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EPA WORK ASSIGNMENT NUMBER: 168-1L16

EPA CONTRACT NUMBER: 68-01-7250

EBASCO SERVICES INCORPORATED

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INTERIM TECHNICAL MEMORANDUM EVALUATION OF CHARLES GEORGE LANDFILL SETTLEMENT

CHARLES GEORGE LAND RECLAMATION TRUST LANDFILL SITE TYNGSBOROUGH, MASSACHUSETTS

NOVEMBER 1988

Submitted by:

Guy Wm. Vaillancourt, P.E.
Site Manager
E.C. Jordan Co.

Approved by:

Russell H. Boyd, Jr., P.E.
Regional Manager
Ebasco Services Incorporated

COMPLETED

32 pages

NOTICE

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EXECUTIVE SUMMARY

This document was prepared in response to Work Assignment No. 168-1L16 for the Charles George Landfill. The specific subject of this task is the evaluation of the landfill settlement and its potential effects on the integrity of the flexible membrane (high density polyethylene) cover system. This cover system for the Charles George Landfill was specified in a Record of Decision signed by the United States Environmental Protection Agency (EPA) in July 1985. Construction of the flexible membrane cap with associated systems for leachate collection, surface water diversion, and landfill gas collection and venting is anticipated to begin in 1989. This evaluation is based on two topographic mappings dated approximately three years apart, and on physical evidence observed during two site visits.

The surveys and observations indicate that settlement has occurred. Settlement to date is not believed to be sufficient enough to affect the integrity of the proposed cover system; however, future settlement and settlement caused by the installation of the cover system may affect the integrity. Additional surveying of the landfill surface and landfill monitoring wells will be performed to measure ongoing settlement and to project future impacts.

1.0 INTRODUCTION

In October 1987, EPA authorized E.C. Jordan Co. (Jordan) through Ebasco Services Incorporated (Ebasco) to perform an evaluation of the potential landfill settlement at the Charles George Landfill Reclamation site. This document is prepared in response to Work Assignment No. 168-1L16 for the Charles George Landfill.

The remedial design planned for the Charles George landfill is the installation of a multi-layer cover system. Evidence collected by Jordan personnel during two site visits suggests that the Charles George landfill is undergoing internal consolidation resulting in settlement of the surface of the landfill. As a result of this information, EPA requested that Jordan evaluate the landfill settlement to assess its impact on the integrity of the proposed cover system.

Municipal landfills will settle with time due to a variety of factors. These factors include such things as the waste composition, landfill density, landfill age, thickness of the landfill, etc. In addition, landfill settlement is not uniform due to local variations of composition, density, thickness and proximity to the landfill side slopes. Assessing the impact of landfill settlement without site-specific survey data is tenuous and qualitative. Periodic survey information is required to

determine quantitative settlement rates and to estimate future impacts. For this reason, this evaluation has been separated into two parts.

The first part documents the settlement observed to date. This was done by comparing selected cross sections of two photogrammetric mappings based on aerial photographs taken approximately three years apart and observing physical evidence during site visits. This interim report completes the first part of this evaluation and documents the settlement from 1984 to date.

The second part is to determine current settlement rates and to estimate future settlement and the probable impacts of future subsidence. Beginning in September 1988, and continuing to May-July 1989, periodic surveys of the selected cross sections of the landfill will be conducted to determine if settlement is continuing and, if so, the rate of settling, and to allow an assessment of potential future impacts of the settlement. A final report is planned for issue in August 1989, following completion of the survey and the evaluation.

A chronology of the events described in this memorandum is shown in Table 1.

TABLE 1

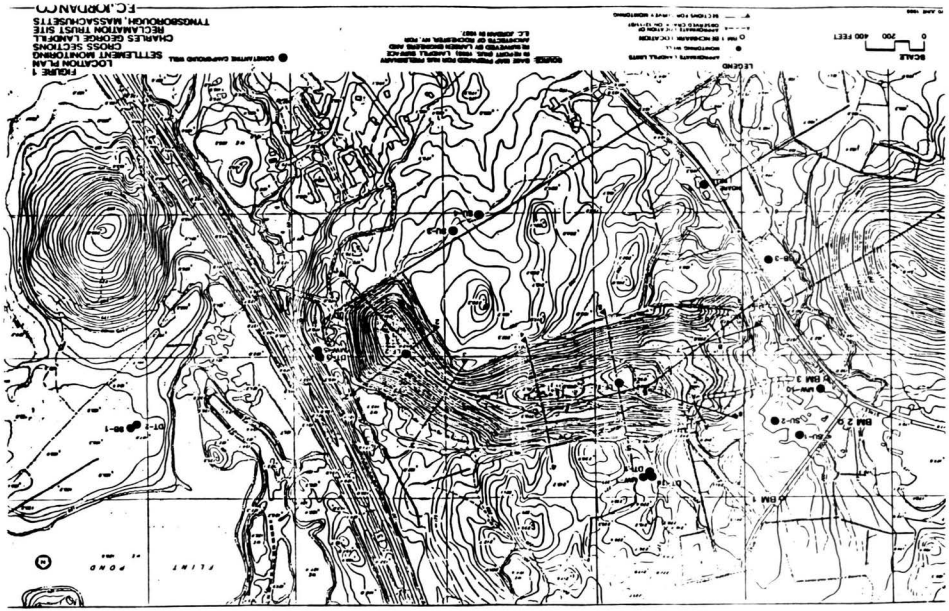
CHRONOLOGY OF LANDFILL SETTLEMENT OBSERVATIONS

