Meixell

CRUCIBLE SPECIALTY METALS

A Division Of

Crucible Materials Corporation

Revised Landfill Closure Plan

VOLUME 2

APPENDICES - FIGURES - DRAWINGS

January 1986

Calocerinos & Spina
CONSULTING ENGINEERS

1020 Seventh North Street, Liverpool, NY 13088 · Phone (315) 457-6711

CLOSURE PLAN

TABLE OF CONTENTS

CLOSURE PLAN

TABLE OF CONTENTS
(Continued)

CLOSURE PLAN

TABLE OF CONTENTS
(Continued)

List of Tables

Volume 1

List of Figures

Volume 2

Figures

List of Appendices

Volume 2

Appendix	
A	Onondaga County Permit for Crucible Landfill
B	Analytical Results - Quarterly Monitoring Program
C	Geotechnical Engineering Report
D	Quality Assurance Specifications
E	Recommendations of Dr. Norman Richards on Soil Cover
F	Reports Pertaining to Membrane Life
G	Landfill Monitoring Report Forms
H	Detailed Cost Estimate - Closure
I	Financial Assurance Documentation
J	Notification In Deed

List of Accompanying Drawings

Volume 2

1. Title
2. Existing Site Plan
3. Final Grading Plan
4. Closure Sequencing Plan
5. Site Profiles
6. Site Profiles
7. Site Profiles
8. Membrane Installation Plan
9. Capping Details
10. Membrane Installation Details
11. Drainage Collection Plan
12. Drainage Details

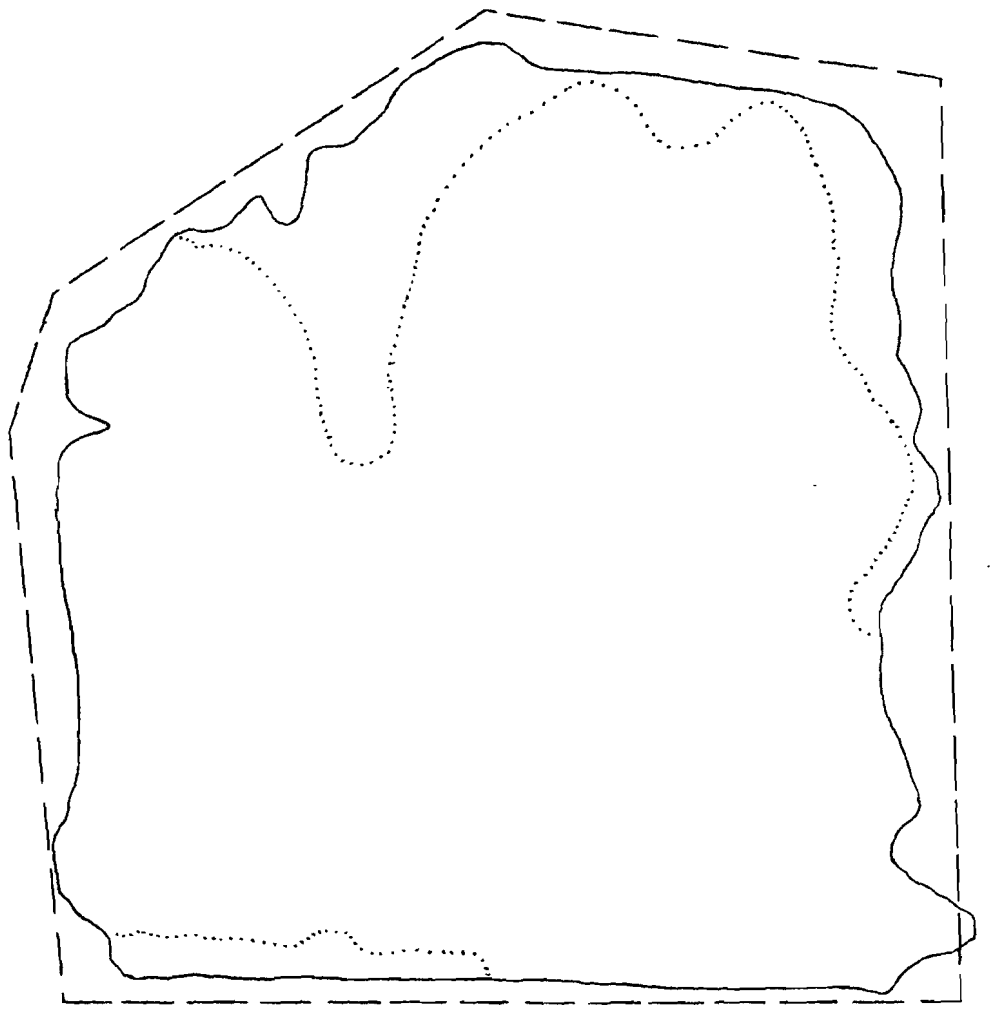
List of Accompanying Documents

Six volume "Report to Accompany Application For a Permit to Continue Operation of an Existing Solid Waste Management Facility For Industrial Non-Hazardous Solid Wastes".

1.	Volume 1-a	Engineering Report and Plan of Operation
2.	Volume 1-b	Appendices to Engineering Report
3.	Volume 2	Geotechnical Report by Thomsen Associates
4.	Volume 3	Figures and Boring Logs to Geotechnical Report
5.	Volume 4	Draft Environmental Impact Statement
6.	Volume 5	Accompanying Drawings

FIGURE 1.1

LIMITS OF FILL FOR HAZARDOUS MATERIALS



SCALE

200 0 200

1"=200'

——— Existing Limit Of Fill

— — — Proposed Final Limits

..... Limit Of Fill For Hazardous Materials

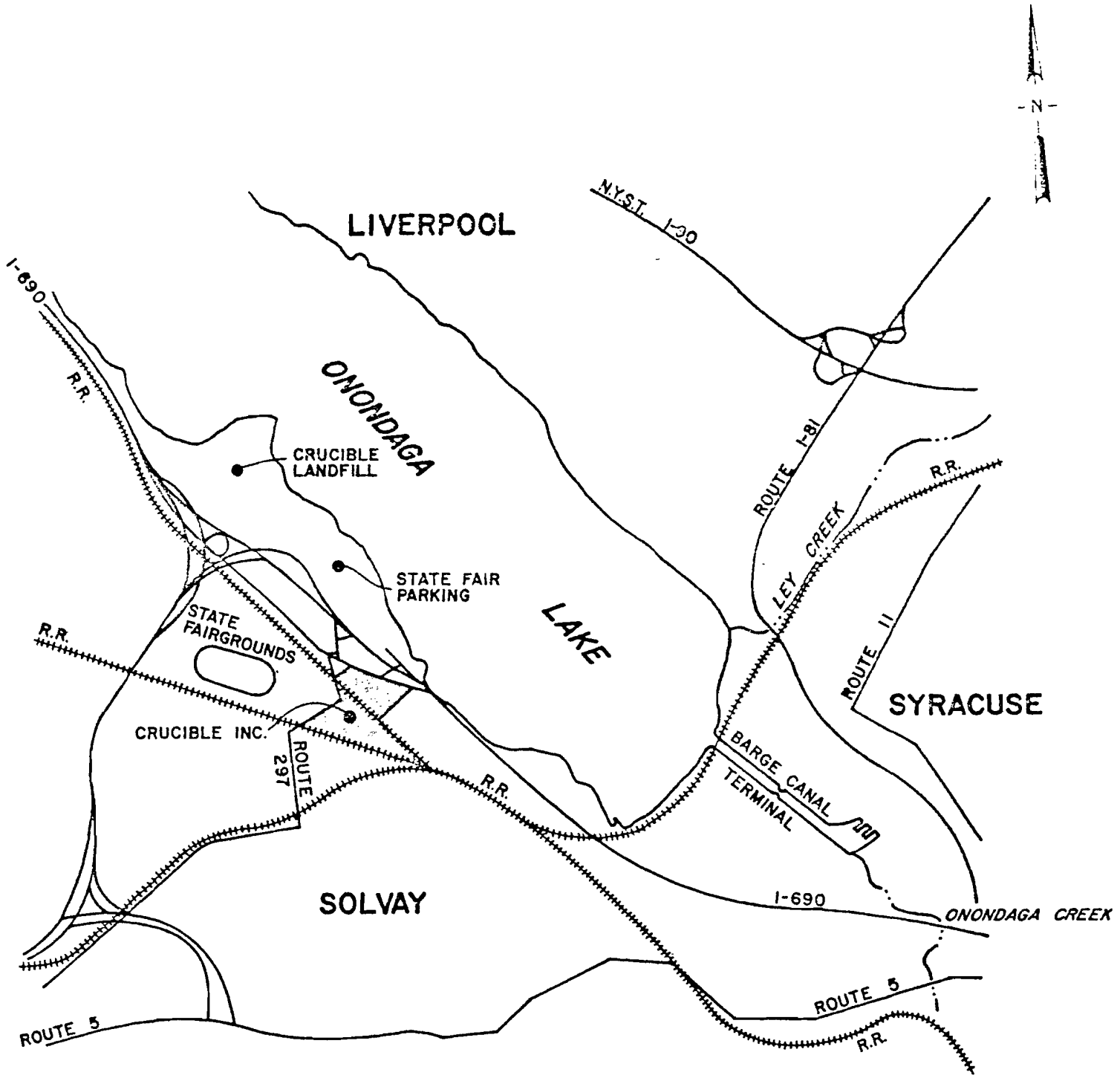
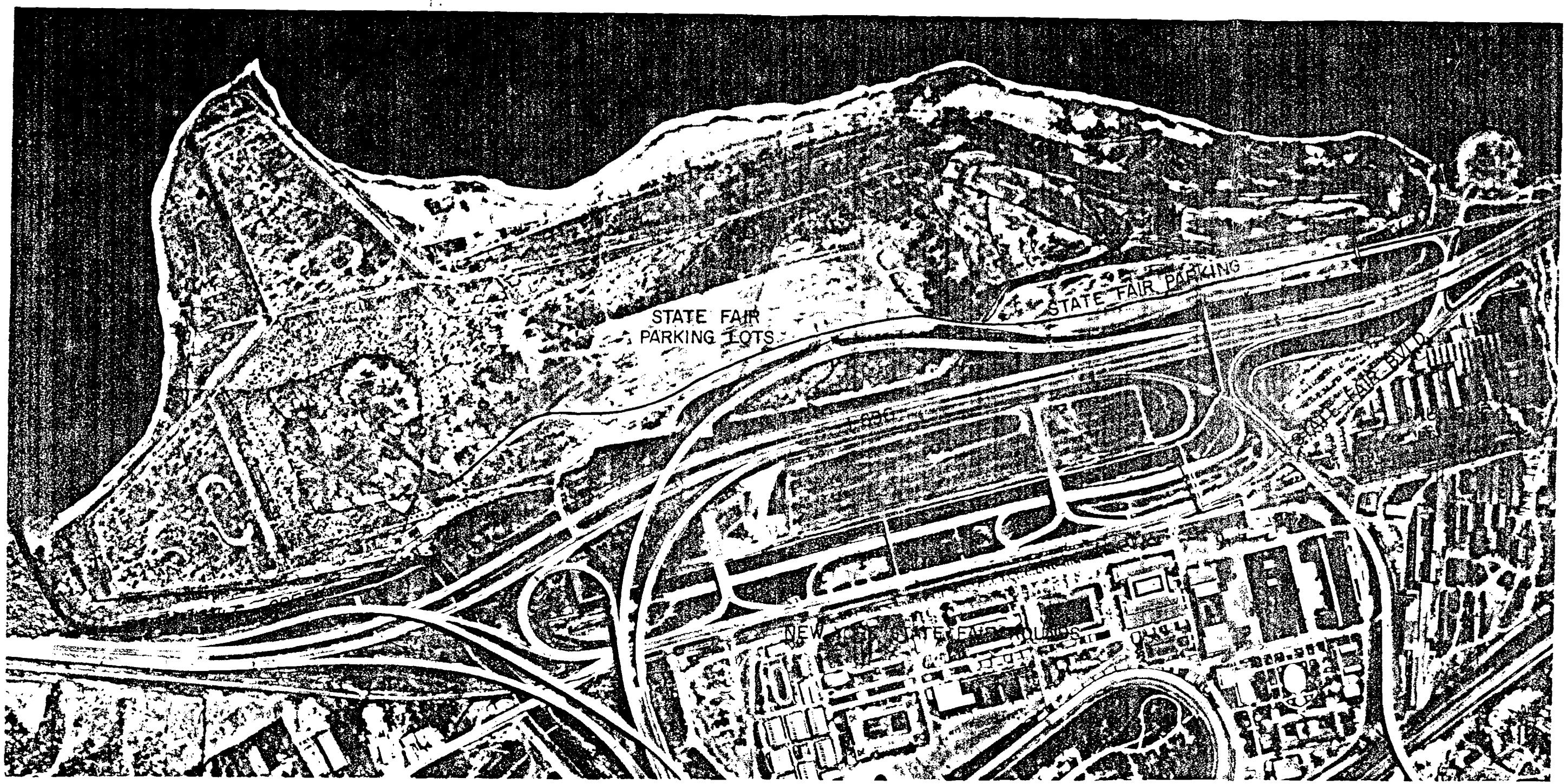


