHENE	ND	5	UG/L		VOMSBAX435
TRICHLOROFLUOROMETHANE	ND	10.	UG/L		VOMSBAX435
VINYL ACETATE	ND	10.	UG/L		VOMSBAX435
VINYL CHLORIDE	ND	10.	UG/L		VOMSBAX435
XYLENE(TOTAL)	ND	10.	UG/L		VOMSBAX435

NA = Not Analyzed **ND = Not Detected** **TBK = Trip Blank**

Item	Additional Comment Explanations (NQ/DL)
ACRYLONITRILE	Analyzed by approved screen methodology per EPA Method 624 or analyzed quantitatively per SW-846 methods.

WMX TECHNOLOGY CENTER, INC.

EVENT SUMMARY REPORT

Site: 134 - Piedmont Landfill
Disposal Facility
9900 Freeman Road
Kernersville NC 27284

ENS: 97-13908
MP: 134972
Rev / Task: 00 /
Sample Type: LEACHATE
Reported: 23-JUL-1998

Analyte	Sample Point: / Sample Number: / Sampled:	134-SUMD AS4058 15-OCT-1997	EML RL	TBK-SUMD AS4058 15-OCT-1997	EML RL			Units
FIELD DATA:								
PH FIELD		6.29						PH UNITS
SPECIFIC CONDUCTANCE FIELD		6800						UMHOS/CM
WATER TEMPERATURE IN DEG. CELSIUS FIELD		18.6						DEGREES C
CHEMICAL METHODS & ROBOTICS:								
CHEMICAL OXYGEN DEMAND		12100	250.					MG/L
NITROGEN, NITRATE		0.050	0.050					MG/L
PH		6.39	0.05					PH UNITS
PHOSPHOROUS, TOTAL		ND	0.20					MG/L
INORGANICS:								
ANTIMONY-TOTAL		109	30.0					UG/L
ARSENIC-TOTAL		48.2	10.0					UG/L
BARIUM-TOTAL		1830	500.					UG/L
BERYLLIUM-TOTAL		ND	2.00					UG/L
BIOCHEMICAL OXYGEN DEMAND		6710	6000					MG/L
CADMIUM-TOTAL		23.7	1.00					UG/L
CHROMIUM-TOTAL		194	10.0					UG/L
COBALT-TOTAL		270.	10.0					UG/L
COPPER-TOTAL		ND	200.					UG/L
LEAD-TOTAL		14.8	10.0					UG/L
NICKEL-TOTAL		333	50.0					UG/L
SELENIUM-TOTAL		ND	20.0					UG/L
SILVER-TOTAL		ND	10.0					UG/L
SULFATE		87.9	12.0					MG/L
THALLIUM-TOTAL		45.6	2.00					UG/L
VANADIUM-TOTAL		78.5	40.0					UG/L
ZINC-TOTAL		485	50.0					UG/L
VOLATILE ORGANICS:								
1,1,1,2-TETRACHLOROETHANE		ND	22	ND	5			UG/L
1,1,1-TRICHLOROETHANE		ND	22	ND	5			UG/L
1,1,2,2-TETRACHLOROETHANE		ND	33	ND	5			UG/L
1,1,2-TRICHLOROETHANE		ND	22	ND	5			UG/L
1,1-DICHLOROETHANE		76	22	ND	5			UG/L
1,1-DICHLOROETHENE		ND	33	ND	5			UG/L
1,2,3-TRICHLOROPROPANE		ND	67	ND	10.			UG/L
1,2-DIBROMO-3-CHLOROPROPANE		ND	1					UG/L
1,2-DIBROMOETHANE		ND	1					UG/L
1,2-DICHLOROBENZENE		ND	22	ND	10.			UG/L
1,2-DICHLOROETHANE		ND	22	ND	5			UG/L
1,2-DICHLOROPROPANE		ND	22	ND	5			UG/L
1,4-DICHLOROBENZENE		ND	22	ND	10.			UG/L
2-BUTANONE		13000	280	ND	10.			UG/L
2-HEXANONE		ND	100	ND	10.			UG/L
4-METHYL-2-PENTANONE		620	89	ND	10.			UG/L
ACETONE		5100	560	ND	34			UG/L
ACRYLONITRILE		ND	222	ND	200.			UG/L

NA = Not Analyzed **ND = Not Detected** **TBK = Trip Blank** **s = EML Subcontract Data**

WMX TECHNOLOGY CENTER, INC.

EVENT SUMMARY REPORT

Site: 134 - Piedmont Landfill
Disposal Facility
9900 Freeman Road
Kernersville NC 27284

ENS: 97-13908
MP: 134972
Rev / Task: 00 /
Sample Type: LEACHATE
Reported: 23-JUL-1998

Analyte	**Sample Point:** / **Sample Number:** / **Sampled:**	134-SUMD AS4058 15-OCT-1997	EML RL	TBK-SUMD AS4058 15-OCT-1997	EML RL			Units
BENZENE		ND	22	ND	5			UG/L
BROMOCHLOROMETHANE		ND	22	ND	10.			UG/L
BROMODICHLOROMETHANE		ND	22	ND	5			UG/L
BROMOFORM		ND	22	ND	5			UG/L
BROMOMETHANE		ND	33	ND	10.			UG/L
CARBON DISULFIDE		ND	22	ND	5			UG/L
CARBON TETRACHLORIDE		ND	33	ND	5			UG/L
CHLOROBENZENE		ND	22	ND	5			UG/L
CHLOROETHANE		49	33	ND	10.			UG/L
CHLOROFORM		ND	22	ND	5			UG/L
CHLOROMETHANE		ND	44	ND	10.			UG/L
CIS-1,2-DICHLOROETHENE		37	33	ND	10.			UG/L
CIS-1,3-DICHLOROPROPENE		ND	22	ND	5			UG/L
DIBROMOCHLOROMETHANE		ND	11	ND	5			UG/L
DIBROMOMETHANE		ND	22	ND	10.			UG/L
ETHYLBENZENE		70.	22	ND	5			UG/L
IODOMETHANE		ND	33	ND	10.			UG/L
METHYLENE CHLORIDE		390	33	ND	5			UG/L
STYRENE		ND	22	ND	5			UG/L
TETRACHLOROETHENE		ND	33	ND	5			UG/L
TOLUENE		940	22	ND	5			UG/L
TRANS-1,2-DICHLOROETHENE		ND	33	ND	10.			UG/L
TRANS-1,3-DICHLOROPROPENE		ND	22	ND	5			UG/L
TRANS-1,4-DICHLORO-2-BUTENE		ND	56	ND	10.			UG/L
TRICHLOROETHENE		ND	22	ND	5			UG/L
TRICHLOROFLUOROMETHANE		ND	33	ND	10.			UG/L
VINYL ACETATE		ND	78	ND	10.			UG/L
VINYL CHLORIDE		ND	33	ND	10.			UG/L
XYLENE(TOTAL)		160	67	ND	10.			UG/L

NA = Not Analyzed **ND = Not Detected** **TBK = Trip Blank** **s = EML Subcontract Data**

JUL 27

WMX TECHNOLOGY CENTER, INC.

DATA QUALIFIER REPORT

Site: 134 - Piedmont Landfill

ENS: 97-13908

Report Date: 23-JUL-1998

Sample Pt	Samp Date	Analyte	Method	Comment	Additional Comments Explanations (NQ/DL)
SUMD	15-OCT-1997	CHEMICAL OXYGEN DEMAND	CRCODXXX01	DL	Dilution factor 25 applied.
SUMD	15-OCT-1997	PHOSPHOROUS, TOTAL	CRTPXXXX02	PX	
SUMD	15-OCT-1997	NITROGEN, NITRATE	CRNO3HYD01	NQ	The sample was filtered due to particulates.
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INICPTOTBA	PX	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INICPTOTCU	PX	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INICPTOTNI	PX	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INICPTOTZN	PX	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INTJATOTAG	PX	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INTJATOTAS	PX	
SUMD	15-OCT-1997	ARSENIC-TOTAL	INTJATOTAS	BL	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INTJATOTBE	PX	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INTJATOTCD	PX	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INTJATOTCO	PX	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INTJATOTCR	PX	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INTJATOTPB	PX	
SUMD	15-OCT-1997	LEAD-TOTAL	INTJATOTPB	BL	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INTJATOTSB	PX	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INTJATOTSE	PX	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INTJATOTTL	PX	
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	INTJATOTXV	PX	
SUMD	15-OCT-1997	SULFATE	INICXXSO4X	DL	Dilution factor 10 applied.
SUMD	15-OCT-1997	BIOCHEMICAL OXYGEN DEMAND	INBODXXX01	DL,NQ	A GGA standard was outside of the control limits required by the method (167.5-228.5 mg/L). However, the GGA standard was within the laboratory historical limits. THE SEED CORRECTION FACTOR WAS OUTSIDE THE RANGE OF .6-10. Dilution factor 3000 applied. RESULTS CONFIRMED ON YS200 W/PASSING GGA'S.
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	VOMSBAA004	DL,PX	Dilution factor 27.778 applied.
SUMD	15-OCT-1997	ACRYLONITRILE	VOMSBAA004	NQ	Analyzed by approved screen methodology per EPA Method 624 or analyzed quantitatively per SW-846 methods.
SUMD	15-OCT-1997	EVERY ANALYTE FOR THIS METHOD	VOMSBAX435	DL,PX	Dilution factor 27.778 applied.
TBK-SUMD	15-OCT-1997	ACRYLONITRILE	VOMSBAA004	NQ	Analyzed by approved screen methodology per EPA Method 624 or analyzed quantitatively per SW-846 methods.

WMX TECHNOLOGY CENTER, INC.

DATA QUALIFIER REPORT

Site: 134 – Piedmont Landfill

ENS: 97-13908

Report Date: 23-JUL-1998

Code	Data Qualifier Comment Code Definition
BL	The method blank concentration associated with this analyte was greater than or equal to the MDL. Note: This qualifier is not used when the sample concentration is greater than or equal to twenty times the blank value.
DL	Sample diluted; reporting limits have been adjusted where necessary.
NQ	No standard qualifier code is in use for this qualification. See the associated comment.
PX	This sample required preservation in the field to a pH of less than 2. The pH was checked before analysis and did not have a pH of less than 2.

Appendix 10

EcoLogic Associates, P.C.
2007 Yanceyville St., Suite 223
Greensboro, NC 27405-5004

PROJECT:	PIEDMONT LANDFILL KERNERSVILLE, NC
SUBJECT:	LEACHATE RECIRCULATION EXPECTED ENGINEERING PERFORMANCE
BY: M. TAYLOR	DATE: MARCH, 1997

13 782 500 SHEETS, FILLER 5 SQUARE
42-381 50 SHEETS EYE-EASE® 5 SQUARE
42-382 100 SHEETS EYE-EASE® 5 SQUARE
42-389 200 SHEETS EYE-EASE® 5 SQUARE
42-392 100 RECYCLED WHITE 5 SQUARE
42-399 200 RECYCLED WHITE 5 SQUARE
Made in U.S.A.
National® Brand

EXPECTED MAXIMUM HEAD ON LINER FROM LEACHATE RECIRCULATION

1. FROM RUST CALCULATIONS IN "TRANSITION APPLICATION AND PERMIT RENEWAL" DATED APRIL, 1994 (REV.), THE FOLLOWING ITEMS ARE NOTED:

   - DESIGN IMPINGEMENT RATE, r = 6.1"/mo. = 5520 gal./ac./day = 6×10^{-6} cm/s
     (BASED ON HISTORICAL PEAK MONTHLY PRECIP.)
   - USED FS = 4 ON PERMEABILITY, k, OF GEONET AND SLOPE = 2%
   - NOTED THAT LONG-TERM LOADING REDUCES k_{NET} BY 16%
   - * CALCULATED MAX. HEAD ON LINER = 0.2" USING McENROE METHOD (ASSUMES LONG-TERM, STEADY STATE INFLOW)

2. SINCE McENROE METHOD IS LESS CONSERVATIVE, CHECK USING EPA MOUND EQN.:

$$h = \frac{L\sqrt{c}}{2}\left[\frac{\tan^2\alpha}{c} + 1 - \frac{\tan\alpha}{c}\sqrt{\tan^2\alpha + c}\right]$$

$$\text{where } c = \frac{q}{k} = \frac{6\times10^{-6}\text{ cm/s}}{8.75\text{ cm/s}} = 6.86\times10^{-7}$$

$$\therefore h = \frac{465\sqrt{c}}{2}\left[\frac{(.02)^2}{c} + 1 - \frac{.02}{c}\sqrt{(.02)^2 + c}\right]$$

$$\simeq 0.1' = 1.2'' \ll 12'' \ \underline{\text{ok}}$$

3. IF ALL LEACHATE STORED ON SITE (25000 gal.) WAS RECIRCULATED IN ONE DAY (MAXIMUM LOADING SCENARIO), CALCULATE THE IMPINGEMENT RATE ON THE LCS, ASSUMING IT IS EVENLY DISTRIBUTED OVER THE ENTIRE CELL (9.4 AC.):

$$r = \frac{25000}{9.4 \times 1} = 2660 \text{ gal./ac./day}$$

NOTE THAT THIS IS 48% OF THE DESIGN VALUE USED BY RUST.

$\therefore$ IF ONLY DISTRIBUTED OVER 50% OF THE CELL, h = 0.2" (McENROE)
= 1.2" (EPA)

... CONTINUED

EcoLogic Associates, P.C.
2007 Yanceyville St., Suite 223
Greensboro, NC 27405-5004

PROJECT:	PIEDMONT LANDFILL KERNERSVILLE, NC
SUBJECT:	LEACHATE RECIRCULATION EXPECTED ENGINEERING PERFORMANCE
BY: M. TAYLOR	DATE: MARCH, 1997

13-782 500 SHEETS, FILLER 5 SQUARE
42-381 50 SHEETS EYE-EASE® 5 SQUARE
42-382 100 SHEETS EYE-EASE® 5 SQUARE
42-389 200 SHEETS EYE-EASE® 5 SQUARE
42-392 100 RECYCLED WHITE 5 SQUARE
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EXPECTED HEAD ON LINER (CONTINUED):

CALCULATE HOW POOR THE DISTRIBUTION OF RECIRCULATED LEACHATE WOULD HAVE TO BE TO GET $h = 12''$:

$$A = \left(\frac{25000}{5520 \times 1}\right)\left(\frac{0.2}{12}\right) = 0.08 \text{ ac. } (< 1\% \text{ OF AVAIL. AREA})$$

USING h FROM EPA METHOD,

$$A = (4.53 \text{ ac.})\left(\frac{1.2}{12}\right) = 0.45 \text{ ac. } (4.8\% \text{ OF AVAIL. AREA})$$

CONCLUSION: THE MAXIMUM RECIRCULATION LOADING RATE WILL RESULT IN A LEACHATE HEAD ON THE LINER OF ONLY A FRACTION OF THE ALLOWABLE 12" IF WE ASSUME LESS THAN 50% DISTRIBUTION EFFICIENCY.

HYDRAULIC CAPACITY OF THE LCS SYSTEM

1. REQUIRED LOADING = INFILTRATION FROM 25 YR./24 HR. STORM PLUS RECIRCULATION.

$I_{25/24}$ = 6"/24 Hr. (FROM TP 40 - RAINFALL FREQ. ATLAS OF U.S., 1968, NOAA)

= 162,900 gal/ac/day = 1.8×10^{-4} cm/s

FROM TABLE 8.03a, NC EROSION + SEDIMENT CONTROL PLANNING + DESIGN MANUAL,

RUNOFF COEFF., C = 0.2 - 0.5 FOR BARE, PACKED SOIL. USE 0.4.