1984	Aerial photographs taken by Charles H. Sells Co., from which a topographic map was developed for Camp, Dresser & McKee, Inc.
March 1987	Landfill monitoring wells LF-1 and LF-2 installed by E.C. Jordan Co.
May 1987	Aerial photographs taken by Erdman, Anthony Associates, from which a topographic map was developed by Larsen Engineers.
December 1987 Site Visit (See Site Reconnaissance Reports in Appendix)	Concrete seal around LF-1 was exposed 15 inches above the landfill surface. Concrete seal around LF-2 was exposed 18 inches above the landfill surface. Two large cracks (A-A' and B-B') were observed at the western end of the landfill.
April 1988 Site Visit (see Site Reconnaissance Reports in Appendix)	The landfill surface in the vicinity of the wells appeared to be unchanged since the last visit. Crack A-A' grew considerably since the last visit. Crack B-B' appeared unchanged. New cracks had formed in the western and eastern ends of the landfill.
September 1988	Interim report outlining settlement to date issued to EPA.
September 1988 through May 1989	Periodic landfill surveys to determine settlment rates.
August 1989	Final report discussing current settlement rates and potential future settlement rates issued to EPA.

2.0 EVALUATION OF CHARLES GEORGE LANDFILL SUBSIDENCE

Site visits to the Charles George Landfill by Jordan personnel, in December 1987 and April 1988, indicated that the landfill is experiencing settlement and surface distress. Concrete seals around landfill monitoring wells installed in early March 1987 were almost completely exposed during the site visits, suggesting that the landfill is subsiding or the wells are being thrust upwards. Significant surface cracks were also observed at several locations. Additional growth of a large crack at the western end of the landfill occurred between the visits; additional cracks were observed during the second visit. The site reconnaissance reports, providing detailed observations, are included in Appendix A.

To evaluate the amount and rate of landfill settlement, seven cross sections of the landfill surface, located as shown in Figure 1, were plotted using surface elevations taken from two photogrammetric maps that were developed from aerial photographs taken approximately three years apart. The cross sections are shown in Figure 2. The first photographs were taken in 1984 for Camp, Dresser & McKee, Inc. Surface topography was generated from aerial photographs taken by Charles H. Sells Co. in June and December 1984. Three benchmarks were used as controls for the photogrammetrically mapped elevations. The first benchmark, BM-1, was located at a drill hole in the east side of a stone



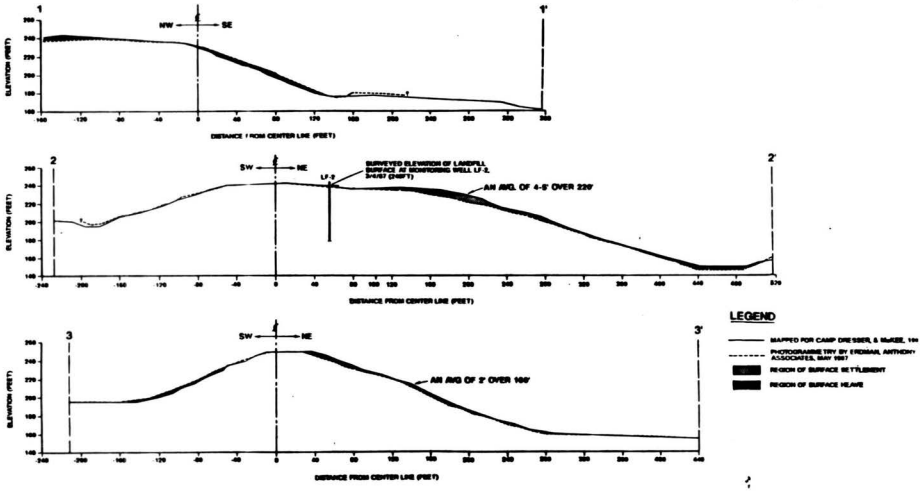


FIGURE 2 (PAGE 1 OF 2
SETTLEMENT MONITORING CROSS SECTION
CHARLES GEORGE LANDFILL
RECLAMATION TRUST SITE
TYNGSBOROUGH, MASSACHUSETTS