FIGURE 1-2

LOCATION PLAN

CRUCIBLE INC.



LEGEND

- GATE
- FENCE
- CURRENT FILL LIMITS
- TRANSPORTATION ROUTE FROM MILL TO SITE
- APPROXIMATE PERMIT LIMITS

N

FIGURE 1-3

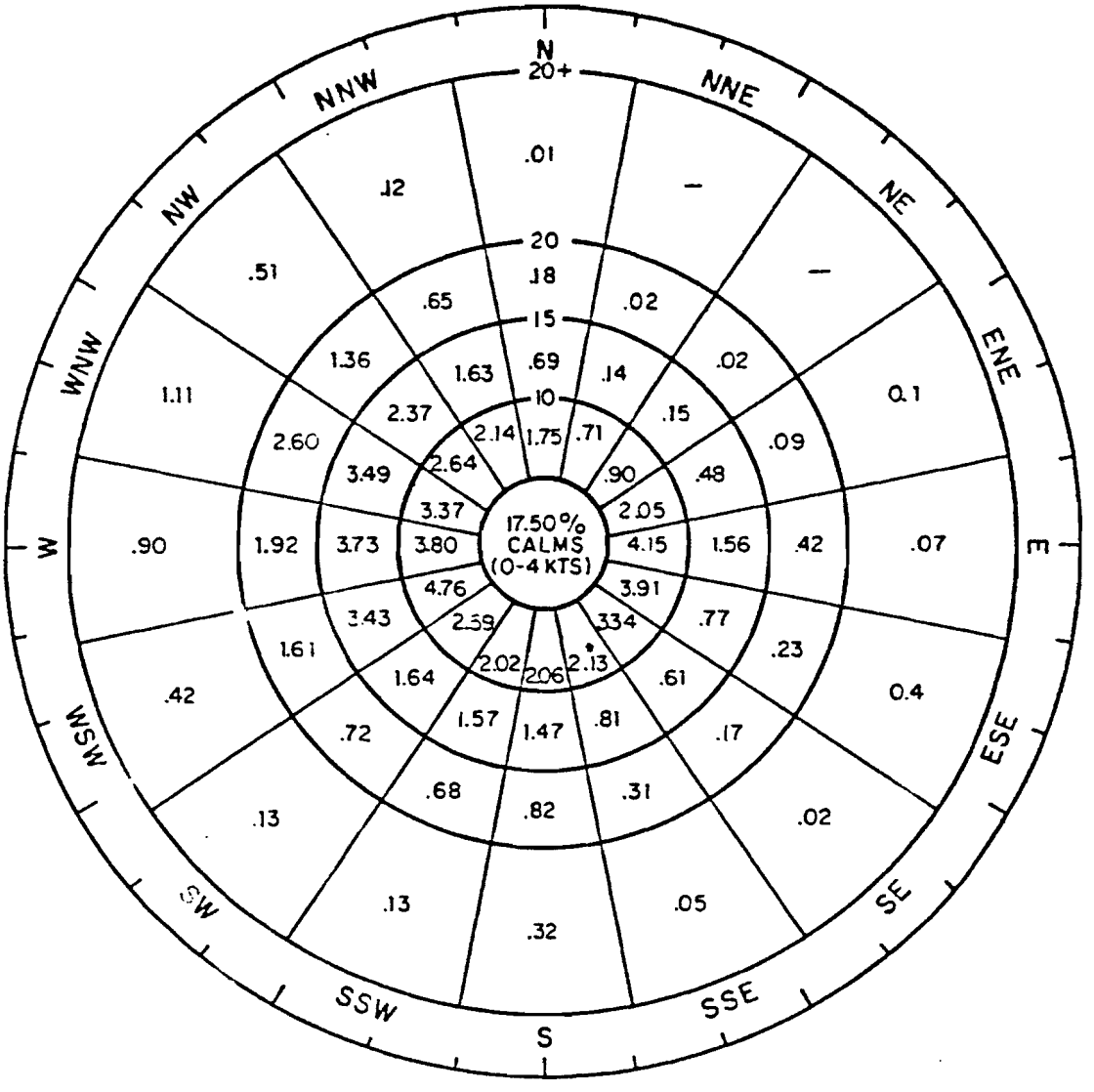
AREA VIEW +

TRANSPORTATION ROUTES

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

FIGURE 1.4

ALL WEATHER WIND ROSE



SOURCE: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL CLIMATIC CENTER / ASHEVILLE, NORTH CAROLINA

PERIOD: 1960-1964 (43,838 TOTAL OBSERVATIONS)

FIGURE 1-5

ONONDAGA LAKE

LEGEND

CM - Composite Monitor (Within Solvay Waste)
DW - Deep Well (Greater Than 100 Feet)
LY - Lysimeter Location
MS - Multi Screened Location
Cluster of Five 2" Dia. PVC Pipe
PZ - Piezometer Location
W - 2" Dia. PVC Pipe Well
WP - Well Point
SG - Seepage Gallery
---- Limit of Waste
100-Year Floodplain Boundary (approximate)
Contour Interval = 10 Feet
NOTE See Figure 5.1 in text for Access Gate and Fence.

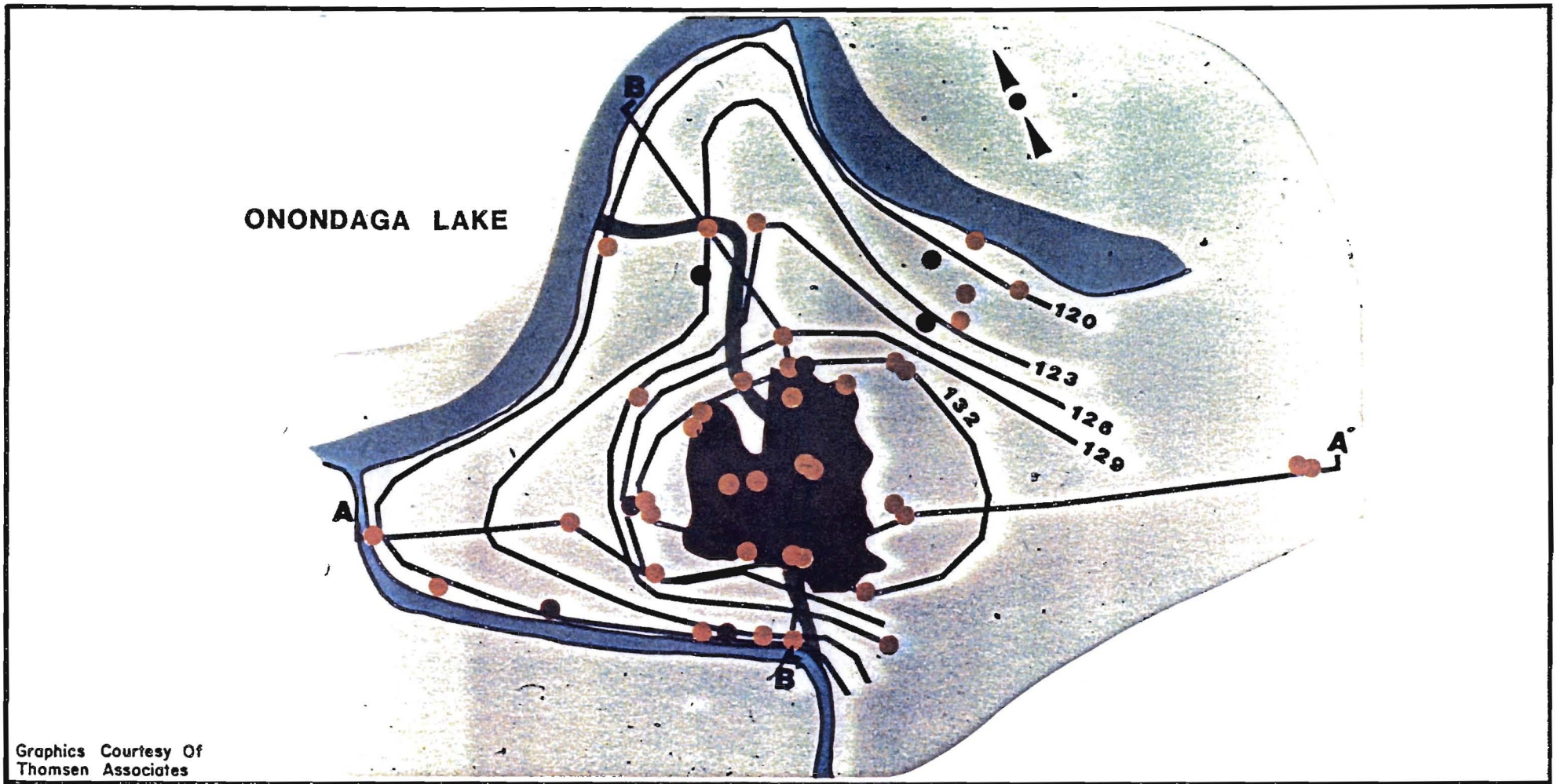
WIND ROSE

SOURCE: National Oceanic and Atmospheric Administration
National Climatic Center/Asheville, North Carolina

WP17.1
DW102
PZ9.1-9.2
W18.3
W18.1
W18.2
W18.4
SG5
PZ11.2
W11.1
SG4
PZ8.1-8.2
MS301.1-301.5
CM201
CM107
W10.1
W10.2
LY201.1-201.4
PZ201.1-201.4
PZ7.1-7.3
CRUCIBLE FILL
PZ101.1-101.3
DW101
CM108
MS106.1-106.5
PZ4.1-4.3
SG1
W1.2
W1.3
W1.1
W5.6
PZ5.1-5.3
W5.5
WP16.1
PZ6.1-6.2
MS104.1-104.5
MS105.1-105.5
CM109
PZ2.1-2.3
DW103
WP15.1
W14.1
SG2
SG3
W13.2
W13.1
PZ3.1
PZ3.2
Ninemile Creek
690
400
CONRAIL
370

SCALE IN FEET
200 0 200 400 FEET

REVISIONS	CRUCIBLE LANDFILL Groundwater Monitoring Installations
Ceteceringe & Soine Consulting Engineers	DATE: NOVEMBER, 1983 SCALE: AS SHOWN SHEET NO.