∴ INFILTRATION = 0.6 (162,900) = 97,740 gal./ac./day

≈ 1.06×10^{-4} cm/s

MAX. RECIRC. LOADING, ASSUMING 50% DISTRIBUTION EFFICIENCY,

$$= \frac{25000}{.5(9.4) \times 1} = 5320 \text{ gal./ac./day} = 5.8 \times 10^{-6} \text{ cm/s}$$

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BY: M. TAYLOR	DATE: MARCH, 1997

HYDRAULIC CAPACITY OF LCS (CONTINUED):

COMBINED LOADING = 97740 + 5320 = 103,060 gal./ac/day

$\simeq 1.12 \times 10^{-4}$ cm/s

2. CHECK CAPACITY OF SYSTEM COMPONENTS (COMPONENT PROPERTIES FROM RUST CQA REPORT DATED 12/95):

PROTECTIVE COVER: ASSUME SATURATED AND FLOW IS VERTICAL,

THEN $i = 1$ (UNIT GRADIENT) AND $v = ki \Rightarrow v = k$ (FLOW/UNIT AREA)

$k = 2 \times 10^{-2}$ cm/s >>> 1.12×10^{-4} cm/s OK

DESIGN RATIO, DR = $\frac{2 \times 10^{-2}}{1.12 \times 10^{-4}} = 179$ (FACTOR OF SAFETY)

GEOTEXTILE FILTER: SYNTHETIC INDS. SI-1751 HAS A PERMITTIVITY (OR UNIT FLOW CAPACITY), $\Psi = 50$ gal./min./ft^2

$$50 \text{ gal./min./ft}^2 \left(\frac{.1337 \text{ ft}^3}{1 \text{ gal}}\right)\left(\frac{12 \times 2.54 \text{ cm}}{1 \text{ ft.}}\right)\left(\frac{1 \text{ min.}}{60 \text{ sec.}}\right)$$

$= 3.4$ cm/s >>> 1.12×10^{-4} cm/s OK

DR = $\frac{3.4}{1.12 \times 10^{-4}} \approx 30{,}000$ SUFFICIENT TO OFFSET BIOLOGICAL CLOGGING

GEONET: TENSAR NS 1405 HAS A TRANSMISSIVITY, Θ = 4.5×10^{-3} m^2/sec @ $i = 0.10$ AND $\sigma_N = 10000$ psf (SEE PUB. DATA ATTACHED)

CUMULATIVE FLOW IN GEONET, PARALLEL TO SLOPE

= IMPING. RATE × FLOW LENGTH TO OUTLET

$= 1.12 \times 10^{-4} \text{ cm/s} \left(\frac{1 \text{ m}}{100 \text{ cm}}\right) \times 250' \left(\frac{.3048 \text{ m}}{1 \text{ ft.}}\right)$

$= 8.5 \times 10^{-5}$ m^2/s << 4.5×10^{-3} m^2/s OK

DR = $\frac{4.5 \times 10^{-3}}{8.5 \times 10^{-5}} = 53$ SUFFICIENT TO OFFSET GEOTEXTILE INTRUSION

EcoLogic Associates, P.C.
2007 Yanceyville St., Suite 223
Greensboro, NC 27405-5004

PROJECT:	PIEDMONT LANDFILL KERNERSVILLE, NC
SUBJECT:	LEACHATE RECIRCULATION EXPECTED ENGINEERING PERFORMANCE
BY: M. TAYLOR	DATE: MARCH, 1997

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42-392 100 RECYCLED WHITE 5 SQUARE
42-399 200 RECYCLED WHITE 5 SQUARE
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HYDRAULIC CAPACITY OF LCS (CONTINUED):

PIPES: 6" HDPE ($D = 0.5'$) MIN. SLOPE = 1.1% ($S = 0.011$) (FROM OSA RECORD DWG.)

ASSUME $n = 0.015$ (CONSERVATIVE)

USING MANNING'S EQ. FOR PIPE FLOWING FULL,

$$Q = \frac{0.463}{n} \cdot D^{8/3} \cdot S^{1/2} \quad \text{(PIPE CAPACITY)}$$

$$= \frac{0.463}{.015}(0.5)^{8/3}(.011)^{1/2} = 0.5 \text{ cfs}$$

MAX. CONTRIBUTING AREA TO ONE PIPE ≈ 3.5 ac. (FROM OSA DWG.)

$$\therefore \text{MAX-FLOW} \approx 103{,}060 \text{ gal./ac./day} \times 3.5 \text{ ac.}$$

$$= 360{,}710 \text{ gal/day} \left(\frac{.1337 \text{ ft}^3}{1 \text{ gal.}}\right)\left(\frac{1 \text{ day}}{24 \times 3600 \text{ s}}\right)$$

$$= 0.56 \text{ cfs, SLIGHTLY} > 0.5 \text{ cfs}$$

OK CONSIDERING CAPACITY OF STONE SURROUNDING PIPE.

3. CALCULATE TIME TO REMOVE ALL LEACHATE PRODUCED BY 25 YR., 24 HR STORM PLUS RECIRCULATION:

RATED CAPACITY OF EPG WSORT 16-1 SUREPUMP = 80 gpm = 0.18 cfs

$$\therefore t = \frac{103{,}060 \text{ gal./ac/day} \times 9.4 \text{ ac.} \times 1 \text{ day}}{80 \text{ gpm}}$$

$$= 12{,}110 \text{ min.} = 202 \text{ hrs.} = \boxed{8.4 \text{ days}}$$

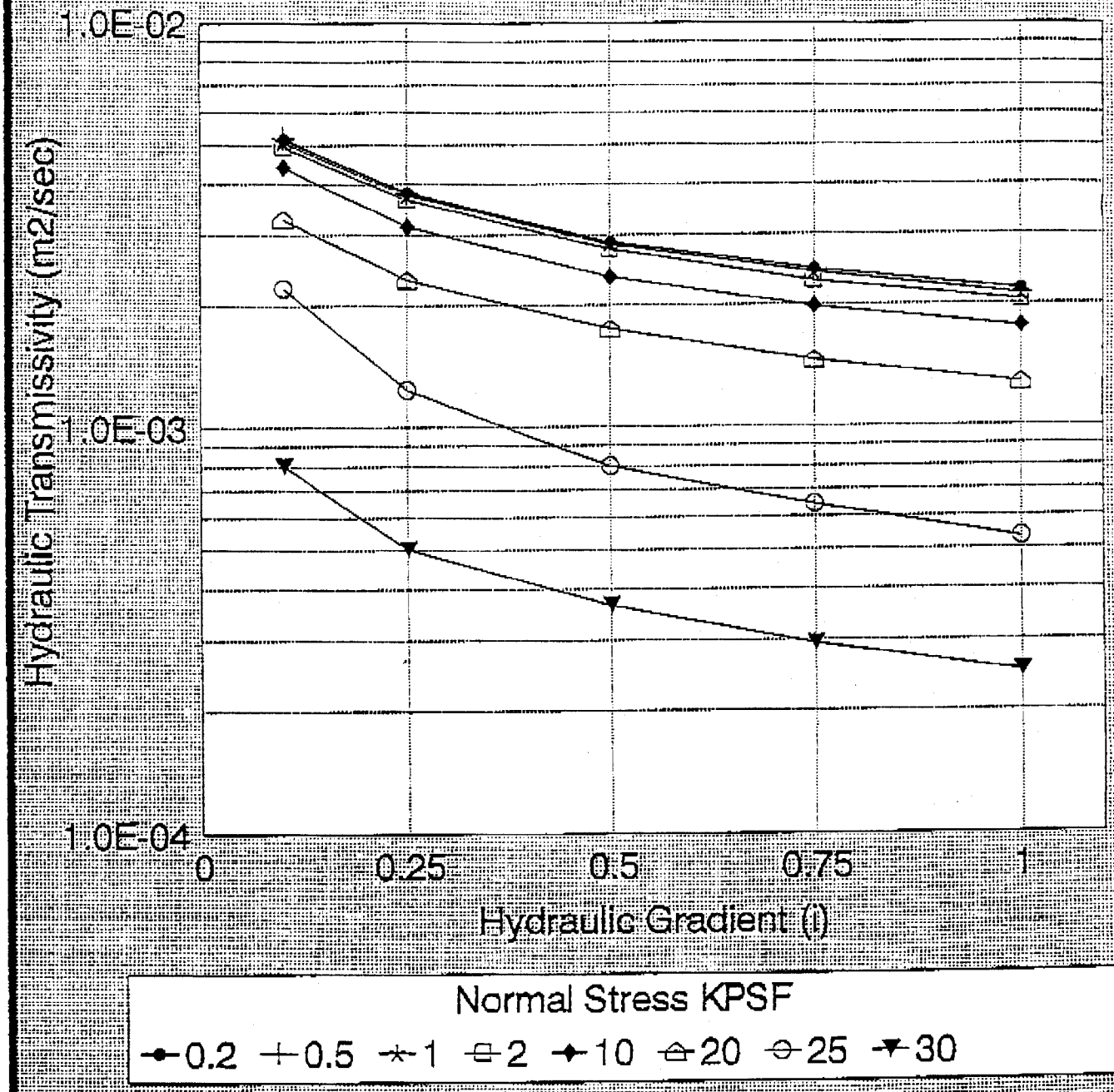
MOUNDING OF LEACHATE ABOVE 12" ABOVE THE LINER MAY OR MAY NOT OCCUR DEPENDING ON THE RELEASE RATE FROM THE WASTE BEFORE, DURING, + AFTER STORM INFILTRATION.

NOTE: THE PERMITTED DESIGN ALLOWED A TIME TO DEWATER THE EMPTY CELL OF RUNOFF FROM THE FULL 25 YR., 24 HR. STORM EQUAL TO:

$$\frac{135{,}360 \text{ ft}^3}{0.18 \text{ cfs}}\left(\frac{1 \text{ day}}{3600 \times 24 \text{ s}}\right) = 8.7 \text{ days} \approx 8.4 \text{ days}$$

(SEE "TRANSITION APPLICATION AND PERMIT RENEWAL", RUST, 4/94)

Hydraulic Transmissivity
NS1405



Boundary Conditions:Plate/Sample/Plate July 23, 1992

TTC389

Typical Test Results THE TENSAR CORPORATION

DRAINAGE NET NS1405

The drainage net shall be an integrally formed polyethylene net structure. It shall have uniform channels, open area and thickness to assure uniform flow throughout the structure. It shall have high tensile strength and tear strength to resist installation damage and loading on steep slopes. It shall also have a low compressibility under high loadings to maintain a high transmissivity under a range of loading conditions. The drainage net shall also be resistant to ultraviolet degradation. The drainage net shall conform to the property requirements listed below.

PROPERTY	TEST METHOD	NOTES	UNITS	VALUE
Flow Capacity		1		
@ Gradient of 1	ASTM 4716		$x10^{-3}ft^2/sec$	21
@ 500 psf			(gpm/ft)	(9.55)
@ 10,000 psf			$x10^{-3}ft^2/sec$	16
			(gpm/ft)	(7.24)
@ 20,000 psf			$x10^{-3}ft^2/sec$	8.6
			(gpm/ft)	(3.86)
Mechanical Properties		1		
• Compressibility:	ASTM	3,4,5		
@ 20,000 psf			%	50
• Peak Tensile Strength-MD	ASTM D638 Modified	2,5	lbs/ft	575
• Porosity				0.55-0.60
• Elongation to Break MD/TD			%	540/350
Material				
• Polyethylene Polymer				
- Specific Gravity	ASTM D1505		g/cm^3	0.940
- Carbon Black Stabilization	ASTM D4218		%	2.5
Dimensions - Finished Product				
• Thickness	O.D. Calipered	2,6	inches	.20
• Roll Length			ft	98.4/300
• Roll Width			ft	6.33
• Roll Weight			lbs	118/350
• Unit Weight			oz/sy	29

Notes

1. Except where noted, all reported test values are nominal.
2. Minimum value.
3. Compression tests are performed on a 2-inch square sample loaded at a 1mm/minute constant rate of strain.
4. Maximum
5. Tensile strength and compressibility properties shall be tested by the manufacturer every 10,000 square yards of product.
6. Thickness is measured by placing the specimen flat on a comparator base and lowering a round 1/2 inch diameter flat end contact surface squarely over a junction.

The Tensar Corporation
1210 Citizens Parkway
Morrow, GA 30260
800-845-4453

Specification Sheet
NS1405
1992

FROM "RQMTS. FOR HAZ. WASTE LANDFILL DESIGN, CONST., AND CLOSURE" (EPA/625/4-89/022)

Thus, both transmissivity and permittivity values allow for the thickness to be avoided in subsequent analyses.

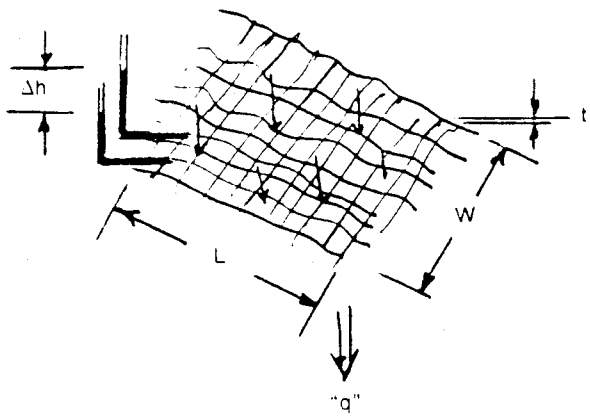


Figure 4-3. Variables for calculating crossplane flow rates (permittivity).

Table 4-1 shows some of the ASTM test methods and standards for drainage and filter materials used in primary leachate collection and leachate detection and collection systems. Test methods are determined by D18, the Soil and Rock Committee of ASTM, and by D35, the Committee on Geosynthetics.

Primary Leachate Collection and Removal (PLCR) Systems

The various design options for primary leachate collection systems are granular soil drains, perforated pipe collectors, geonet drains, sand filters, and geotextile filters. Figure 4-4 shows a cross section of a primary leachate collection system with a geonet drain on the side slope leading into a gravel drain on the bottom. This gravel drain then leads into a perforated pipe collector. A geotextile acts as a filter protecting the geonet and sand acts as a filter for the drainage gravel. Quite often the sideslope geotextile extends over the bottom sand filter as shown in Figure 4-4.

Granular Soil (Gravel) Drainage Design

Current minimum technology guidance (MTG) regulations require that granular soil drainage materials must:

- Be 30 centimeters (12 inches) thick.
- Have 0.01 cm/sec (≃ 0.02 ft/min) permeability (hydraulic conductivity).
- Have a slope greater than 2 percent.
- Include perforated pipe.
- Include a layer of filter soil.
- Cover the bottom and side walls of the landfill.

There are two ways to calculate the required flow rate, q, in granular soil drainage designs. One is based on the above MTG values; the other is based on the Mound Model (see Figure 4-5). Based on MTG values:

$$q = kiA \qquad (7)$$
$$= (0.02)(0.02)(1 \times 1)$$
$$= 4 \times 10^{-4}\ ft^3/min$$

Note that if MTG increases the required hydraulic conductivity of the drainage soil to 1 cm/sec, the above flow rate will be increased to 0.04 ft^3/min.

In the Mound Model, the maximum height between two perforated pipe underdrain systems is equal to:

$$h_{max} = \frac{L/c}{2}\left[\frac{\tan^2\alpha}{c} + 1 - \frac{\tan\alpha}{c}\sqrt{\tan^2\alpha + c}\right] \qquad (8)$$

where $c = q/k$

k = permeability

q = inflow rate

The two unknowns in the equation are L, the distance between pipes, and c, the amount of leachate coming through the system. Using a maximum allowable head, h_{max}, of 1 foot, the equations are usually solved for L.