F.C. JORDANO

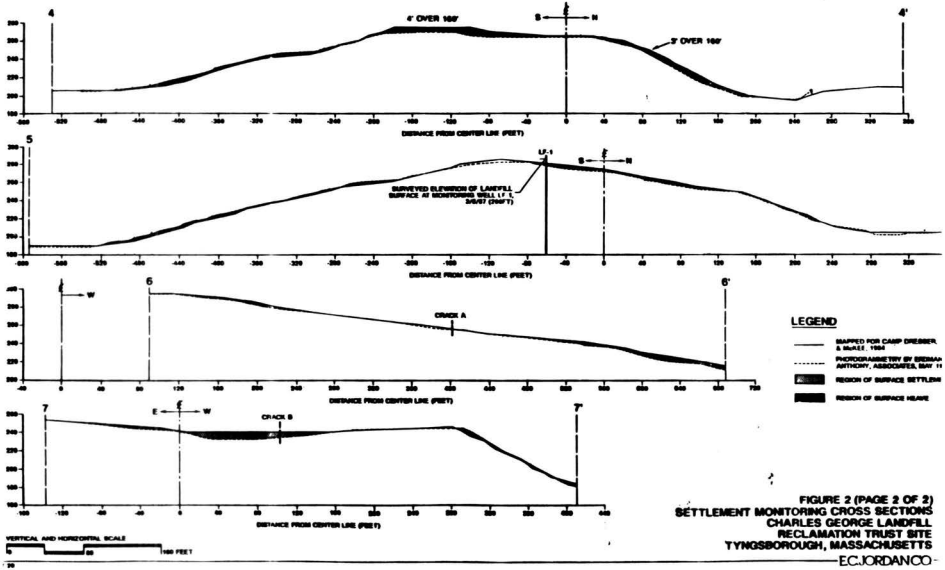


FIGURE 2 (PAGE 2 OF 2)
SETTLEMENT MONITORING CROSS SECTIONS
CHARLES GEORGE LANDFILL
RECLAMATION TRUST SITE
TYNGSBOROUGH, MASSACHUSETTS

E.C. JORDAN CO.

wall, 30 feet south of Utility Pole 33 on Blodgett Road, and was at an elevation of 217.42 feet. The second benchmark, BM-2, was located at a chipped square in the top of a boulder, west of the landfill entrance on Blodgett Road near Dunstable Road, and was at an elevation of 179.42 feet. The third benchmark, BM-3, was located at a spike in Utility Pole 74, on the east side of Dunstable Road, and was at an elevation of 158.57 feet. The locations of these benchmarks are identified on Figure 1.

The second mapping was performed for Jordan by Larsen Engineers and Architects. Surface topography was generated from aerial photographs taken by Erdman, Anthony, Associates on May 3, 1987. The benchmarks used for this mapping were identical to those used in the first survey.

Placement of the cross sections on the topographic maps was determined by location relative to the State of Massachusetts grid system established over the landfill area (see Figure 1). The cross sections may contain error in the horizontal plane due to slight scaling differences caused by the printing process used to duplicate the topographic maps. Horizontal error associated with cross section placement and scaling differences is thought to be less than 10 feet. There may also be error, on the order of 1 foot, in the vertical direction due to the accuracy of the photogrammetry. The comparison of these two topographic maps will not provide exact settlement data because errors may exist between the two maps or in plotting the cross

sections. It will, however, identify areas of vertical movement throughout the landfill.

Indications of landfill settlement were evident at each of the selected cross sections. The upper, flat portion of Section 1-1' shows that the landfill may have experienced up to 6 feet of settlement between 1984 and 1987 (see Figure 2). Cracks, which may be the result of landfill settlement, were observed in this area in April 1988. The sloped section indicates approximately 2 to 4 feet of heave, which suggests that the eastern slope may be bulging due to settlement of the top of the landfill surface.

The upper, northeastern slope of Section 2-2' displays settlement on the order of 6 to 8 feet. The middle and lower slope areas also show some settlement. The top and southern slopes of the landfill in this section appear to be stable. The surface around Monitoring Well LF-2 also appears to have been relatively stable; however, the 18 inches of exposed concrete seal observed at this well in December 1987 suggests that landfill settlement is occurring in this area as well.

The upper northern slope of Section 3-3' shows approximately 2 to 4 feet of settlement. The lower northern slope and the southern slope show some settlement and heave, respectively.

Section 4-4' indicates that between 6 and 8 feet of settlement occurred at the top of the landfill. The northern slope shows settlement; the southern slope indicates heave similar to Section 3-3'.