Graphics Courtesy Of
Thomsen Associates

FIGURE NO. 2-1

LEGEND

Monitor Locations

129 Water Table Contour In Meters

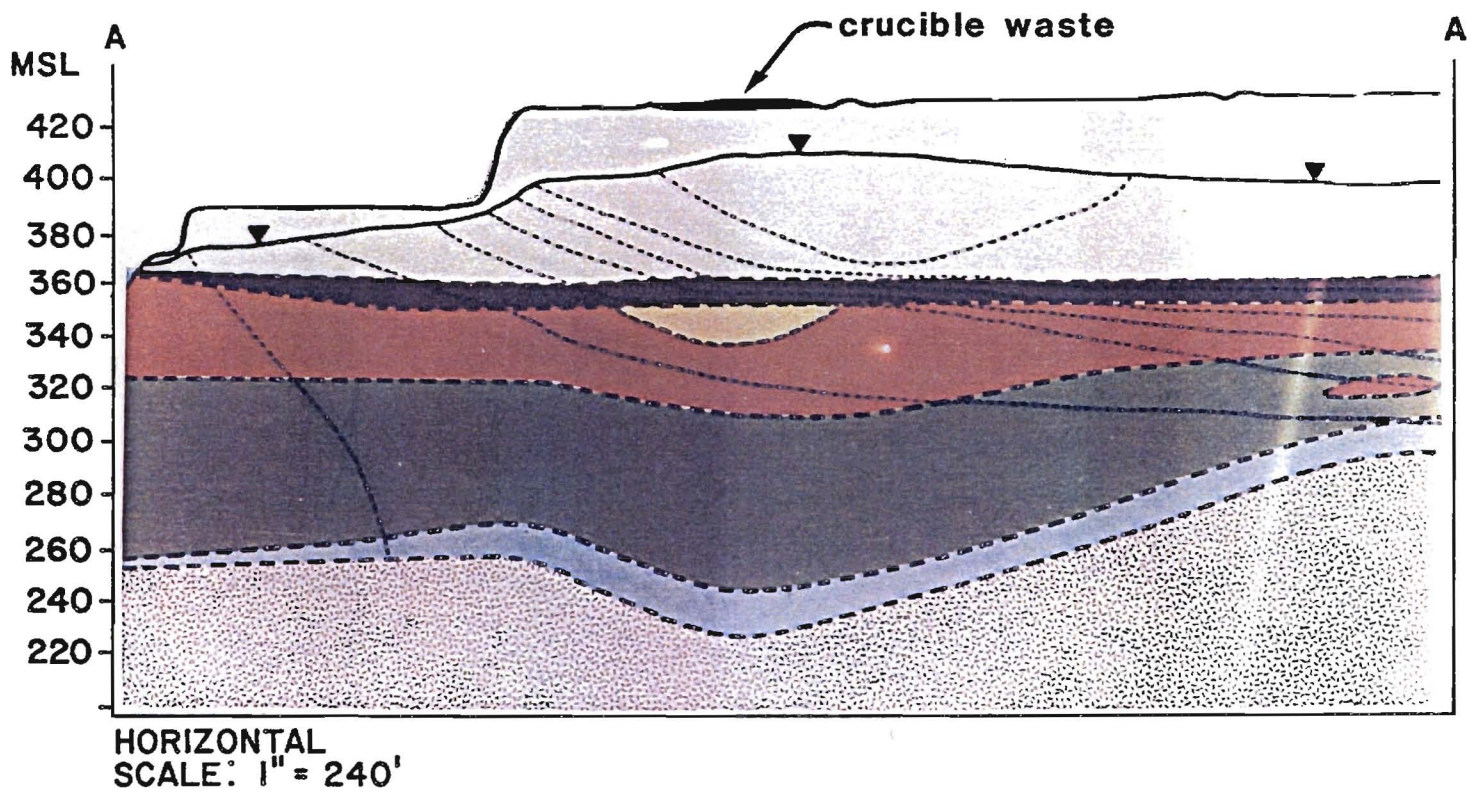
A A Hydrogeologic Profile Line

Profile Location Plan

CRUCIBLE, INC.
LANDFILL CLOSURE
PLAN REPORT

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

FIGURE NO. 2-1



Graphics Courtesy Of
Thomsen Associates

FIGURE NO. 2-2

LEGEND

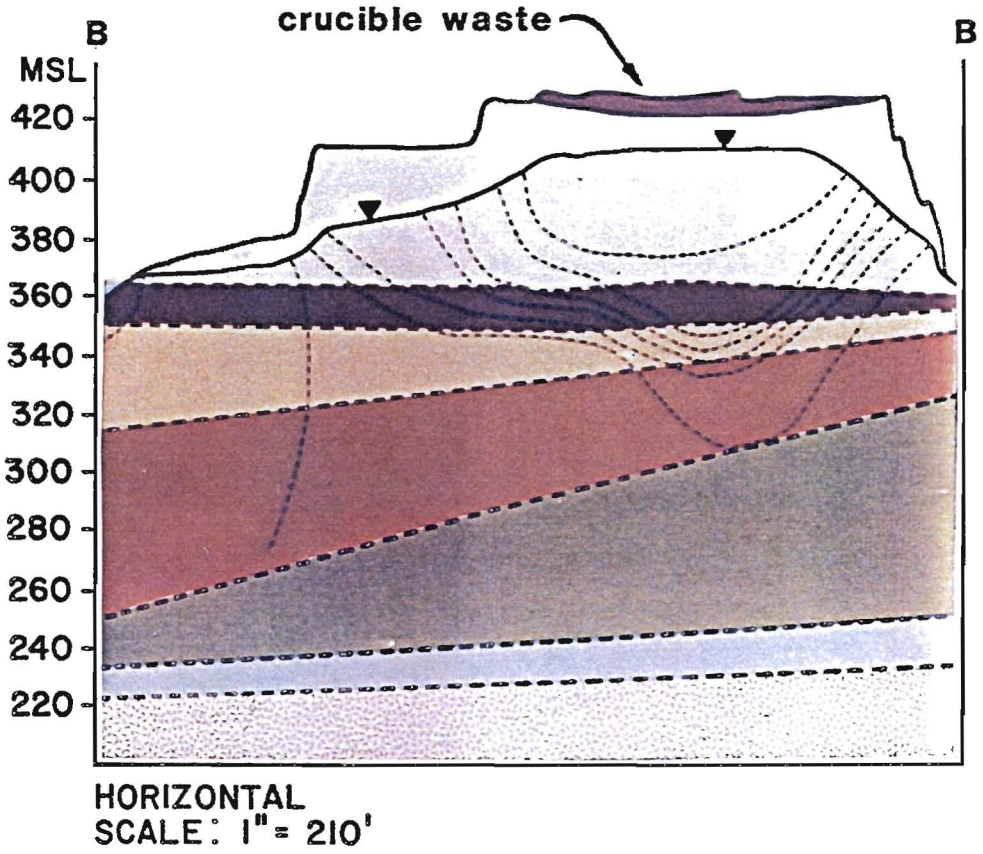
- Water Table Surface
- Equipotential Line
- Solvay Process Waste
- Swamp Deposits
- Mixed Alluvial Deposits
- Upper Glaciolacustrine Deposits
- Lower Glaciolacustrine Deposits
- Ablation Till
- Vernon Shale

Hydrogeologic Profile A-A

CRUCIBLE, INC.
LANDFILL CLOSURE
PLAN REPORT

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

FIGURE NO. 2-2



Graphics Courtesy Of
Thomsen Associates

FIGURE NO. 2-3

LEGEND

- Water Table Surface
- Equipotential Line
- Solvay Process Waste
- Swamp Deposits
- Mixed Alluvial Deposits
- Upper Glaciolacustrine Deposits
- Lower Glaciolacustrine Deposits
- Ablation Till
- Vernon Shale

Hydrogeologic Profile B-B

CRUCIBLE, INC.
LANDFILL CLOSURE
PLAN REPORT

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

FIGURE NO. 2-3

ONONDAGA LAKE

N

LEGEND

PZ6.1 - Well Designation
369.9 - Water Table Elevation (MSL)
~385~ Water Table Contour Lines
Water Table Contour Interval = 5 Feet
~400~ Topographic Contour Lines
Topographic Contour Interval = 10 Feet
(Mean Values Compiled From Quarterly Monitoring Program For Period (8/82 4/84)

WP17.1 365.9
363 W18.3
PZ11.3 370.1
CRUCIBLE FILL
407.5 PZ5.1
365.05 WP16.1
PZ6.1-6.2 386.7
PZ2.1 2.3 406.15
364.2 WP15.1
Ninemile Creek
W13.2
365.5
W13.1 371.95
380.1 PZ3.2
690
CONRAIL

365 370 375 380 400 385 390 395 400 405 400 400

SCALE IN FEET
200 0 200 400 FT.