One method of determining the value of c is using the Water Balance Method:

$$PERC = P - R/0 - ST - AET \qquad (9)$$

where PERC = percolation, i.e. the liquid that permeates the solid waste (gal/acre/day).

P = precipitation for which the mean monthly values are typically used.

R/O = surface runoff.

ST = soil moisture storage, i.e., moisture retained in the soil after a given amount of accumulated potential water loss or gain has occurred.

AET = actual evapotranspiration, i.e., actual amount of water loss during a given month.

Appendix 11

WASTE MANAGEMENT OF CAROLINAS, INC.

TRANSITION APPLICATION AND PERMIT RENEWAL

FOR

PIEDMONT LANDFILL AND RECYCLING CENTER
KERNERSVILLE, NORTH CAROLINA

Prepared By:
RUST ENVIRONMENT & INFRASTRUCTURE
GREENVILLE, SOUTH CAROLINA
NAPERVILLE, ILLINOIS

DECEMBER 1993

REVISED: APRIL 1994

The leachate collection system will be constructed directly above the composite liner, and will consist of a HDPE geonet drainage layer , overlain by a geotextile filter/cushion, overlain by two feet of drainage/ protective soil with a minimum saturated hydraulic conductivity of 1×10^{-4} cm/sec. This collection system will be designed to effectively collect and remove leachate generated by the landfill. The function of the drainage/protective soil is to establish a zone of protection between the composite liner and the waste.

3.2 Leachate Collection System Design

NCAC 13B .1624 (b)(2)

(A) The leachate collection system shall be hydraulically designed to remove leachate from the landfill and ensure that the leachate head on the composite liner does not exceed one foot. A means of quantitatively assessing the performance of the leachate collection system under uniform conditions must be provided in the engineering plan. The performance analysis must evaluate the flow capacities of the pipe network necessary to convey leachate to the storage facility or off-site transport location. The engineering evaluation shall incorporate the following criteria:

(i) At a minimum, the impingement rate on the drainage layer shall be equal to the peak monthly precipitation rate to evaluate the relationship between base slope, drainage layer permeability, and collector pipe spacing.

(ii) At a minimum, the geometry of the landfill shall be designed to control and contain the volume of leachate generated by the 24-hour, 25-year storm.

(iii) Collection pipe flow capacity shall be sized to drain the critical volume of leachate generated by the 24-hour, 25-year storm in a specified period of time.

(B) The leachate collection system shall be designed to provide a zone of protection at least 24 inches thick separating the composite liner from landfilling activities.

(C) The leachate collection system shall include a drainage layer, a pipe network with clean-outs, and the necessary filters designed to

prevent physical clogging and promote leachate collection and removal from the landfill.

The leachate collection system for the PLRC is designed to be capable of hydraulically removing leachate from the landfill while ensuring that the leachate head on the composite liner is one foot or less under normal operating conditions.

Calculations were performed in order to determine the performance of the leachate collection system. These calculations included determining the maximum head anticipated on the liner and determining whether the geometry of the cells are capable of containing the 25-year, 24-hour storm (see attached appendix).

The evaluation of the leachate collection system incorporates several design criteria. The leachate collection system design criteria include provisions for leachate impingement rate, leachate volume, pipe flow capacity, zone of protection, and system components. For design purposes, the impingement rate on the drainage layer was equal to the peak monthly precipitation rate from on-site historic precipitation data and the HELP model. The relationship between this value and the base slope, drainage layer permeability, and collector pipe spacing was evaluated to determine leachate head. The geometry of the landfill was evaluated to control and contain the volume of leachate generated by the 24-hour, 25-year storm event. In addition, the collection pipe is a size capable of draining the volume of leachate generated by the 24-hour, 25-year storm event. The zone of protection separating the composite liner from landfilling activities is at least 24 inches thick. The collection system design will also provide for pipe network clean-outs necessary to prevent clogging and promote leachate collection and removal from the landfill.

Refer to the design drawings and the engineering calculations in the appendices for further detail.

3.3 Horizontal Separation Requirements

NCAC 13B .1624 (b)(3)

(A) Property line buffer. New MSWLF units at a new facility shall establish a minimum 300-foot buffer between the MSWLF unit and all property lines.

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. 2222

CLIENT Piedmont LRC

SUBJECT Leachate Head Analysis

PROJECT Transition Application & Permit Renewal

Prepared By [illegible] Date 3/18/94

Reviewed By DNW Date 3/30/94

Approved By ____ Date ____

Purpose: To re-evaluate the leachate head estimate on the landfill base. The estimate was originally performed on 11/4/93 as part of the original permit application. However, based on comments by the State of North Carolina, Division of Solid Waste Management, the factor of safety applied to the geonet permeability will be increased to demonstrate continued performance of the leachate collection system.

Givens & Assumed:

- Permeability = k = 35 cm/sec for geonet under the "open cell" conditions. These conditions represent <u>worst case</u> scenario for potential leachate head build-up.

- Factor of safety to account for potential clogging and degredation of the geonet will be increased from 2 (from 11/4/94 calcs) to 4.

  i.e. $FOS = 4 = \frac{35}{x}$ $\quad x = 8.75$ cm/sec = k

  $k = 8.75$ cm/sec

- Thickness of geonet ≅ 0.2 inches

- Leachate Head Calculation, developed by Dr. Bruce M. McEnroe (of the University of Kansas) in a published article titled "Maximum Saturated Depth Over Landfill Liner", published in the <u>Journal of Environmental Engineering</u> (pp. 262-270), March/April 1993. (REF. 1)

① For $R < 1/4$ $\quad Y_{max} = (R - RS + R^2S^2)^{1/2} \left[\frac{(1-A-2R)(1+A-2RS)}{(1+A-2R)(1-A-2RS)}\right]^{1/2A}$

② For $R = 1/4$ $\quad Y_{max} = \left(\frac{R(1-2RS)}{(1-2R)}\right) e^{\left[\frac{2R(S-1)}{(1-2RS)(1-2R)}\right]}$

③ For $R > 1/4$ $\quad Y_{max} = \left[(R - RS + R^2S^2)^{1/2}\right] \cdot e^{\left[\frac{1}{B}\tan^{-1}\left(\frac{2RS-1}{B}\right) - \frac{1}{B}\tan^{-1}\left(\frac{2R-1}{B}\right)\right]}$

Where:

- k = Hydraulic conductivity of Geonet = 8.75 cm/sec (at F.O.S. = 4)
- L = Drainage Distance = 465'
- r = Vertical Liquid Impingement = 6.1 in/month = 5.98×10^{-6} cm/sec (REF. 2)
- $S = \tan\alpha \cong \sin\alpha = .02$ = slope of landfill base
- $R = r/(k \sin^2\alpha)$
- $Y_{max} = y_{max}/(L \tan\alpha)$ ⇒ y_{max} = Maximum Saturated Depth
- $A = (1-4R)^{1/2}$
- $B = (4R-1)^{1/2}$

CLIENT Piedmont LRC
PROJECT Transition Application + Permit Renewal

SUBJECT Leachate Head (cont.)

Prepared By GJM Date 3/18/94
Reviewed By DMW Date 3/30/94
Approved By ____ Date ____

$$R = \sigma/(k \sin^2 \alpha) = \frac{5.98\times10^{-6}\ cm/sec}{(8.75\ cm/sec)(.02)^2} = 1.7086\times10^{-3} < 1/2,\ \text{use equation ①}$$

$$A = (1-4R)^{1/2} = (1-4(1.7086\times10^{-3}))^{1/2} = .9966$$

$$y_{max} = (R - RS + R^2S^2)^{1/2}\left[\frac{(1-A-2R)(1+A-2RS)}{(1+A-2R)(1-A-2RS)}\right]^{\frac{1}{2A}}$$

$$= (4.092\times10^{-2})\left[\frac{(5.86\times10^{-6})(1.9965)}{(1.99316)(3.355\times10^{-3})}\right]^{\frac{1}{2(.9964)}}$$

$$= 1.693\times10^{-3}$$

$$y_{max} = (1.693\times10^{-3})(465\ ft)(.02) = \cancel{1.753}\ 1.575\times10^{-2}\ \text{Feet} = \underline{0.19\ \text{inches}}$$

Conclusion: Despite the excessively high F.O.S. of 4, the leachate head levels remain within the 0.2" thick geonet layer. This demonstrates the inherently high liquid carrying capacity of the geonet.

A F.O.S. of 4 is more than sufficient to comfortably account for the anticipated clogging of the geonet due to solids and biomass. In addition, this scenario represents critical drainage conditions. Flow rates will greatly decrease as waste disposal is begun.

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. 57221

CLIENT Piedmont LRC

PROJECT Transition Application and Permit Renewal

SUBJECT Additional Leachate Generation and Permeability Analysis

Prepared By AJM Date 3/18/

Reviewed By [illegible] Date 3/30/

Approved By ____ Date ____

Purpose: To determine an estimate for leachate collected within the Piedmont LRC geonet drainage layer under "interim fill" conditions. This estimate, along with the estimate for geonet transmissivity under full landfill loading, will be compared to the respective values under "open cell" conditions. Based on the resulting information, it can be determined whether the most critical and conservative conditions were analyzed in the 11/4/93 leachate head calcs (Appendix C- Engineering Report).

Givens + Assumed:

- Use the Hydrologic Evaluation of Landfill Performance (HELP) model, Version 3 to estimate leachate generation quantities.
- Analyze under interim conditions (i.e. 60 feet of waste).
- Assume a time frame of 20 years prior to final cover application. This is a conservatively long estimate.
- Permeability of geonet = k = 29.5 cm/sec. It should be noted that the higher the k value of the drainage layer, the higher the leachate drainage estimate. The selected value was calculated, and is attached.
- The initial moisture contents of the layers of the landfill cross-section will be initiated by the model.
- Slope of drainage in the geonet drainage layer will be selected as 5.7%. It should be noted that higher drainage slopes will result in higher leachate drainage quantities. (Phase 3-Cell 1-Subcell 2)
- The length of drainage is selected to be 250'. It should be noted that the shorter the drainage length, the resulting quantities of drainage will increase. (Phase 3-Cell 1-Subcell 2)
- Synthetic rainfall data from Greensboro, N. Carolina.
- Refer to the landfill cross-section on the following page.

CLIENT Piedmont Lec

SUBJECT Leachate (cont.)

Prepared By AJM Date 3/18/

PROJECT Transition Application & Permit Renewal

Reviewed By [illegible] Date 3/31/

Approved By ____ Date ____

① Intermediate Cover
- Soil Texture # 10
- Porosity = .398
- Field Capacity = .244
- Wilting Point = .136

② Waste
- Soil Texture # 18
- Porosity = .650
- Field Capacity = .294
- Wilting Point = .128

③ Protective Soils
- Soil Texture # 10
- Porosity = .398
- Field Capacity = .244
- Wilting Point = .136

④ Geonet
- Soil Texture # 19
- Porosity = 0.80 (Manufacturer's Data)
- Field Capacity = .030
- Wilting Point = .020

⑤ Base Liner
- Soil Texture # 16
- Porosity = .430
- Field Capacity = .366
- Wilting Point = .280

① 12" Intermediate Cover

② 720' Waste

③ 24" Protective Soils

④ 0.2" Geonet

⑤ 24" of Compacted Clay Overlain by 60 mil

Based on the results of the HELP model, the peak daily drainage through the geonet = 0.0288 inches/day.

⇒ Compare this value to the value of impingement used in evaluating the leachate heads under "open cell" conditions (performed 11/4/94)

"Open Cell" = 6.1 in/month (This was the peak rainfall value measured at the facility over a 13 month period. The 25-year, 24-hour storm ≅ 6 in/month)

Interim Fill = .0288 in/day = .893 in/month (at 31 day month)

⇒ Decrease in leachate drainage by going from "open" to interim conditions is as follows: $\left[\frac{6.1 - .893}{6.1}\right] 100\% = \underline{85.4\%}$

⇒ Compare the geonet permeabilities given the overburden conditions...

"Open Cell" = 35 cm/sec

Interim Fill (or Max Final Fill) = 29.5 cm/sec

⇒ Decrease in permeability by going from "open" to interim conditions is as follows: $\left[\frac{35 - 29.5}{35}\right] 100\% = \underline{15.7\%}$

Conclusion: Although the interim and final fill conditions decrease the geonet permeability by 15.7%, the filling to interim conditions decreases the peak anticipated leachate drainage in the geonet by 85.4%. Under final conditions, with final cover application, the leachate quantity will decrease further. The huge benefits of decrease leachate drainge by filling with waste greatly exceed the loss in permeability resulting from filling to maximum elevations. Therefore, analyzing head buildups in the drainage layer under "open cell" conditions, as was done on 11/4/93 (Appendix C) is the most conservative analysis.

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE 1 OF 2
PROJECT NO. 82221

CLIENT Piedmont LRC
PROJECT Transition Application + Permit Renewal

SUBJECT Geonet Permeability Calculations

Prepared By GJM Date 3/18
Reviewed By DMW Date 3/30/
Approved By ____ Date ____

Purpose: Calculate the hydraulic conductivity of the geonet drainage layer component of the landfill base liner under iterim and final closure conditions. The manufacturer's transmissivity chart will be referenced for this purpose.