Between 2 and 4 feet of settlement is indicated at the top and upper northern slope of Section 5-5'; the southern slope appears to have heaved approximately 2 feet. Settlement in the vicinity of monitoring well LF-1 is approximately 2 to 3 feet, suggesting that the 15 inches of exposed concrete seal observed during the site visits were caused by settlement of the landfill around the well.

Section 6-6' is generally stable with some indication of settlement in the upper and lower slopes, on the order of 2 feet. Settlement may have also occurred in the vicinity of the large crack (denoted as A-A') in the western slope. This crack was not observed until after the May 1987 survey; therefore, considerable surface deformation could have occurred since the 1987 photogrammetry.

Finally, Section 7-7' indicates approximately 6 to 8 feet of settlement in the vicinity of a landfill crack along the western slope (denoted as B-B'). The section also shows 2 to 4 feet of heave on the western slope.

In summary, all cross sections indicate vertical movement of the landfill surface between 1984 and 1987. Settlement appears to be confined primarily to the top and upper northern slope of the landfill, although comparisons of the cross sections indicate that settlement and heave have occurred at other locations.

3.0 DISCUSSIONS AND CONCLUSIONS

It appears from this evaluation that vertical movement (settlement and heave) has occurred throughout much of the landfill. Settlement in the areas of Sections 2-2' and 4-4' appears to be the greatest; on the order of 6 to 8 feet. With the assumption that the mappings represent the elevation of the landfill surface in December 1984 and May 1987, the apparent rate of settlement during that period was 2.5 to 3.3 feet/year.

Preliminary calculations by Jordan using the settlement observed on Sections 2-2' and 4-4' indicate that a maximum of 3 percent elongation of the landfill surface would occur. This is well below the 13 percent elongation yield normally recommended for HDPE liners. The potential also exists for the liner to be stressed by stretching over localized landfill cracks. Several landfill cracks and holes have been noted at the landfill, some approaching 2 feet. HDPE breakpoint in a 360 degree stretching elongation test occurs at 120 percent. While none of the current cracks would be expected to cause tearing of the HDPE, continued settlement or subsidence in these localized areas could tear the liner if it were unable to move under the weight of the soil cover.

Each of the seven selected cross sections will be field surveyed on a periodic basis from Fall 1988 to Spring 1989, to more accurately determine settlement rates and to assess the

potential for future settlement. In addition, Monitoring Wells LF-1 and LF-2 will be resurveyed to determine if they have moved or if the landfill has settled. The HDPE liner stability will be further evaluated after completion of the field surveys.

Based on our observations to date, the site surveys, and our understanding of the nature of landfill performance, we believe that vertical movement of the landfill surface, including settlement and heaving, has and will continue at the Charles George landfill. Settlement is considered to be more of a concern than heave over the long term, particularly as the landfill slopes become stable over time. The overall landfill settlement can be aggravated by the cover installation and may approach levels in excess of the recommended 13 percent HDPE stretch limits but is not expected to approach the breakpoint of 120 percent. However, induced stress by the cover material in localized areas is potentially capable of tearing the liner or making the HDPE more vulnerable to chemical degradation. This is most likely to occur in localized crack areas or in areas where the landfill side slopes could become unstable due to the installation of the cover material.

These preliminary conclusions will be reviewed as additional survey information becomes available.

APPENDIX A

SITE RECONNAISSANCE REPORTS

E.C JORDAN CO ENGINEERS & SCIENTISTS

MEMO

TO: D. Mosher

FROM: M. Muzzy

DATE: January 18, 1988

SUBJECT: Subsidence/Stability Reconnaissance
Charles George Landfill

On December 11, 1987, Alan Piecuch, Stephen Mitchell, and Matthew Muzzy visited the Charles George Landfill in Tyngsboro, Massachussets. The purpose of the site visit was to conduct site reconnaissance for observation of reported subsidence around monitoring wells LF-1 and LF-2.

Background

Charles George Landfill covers an area of approximately 70 acres and has a maximum waste thickness of about 100 feet. The landfill is closed in terms of accepting new waste, however, no low permeability cover has been placed over the waste to limit precipitation infiltration or leachate generation. Tentative future plans for closure of the landfill include installation of a low permeability cover system.

In March, 1987, two exploratory borings LF-1 and LF-2 were made in the landfill at the locations shown on Figure 1. The borings extended through the landfill into underlying native dense soils. A single monitoring well was placed in each boring; with the well tip located at or near the bottom of the boring. Boring logs and well installation details for LF-1 and LF-2 are attached. Protective steel casings with lockable covers were installed over each of the monitoring wells such that a portion of the casing extended into the bore hole annulus. A surface seal, consisting of concrete, was placed around each of the protective casings as shown on the well installation details.