CRUCIBLE, INC.
LANDFILL CLOSURE
PLAN REPORT

Mean Water Table Map

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

FIGURE NO. 2-4

ONONDAGA LAKE

N

LEGEND

PZ4.3 - Well Designation
16.1 - Difference in Maximum (4/84)
And Minimum (8/82) Water Table Elevations (Feet)
—16— Isopach Contour Lines
Isopach Contour Interval = 2 Feet
—400— Topographic Contour Lines
Topographic Contour Interval = 10 Feet

WP17.1 4.6
PZ11.3 3.8
5.1 MS301.1-301.5
14.1 PZ201.1-201.4
9.7 PZ7.1-7.3
CRUCIBLE FILL
16.1 PZ4.1-4.3
PZ5.1 16.0
PZ6.1-6.2 10.4
1.6 WP16.1
3.2 WP15.1
7.3 PZ3.1
3.8 W13.1
1.5 W14.1
Ninemile Creek
690
CONRAIL
400
2
4
6
8
10
12
14

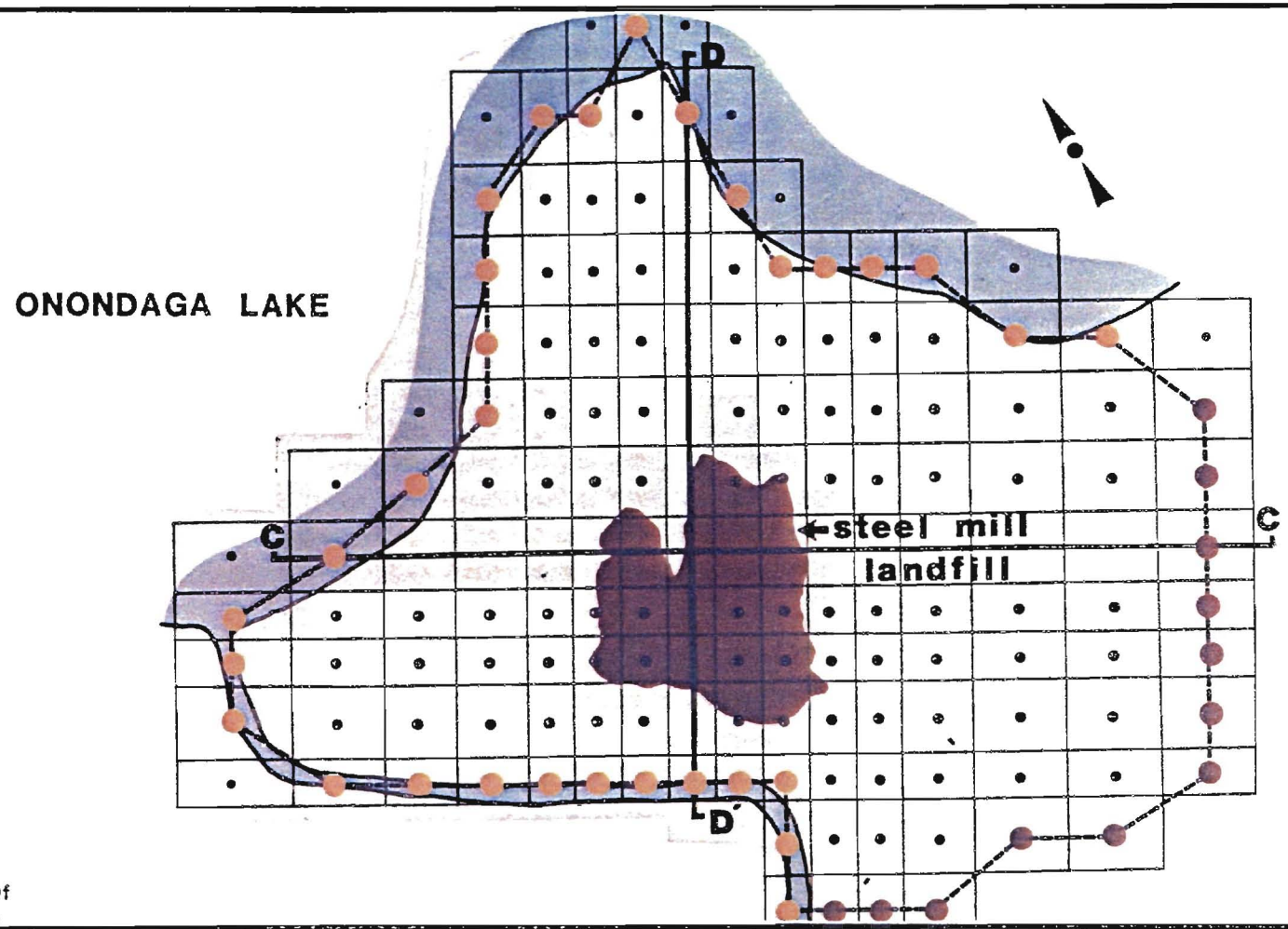
SCALE IN FEET
200 0 200 400 FT

CRUCIBLE, INC.
LANDFILL CLOSURE
PLAN REPORT

Annual Water Table Fluctuation

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

FIGURE NO. 2-5



Graphics Courtesy Of
Thomsen Associates

LEGEND

- Recharge Node
- Constant Head Node
- Model Node
- D — D: Hydrologic Profile Line

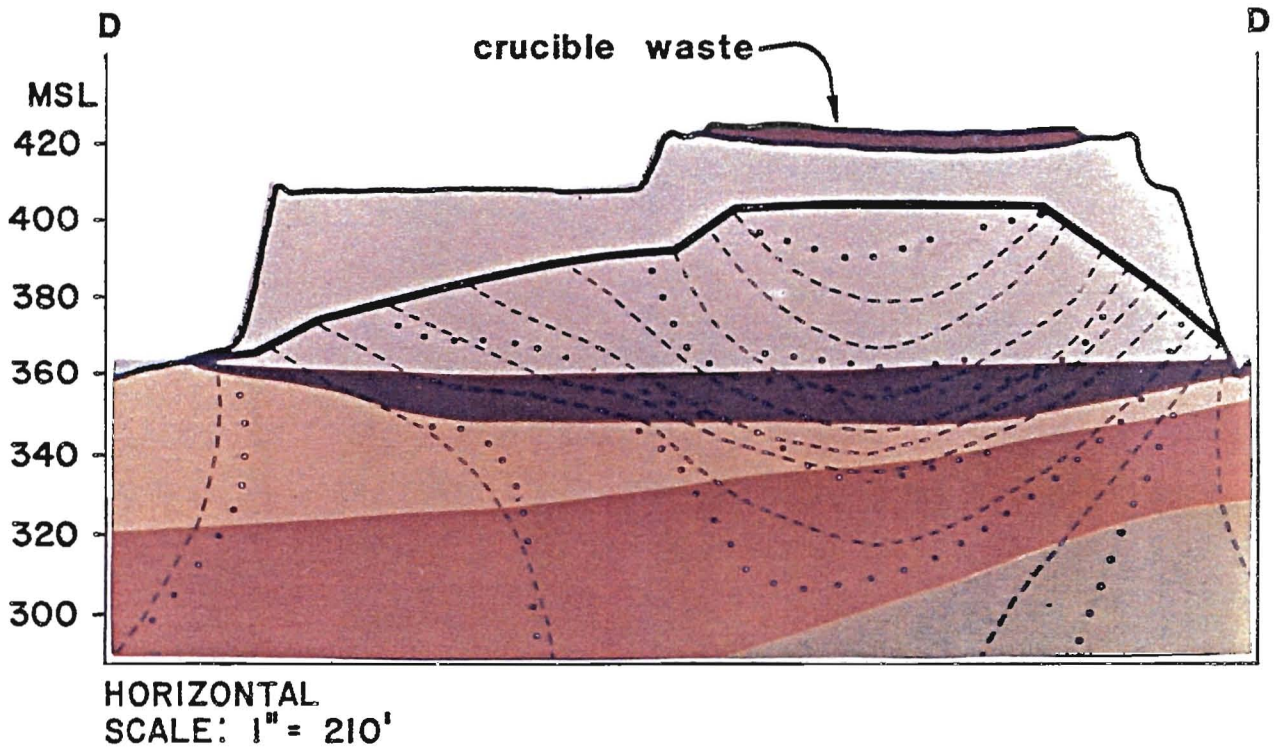
Groundwater Model Node Plan

FIGURE NO. 2-6

CRUCIBLE, INC.
LANDFILL CLOSURE
PLAN REPORT

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

FIGURE NO. 2-6



Graphics Courtesy Of
Thomsen Associates

FIGURE NO. 2-8

LEGEND

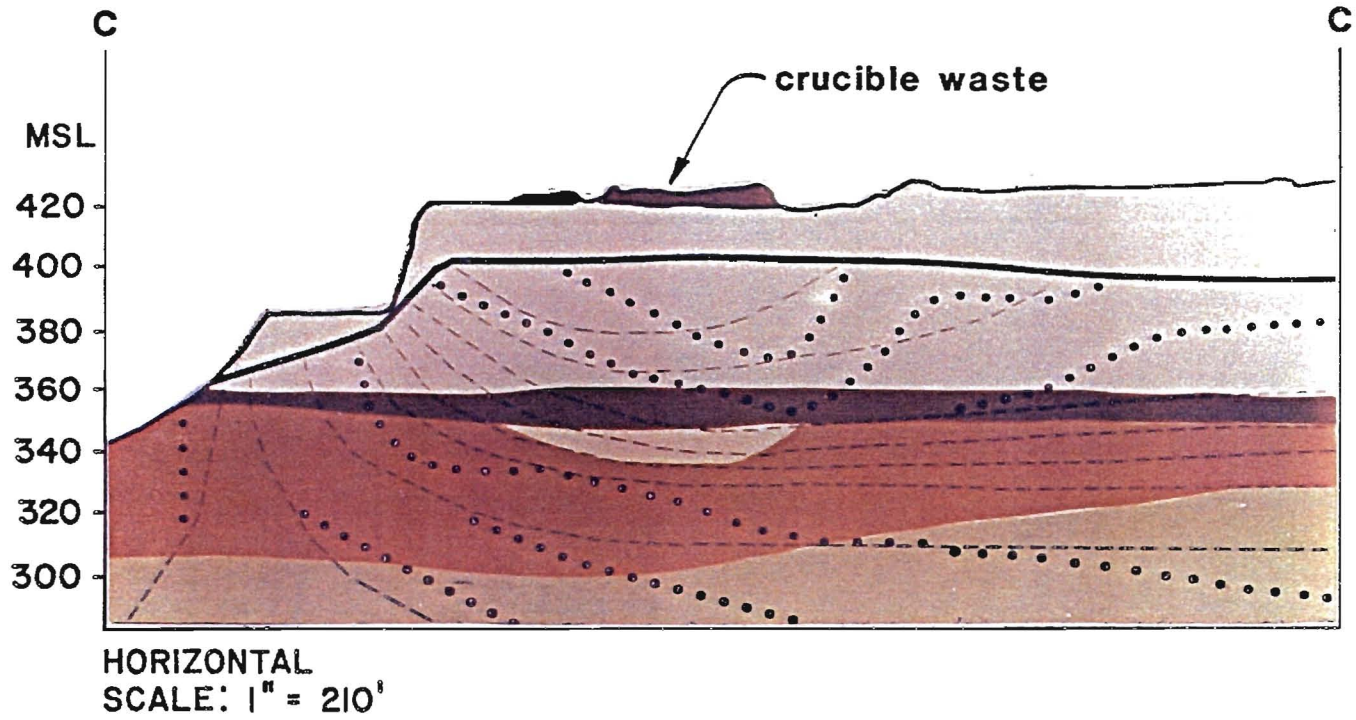
- Equipotential Line (Model)
- Equipotential Line (Field Data)
- Water Table Surface
- Solvay Process Waste
- Swamp Deposits
- Mixed Alluvial Deposits
- Upper Glaciolacustrine Deposits
- Lower Glaciolacustrine Deposits