Givens + Assumed:

- Material: PN 3000 texnet (i.e. geotextile above the geonet)
- Assumed Interim Fill Conditions = 63' of waste and soils overly geonet
  - 1' of intermediate cover @ $\gamma = 120$ pcf
  - 60' of waste @ $\gamma = 75$ pcf
  - 2' of protective soils @ $\gamma = 135$ pcf

  ⇒ Overburden $= (1')(120\ lb/ft^3) + (60')(75\ lb/ft^3) + (2')(135\ lb/ft^3) = 4890$ psf

- Assumed Fill Closure Fill Conditions = 125.5' of waste and soils overly geonet
  - 3.5' of final cover @ $\gamma = 120$ pcf
  - 120' of waste @ $\gamma = 75$ pcf (This represents a <u>worst</u> case scenario
  - 2' of protective soils @ $\gamma = 135$ pcf

  ⇒ Overburden $= (3.5')(120\ lb/ft^3) + (120')(75\ lb/ft^3) + (2')(135\ lb/ft^3) = 9690$ psf

- Slope = Gradient = 2% min → 6.7% max

- Thickness of geonet = 0.2"

- From <u>Designing with Geosynthetics</u>; 2nd Edition, by Robert Koerner, pps 90-

$$\theta = k_p t \quad \Rightarrow \quad k_p = \theta / t$$

Where: θ = hydraulic transmissivity
k_p = permeability coefficient in the plane of the geonet
t = thickness of geonet

CLIENT Piedmont LRC
PROJECT Transition Application & Permit Renewal

SUBJECT Gemet (cont)

Prepared By GAM Date 3/18/9
Reviewed By Dmur Date 3/30/9
Approved By ____ Date ____

Calculations:

① INTERIM FILL CONDITIONS

- From Attached Chart; @ - Gradient = 0.1 (Conservative)
  - Overburden = 5,000 psf (conservative)

$\theta = 1.5 \times 10^{-3}\ m^2/sec$

$\theta = k_p t \qquad k_p = \theta / t$

$k_p = (1.5 \times 10^{-3}\ m^2/sec)\left(\frac{100cm}{1m}\right)^2\left(\frac{1}{0.2in}\right)\left(\frac{1in}{2.54cm}\right) = 29.5\ cm/sec$

$\underline{k_p = 29.5\ cm/sec}$ (at interim conditions analyzed)

② FINAL CLOSURE CONFIGURATION

- From Attached Chart; @ - Gradient = 0.1 (conservative)
  - Overburden = 10,000 psf (conservative)

$\theta = 1.5 \times 10^{-3}\ m^2/sec$

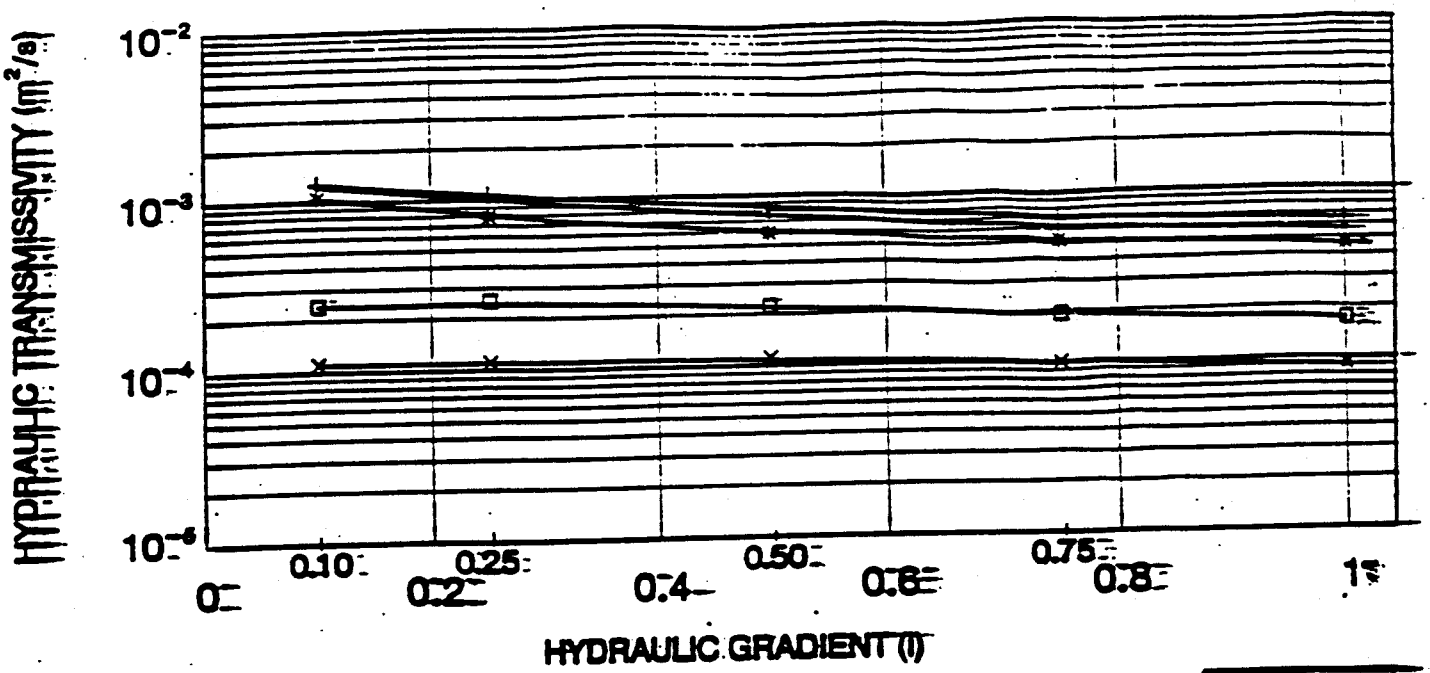
$\theta = k_p t \qquad k_p = \theta / t$

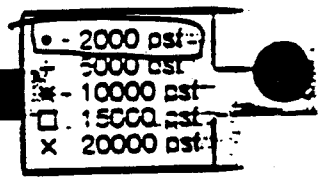
$k_p = (1.5 \times 10^{-3}\ \frac{m^2}{sec})\left(\frac{100cm}{m}\right)^2\left(\frac{1}{0.2in}\right)\left(\frac{1in}{2.54cm}\right) = 29.5\ cm/sec$

$\underline{k_p = 29.5\ cm/sec}$ (at worst case closure conditions)

POLY-NET PN2000

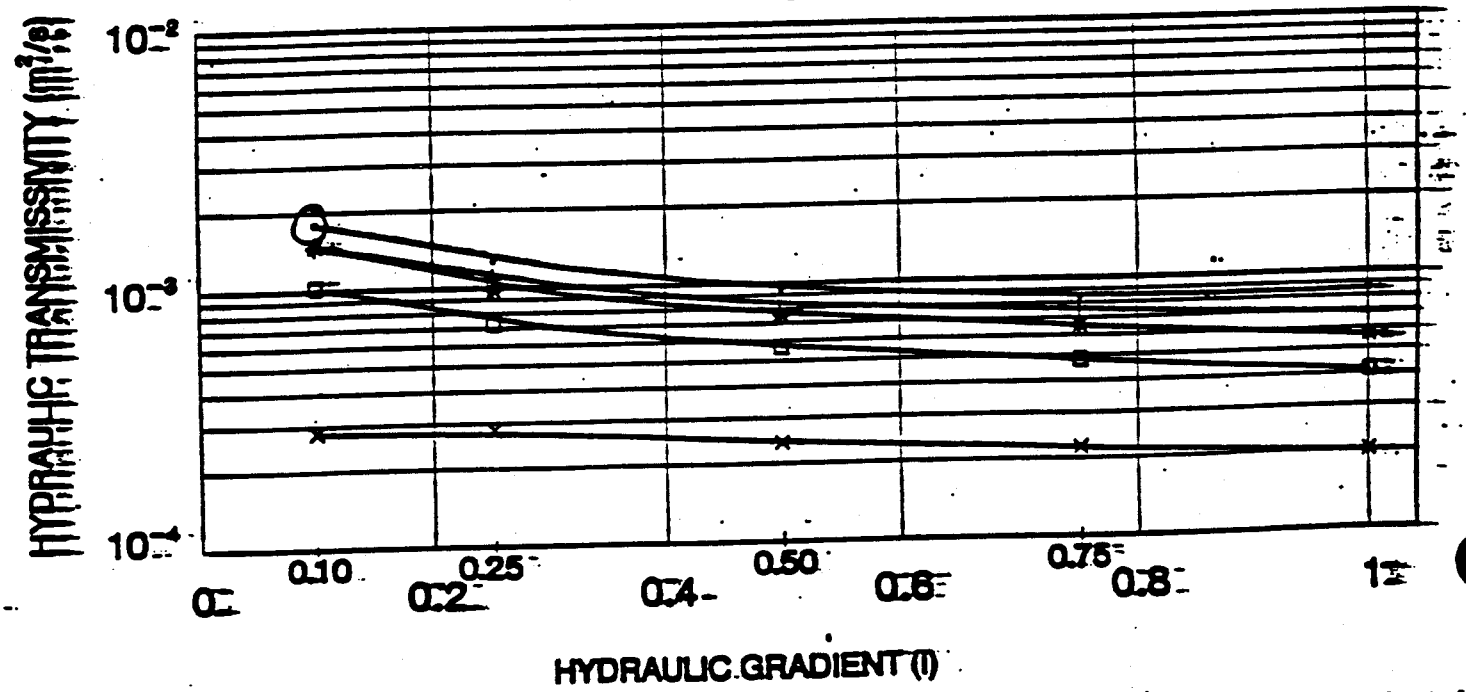
HDPE/PN2000/geotextile/soil





POLY-NET PN3000

HDPE/PN3000/geotextile/soil



LEACHATE DISPOSAL QUANTITIES FOR THE PIEDMONT LANDFILL & RECYC. CTR

Month/Year	Quantity Removed	Average Quantity Gal/day	Monthly Rainfall, Inches	Sq. Ft Open to Rainfall	Gal/acre/in Rainfall	Notes
Jul-92	204,795	7,877	→ 6.1	740,520	1,868	
Aug-92	239,665	9,218	5.9	740,520	2,389	
Sep-92	100,809	3,877	2.3	740,520	2,578	
Oct-92	162,151	6,237	3.8	740,520	2,510	
Nov-92	489,994	18,846	5.4	740,520	5,338	
Dec-92	313,578	12,061	4.2	740,520	4,392	
Jan-93	407,836	15,686	5.6	740,520	4,284	
Feb-93	361,356	13,898	3.5	958,320	4,761	See Note A
Mar-93	608,562	23,406	5.2	958,320	5,320	
Apr-93	337,597	12,985	5.2	958,320	2,951	
May-93	152,200	5,854	2.5	958,320	2,767	
Jun-93	80,402	3,092	3.1	958,320	1,179	
Jul-93	106,434	4,094		958,320	ERR	
Aug-93	85,615	3,293	3.3	958,320	1,197	
Total:	3,650,994		56			
Average:		10,277			ERR	

ALSO, THE AVERAGE MONTHLY RAINFALL DATA WAS CALCULATED USING 20 YEARS OF SYNTHETICALLY GENERATED RAINFALL FOR THE NEAREST MAJOR CITY, GREENSBORO, NC (VIA HELP MODEL). AS YOU CAN SEE, THE 6.1" USED IN OUR CALCULATIONS EXCEEDS THE PEAK MONTHLY AVERAGE BY NEARLY 1.8". SO 6.1" IS A RATHER CONSERVATIVE NUMBER.

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.15	3.42	3.54	3.51	2.75	4.33
	3.63	4.29	2.99	3.99	2.40	3.09

Maximum Saturated Depth over Landfill Liner

By Bruce M. McEnroe,[1] Member, ASCE

Abstract: Explicit formulas for the steady-state maximum saturated depth over a landfill liner are derived analytically from basic principles of unconfined seepage. The lateral drainage over the liner is described by an extended form of the Dupuit discharge formula. The liner is modeled as an impervious sloping plane. The factors that determine the maximum saturated depth over the liner are the rate of vertical inflow to the drainage layer, the hydraulic conductivity of the drainage layer, the slope of the liner, the maximum distance of flow, and the hydraulic condition at the downstream end of the drainage layer. Practical applications of these formulas include the analysis and design of drainage systems for landfill covers and bottom liners. An example illustrates the use of these formulas in the design of a cover drain for a hazardous-waste landfill. A formula that appears in several technical guidance documents of the U.S. Environmental Protection Agency is shown to overestimate the maximum saturated depth over a landfill liner.

Introduction

Flexible membrane liners of various geosynthetic materials are commonly used to prevent migration of leachate from landfills. Final covers for landfills and hazardous-waste sites also incorporate flexible membrane barriers to keep water from percolating into the waste. The barrier is normally placed on a slope, with a drainage layer of coarse granular material over it. Liquids percolate downward into a saturated zone directly over the barrier and flow laterally to a collection system, which is typically a perforated pipe. The drainage system should be designed to prevent saturation within the overlying waste or cover soil.

Several different methods for estimating the steady-state maximum saturated depth over a landfill liner have been proposed. An earlier paper by the writer (McEnroe 1989) presents an analytical solution for the saturated depth at any point along the liner. However, the determination of the maximum saturated depth from this general solution can be tedious. Furthermore, because this solution is based on the standard Dupuit assumptions for unconfined seepage, it underestimates saturated depths for liner slopes greater than about 10% (6°).

An explicit formula for the maximum saturated depth over a sloping liner appears in several technical guidance documents of the U.S. Environmental Protection Agency (USEPA) (Moore 1983; "Requirements" 1989). This formula is

$$y_{max} = L\left(\frac{r}{K}\right)^{1/2}\left[\frac{KS^2}{r} + 1 - \frac{KS}{r}\left(S^2 + \frac{r}{K}\right)^{1/2}\right] \quad (1)$$

in which y_{max} = maximum saturated depth over the liner; L = maximum distance of flow; r = rate of vertical inflow to the drainage layer per unit horizontal area; K = hydraulic conductivity of the drainage layer; and S = dimensionless slope of the liner. This formula was first presented by Moore (1983) without derivation or explanation of its origin or limitations.

Other investigators have published solutions for closely related problems with different boundary conditions. Yates et al. (1985) presented a general analytical solution for steady drainage over an impervious sloping barrier with recharge, based on the standard Dupuit assumptions. Werner (1957) presented an approximate solution for this problem. McEnroe and Schroeder (1988) used numerical methods to investigate steady drainage over a slightly pervious sloping barrier. Childs (1971), Towner (1975), and McBean et al. (1980) all presented solutions for steady drainage over a sloping barrier with drains at both the upper and lower ends. The latter drain configuration is not typical for landfill drainage systems.

This paper presents a set of explicit formulas for the steady-state maximum saturated depth over an impervious sloping barrier. These formulas are derived analytically from the equation of continuity and an extended form of the Dupuit discharge formula for unconfined seepage.

Problem Formulation

Fig. 1 shows the typical components of a landfill drainage system, and defines the coordinate system and some of the variables used in the analysis. Because the upstream boundary is either a drainage divide or an impervious sidewall, no flow can cross this boundary. Under steady-state conditions, continuity requires that the discharge at any location equals the vertical inflow upstream of this location, i.e.

$$Q = rx \quad (2)$$

in which x = horizontal distance from the upstream boundary; Q = discharge per unit width in the saturated zone; and r = vertical discharge into the saturated zone per unit horizontal area.

The standard Dupuit assumptions for unconfined ground water flow are that the streamlines are essentially horizontal and the equipotentials are essentially vertical, which means that the hydraulic gradient equals the slope of the phreatic surface and does not vary with depth. These approximations lead to the discharge formula

$$Q = -Ky\frac{dh}{dx} \quad (3)$$

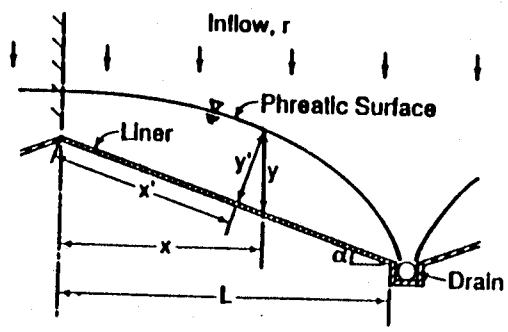


FIG. 1. Landfill Drainage System

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Note. Discussion open until September 1, 1993. To extend the closing date one month, a written request must be filed with the ASCE Manager of Journals. The manuscript for this paper was submitted for review and possible publication on June 15, 1992. This paper is part of the *Journal of Environmental Engineering*, Vol. 119, No. 2, March/April, 1993. ©ASCE, ISSN 0733-9372/93/0002-0262/$1.00 + $.15 per page. Paper No. 348.

in w y = saturated depth, measured vertically; and h = elevation of the phreatic surface. The elevation of the phreatic surface can be expressed in terms of the saturated depth and the slope of the liner

$$h = y + x \tan \alpha \quad \text{(4)}$$

The standard Dupuit assumptions are generally satisfactory for slopes up to about 10% (6°). For steeper slopes, the extended Dupuit assumptions are more realistic. These assumptions are that the streamlines are essentially parallel to the liner, and that the equipotentials are essentially perpendicular to the liner. The extended Dupuit assumptions lead to the discharge formula

$$Q = -Ky' \frac{dh}{dx'} \quad \text{(5)}$$

in which x' = distance from the upstream boundary measured parallel to the liner; and y' = saturated depth measured perpendicular to the liner. This extended Dupuit discharge formula can be written in terms of the horizontal and vertical coordinates as (Childs 1971)

$$Q = \frac{-Ky \dfrac{dh}{dx}}{1 - \dfrac{dh}{dx} \sin \alpha \cos \alpha} \quad \text{(6)}$$

Chapman (1980) showed that (6) also can be expressed in the form

$$Q = \frac{-Ky \dfrac{dh}{dx} \cos^2\alpha}{1 - \dfrac{dy}{dx} \sin \alpha \cos \alpha} \quad \text{(7)}$$

Because the assumptions used to derive (7) require that $dy/dx << 1$, this equation is closely approximated by the simpler discharge equation

$$Q = -Ky \frac{dh}{dx} \cos^2\alpha \quad \text{(8)}$$

Chapman showed that (8) is a major improvement on the standard Dupuit discharge formula, and a fair approximation of the extended Dupuit discharge formula for unconfined seepage on steep slopes.