Sometime after the well installations were completed observations were made suggesting the landfill surface in the vicinity of the wells had undergone vertical movement. The movement was evidenced by a portion of the concrete seal around the wells becoming exposed. This movement suggested a subsidence condition was occurring at the landfill.

Observed Landfill Surface Conditions

During the December 11, 1987 reconnaissance, the following observations were made:

1. A crack in the landfill (denoted as A-A on Figure 1) was observed. The crack width at the landfill surface was generally in excess of 12 inches; the crack depth was variable to about 24 inches. Considerable caving of soil into the crack was observed indicating the crack had filled. The crack length was estimated to be in excess of 150 feet. No vegetation was noted growing from the crack suggesting it to be a recent opening.

2. A crack in the landfill (denoted as B-B on Figure 1) was observed. This crack had a surface width of approximately 4 to 6 inches and an observed depth of about 12 inches. No vegetation was noted growing from the crack suggesting it to be a recent opening.

3. Reconnaissance along the break in slope (i.e., approximately elevation 250 on Figure 1) revealed numerous small, 1-inch wide or less, cracks in the landfill surface. The cracks were generally oriented both perpendicular and parallel to the slope. In some cases the cracks appeared to be almost healed in that soil had caved into them and vegetation was growing; in other areas the cracks appeared to be more recent.

4. Considerable gas venting was observed at the landfill surface approximately 350 feet west of monitoring well LF-1. Gas venting was not noted at any other location in the landfill. The landfill surface in the venting area appeared to be uneven and rough with respect to other areas in the landfill, suggesting that area in particular may have experienced some instability since the landfill operation was discontinued.

5. The concrete seals around the protective casings for monitoring wells LF-1 and LF-2 were observed to be approximately 15 inches and 18 inches, respectively, above the landfill surface. Observation of the immediate area around the wells did not show any indication of material collapse into the bore hole annulus. From this it is considered subsidence at the landfill is occurring and at the locations of LF-1 and LF-2 it appears the present rate of movement is on the order of approximately one and one-half feet per year.

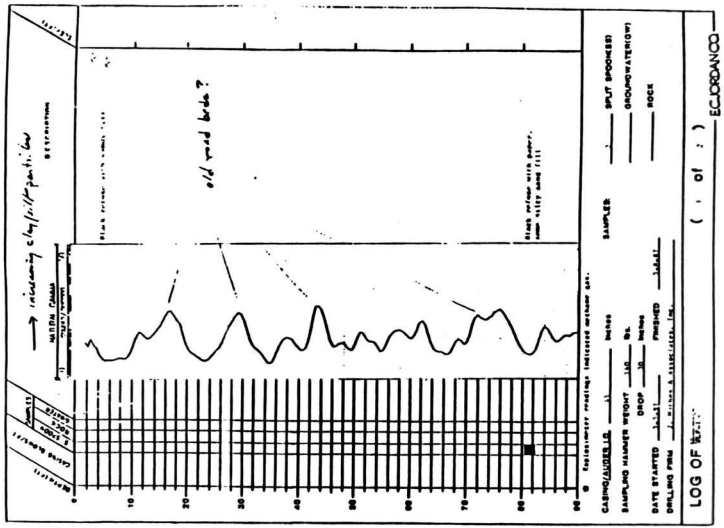
Evaluation

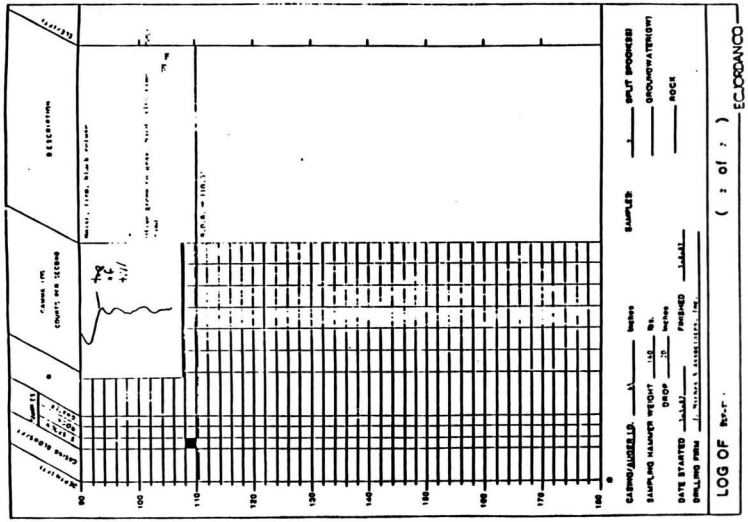
The observed landfill surface cracking and subsidence around the monitoring wells LF-1 and LF-2 raises the question of what cover integrity can be expected if a cover were installed over the landfill in the immediate future. More specifically, would shortening or lengthening of the landfill slopes and top area cause distress to a cover system by either placing the cover system into tension or compression? Additionally, the more substantial cracking of the landfill surface at A-A and B-B suggests that landfill stability may also be an issue. Crack A-A is located near a sand and gravel borrow pit suggesting movement may be occurring towards the depression formed by the borrow. Crack B-B is located about 700 feet from a ponded water area (See Figure 1). The landfill surface starts approximately at the pond's edge and slopes upward at an angle of approximately 2 horizontal to 1 vertical (as scaled from Figure 1) through a vertical distance of about 90 feet. Generally landfill slopes are desired to be maintained at a maximum slope angle of 3 horizontal to 1 vertical to enhance slope stability. To this end, the orientation of crack B-B and its location relative to the landfill's perimeter present a concern for side slope stability at the western side of the landfill.