Hydrogeologic Profile D-D

CRUCIBLE, INC.
LANDFILL CLOSURE
PLAN REPORT

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

FIGURE NO. 2-8



Graphics Courtesy Of
Thomsen Associates

FIGURE NO. 2-7

LEGEND

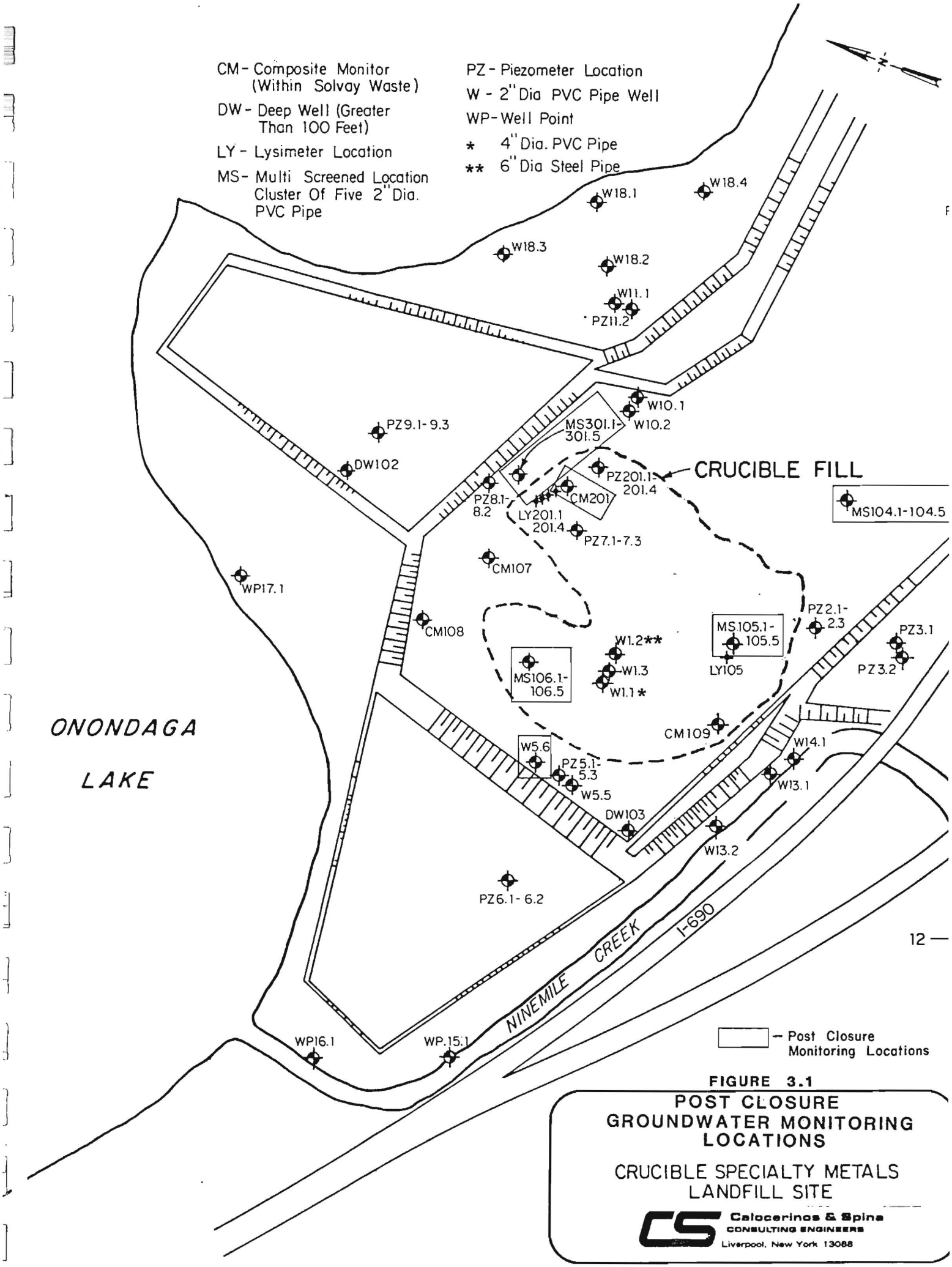
- Equipotential Line (Model)
- Equipotential Line (Field Data)
- Water Table Surface
- Solvay Process Waste
- Swamp Deposits
- Mixed Alluvial Deposits
- Upper Glaciolacustrine Deposits
- Lower Glaciolacustrine Deposits

Hydrogeologic Profile C-C

CRUCIBLE, INC.
LANDFILL CLOSURE
PLAN REPORT

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

FIGURE NO. 2-7



12 —

FIGURE 3.1

POST CLOSURE GROUNDWATER MONITORING LOCATIONS

CRUCIBLE SPECIALTY METALS LANDFILL SITE

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

Appendices

APPENDIX A

ONONDAGA COUNTY PERMIT FOR CRUCIBLE LANDFILL

COUNTY OF ONONDAGA

PERMIT

FOR USE OF COUNTY-OWNED PROPERTY

PERMISSION IS HEREBY GRANTED

TO: Crucible Materials Corporation, Specialty Metals Division of State Fair Boulevard, Box 977, Syracuse, New York 13201 and Colt Industries, Inc. (hereinafter referred to as Permittees), to use and occupy the County-owned property at the particular location described on the map hereto attached and pursuant to the conditions and regulations, whether general or special, which are hereinafter set forth; all forming a part hereof, to wit:

CONDITIONS AND REGULATIONS

1. The term of this Permit shall be an indefinite duration; however, the County of Onondaga hereby reserves the right to revoke the same at any time with or without cause upon thirty (30) days notice.

2. The property covered by this Permit shall be used only for the purpose of industrial non-hazardous solid waste disposal landfill by the permittees, in compliance with the Department of Environmental Conservation Part 360 Operating Permit, and United States Environmental Protection Agency RCRA Closure Plan, and for no other purpose whatsoever. This permit shall not be assigned or transferred without the prior written consent of the Onondaga County Executive.

3. Permittees are responsible for assuring that their occupancy shall be in compliance with any and all applicable federal, state and local laws, ordinances, codes, rules and regulations affecting the use of the property for the purpose recited above.

4. Permittees are responsible for any repairs, improvements or maintenance work of any kind on the property. It is the responsibility of the Permittee to notify the County immediately of any unsafe or hazardous condition or conditions that would affect continued occupation of property.

5. Permittees shall operate said landfill in strict compliance with the New York State Department of Environmental Conservation Part 360 Operating Permit, as amended, Permit Number 1573 issued November 3, 1982. Appendix A attached hereto and made a part hereof sets forth the New York State Department of Environmental Conservation's procedures for operation of said landfill, to which procedures must be strictly adhered. If said Permit shall be amended, then any additional requirements must be strictly adhered to. In addition, Permittee shall operate said landfill in strict compliance with the United States Environmental Protection Agency RCRA Closure Plan. If said Part 360 Operating Permit and/or EPA authorization

should be terminated, then this Permit shall concurrently expire.

6. Upon notice of termination of this Permit, the Permittees shall be responsible for closure of the subject landfill in accordance with DEC and EPA Rules and Regulations. The Permittee shall be required to obtain a Closure Bond in such amount as may be required from time to time by the New York State Department of Environmental Conservation or by the United States Environmental Protection Agency to guarantee closure of the subject landfill in accordance with DEC and EPA Rules and Regulations. Said Bond is to name the County of Onondaga as obligee. The bond amount may be reduced as portions of the landfill are closed.

7. Permittees further agree to operate said landfill in accordance with the following requirements:

   - The landfill should blend with or be visually unobtrusive to the surrounding area;

   - The drainage swales between a grouping of eight sequentially closed waste stages will direct runoff from the cap and provide effective drainage as well as minimization of erosion;

   - The side slopes should be stable and vegetated; and

   - The closure sequence will follow from Stage 1 through 8 as shown on Drawing Number 3, attached hereto and made a part hereof.

8. The Permittees covenant and agree to indemnify, defend and hold harmless the County of Onondaga, its officers, agents and employees from and against any and all loss or expense that may arise by reason of liability for damage, injury or death, or expense that may arise by means of liability for sudden or non-sudden environmental pollution occurrences, or for invasion of personal or property rights, of every name and nature, and whether casual or continuing trespass or nuisance, and any other claim for damages arising at law and equity alleged to have been caused or sustained in whole or in part by or because of any omission of duty, negligence or wrongful act on the part of the Permittees, its employees or agents, or because of any joint omission of duty, negligence or wrongful act on the part of the Permittees and the County, their officers, agents or employees in connection with this Permit. Such covenant and agreement to continue in force for a period of thirty (30) years after closure of the landfill facility.

9. The Permittees also agree to purchase Environmental Liability Insurance coverage with the County of Onondaga being named as an additional insured for sudden accidental occurrences of pollution by the harmful presence of Solid, Liquid, Gaseous Substance or Thermal Contaminants upon Land, Atmosphere or Body of Water, with (1) limits of at least $1,000,000 per each occurrence/per each claim/per pollution incident and $1,000,000 annual aggregate, exclusive of legal defense costs, subject to a $200,000 deductible and (2) limits of $5,000,000 for all claims of non-sudden

environmental impairment with a $10,000,000 aggregate subject to a $500,000 deductible. This insurance coverage shall be maintained for such period of time following final closure of the subject landfill as is required by State and Federal Rules, Regulations and Orders.

The insurance policy must be endorsed so as to provide that the issuing company(s) will notify the Certificate of Insurance Holder, who shall be the Onondaga County Attorney, located in the Department of Law, Civic Center, 421 Montgomery Street, Syracuse, New York, 13202, by certified mail thirty (30) days prior to any change diminishing coverage, limits, cancellation or non-renewal of the insurance policies.

The Permittees shall have furnished to the Onondaga County Department of Law a Certificate of Insurance which shall evidence all of the above requirements of insurance. Said Certificate must contain specific language so as to adequately advise the County of the Permittees compliance with the aforesaid requirements of insurance, including but not limited to specifically detailing the types, amount and duration of the insurance coverages and to notify the County of any change diminishing coverage, limits, cancellation or non-renewal of the insurance policies. Upon any and all renewals of the subject insurances during the duration of this contract, a new Certificate of Insurance shall immediately be sent to the Certificate of Insurance Holder, the Onondaga County Attorney.

ACCEPTANCE:

In consideration of the granting of the within Permit, the undersigned, duly authorized representative of the Permittee, hereby accepts the same subject to the restrictions and obligations herein described.

COLT INDUSTRIES, INC.

Dated March 14, 1985. By: T. H. Cassidy

Vice President

CRUCIBLE MATERIALS CORPORATION,
SPECIALTY METALS DIVISION

Dated March 12, 1985. By: [signature]

Division President

APPROVAL OF COUNTY:

COUNTY OF ONONDAGA

Dated _____, 1984. By: _____

John H. Mulroy, County Executive

cjk/wp

CRUCIBLE STEEL
PART 360
OPERATING PERMIT

1. Crucible Steel's operating procedure submitted in the C & S Report will be followed unless modified by the following conditions.