Eqs. (2), (4), and (8) can be combined to form the governing equation in terms of saturated depth

$$Ky \left(\frac{dy}{dx} - \tan \alpha\right) \cos^2\alpha + rx = 0 \quad \text{(9)}$$

The specification of the saturated depth at the downstream boundary, y_L, completes the problem statement. The saturated-depth profile is determined by the values of K, r, α, and y_L.

The analysis can be simplified by restating the governing equation and boundary condition in terms of the dimensionless variables $X = x/L$; $R = r/(K \sin^2\alpha)$; $Y = y/(L \tan \alpha)$; and $Y_L = y_L/(L \tan \alpha)$. The dimensionless form of the governing equation is

$$Y \left(\frac{dY}{dX} - 1\right) + RX = 0 \quad \text{(10)}$$

The boundary condition for (10) is $Y = Y_L$ at $X = 1$.

Saturated-Depth Profile

Eq. (10) is a nonlinear differential equation of homogeneous type. This equation becomes separable upon the change of variable $u = Y/X$, and can be integrated directly. In terms of this new variable, the governing equation is

$$-\frac{dX}{X} = \frac{u\, du}{R - u + u^2} \quad \text{(11)}$$

Integration of (11) yields

$$-\ln X = \frac{1}{2} \ln (R - u + u^2) + \frac{1}{2A} \ln \frac{2u - 1 - A}{2u - 1 + A} + C$$

for $R < 1/4$ (12)

$$-\ln X = \ln \left(\frac{1}{2} - u\right) + \frac{1}{1 - 2u} + C \quad \text{for } R = 1/4 \quad \text{(13)}$$

and

$$-\ln X = \frac{1}{2} \ln (R - u + u^2) + \frac{1}{B} \tan^{-1} \left(\frac{2u - 1}{B}\right) + C$$

for $R > 1/4$ (14)

in which

$$A = (1 - 4R)^{1/2} \quad \text{(15)}$$

$$B = (4R - 1)^{1/2} \quad \text{(16)}$$

and C = a constant of integration. Application of the boundary condition $u = Y_L$ at $x = L$ leads to the formulas

$$X = \left(\frac{R - Y_L + Y_L^2}{R - u + u^2}\right)^{1/2} \left[\frac{(1 - A - 2u)(1 + A - 2Y_L)}{(1 + A - 2u)(1 - A - 2Y_L)}\right]^{1/2A}$$

for $R < 1/4$ (17)

$$X = \frac{1 - 2Y_L}{1 - 2u} \exp \left[\frac{2(Y_L - u)}{(1 - 2Y_L)(1 - 2u)}\right] \quad \text{for } R = 1/4 \quad \text{(18)}$$

and

$$X = \left(\frac{R - Y_L + Y_L^2}{R - u + u^2}\right)^{1/2} \exp \left[\frac{1}{B} \tan^{-1} \left(\frac{2Y_L - 1}{B}\right)\right.$$

$$- \frac{1}{B} \tan^{-1}\left(\frac{2u - 1}{B}\right)\Bigg] \quad \text{for } R > 1/4 \quad \ldots\ldots (19)$$

The values of R and Y_L completely determine the saturated-depth profile. To compute the coordinates of a point on the profile, one selects a feasible value of u and solves (17), (18), or (19) for X. The value of Y at this location is obtained from the relationship $Y = uX$. An earlier paper by the writer (McEnroe 1989) shows the possible shapes of the phreatic-surface profile.

Maximum Saturated Depth

General Case

The saturated depth is a maximum in which $dY/dX = 0$. From (10), the maximum saturated depth occurs where $Y = RX$ (i.e., where $u = R$). The substitution of R for u in (17)–(19) leads to the following explicit formulas for Y_{max}:

$$Y_{max} = (R - Y_L + Y_L^2)^{1/2} \left[\frac{(1 - A - 2R)(1 + A - 2Y_L)}{(1 + A - 2R)(1 - A - 2Y_L)}\right]^{1/2A}$$

$$\text{for } R < 1/4 \quad \ldots\ldots (20)$$

$$Y_{max} = \frac{R(1 - 2Y_L)}{1 - 2R} \exp\left[\frac{2(Y_L - R)}{(1 - 2Y_L)(1 - 2R)}\right] \quad \text{for } R = 1/4 \quad \ldots (21)$$

and

$$Y_{max} = (R - Y_L + Y_L^2)^{1/2} \exp\left[\frac{1}{B}\tan^{-1}\left(\frac{2Y_L - 1}{B}\right) - \frac{1}{B}\tan^{-1}\left(\frac{2R - 1}{B}\right)\right] \quad \text{for } R > 1/4 \quad \ldots\ldots (22)$$

Free-Drainage Boundary Condition

Drainage is normally collected in a perforated pipe bedded in a drain trough. If the drainage system is functioning properly, the water level in the collection trough is below the top of the trough, and therefore has no effect on the saturated-depth profile over the liner. This desired operating condition is termed free drainage. If the collection system is undersized or clogged, water may pond over the collection trough and create a backwater effect over the liner.

A solution for the phreatic-surface profile in the vicinity of a bottom drain by Numerov (Harr 1962) provides guidance for estimating Y_L for the free-drainage boundary condition. For the boundary geometry in Fig. 2, Numerov's solution is

$$x = K\frac{h_0^2 - h^2}{2Q} + \frac{Q}{K}F(u) \quad \ldots\ldots (23)$$

in which

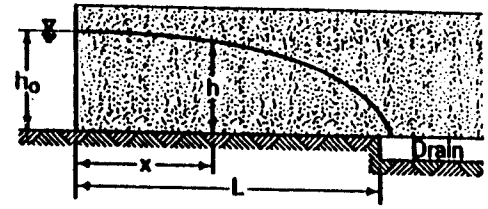

FIG. 2. Simplified Analysis of Free-Drainage Boundary Condition

$$Q = \frac{Kh_0^2}{L + \left(L^2 + \frac{h_0^2}{3}\right)^{1/2}} \quad \ldots\ldots (24)$$

$$u = \tanh\left(K\pi\frac{h_0 - h}{2Q}\right) \quad \ldots\ldots (25)$$

$$F(u) = \frac{2}{\pi}\int_0^1 \tan^{-1}\left(u\tan\frac{\pi t}{2}\right)\left[1 - \frac{1}{\pi}\tan^{-1}\left(u\tan\frac{\pi t}{2}\right)\right]dt \quad \ldots\ldots (26)$$

This solution was derived by conformal mapping without invoking the Dupuit approximations. The evaluation of this solution for specific values of L and y_0 indicates that the hydraulic gradient $dh/dx \approx -1$ at $x = L$ provided $L > y_0$. Although this result is based on a horizontal linear and no vertical inflow, the effects of the slope of the liner and the rate of vertical inflow on the conditions at the brink of the trough should be minor. The situation is roughly analogous to an abrupt overfall in open-channel flow with subcritical flow upstream of the overfall. In the latter case, the depth at the brink of the overfall depends only on the discharge and channel geometry at the overfall, and not on the slope of the channel or the rate of lateral inflow upstream of the overfall. Therefore, the approximation $dh/dx = -1$ at $x = L$ is recommended for free drainage, regardless of the slope of the liner or the rate of inflow. The corresponding value of y_L follows from the substitution of rL for Q and -1 for dh/dx in (8). The result is $y_L = rL/(K\cos^2\alpha)$, or $Y_L = RS$, in which $S = \tan\alpha$. The substitution of RS for Y_L in (20)–(22) leads to the following explicit formulas for the maximum saturated depth over a landfill liner that is draining freely with no backwater effect from the collection trough:

$$Y_{max} = (R - RS + R^2S^2)^{1/2} \left[\frac{(1 - A - 2R)(1 + A - 2RS)}{(1 + A - 2R)(1 - A - 2RS)}\right]^{1/2A}$$

$$\text{for } R < 1/4 \quad \ldots\ldots (27)$$

$$Y_{max} = \frac{R(1 - 2RS)}{1 - 2R} \exp\left[\frac{2R(S - 1)}{(1 - 2RS)(1 - 2R)}\right] \quad \text{for } R = 1/4 \quad \ldots (28)$$

and

$$Y_{max} = (R - RS + R^2S^2)^{1/2} \exp\left[\frac{1}{B}\tan^{-1}\left(\frac{2RS - 1}{B}\right)\right.$$

$$- \frac{\cdot}{B} \quad \cdot \left(\frac{2R - 1}{B}\right)\Bigg] \quad \text{for } R > 1/4 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (29)$$

Comparison with Formula of USEPA

Eq. (1), which appears in several publications of the U.S. Environmental Protection Agency, can be written in the dimensionless form

$$Y_{max} = R^{1/2}\left[1 - \frac{(1 + R)^{1/2} - 1}{R}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (30)$$

provided the slope of the liner is small enough that the approximation $\sin\alpha = \tan\alpha$ is good. Fig. 3 compares (30) with (27)–(29). This comparison shows that (30) overestimates the maximum saturated depth significantly for $R < 1$, which includes much of the range of practical interest. For a drainage layer with a hydraulic conductivity of 10^{-2} cm/s on a slope of 3%, R would exceed unity only for a vertical inflow rate greater than 280 cm/yr.

Practical Applications

Eqs. (27)–(29) are useful for the analysis and design of landfill covers and leachate-collection systems. These equations yield an estimate of the maximum saturated depth over the liner for a constant rate of inflow. This maximum saturated depth is a spatial maximum for steady-state conditions. If the rate of inflow is an estimate of the long-term average inflow rate, then the resulting maximum saturated depth should be considered a long-term average. Over the short term, both the rate of inflow and the maximum saturated depth may differ considerably from their long-term averages.

The U.S. Environmental Protection Agency currently recommends that granular drainage layers for final covers on hazardous-waste landfills have a minimum thickness of 30 cm, a minimum hydraulic conductivity of 0.01 cm/s, and a minimum slope of 3% at the bottom of the layer ("Technical"

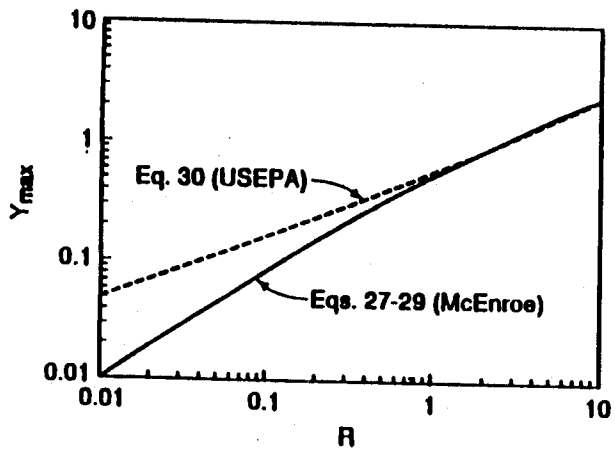

FIG. 3. Comparison of (27)–(29) and (30) for Maximum Saturated Depth over Landfill Liner

1989). The maximum saturated depth over the liner should not ed the thickness of the drainage layer, so that saturated conditions do not extend into the overlying soil cover. The following example illustrates the application of (27)–(29) to the design of a cover drain for a hazardous-waste landfill.

Problem

A final cover for a hazardous-waste landfill is to be constructed on a slope of 3% with a maximum drainage distance of 200 m. The granular drainage layer is to be 30 cm thick. The amount of rainfall percolating though the cover should average about 30 cm/yr. Estimate the minimum acceptable hydraulic conductivity for the drainage material.

Solution

The maximum saturated depth over the cover liner should not exceed 30 cm, which is the thickness of the drainage layer. The hydraulic conductivity needed to meet this constraint for a constant inflow rate of 30 cm/yr is determined by trial. For a hydraulic conductivity of 0.01 cm/s, the dimensionless inflow rate $R = 0.11$, (27) yields $Y_{max} = 0.088$, and the maximum saturated depth $y_{max} = 53$ cm. A hydraulic conductivity of 0.02 cm/s yields a maximum saturated depth of 28 cm, slightly less than the drainage-layer thickness, which would be acceptable if the rate of inflow were truly constant at 30 cm/yr. Because the rate of inflow to the drainage layer would vary with time, a larger hydraulic conductivity should be specified to prevent saturation of the cover soil during prolonged wet periods. A hydraulic conductivity of 0.1 cm/s should be satisfactory. This hydraulic conductivity would yield a maximum saturated depth of 6 cm for a constant inflow rate of 30 cm/yr.

The approximate formula of the USEPA greatly overestimates y_{max} for the conditions in this example. Eq. (1) yields $y_{max} = 100$ cm for $K = 0.01$ cm/s, $y_{max} = 70$ cm for $K = 0.02$ cm/s, and $y_{max} = 31$ cm for $K = 0.1$ cm/s. These values of y_{max} exceed the values from (27)–(29) by 90%, 150%, and 420%.

Conclusions

Eqs. (20)–(22) comprise a general solution for the steady-state maximum saturated depth over an impervious liner. The maximum saturated depth depends upon five factors: the rate of vertical inflow to the drainage layer, the hydraulic conductivity of the drainage layer, the maximum distance of flow, the slope of the liner, and the saturated depth at the downstream boundary. In landfill systems, the normal condition at the downstream boundary is a free overfall to a collection trough. Eqs. (27)–(29) yield the maximum saturated depth for this case. These formulas are recommended for the analysis and design of drainage systems for landfill covers and bottom liners. Eq. (1), which appears in several publications of the U.S. Environmental Protection Agency, greatly overestimates maximum saturated depths.

Acknowledgments

This work was supported by University of Kansas General Research Allocation No. 3139.

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Appendix II. Notation

The following symbols are used in this paper:

h = elevation of phreatic surface (L);
K = hydraulic conductivity of drainage layer (L/T);
L = drainage distance, measured horizontal (L);
Q = lateral discharge per unit width (L^3/T);
R = $r/(K \sin^2\alpha)$;
r = vertical inflow per unit horizontal area ($L^3/T/L^2$);
S = slope of liner ($= \tan\alpha$);
u = Y/X;
X = x/L;
x = distance coordinate, measured horizontally (L);
x' = distance coordinate, measured parallel to barrier (L);
Y = $y/(L \tan\alpha)$;
Y_L = $y_L/(L \tan\alpha)$;
Y_{max} = $y_{max}/(L \tan\alpha)$;
y = saturated depth, measured vertically (L);
y' = saturated depth, measured perpendicular to barrier (L);
y_L = saturated depth at brink of drain trough, measured vertically (L);
y_{max} = maximum saturated depth (L); and
α = liner angle, measured from horizontal.

Minimization of Multistage RBC Active Disc Area

By Roland Leduc[1] and Ian Buchanan[2]

Abstract: An analytical approach to the minimization of total active disc area (A_T), required for organic carbon removal [i.e., biochemical oxygen demand (BOD)] by a multistage rotating biological contactor (RBC), is presented. RBC operation is simulated using semiempirical models based on a saturation-type (Monod) removal rate, and on a first-order kinetics removal rate. The parameters used in the predictive equations are considered to be different from one RBC stage to the next. The minimizations of A_T, based in turn on each of the two semiempirical models, lead to a relationship between the optimal soluble substrate concentration of any stage and those of the immediately preceding and succeeding stages. When used in design, these relationships allow the minimum A_T, as well as the optimal number of stages required for carbon removal, to be obtained. For the saturation model, two parametric ratios (Φ_P and Φ_{K_S}) are introduced, which define the change in the model parameters with stage. Application of the relationships to the determination of the optimal number of stages and the minimum A_T is included.