Recommendations

Prior to initiating a cover design for the landfill it is recommended both the subsidence and stability concerns discussed herein be resolved. A study should be conducted to monitor landfill surface movements at a number of areas over a period of time substantial enough to allow movement to occur. Accordingly, several sections have been suggested for monitoring on Figure 1. The monitoring should consist of conducting horizontal and vertical survey of the sections at 1 to 2 month intervals with at least three separate survey events occurring. Additionally cracks A-A and B-B should be horizontally and vertically located and monitored. The data collected from this monitoring should be reviewed by a geotechnical engineer as it becomes available. As more monitoring data accumulates confidence can be established with respect to what landfill movements are occurring and whether cover design or additional evaluation is appropriate.

Before initiating the monitoring program it is recommended that a geotechnical engineer review and approve the locations of sections to be monitored and establish the accuracy of survey needed to collect the field data which will be used to evaluate landfill movement.

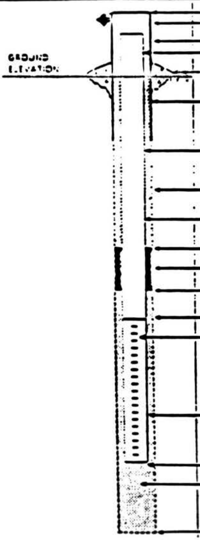




BORING NO. JLF-1

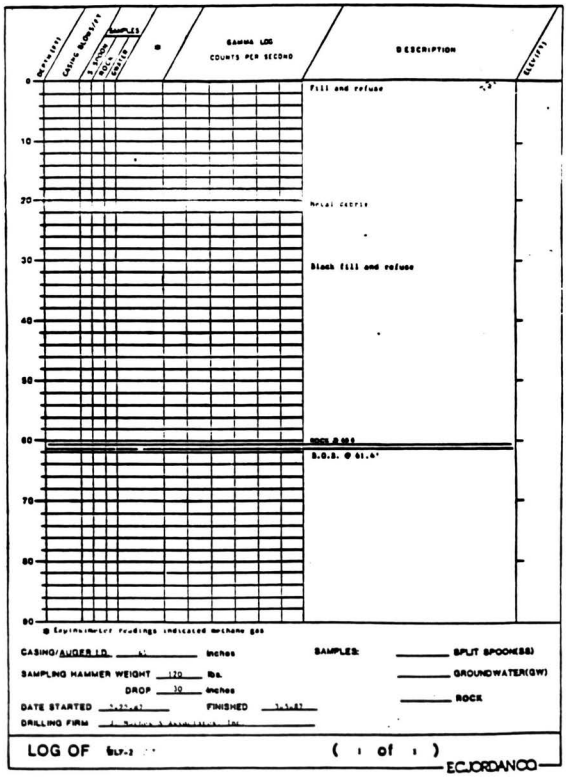
OVERBURDEN MONITORING WELL SHEET

PROJECT Charles George	LOCATION Tyngsboro, MA	DRILLER [illegible]
PROJECT NO [illegible]	BORING JLF-1	DRILLING METHOD HSA
ELEVATION	DATE [illegible]	DEVELOPMENT METHOD N.A.
FIELD GEOLOGIST [illegible]		



ELEVATION OF TOP OF SURFACE CASING	289.15
ELEVATION OF TOP OF RISER PIPE	288.95
STICK-UP TOP OF SURFACE CASING	+3.1'
STICK-UP RISER PIPE	+2.9'
TYPE OF SURFACE SEAL	Concrete
I.D. OF SURFACE CASING	4"
TYPE OF SURFACE CASING	Black steel
RISER PIPE I.D.	2"
TYPE OF RISER PIPE	Stainless steel
BOREHOLE DIAMETER	Nominal 6"
TYPE OF BACKFILL	Natural - Fill
ELEVATION/DEPTH TOP OF SEAL	94.7'
TYPE OF SEAL	Bentonite Pellets
DEPTH TOP OF SAND PACK	97.7'
ELEVATION/DEPTH TOP OF SCREEN	99.7'
TYPE OF SCREEN	Wire wrap stainless steel
SLOT SIZE x LENGTH	0.010 inch
I.D. OF SCREEN	2"
TYPE OF SAND PACK	Caved Refuse; Hole caved to 47' after placement of riser
ELEVATION/DEPTH BOTTOM OF SCREEN	108'
ELEVATION/DEPTH BOTTOM OF SAND PACK	108'
TYPE OF BACKFILL BELOW OBSERVATION WELL	Natural materials in hole
ELEVATION/DEPTH OF HOLE	110.5'