2. The following Crucible waste materials are approved for disposal: slag, constructi and refactory debris, absorbents, boiler house ashes, coolant swarves, mill scale and wastewater treatment sludges. Any other waste need specific approval of the Department.

3. One year prior to entering new areas of the landfill that had not been entered as of September 23, 1982, Crucible Steel will submit a completed engineering report and design in accordance with Part 360 requirements for a leachate liner and collection. The report should evaluate various materials including Solvay process waste and various admixtures. The economics, technical feasibility impact of the various liners should be addressed.

4. Submit engineering design for the current facility with grading in conformance with requirements of Part 360.

5. Daily and intermediate cover will not be required unless there is a problem related to blowing dust, odor, vectors or other Part 360 violations. In those cases upon notice from the Department a cover material applicable to the requirements of Part 360 will be utilized.

6. The quality of the final cover of completed areas (per Crucible's operating plan) must meet the specifications of Part 360.

7. Those areas in the existing facility that have received waste that have been defined as hazardous waste by the Department of Environmental Conservation including AOD dust and/or air pollution dust shall be capped with suitable cover material with a permeability of 1×10^{-7} cm/sec or less. The minimum depth of the cap shall be 18".

8. The quarterly groundwater monitoring plan for the site will be according to the attached.

9. All other general provisions of Part 360 applicable to solid waste landfills are to be followed unless variance is granted in these conditions.

10. In 60 days Crucible will submit a clarification of the contingency plan in the C & S Report dated June, 1982, Section 5.09. The clarification should define "Crucible derived contaminant" and "statistically documented increases".

QUARTERLY GROUNDWATER MONITORING PLAN

A. Quarterly Inspections

1. Sampling and bailing of wells (20 locations as approved by the Department of Environmental Conservation)

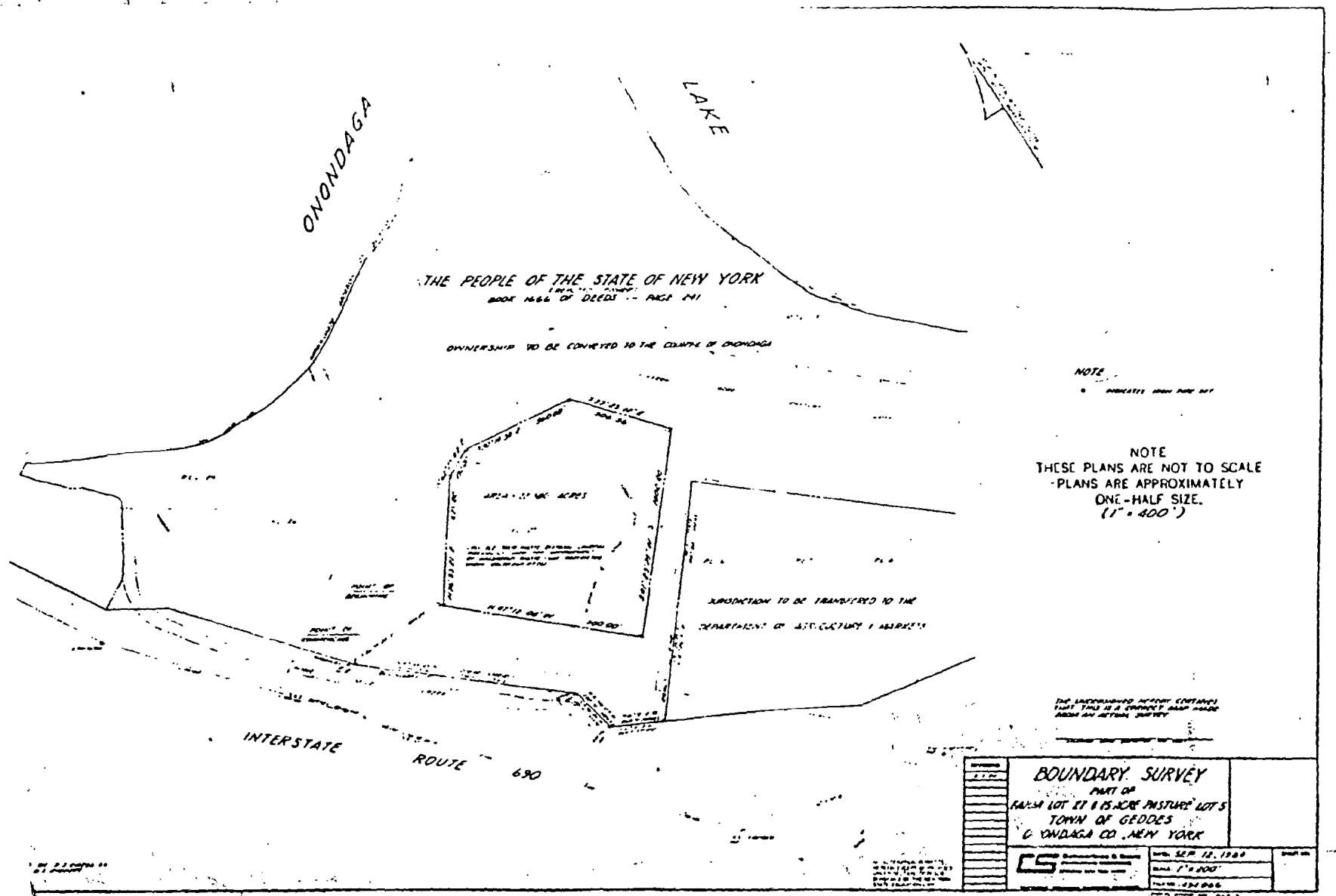
1a. Sample all spring seepage galleries and areas of established seeps as submitted in the Crucible Steel engineering report. Monitoring will be conducted in the spring, summer, fall and winter as they are evident.

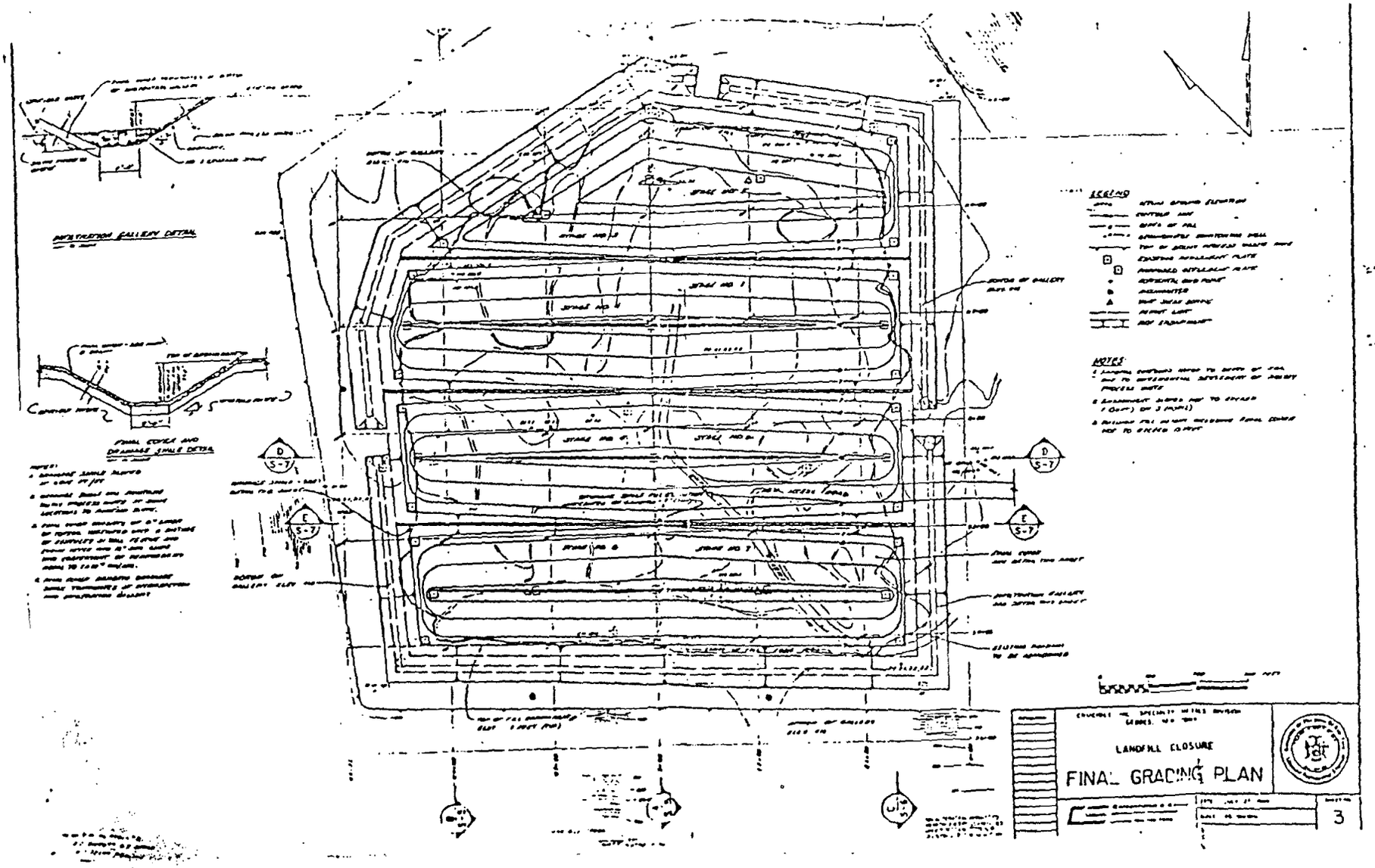
2. Inspection of site

3. Twenty locations x 4 times/year

pH	Alkalinity	Water Elevation
Conductivity	Arsenic	Calcium
Chlorides	Cadmium	Sodium
TOC	Copper	Redox Potential
Phenol	Mercury	
Cyanides	Zinc	
Iron	Manganese	
Lead	Sulfates	
Chrome (Total)	Total Dissolved Solids	
Chrome (Hex.)	Water Temperature	

4. Submission of a quarterly report to the DEC Region 7 Office.


ONONDAGA
LAKE
THE PEOPLE OF THE STATE OF NEW YORK
BOOK 1466 OF DEEDS - PAGE 141
OWNERSHIP TO BE CONVEYED TO THE COUNTY OF ONONDAGA
NOTE
NOTE
THESE PLANS ARE NOT TO SCALE
-PLANS ARE APPROXIMATELY
ONE-HALF SIZE.
(1" = 400')
JURISDICTION TO BE TRANSFERRED TO THE
INTERSTATE
ROUTE
690
BOUNDARY SURVEY
PART OF
MARSH LOT 27 & 15 ACRE PASTURE LOTS
TOWN OF GEDDES
ONONDAGA CO., NEW YORK


LANDFILL CLOSURE
FINAL GRADING PLAN
3

APPENDIX B

ANALYTICAL RESULTS

QUARTERLY MONITORING PROGRAM

CRUCIBLE LANDFILL QUARTERLY MONITORING PROGRAM

CALDERBANK & SPINA CONSULTING ENGINEERS

PAGE... 1 DATE...07-Oct-85 SOURCE FILE.../usr/indy/crucible/QRTR.dat
FORMAT FILE.../usr/indy/crucible/QRTR.for