Introduction

The rotating biological contactor (RBC) is a biological process for the treatment of wastewaters. It provides an environment in which biodegradable organic material contained in wastewater is metabolized by attached-growth microorganisms, thereby reducing the concentration of soluble organic material in the wastewater [often expressed as the soluble biochemical oxygen demand (SBOD)]. Rotating biological contactors are most often designed as a series of stages (see Fig. 1 for an illustration of a four-stage RBC). The series arrangement results in a high degree of organic removal for the following reasons (Antonie 1976):

- Microorganisms that grow in a particular stage are adapted to the wastewater characteristics of that stage.
- The residence time distribution within a multistage RBC approaches plug-flow, which increases the biochemical oxygen demand (BOD) removal rate.

An RBC stage consists of a tank through which wastewater flows and an array of plastic discs (the media) mounted on a horizontal shaft, which is slowly rotated. This rotation causes an area of the discs to be alternatively submerged in the wastewater flow and exposed to the air. Microorganisms grow to form an attached biofilm on the portion of the discs that is periodically submerged. This area is hereinafter termed the active disc area.

For the attached microorganisms to grow, they require a steady supply

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[2]Res. Asst., Dept. of Civ. Engrg. and Appl. Mech., McGill Univ., Montreal, Quebec, Canada H3A 2K6.

Note. Discussion open until September 1, 1993. To extend the closing date one month, a written request must be filed with the ASCE Manager of Journals. The manuscript for this paper was submitted for review and possible publication on December 12, 1991. This paper is part of the *Journal of Environmental Engineering*, Vol. 119, No. 2, March/April, 1993. ©ASCE, ISSN 0733-9372/93/0002-0271/$1.00 + $.15 per page. Paper No. 3090.

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. 27221

CLIENT Pelmont LLC

PROJECT Transition Application and permit renewal

SUBJECT Dewatering Time for Phase 3-Cell 2-Subcell 1

Prepared By RJM Date 4/13/

Reviewed By JM Date 4/13/

Approved By ____ Date ____

Purpose: Determine the time required to empty the stormwater collected from the 25-year, 24-hour storm event within Phase 3-Cell 2-Subcell 1. The situation will be analyzed under "open cell" conditions, where no stormwater can run-off and out of the cell.

Given & Assumed:

- From the Leachate Containment Calculation, provided in Appendix O of the Engineering Report (calculation prepared 10/15/93 and revised 4/13/94)
  - Volume Available in Cell for Storage: 3.929 acre-ft
  - 25-year / 24-hour pond routing information included.

Calculation:

- Determine the total volume of water entering Phase 3-Cell 2-Subcell 1.

From attached data, the various inflow rates and lengths of time at those inflow rates are as follows:

INFLOW (CFS)	Time (hours)	Volume (Ft³)
1	8.2	29,520
2	2.4	17,280
3	0.6	6,480
4	0.4	5,760
5	0.1	1800
6	0.2	4,320
7	0.1	2,520
8	0.1	2,880
10	0.2	7,200
13	0.1	4,680
17	0.1	6,120

Inflow (cfs)	Time (hours)	Volume (Ft³)
18	0.1	6,480
24	0.1	8,640
27	0.1	9,720
30	0.1	10,800
31	0.1	11,160

135,360 TOTAL

CLIENT Piedmont LLC

SUBJECT Phase 3-Cell 2-Subcell 1 (cont.)

PROJECT Transition Application and Permit Renewal

Prepared By GJM Date 4/13

Reviewed By GJM Date 4/13

Approved By ____ Date ____

- Determine time to pump out the volume collected

$V = 135,360\ ft^3$

$Rate_{min} = 40\ gpm = 0.089\ cfs$

$$\text{Maximum time} = \frac{V}{R} = \frac{135,360\ ft^3}{0.089\ \frac{ft^3}{sec}} \cdot \frac{1\ hour}{3600\ sec} \cdot \frac{day}{24\ hr} = \underline{17.6\ days}\ \text{for one 40 gpm}$$

∴ Additional pumps may be added as necessary to expedite the discharge process to facilitate operational needs. This situation represents a worst case situation, when this cell has no waste in it and its struck with the 25-year, 24-hour storm. All liquids can be pumped as stormwater. If partial filling within the cell floor occurs prior to the storm, the volume available for water collection will decrease, thereby decreasing the time to drain the cell.

```
*************************************************
*                                               *
*     Piedmont Landfill and Recycling Center    *
*  Kernersville, Forsyth County, North Carolina *
*          Phase 3 - Cell 2 - Subcell 1         *
*          24 hr - 25 yr Storm Storage          *
*                                               *
*************************************************
```

Inflow Hydrograph: c:PIED2 .HYD
Rating Table file: c:PIED2 .PND

----INITIAL CONDITIONS----
Elevation = 757.00 ft
Outflow = 0.00 cfs
Storage = 0.00 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
757.00	0.0	0.000
758.00	0.0	0.028
760.00	0.0	0.439
762.00	0.0	2.210
762.90	0.0	3.929

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
0.0	0.0
6.9	6.9
106.1	106.1
534.8	534.8
950.8	950.8

Time increment (t) = 0.100 hrs.

Pond File: c:PIED2 .PND
Inflow Hydrograph: c:PIED2 .HYD
Outflow Hydrograph: c:POND2 .HYD

INFLOW HYDROGRAPH

ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	1.00	-----	0.0	0.0	0.00	757.00
11.100	1.00	2.0	2.0	2.0	0.00	757.29
11.200	1.00	2.0	4.0	4.0	0.00	757.58
11.300	1.00	2.0	6.0	6.0	0.00	757.87
11.400	1.00	2.0	8.0	8.0	0.00	758.02
11.500	2.00	3.0	11.0	11.0	0.00	758.08
11.600	2.00	4.0	15.0	15.0	0.00	758.16
11.700	2.00	4.0	19.0	19.0	0.00	758.24
11.800	3.00	5.0	24.0	24.0	0.00	758.35
11.900	3.00	6.0	30.0	30.0	0.00	758.47
12.000	6.00	9.0	39.0	39.0	0.00	758.65
12.100	10.00	16.0	55.0	55.0	0.00	758.97
12.200	18.00	28.0	83.0	83.0	0.00	759.53
12.300	27.00	45.0	128.0	128.0	0.00	760.10
12.400	31.00	58.0	186.0	186.0	0.00	760.37
12.500	30.00	61.0	247.0	247.0	0.00	760.66
12.600	24.00	54.0	301.0	301.0	0.00	760.91
12.700	17.00	41.0	342.0	342.0	0.00	761.10
12.800	13.00	30.0	372.0	372.0	0.00	761.24
12.900	10.00	23.0	395.0	395.0	0.00	761.35
13.000	8.00	18.0	413.0	413.0	0.00	761.43
13.100	7.00	15.0	428.0	428.0	0.00	761.50
13.200	6.00	13.0	441.0	441.0	0.00	761.56
13.300	5.00	11.0	452.0	452.0	0.00	761.61
13.400	4.00	9.0	461.0	461.0	0.00	761.66
13.500	4.00	8.0	469.0	469.0	0.00	761.69
13.600	4.00	8.0	477.0	477.0	0.00	761.73
13.700	4.00	8.0	485.0	485.0	0.00	761.77
13.800	3.00	7.0	492.0	492.0	0.00	761.80
13.900	3.00	6.0	498.0	498.0	0.00	761.83
14.000	3.00	6.0	504.0	504.0	0.00	761.86
14.100	3.00	6.0	510.0	510.0	0.00	761.88
14.200	2.00	5.0	515.0	515.0	0.00	761.91
14.300	2.00	4.0	519.0	519.0	0.00	761.93
14.400	2.00	4.0	523.0	523.0	0.00	761.94
14.500	2.00	4.0	527.0	527.0	0.00	761.96
14.600	2.00	4.0	531.0	531.0	0.00	761.98
14.700	2.00	4.0	535.0	535.0	0.00	762.00
14.800	2.00	4.0	539.0	539.0	0.00	762.01
14.900	2.00	4.0	543.0	543.0	0.00	762.02
15.000	2.00	4.0	547.0	547.0	0.00	762.03
15.100	2.00	4.0	551.0	551.0	0.00	762.04
15.200	2.00	4.0	555.0	555.0	0.00	762.04
15.300	2.00	4.0	559.0	559.0	0.00	762.05
15.400	2.00	4.0	563.0	563.0	0.00	762.06

Pond File: c:PIED2 .PND
Inflow Hydrograph: c:PIED2 .HYD
Outflow Hydrograph: c:POND2 .HYD

INFLOW HYDROGRAPH / ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	2.00	4.0	567.0	567.0	0.00	762.07
15.600	2.00	4.0	571.0	571.0	0.00	762.08
15.700	2.00	4.0	575.0	575.0	0.00	762.09
15.800	2.00	4.0	579.0	579.0	0.00	762.10
15.900	2.00	4.0	583.0	583.0	0.00	762.10
16.000	2.00	4.0	587.0	587.0	0.00	762.11
16.100	2.00	4.0	591.0	591.0	0.00	762.12
16.200	2.00	4.0	595.0	595.0	0.00	762.13
16.300	1.00	3.0	598.0	598.0	0.00	762.14
16.400	1.00	2.0	600.0	600.0	0.00	762.14
16.500	1.00	2.0	602.0	602.0	0.00	762.15
16.600	1.00	2.0	604.0	604.0	0.00	762.15
16.700	1.00	2.0	606.0	606.0	0.00	762.15
16.800	1.00	2.0	608.0	608.0	0.00	762.16
16.900	1.00	2.0	610.0	610.0	0.00	762.16
17.000	1.00	2.0	612.0	612.0	0.00	762.17
17.100	1.00	2.0	614.0	614.0	0.00	762.17
17.200	1.00	2.0	616.0	616.0	0.00	762.18
17.300	1.00	2.0	618.0	618.0	0.00	762.18
17.400	1.00	2.0	620.0	620.0	0.00	762.18
17.500	1.00	2.0	622.0	622.0	0.00	762.19
17.600	1.00	2.0	624.0	624.0	0.00	762.19
17.700	1.00	2.0	626.0	626.0	0.00	762.20
17.800	1.00	2.0	628.0	628.0	0.00	762.20
17.900	1.00	2.0	630.0	630.0	0.00	762.21
18.000	1.00	2.0	632.0	632.0	0.00	762.21
18.100	1.00	2.0	634.0	634.0	0.00	762.21
18.200	1.00	2.0	636.0	636.0	0.00	762.22
18.300	1.00	2.0	638.0	638.0	0.00	762.22
18.400	1.00	2.0	640.0	640.0	0.00	762.23
18.500	1.00	2.0	642.0	642.0	0.00	762.23
18.600	1.00	2.0	644.0	644.0	0.00	762.24
18.700	1.00	2.0	646.0	646.0	0.00	762.24
18.800	1.00	2.0	648.0	648.0	0.00	762.24
18.900	1.00	2.0	650.0	650.0	0.00	762.25
19.000	1.00	2.0	652.0	652.0	0.00	762.25
19.100	1.00	2.0	654.0	654.0	0.00	762.26
19.200	1.00	2.0	656.0	656.0	0.00	762.26
19.300	1.00	2.0	658.0	658.0	0.00	762.27
19.400	1.00	2.0	660.0	660.0	0.00	762.27
19.500	1.00	2.0	662.0	662.0	0.00	762.28
19.600	1.00	2.0	664.0	664.0	0.00	762.28
19.700	1.00	2.0	666.0	666.0	0.00	762.28
19.800	1.00	2.0	668.0	668.0	0.00	762.29
19.900	1.00	2.0	670.0	670.0	0.00	762.29
20.000	1.00	2.0	672.0	672.0	0.00	762.30

Pond File: c:PIED2 .PND
Inflow Hydrograph: c:PIED2 .HYD
Outflow Hydrograph: c:POND2 .HYD

INFLOW HYDROGRAPH

ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
20.100	1.00	2.0	674.0	674.0	0.00	762.30
20.200	1.00	2.0	676.0	676.0	0.00	762.31
20.300	1.00	2.0	678.0	678.0	0.00	762.31
20.400	1.00	2.0	680.0	680.0	0.00	762.31
20.500	1.00	2.0	682.0	682.0	0.00	762.32
20.600	1.00	2.0	684.0	684.0	0.00	762.32
20.700	1.00	2.0	686.0	686.0	0.00	762.33
20.800	1.00	2.0	688.0	688.0	0.00	762.33
20.900	1.00	2.0	690.0	690.0	0.00	762.34
21.000	1.00	2.0	692.0	692.0	0.00	762.34
21.100	1.00	2.0	694.0	694.0	0.00	762.34
21.200	1.00	2.0	696.0	696.0	0.00	762.35
21.300	1.00	2.0	698.0	698.0	0.00	762.35
21.400	1.00	2.0	700.0	700.0	0.00	762.36
21.500	1.00	2.0	702.0	702.0	0.00	762.36
21.600	1.00	2.0	704.0	704.0	0.00	762.37
21.700	1.00	2.0	706.0	706.0	0.00	762.37
21.800	1.00	2.0	708.0	708.0	0.00	762.37
21.900	1.00	2.0	710.0	710.0	0.00	762.38
22.000	1.00	2.0	712.0	712.0	0.00	762.38
22.100	1.00	2.0	714.0	714.0	0.00	762.39
22.200	1.00	2.0	716.0	716.0	0.00	762.39
22.300	1.00	2.0	718.0	718.0	0.00	762.40
22.400	1.00	2.0	720.0	720.0	0.00	762.40
22.500	1.00	2.0	722.0	722.0	0.00	762.40
22.600	1.00	2.0	724.0	724.0	0.00	762.41
22.700	1.00	2.0	726.0	726.0	0.00	762.41
22.800	1.00	2.0	728.0	728.0	0.00	762.42
22.900	1.00	2.0	730.0	730.0	0.00	762.42
23.000	1.00	2.0	732.0	732.0	0.00	762.43
23.100	1.00	2.0	734.0	734.0	0.00	762.43
23.200	1.00	2.0	736.0	736.0	0.00	762.44
23.300	1.00	2.0	738.0	738.0	0.00	762.44
23.400	1.00	2.0	740.0	740.0	0.00	762.44
23.500	1.00	2.0	742.0	742.0	0.00	762.45
23.600	1.00	2.0	744.0	744.0	0.00	762.45
23.700	1.00	2.0	746.0	746.0	0.00	762.46
23.800	1.00	2.0	748.0	748.0	0.00	762.46
23.900	1.00	2.0	750.0	750.0	0.00	762.47
24.000	0.00	1.0	751.0	751.0	0.00	762.47
24.100	0.00	0.0	751.0	751.0	0.00	762.47
24.200	0.00	0.0	751.0	751.0	0.00	762.47
24.300	0.00	0.0	751.0	751.0	0.00	762.47
24.400	0.00	0.0	751.0	751.0	0.00	762.47
24.500	0.00	0.0	751.0	751.0	0.00	762.47
24.600	0.00	0.0	751.0	751.0	0.00	762.47

Pond File: c:PIED2 .PND
Inflow Hydrograph: c:PIED2 .HYD
Outflow Hydrograph: c:POND2 .HYD

INFLOW HYDROGRAPH

TIME (hrs)	INFLOW (cfs)
24.700	0.00
24.800	0.00
24.900	0.00
25.000	0.00
25.100	0.00
25.200	0.00
25.300	0.00
25.400	0.00
25.500	0.00
25.600	0.00
25.700	0.00
25.800	0.00
25.900	0.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
0.0	751.0	751.0	0.00	762.47
0.0	751.0	751.0	0.00	762.47
0.0	751.0	751.0	0.00	762.47
0.0	751.0	751.0	0.00	762.47
0.0	751.0	751.0	0.00	762.47
0.0	751.0	751.0	0.00	762.47
0.0	751.0	751.0	0.00	762.47
0.0	751.0	751.0	0.00	762.47
0.0	751.0	751.0	0.00	762.47
0.0	751.0	751.0	0.00	762.47
0.0	751.0	751.0	0.00	762.47
0.0	751.0	751.0	0.00	762.47
0.0	751.0	751.0	0.00	762.47

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: c:PIED2 .PND
Inflow Hydrograph: c:PIED2 .HYD
Outflow Hydrograph: c:POND2 .HYD

Starting Pond W.S. Elevation = 757.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 31.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 762.47 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 0.00 ac-ft
Peak Storage From Storm = 3.10 ac-ft

Total Storage in Pond = 3.10 ac-ft

Warning: Inflow hydrograph truncated on left side.