CGLRT RI/FS WELL INSTALLATION DET



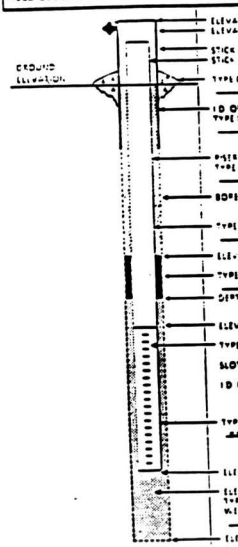
BORING NO. JLF-2

OVERBURDEN MONITORING WELL SHEET

PROJECT: Charles George
PROJECT NO: 5037-03
ELEVATION:
FIELD GEOLOGIST: Grace Tibby

LOCATION: Tyngsboro, MA
BORING: JLF-2
DATE: 3/6/87

DRILLER: JMA
DRILLING METHOD: Auger
DEVELOPMENT METHOD: N.A.



ELEVATION OF TOP OF SURFACE CASING: 763.11'
ELEVATION OF TOP OF RISER PIPE: 763.11'
STICK-UP TOP OF SURFACE CASING: -3.1'
STICK-UP RISER PIPE: -2.9'
TYPE OF SURFACE SEAL: Concrete/cement
I.D. OF SURFACE CASING: 6"
TYPE OF SURFACE CASING: Steel
RISER PIPE I.D.: 2"
TYPE OF RISER PIPE: Stainless steel on fill
BORE-HOLE DIAMETER: Nominal 6"
TYPE OF BACKFILL: Common or Sand/bentonite
ELEVATION / DEPTH TOP OF SEAL: 39.0'
TYPE OF SEAL: Bentonite pellets
DEPTH TOP OF SAND PACK: 41.0'
ELEVATION / DEPTH TOP OF SCREEN: 49.5'
TYPE OF SCREEN: Wire wrap stainless steel
SLOT SIZE x LENGTH: 0.010"
I.D. OF SCREEN: 2"
TYPE OF SAND PACK: Silica or sieved sand/gravel backfill
ELEVATION / DEPTH BOTTOM OF SCREEN: 60.6'
ELEVATION / DEPTH BOTTOM OF SAND PACK: 61.2'
TYPE OF BACKFILL BELOW OBSERVATION WELL:
ELEVATION / DEPTH OF HOLE: 61.4'

CGLRT RI/FS WELL INSTALLATION DETAIL

TABLE P-6 (cont.)
CHLAT GROUNDWATER ELEVATIONS 1984-1987
REMEDIAL INVESTIGATION

Well	ELEVATION TOP OF MEASUREMENT POINT (FT.)	WATER ELEVATIONS (FT.) 10/6/84	1/7,8,9/85	5/29/85	9/5/86	1/21/87	2/6/87	5/5/87	5/C/87	4/2,3,/87	4/30/87
BF-1	124.60	103.02	106.52		107.02						
BF-2	123.61	122.53		120.09							
BF-3	125.08	122.14	123.20	122.03							
BF-4	125.74	122.36	110			123.62	121.80				
BF-5	124.96	122.47		123.31	121.77						124.14
BF-6	126.22	121.94		121.76			122.40			125.45	125.19
BF-7	109.99	103.06			105.99					106.62	106.59
BF-8	151.03	145.13									
BF-9	152.06	140.15				153.10					
BF-10	153.17	152.22								152.67	152.65
JSB-1	191.05							186.33	186.00	187.94	186.36
JSB-2	191.02									189.23	188.37
JSB-3	193.50									186.78	185.07
JSB-4	187.46									184.87	184.01
JLF-1	208.95									203.41	200.00
JLF-2	243.11							188.20	188.61	184.31	181.29

A = Water level measured on February 21, 23, 24, 25, or 26.
B = Water level measured on March 4, 5, or 10.
C = Water level measured on March 14, 16, 17, or 18.
1 = Hole was deepened from 105' to 525' on 5-14-85.
2 = Hole was deepened from 79.0' to 425' on 5-15-85.