CODE	WELL	DATE	TOT.ALK.	CHLOR.	CONDUCT	CYANIDE	TOC	pH	PHEN.	TDS	SULFATE	TEMP	ARSENIC	CALCIUM	CADMIUM	CHROM.(T)	CHROM.(HEX)	COPPER	IRON	LEAD	MANG.	MERCURY	SODIUM	ZINC	REDOX
110	WELL 1.1	82/03/27	na	2280.	12500.	0.16	10.0	12.7	0.286	na	na	na	na	na	na	(0.01	(0.01	na	(0.01	(0.02	na	na	na	na	na
1.0	WELL 1.1	82/12/22	1570	14685.	32000.	0.030	30.0	11.7	0.374	34544.	28.6	10.0	(0.002	7600.	(0.01	(0.01	(0.04	(0.01	0.04	(0.02	0.03	(0.002	2400.	(0.01	-81
110	WELL 1.1	83/03/24	1675	20997	47500	(0.02	51.0	12.1	0.57	38180	22.7	8.0	(0.002	7800	(0.01	(0.01	(0.01	(0.01	0.26	(0.02	(0.01	(0.002	3700	(0.01	na
1.0	WELL 1.1	83/06/21	1620	13220	36000	0.025	37.5	11.2	0.39	25377	21.0	15.5	(0.002	6890	(0.01	(0.01	(0.04	(0.01	0.16	(0.02	(0.01	(0.002	3370	0.02	-204
1.0	WELL 1.1	83/09/22	1655	22950	47000	0.025	54.0	11.6	0.61	49130	21.9	13.0	(0.002	8620	(0.01	(0.01	(0.04	(0.01	0.70	(0.02	0.01	(0.002	4600	(0.01	-232
1.0	WELL 1.1	83/12/15	1680	19180	41000	(0.020	40.0	11.9	0.57	53800	21	10.5	(0.02	8400	(0.01	(0.0	(0.020	(0.01	0.02	(0.02	(0.01	(0.02	4780	0.07	-308
110	WELL 1.1	84/03/20	62.0	na	17000	(0.01	25.0	11.8	0.151	10595	14.2	10.5	(0.002	1300	(0.01	(0.01	(0.02	0.03	0.09	(0.02	0.01	(0.02	890	(0.01	-203
110	WELL 1.1	84/06/20	1900	14100	40000	0.040	36.0	11.5	0.40	40570	23.0	11.0	(0.002	5600	(0.01	(0.03	(0.04	(0.01	0.60	(0.02	0.02	(0.002	2500	0.12	-10
110	WELL 1.1	84/09/26	1650	14500	40000	0.04	36.0	12.1	0.432	30992	22.0	12.0	(0.002	7000	(0.01	(0.05	(0.04	(0.03	0.48	(0.02	0.16	0.004	3000	(0.01	-229
110	WELL 1.1	84/12/11	1740	15000	35000	0.32	35	12.1	0.396	28592	24	12	(0.002	6500	(0.01	(0.05	(0.04	(0.03	0.28	(0.02	0.07	(0.002	2900	0.13	-205
110	WELL 1.1	85/02/20	1750	15800	37000	0.22	31	12.1	0.466	29044	19	9	(0.02	6200	(0.01	(0.05	(0.04	(0.03	0.35	(0.02	0.13	0.003	2300	(0.01	-195
110	WELL 1.1	85/05/2.	1800	24200	48000	(0.04	48	12.1	0.483	37900	17	11	(0.002	6200	(0.01	(0.05	(0.04	(0.03	0.38	(0.02	0.13	(0.002	3000	0.04	-273
110	WELL 1.1	85/08/13	1760	19400	52000	(0.02	44	11.9	0.43	38100	23	11	(0.002	6000	(0.01	(0.05	(0.04	(0.03	0.28	(0.02	0.11	(0.002	2720	0.05	-73
115																									
3+0	WELL13.2	82/08/26	na	25345	56000	0.032	71.0	11.9	0.90	na	na	na	na	na	na	(0.01	(0.01	na	0.09	(0.02	na	na	na	na	na
3+0	WELL13.2	82/12/21	1380	22525	49000	(0.020	42.0	11.4	0.67	44492	22.6	8.5	(0.002	12200	(0.01	(0.01	(0.04	(0.01	0.03	(0.02	0.05	(0.002	4200	0.08	-33
3+0	WELL13.2	83/03/23	1430	21952	49000	(0.020	5...	12.0	0.72	59260	16.6	6.0	(0.002	8500	(0.01	(0.01	(0.01	(0.01	0.08	(0.02	(0.01	(0.002	4300	0.05	na
3+0	WELL13.2	83/06/20	1364	17710	48200	(0.02	61.0	11.6	0.52	36256	36.0	13.5	(0.02	14720	(0.01	(0.01	(0.04	(0.01	0.56	(0.02	(0.01	(0.002	5060	0.10	-137
3+0	WELL13.2	83/09/22	1280	23453	52000	0.065	60.5	11.5	0.67	50090	61.8	14.0	(0.002	8900	(0.01	(0.01	(0.04	(0.01	0.70	(0.02	(0.01	(0.002	5000	0.22	-118
3+0	WELL13.2	83/12/15	1200	16700	35000	0.060	23.5	11.6	0.448	33402	22	7.0	(0.02	3650	(0.01	(0.01	(0.020	(0.01	0.19	(0.02	(0.01	(0.02	1880	0.12	-120
3+0	WELL13.2	84/03/20	1311	na	42000	0.230	35.0	11.6	0.53	32082	15.5	5.5	(0.002	5600	(0.01	(0.01	(0.02	0.01	0.13	(0.02	0.05	(0.02	3520	0.05	-036
3+0	WELL13.2	84/06/19	1520	22000	50000	0.0.0	43.0	11.9	0.52	55620	19.0	15.0	(0.002	7700	(0.01	(0.03	(0.01	(0.01	0.66	(0.02	0.03	(0.002	3320	0.17	-24
3+0	WELL13.2	84/09/25	1430	19220	47000	(0.04	51.0	11.9	0.53	64256	24.0	15.0	(0.002	8800	(0.01	(0.05	(0.04	(0.1	0.47	(0.02	0.19	(0.002	4220	0.02	-80
3+0	WELL13.2	84/12/11	1400	18200	40000	(0.04	54	11.9	0.54	74816	14	7	(0.002	7500	(0.01	(0.05	(0.04	(0.03	1.2	(0.02	0.09	(0.002	3200	0.28	-3
3+0	WELL13.2	85/02/20	1410	19800	45000	(0.04	19	11.8	0.71	35032	16	9	(0.02	11000	(0.01	(0.05	(0.04	(0.03	0.49	(0.02	0.15	(0.002	3320	0.04	+40
3+0	WELL13.2	85/05/22	1450	25500	50000	(0.04	71	11.9	0.55	45320	14	10	(0.002	8000	(0.01	(0.05	(0.04	0.05	1.1	(0.02	0.14	(0.002	3320	0.11	-50
3+0	WELL13.2	85/08/14	1450	28300	52000	(0.04	59	11.8	0.69	42400	20	11	(0.002	6500	(0.01	(0.05	(0.04	(0.03	0.40	(0.02	0.17	(0.002	4200	0.03	-123
3+5																									
330	WELL18.2	82/08/27	na	45240	86000	0.357	177	11.5	3.17	na	na	na	na	na	na	(0.01	(0.01	na	0.05	(0.02	na	na	na	na	na
330	WELL18.2	82/12/21	610	45400	80000	0.31	200	10.7	2.22	75856	150	8.0	(0.002	21000	(0.01	(0.01	(0.04	(0.01	0.06	(0.02	0.04	(0.002	7200	0.10	-35
330	WELL18.2	83/03/24	660	45400	78000	0.155	203	11.5	2.36	97680	182	7.0	(0.002	14300	(0.01	(0.01	(0.01	(0.01	0.04	(0.02	(0.01	(0.002	8620	(0.01	na
330	WELL18.2	83/06/21	720	45160	82500	0.06	190	11.5	2.29	99964	116.0	12.0	(0.002	17600	(0.01	(0.01	(0.04	(0.01	0.17	(0.02	(0.01	(0.002	6290	(0.01	-385
330	WELL18.2	83/09/22	715	44410	80000	0.325	217	10.9	2.40	99964	278	13.0	(0.002	16000	(0.01	(0.01	(0.04	(0.01	0.87	(0.02	0.03	(0.002	10000	0.20	-265
330	WELL18.2	83/12/15	760	44300	80000	0.33	184	11.5	2.33	131000	158	10.0	0.02	13000	(0.01	(0.01	(0.040	(0.01	0.24	(0.02	0.03	(0.02	7620	0.08	-378
330	WELL18.2	84/03/21	744	na	75000	0.24	190	10.9	2.85	118776	146	6.0	(0.002	14000	(0.01	(0.01	(0.02	0.01	0.46	(0.02	0.07	(0.02	8700	(0.01	-350
330	WELL18.2	84/06/20	750	44000	90000	0.13	200	10.9	2.48	91680	160	13.0	0.003	15400	(0.01	(0.03	(0.04	(0.01	1.7	(0.02	0.07	(0.002	8100	0.19	-401
330	WELL18.2	84/09/26	550	42570	50000	0.10	340	11.2	2.34	78852	160	11.0	(0.002	16000	(0.01	(0.05	(0.04	(0.03	1.2	(0.02	0.37	(0.002	8100	(0.01	+52
330	WELL18.2	84/12/12	550	41000	62000	0.31	220	11.2	2.26	58360	150	10	(0.002	15000	(0.01	(0.05	(0.04	(0.03	0.82	(0.02	0.20	(0.002	8500	0.03	-293
330	WELL18.2	85/02/20	620	33520	77000	0.17	156	11.1	2.22	694.2	146	6	(0.02	14100	(0.01	(0.05	(0.04	(0.03	0.84	(0.02	0.25	(0.002	6720	(0.01	-200
330	WELL18.2	85/05/23	790	75800	80000	0.27	190	11.3	2.37	82800	1+6	10	0.002	15000	(0.01	(0.05	(0.04	(0.03	0.82	(0.02	0.23	(0.002	15000	0.05	-405
330	WELL18.2	85/08/14	710	64800	98000	0.17	200	11.1	2.65	66800	150	13	(0.002	16000	(0.01	(0.05	(0.04	(0.03	0.60	(0.02	0.27	(0.002	8500	0.02	-361
440																									
4+0	DW 101	82/08/27	na	16320.	45000.	(0.004	59.0	11.8	0.76	na	na	na	na	na	na	(0.01	(0.01	na	0.04	(0.02	na	na	na	na	na
4+0	DW 101	82/12/27	74.0	62220	120000	(0.020	177	6.1	3.87	132472	(2.0	10.5	(0.002	2490	(0.01	(0.01	(0.04	(0.01	86.0	(0.02	4.40	(0.002	1400	0.16	+34
4+0	DW 101	83/03/24	75.0	59940	30000	(0.020	142	8.8	3.22	119740	56.0	7.0	(0.002	17100	(0.01	(0.01	(0.01	(0.01	72.0	(0.02	3.10	(0.002	600	0.07	na
4+0	DW 101	83/06/20	62.0	54350	100000	(0.02	144	6.3	2.86	86320	59.0	14.5	(0.002	276.	(0.01	(0.01	(0.04	(0.01	6.79	(0.02	3.51	(0.002	10400	0.08	-085
4+0	DW 101	83/09/22	58	61377	100000	0.065	125	6.1	2.87	115210	4.1	12.0	(0.002	19220	0.01	(0.01	(0.04	(0.01	5.90	(0.02	0.85	(0.002	13220	0.13	-34
4+0	DW 101	83/12/15	70	59960	100000	0.030	119	5.7	3.12	11600	INTRF	10.5	(0.02	15900	(0.01	(0.01	(0.040	(0.01	6.14	(0.02	5.36	(0.02	11700	0.10	-059
4+0	DW 101	84/03/20	110	na	56000	(0.02	125	6.2	3.49	106344	3.4	12.5	(0.002	19000	(0.01	0.10	(0.02	0.23	10	(0.02	9.8	(0.02	12000	(0.01	-004
4+0	DW 101	84/06/19	98	62000	65000	0.035	136	6.0	2.98	117850	6.0	13.0	(0.002	20000	(0.01	(0.03	(0.04	(0.01	86	(0.02	9.0	(0.002	11600	0.23	-122
4+0	DW 101	84/09/26	74	57400	110000	(0.04	220	5.9	2.76	124444	(5	12.0	(0.002	22220	(0.01	(0.05	(0.04	(0.03	120	(0.02	6.9	(0.002	12220	(0.01	+91