>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

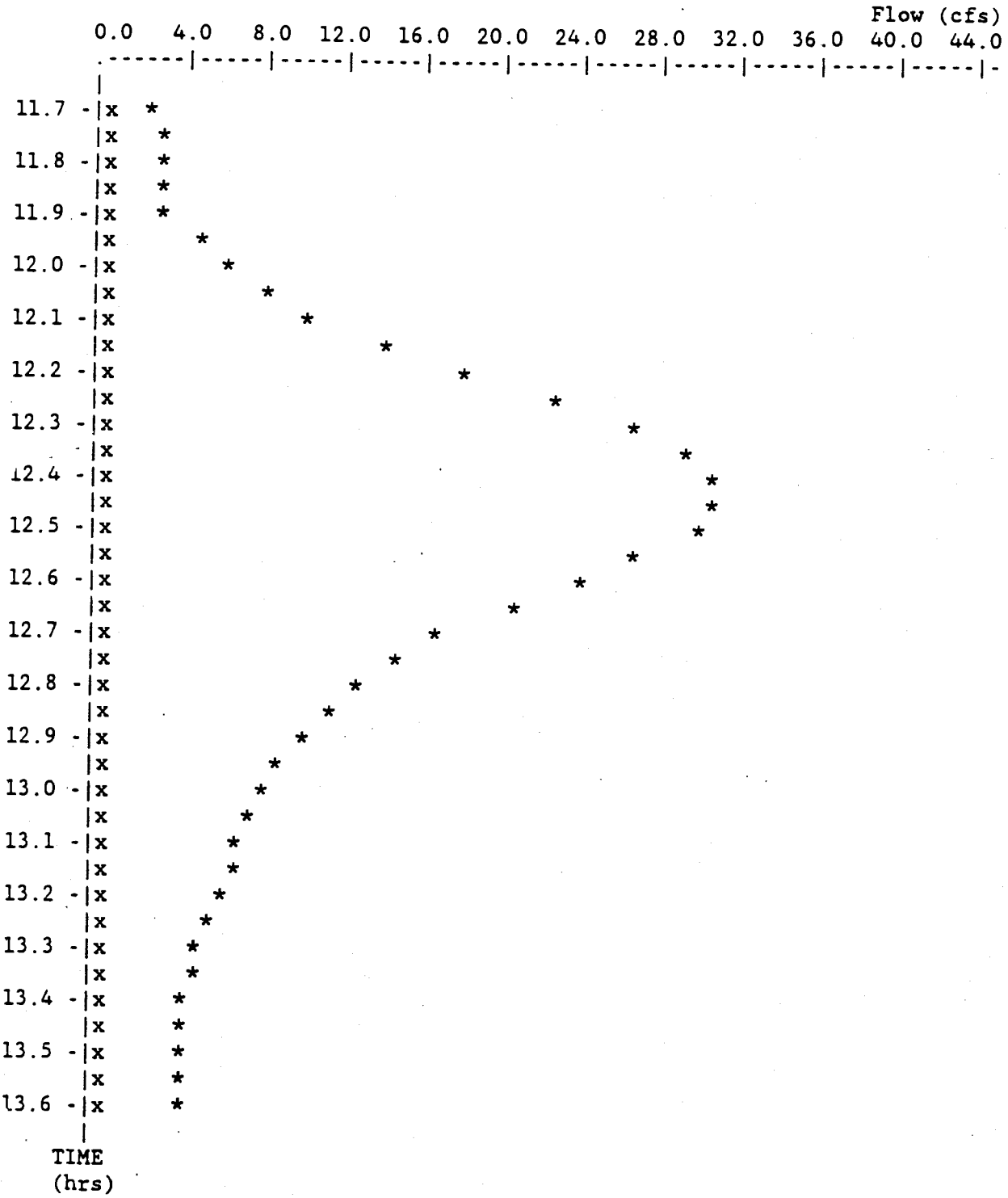
>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

POND-2 Version: 5.15 S/N: 1295100074 Page 7

Pond File: c:PIED2 .PND
Inflow Hydrograph: c:PIED2 .HYD
Outflow Hydrograph: c:POND2 .HYD

EXECUTED: 04-08-1994
11:40:28

Peak Inflow = 31.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 762.47 ft



```
* File:  c:PIED2   .HYD   Qmax =    31.0 cfs
x File:  c:POND2   .HYD   Qmax =     0.0 cfs
```

Appendix 12

PIEDMONT LANDFILL AND RECYCLING CENTER
Kernersville, NC

OPERATING MANUAL
FOR
LEACHATE RECIRCULATION

February, 1998

PURPOSE AND SCOPE

This manual describes the recirculation system and equipment, its operation, and the maintenance schedule for the operator's use in recirculating leachate within the Piedmont Landfill. Recirculation is currently limited to Phase 3, Cell 2, Subcell 1 of the existing facility, which was constructed in compliance with the design and construction requirements of 40 CFR Part 258 ("Subtitle D").

LEACHATE RECIRCULATION SYSTEM

A schematic sketch of the recirculation system as designed by RUST E&I is attached. The layout of the system in Subcell 1 and details of the system components are shown on RUST's Drawing No. 2 also attached.

Leachate is pumped from the on-site storage tanks by a Goulds Model 3656 10-Hp pump. A series of Spears gate valves are used to control leachate flow as shown on the attached diagram by RUST. Leachate flows back into the landfill via the force main and is directed to Subcell 1 by check valves that prevent the leachate from flowing upstream into any other subcells. The leachate is directed into Subcell 1 through a 3-inch ball valve and flow meter located inside a manhole on the south perimeter access road, then through a 3-inch HDPE pipe (contained inside a 6-inch HDPE pipe from the manhole to inside the subcell) to a distribution riser (see Detail 4/2 on RUST's Drawing No. 2). The distribution riser is located in the north-central portion of the subcell, approximately 150 feet north-northeast of the location shown in Detail 1/2 on RUST's Drawing No. 2.

At the distribution riser, the leachate is transferred to a series of distribution lines, one at a time, by manually connecting a flexible hose to vertical riser pipes within the riser (see Detail 2/2 on RUST's Drawing No. 2). Three levels of distribution lines are in

place in Subcell 1. The first (lower) two levels of lines each contain seven (7) distribution lines oriented approximately as shown in Detail 1/2. Those levels are located at approximate elevations 780 and 790 feet. The bottom of the subcell (top of protective sand layer) varies from elevations 762 to 774 feet, and is at approximate elevation 770 feet at the distribution riser. The third level contains only four lines extending generally northward. It is located at approximate elevation 810 feet All lines were constructed in general accordance with Detail 3/2 on RUST's Drawing No. 2.

RECIRCULATION PROCEDURE

The recirculation procedure to be followed is outlined in detail on the attached summary sheet. The one page summary is also printed on the back of the recirculation log used to record each recirculation event. A copy of the blank recirculation log for recording field data is also attached.

Recirculation should not be performed if, 1) greater than 1 inch of rain has fallen in the preceding 24 hours, 2) the leachate level above the liner at Sump D is greater than 12 inches (a sump level reading of greater than 36 inches), or 3) leachate seeps are present or evident on the exterior slopes of the receiving subcell.

When sufficient leachate has accumulated in the storage tanks and weather conditions are conducive to recirculation, the operator shall implement the procedure, beginning with the pipe next in sequence following the prior event. The pipes are numbered sequentially starting with the lowest level; for example, in Subcell 1, pipes 1-7 are in the first or lowest level, pipes 8-14 are in the second or middle level, and pipes 15-18 are in the third or highest level. The prescribed sequence is to go in order of pipe number while alternating levels, e.g., 1, 8, 15, 2, 9, 16, 3, 10, 17, etc. Note that pipe number 5 in Subcell 1 is out of order and should not be used.

The operator shall fill out the log completely, noting weather and site conditions and recording the time and/or quantity of recirculation for each pipe. Weather data for the preceding 24 hours shall be obtained from the landfill office and reviewed to verify that it is OK to recirculate before beginning recirculation. The operator shall also go to the appropriate sump control panel (Sump D for Subcell 1 of Cell 2, Phase 3) and record the leachate levels (subtracting 24 inches from the meter reading to get the level above the liner) and the leachate generation meter reading. Any problems, unusual conditions observed, and/or maintenance required or performed shall also recorded on the recirculation log.

MAINTENANCE SCHEDULE

The system is low maintenance, but the following items should be addressed and recorded regularly:

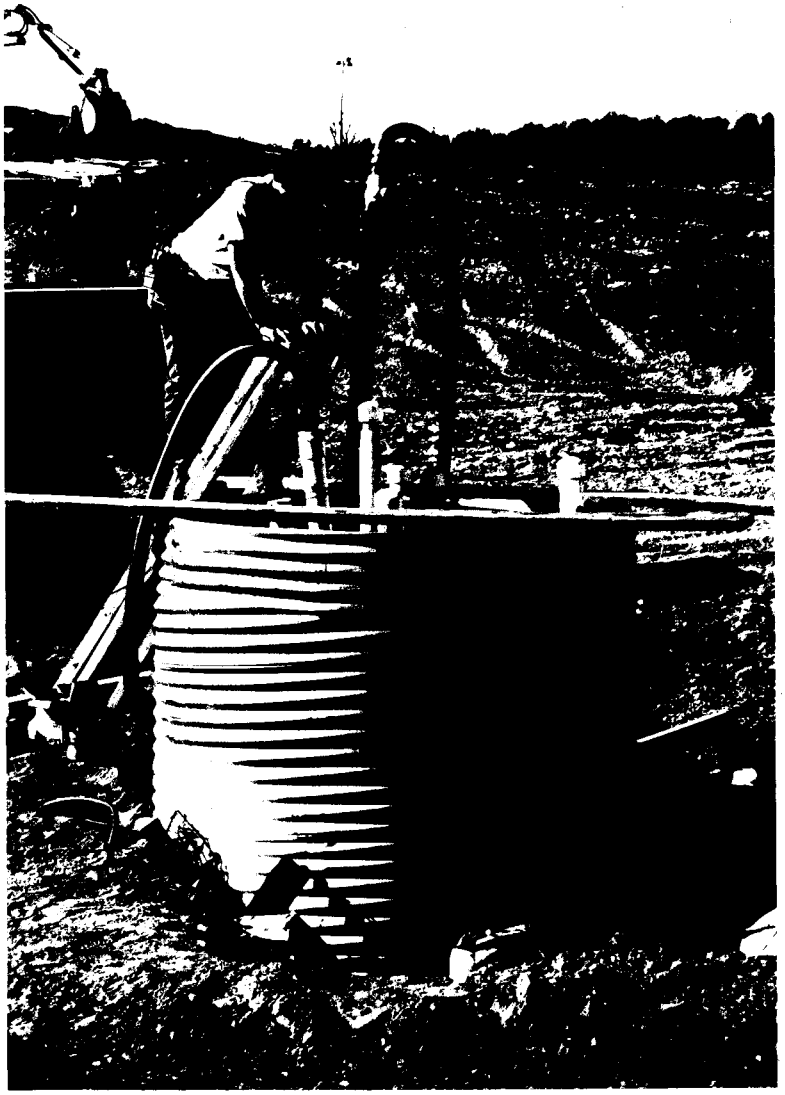
1. Inspect all fittings, pipes and hoses for wear or cracking and report damages to the Operations Supervisor.

2. On leachate pump, grease fittings on electric motor no less often than every 6 months.

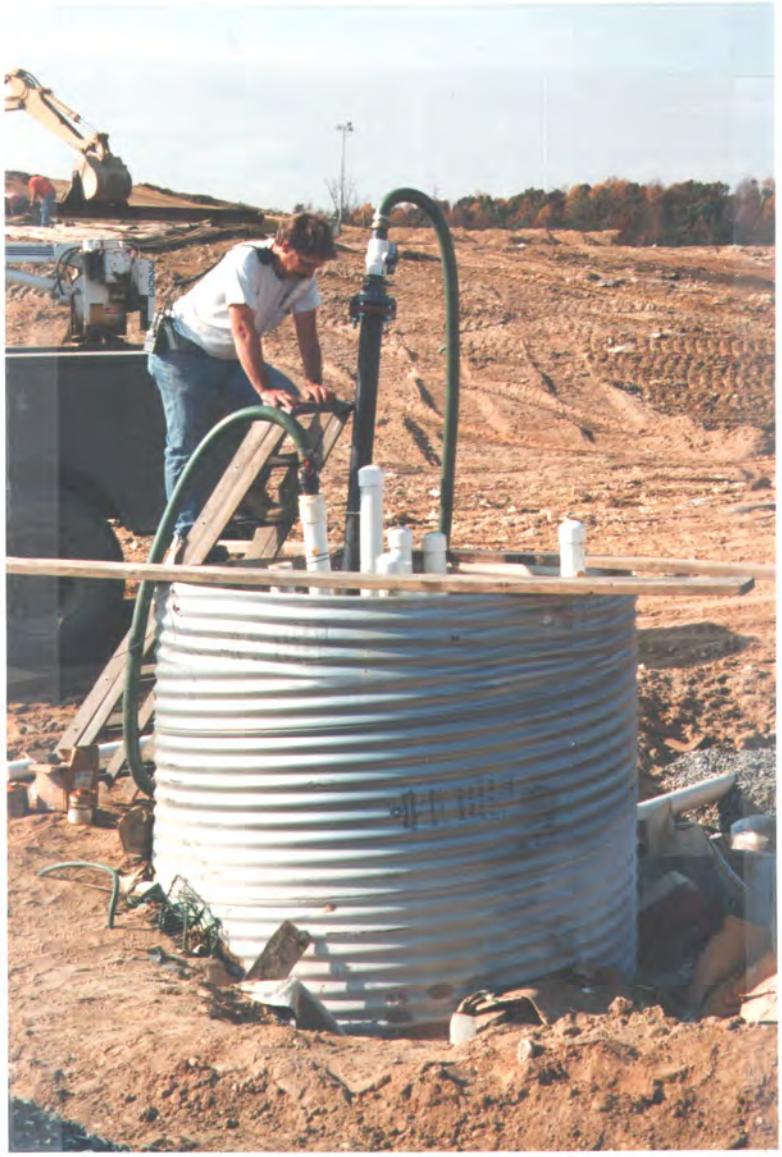
3. If there is evidence of clogging of valves or the flow meter, report the problem and schedule their cleaning as soon as possible.