5037-20

MEMO TO: Susan Waite

FROM: Don Hunt/Alan Piecuch DH AP

DATE: April 14, 1988

SUBJECT: Site Reconnaissance
Charles George Landfill
Tyngsboro, Massachusetts

On Thursday, April 7, 1988, Alan Piecuch and Don Hunt visited the subject landfill. The purpose of the site visit was to determine whether or not the conditions observed during the December 11, 1987 site visit had worsened (reference memo from M. Muzzy to D. Mosher, dated January 18, 1988).

OBSERVATIONS

1. The crack denoted A-A (Figure 1) at the west end of the landfill has lengthened and appears to have branched off into more than one crack. The width and depth of the original portion of the crack are generally the same. Two large holes were observed at the southern end of the enlarged crack (see Photograph 1). The holes were about 2 feet wide, 3 feet long, and 3 feet and greater in depth. At least one of the holes appeared to extend laterally below the surface and away from the entry point. Considerable gas venting was noted at the cracks and holes. Smoke was also seen. The odor at this end of the landfill seemed to be much worse than elsewhere.

2. Crack B-B, which was noted during the December 1987 site visit, did not appear to be any larger.

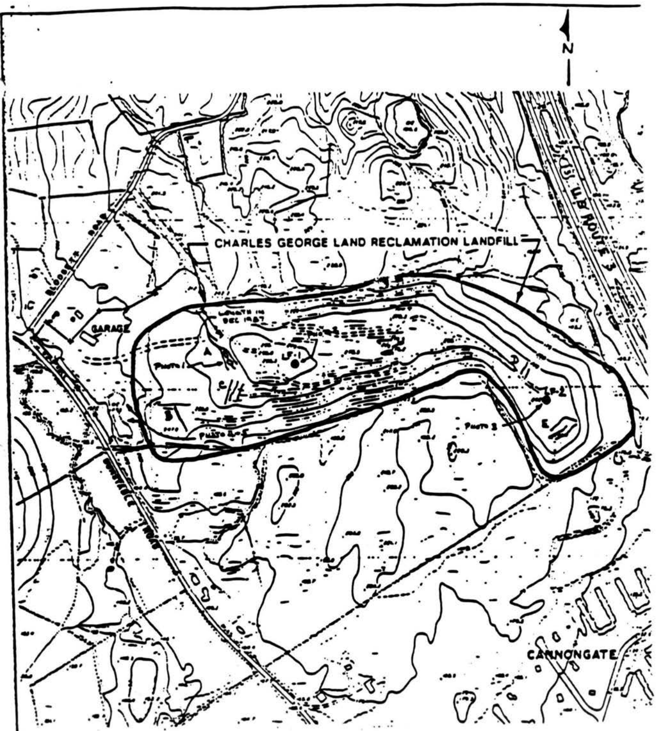
3. Additional cracks were noted at the locations shown on Figure 1. The cracks in general were only 2 to 3 inches in depth and perhaps 0.5 to 1 inch wide. Their orientation on the landfill surface appeared to be largely random, and it could not be determined whether or not they were related to a sliding stability problem. For instance, there were a number of cracks oriented at right angles to the center axis of the landfill. The cracking observed seemed to be limited to the relatively level portions of the landfill surface. Inspection of the steeper side slopes on the north side did not reveal the presence of cracking or any other obvious signs of instability.

4. The conditions at monitoring wells LF-1 and LF-2 do not appear to have worsened (Photographs 2 and 3).

5. Gas venting was noted at other locations on the landfill. It is our perception that the gas venting/odor was strongest in the areas where cracks were observed. Gas was observed bubbling through puddles of water on top of the landfill.

DH/AF:pmp

cc: Mark Peterson



LEGEND

—— APPROXIMATE LANDFILL LIMITS

-x- CHAIN LINK FENCE

SCALE

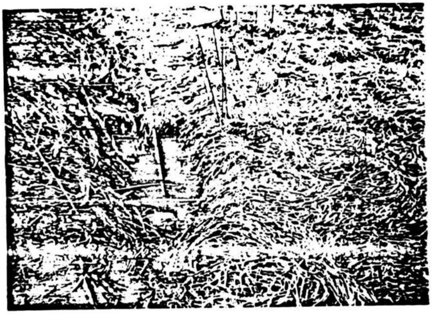
0 500 1000 FEET

NOTES

1. CRACKS A & E NOTED IN DEC. 1987
2. CRACKS B, C, & D WERE NOT NOTED IN EARLIER VISIT.

SITE TOPOGRAPHIC MAP
CGLRT SITE

E.C.JORDAN CO.



PHOTOGRAPH 1: HOLE OBSERVED AT THE SOUTHERN END OF CRACK A-A'

APRIL 7, 1986

PHOTOGRAPH 2:

_XPOSED CONCRETE SEAL AT MONITORING WELL LF-1

APRIL 7, 1988

PHOTOGRAPH 3:

EXPOSED CONCRETE SEAL AT MONITORING WELL LF

APRIL 7, 1988