4. Report any suspected problems with the leachate level or generation meters at the sump control panel to the Operations Supervisor immediately.

Photos

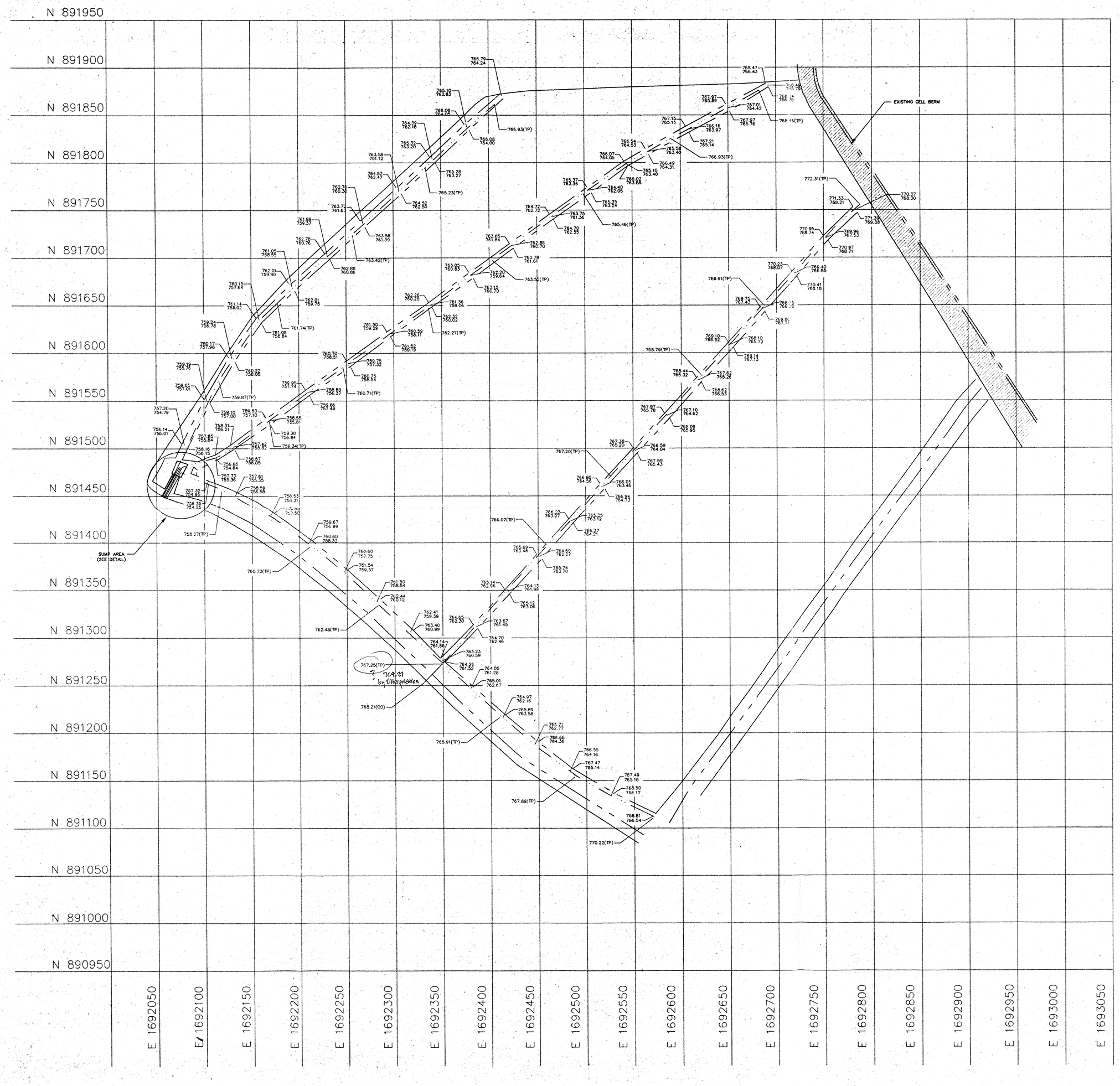


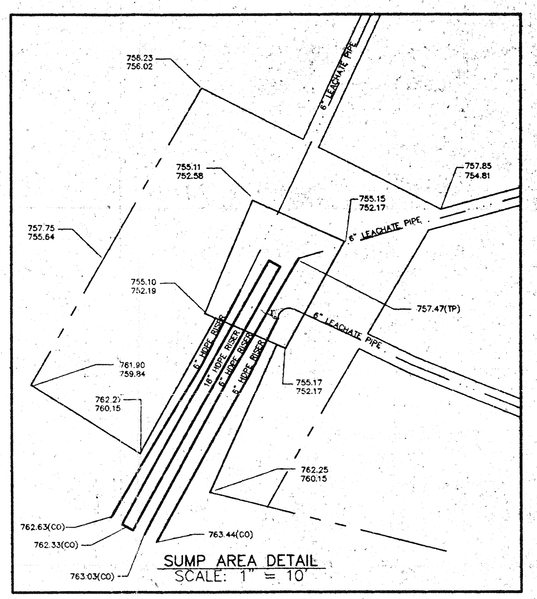
VIEW OF DISTRIBUTION RISER DURING RECIRCULATION



VIEW OF DISTRIBUTION RISER DURING RECIRCULATION

CLOSE-UP OF CONNECTIONS TO FEEDER AND DISTRIBUTION LINES





LEGEND

- TOP OF SAND (DRAINAGE ELEVATION)
- TOP OF CLAY (SUBBASE ELEVATION)
- TOP OF GROUND (SUBGRADE ELEVATION)

Shown on this Plan

- TOE OF SLOPE
- TOP OF SLOPE
- 6" LEACHATE LINE

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RUST E & I PROJECT NO. 34183

LEACHATE LINES AND GRADES
PIEDMONT LANDFILL AND RECYCLING CENTER
PHASE 3 - CELL 2 - SUBCELL 1
KERNERSVILLE
FORSYTH COUNTY, NORTH CAROLINA

NORTH CAROLINA REGISTERED LAND SURVEYOR L-3413 SEAL WILLIAM A. EADES

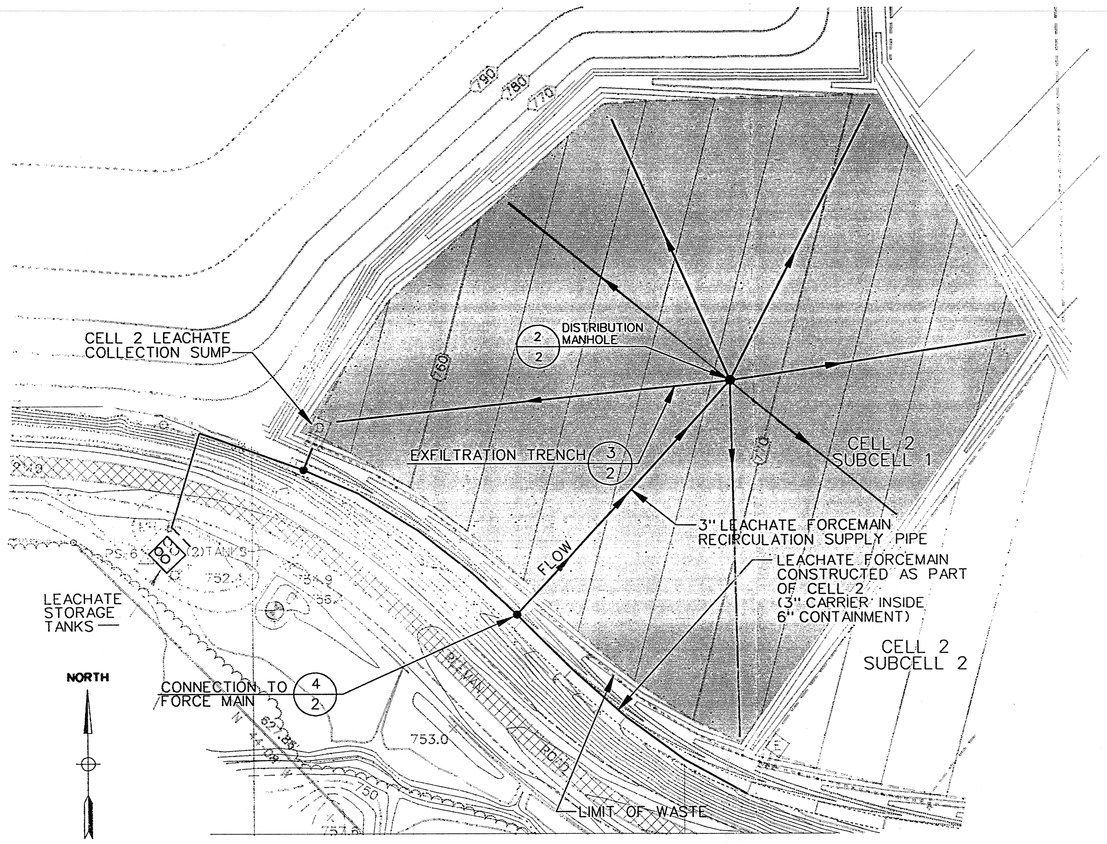
12-27-95

ISSUE SEQUENCE		
NO.	DATE	DESCRIPTION

PROJECT NO.:	93038.03
SURVEYED BY:	JGH
DRAWN BY:	DGS
CHECKED BY:	WAE
SCALE:	1" = 50'
DATE:	11/12/95

SHEET 2
OF 3

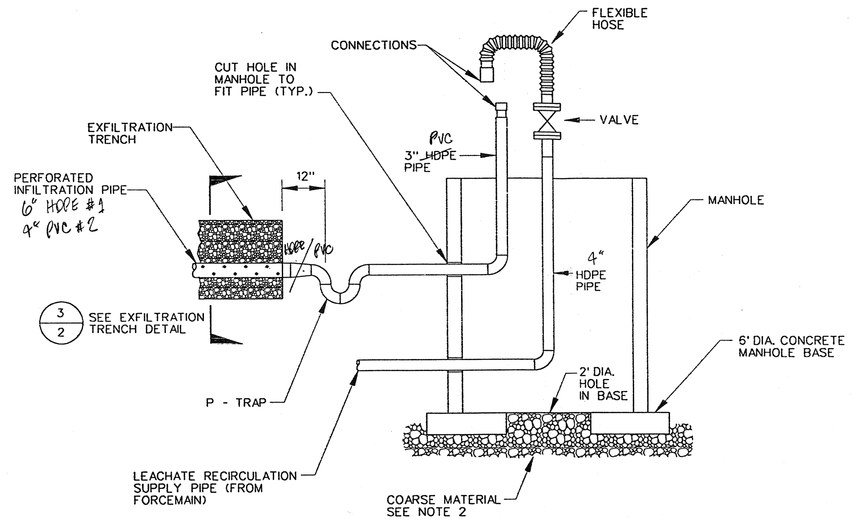
CADD # NEWBASE.DWG



PLAN

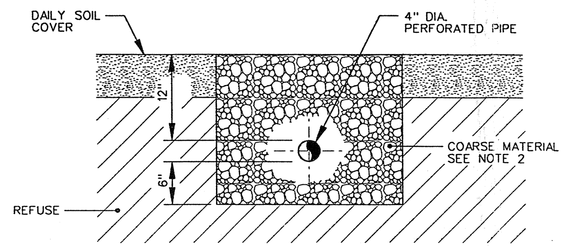
1/2 CELL 2 – LEACHATE RECIRCULATION SYSTEM

0 100' 200' 300'



2/2 DISTRIBUTION MANHOLE

NOT TO SCALE



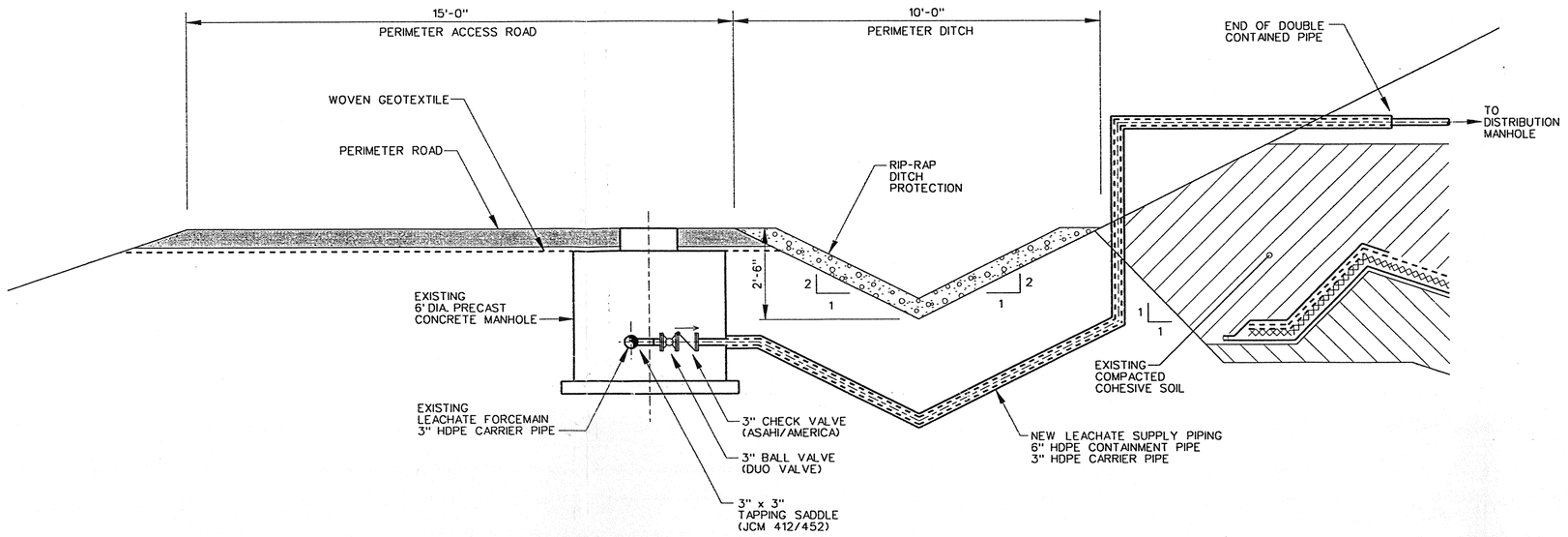
3/2 TYPICAL EXFILTRATION TRENCH DETAIL

NOT TO SCALE

NOTES:

1. DIMENSIONS SHOWN ARE APPROXIMATE AND ARE BASED ON THE BEST AVAILABLE INFORMATION ON OPERATING LEACHATE RECIRCULATION WITH EXFILTRATION SYSTEMS.

2. COARSE MATERIAL IN TRENCHES AND AROUND STRUCTURES MAY BE STONE, TIRE CHIPS, OR OTHER SUITABLE NONDEGRADABLE MATERIAL.



4/2 LEACHATE RECIRCULATION CONNECTION TO FORCEMAIN

REV	DATE	DESCRIPTION	DES BY	APP BY
A	10/4/95	REVIEWS		

PROJECT NO	33025
DATE	JUNE 1995
DES BY	
DRN BY	
CHK BY	
APP BY	

PIEDMONT LANDFILL AND RECYCLING CENTER
KERNERSVILLE, FORSYTH COUNTY, NORTH CAROLINA

LEACHATE RECIRCULATION SYSTEM DETAILS

PREPARED BY:
RUST ENVIRONMENT & INFRASTRUCTURE

Waste Management of Carolinas, Inc.

SHEET 1 OF 2

DRAWING NO **2**

N:\33025\3025ND01.DGN