CRUCIBLE ... QUARTERLY ... PROGRAM

CALOGEROPOULOS & SPINA CONSULTING ENGINEERS

PAGE... 2 DATE...07-Oct-85 SOURCE FILE.../usr/indy/crucible/QRTR.dat
FORMAT FILE.../usr/indy/crucible/QRTR.for

CODE	WELL	DATE	TOT.ALK.	CHLOR.	CONDUCT	CYANIDE	TOC	pH	PHEN.	TDS	SULFATE	TEMP	ARSENIC	CALCIUM	CADMIUM	CHROM.(T)	CHROM.(HEX)	COPPER	IRON	LEAD	MANG.	MERCURY	SODIUM	ZINC	REDOX
4E0	DW 101	84/12/12	64	60000	80000	0.04	100	5.8	2.93	105348	6.5	10	(0.002	20000	(0.01	(0.05	(0.04	(0.03	120	(0.02	7.5	(0.002	13000	0.89	+26
4E0	DW 101	85/02/20	60	57400	100000	0.22	352	5.8	3.03	102416	6.6	10	(0.02	18900	(0.01	(0.05	(0.04	(0.03	122	(0.02	8.5	(0.002	18000	(0.01	+307
4E0	DW 101	85/05/21	58	67100	100000	(0.04	158	5.6	3.05	102000	(2.0	11	(0.002	22500	(0.01	(0.05	(0.04	(0.03	127	(0.02	8.7	(0.002	13000	0.04	+168
4E0	DW 101	85/08/13	58	70400	110000	(0.04	140	6.3	3.57	105000	(2	11	(0.002	21500	(0.01	(0.05	(0.04	(0.03	83	(0.02	8.5	(0.002	11800	0.01	-94
4E5																									
4E0	DW 102	82/08/30	na	65870.	120000	(0.004	45.0	8.9	.041	na	na	na	na	na	na	(0.01	(0.01	na	0.02	(0.02	na	na	na	na	na
4E0	DW 102	82/12/27	82.0	100000	152000	(0.020	24.0	6.7	(0.01	350700	3550	11.0	(0.002	28000	(0.01	(0.01	(0.04	(0.01	6.5	(0.02	1.01	(0.002	3200	0.09	+55
4E0	DW 102	83/03/22	98.0	109850	130000	(0.004	5.0	7.0	0.058	230970	3329	6.0	(0.002	2500	(0.01	(0.01	(0.01	(0.01	0.10	(0.02	(0.01	(0.002	32000	(0.01	na
4E0	DW 102	83/06/20	78.0	100550	150000	(0.008	3.3	7.0	0.13	179500	2885	15.5	(0.002	2300	(0.01	(0.01	(0.04	(0.01	3.58	(0.02	0.19	(0.002	50200	0.03	-000
4E0	DW 102	83/09/22	88	105350	140000	(0.020	10.0	7.1	0.071	175960	3563	12.5	(0.002	2200	(0.01	(0.01	(0.04	(0.01	9.50	0.05	0.20	(0.002	72000	0.20	-74
4E0	DW 102	83/12/16	84	103000	140000	(0.020	9.0	6.9	(0.010	187000	3100	10.5	(0.02	2500	(0.01	0.02	0.017	(0.01	15.0	0.03	1.50	(0.02	63100	0.07	-000
4E0	DW 102	84/03/22	86.0	na	150000	0.009	9.5	7.6	0.011	184000	3191	10.5	(0.002	1600	(0.01	0.0	(0.04	0.02	3.[illegible]	(0.02	1.2	(0.02	71000	(0.01	-017
4E0	DW 102	84/06/20	82	104000	150000	(0.004	9.0	6.9	0.073	175070	3600	11.0	(0.002	1900	(0.01	(0.03	0.021	(0.01	2.9	(0.02	1.50	(0.002	57000	0.16	-119
4E0	DW 102	84/09/25	72	99950	150000	(0.04	14.0	7.2	0.29	192084	3520	10.0	(0.002	2520	(0.01	(0.05	(0.04	(0.03	2.8	0.02	1.5	(0.002	78000	(0.01	-75
4E0	DW 102	84/12/11	78	100000	160000	(0.04	12	7.0	(0.005	92456	3500	11	0.003	2200	(0.01	(0.05	(0.04	(0.03	14	(0.02	1.2	0.002	63000	0.04	+132
4E0	DW 102	85/02/20	92	109000	160000	(0.04	(3	6.8	0.177	189484	2740	10	(0.02	2560	(0.01	(0.05	(0.04	(0.03	15	0.02	2.2	(0.002	55000	0.05	+417
4E0	DW 102	85/05/23	76	84000	160000	(0.04	11	7.0	0.019	176000	[illegible]70	8	(0.002	2400	0.01	(0.05	(0.04	(0.03	9.8	(0.02	2.3	(0.002	68000	0.24	+6
4E0	DW 102	85/08/14	90	126000	160000	(0.04	(3	7.0	0.002	170000	3700	11	(0.002	2700	(0.01	(0.05	(0.04	(0.03	9.2	(0.02	2.4	(0.002	60000	0.02	-107
4E5																									
4E0	DW 103	82/08/30	na	15345.	37000.	(0.004	30.0	11.9	0.16	na	na	na	na	na	na	(0.01	(0.01	na	0.02	(0.02	na	na	na	na	na
4E0	DW 103	82/12/27	60.0	62000	100000	(0.020	27.0	6.2	(0.01	139068	105	10.5	(0.002	18500	(0.01	0.01	(0.04	(0.01	1.0	(0.02	8.7	(0.002	8500	0.12	+7
4E0	DW 103	83/03/22	66.0	59940	100000	(0.020	15.0	6.4	0.016	170404	139	3.0	(0.002	16300	(0.01	(0.01	(0.01	(0.01	48.0	(0.02	4.01	(0.002	12900	0.03	na
4E0	DW 103	83/06/20	20.0	56890	100000	(0.02	5.3	6.1	0.029	144592	.32.0	14.5	(0.002	21700	(0.01	(0.01	(0.04	(0.01	6.72	(0.02	[illegible].5	(0.002	10700	0.10	-242
4E0	DW 103	83/09/22	44	53410	100000	0.035	13.5	6.3	(0.010	123100	534.0	13.0	(0.002	17000	0.01	(0.01	(0.04	(0.01	53.0	(0.02	[illegible].5	(0.002	19000	0.08	-45
4E0	DW 103	83/12/16	40	59400	120000	0.060	11.5	6.1	0.043	152000	320	10.5	(0.02	22000	(0.01	(0.01	(0.040	(0.01	6.27	0.02	0.50	(0.02	18400	0.02	-026
4E0	DW 103	84/03/21	44.0	na	95000	0.010	8.0	6.5	0.011	115600	256	9.5	(0.002	20000	(0.01	(0.01	(0.04	0.02	11	(0.02	16	(0.02	17200	(0.01	000
4E0	DW 103	84/06/19	60	64000	110000	0.050	8.0	6.3	0.013	114000	200	11.0	(0.002	19000	(0.01	(0.05	(0.04	(0.01	85	(0.02	15	(0.002	13000	0.01	-19
4E0	DW 103	84/09/25	28	61350	110000	(0.04	10.0	6.5	0.041	129312	180	13.0	(0.002	19000	(0.01	(0.05	(0.04	(0.03	81	(0.02	11	(0.002	15000	(0.01	-2
4E0	DW 103	84/12/11	10	59000	110000	0.41	9.2	6.0	0.014	104248	140	11	0.004	21000	(0.01	(0.05	(0.04	(0.03	110	(0.02	11	(0.002	13000	0.03	+28
4E0	DW 103	85/02/20	44	54500	100000	(0.04	15	6.1	(0.005	96056	170	10	(0.02	24700	(0.01	(0.05	(0.04	(0.03	86	(0.02	15	(0.02	15200	(0.01	-79
4E0	DW 103	85/05/23	18	72000	90000	0.05	8.0	5.4	(0.010	138000	127	8	0.005	19000	(0.01	(0.05	0.04	(0.03	116	(0.02	17	(0.002	21000	0.06	-9
4E0	DW 103	85/08/13	20	68000	120000	(0.04	12	6.2	0.021	87000	236	11	0.003	20500	(0.01	(0.05	(0.04	(0.03	107	(0.02	17	(0.002	14000	0.05	-73
4E5																									
4E0	MS 104.1	82/08/27	na	61300.	100000	0.44	292.	9.9	6.00	na	na	na	na	na	na	(0.01	(0.01	na	0.03	(0.02	na	na	na	na	na
4E0	MS 104.1	82/12/22	290	60160	100000	0.365	420	9.1	5.72	150164	48.2	10.5	(0.002	19200	(0.01	(0.01	2.04	(0.01	0.22	(0.02	0.03	(0.002	14200	0.03	+74
4E0	MS 104.1	83/03/24	322	66980	85000	0.155	420	9.1	5.24	114580	26.7	9.0	(0.002	5520	(0.01	(0.01	(0.01	(0.01	0.05	(0.02	0.03	(0.002	3000	(0.01	na
4E0	MS 104.1	83/06/21	360	66370	100000	0.27	360	8.8	5.52	137120	33.3	4.0	(0.002	27200	(0.01	(0.01	(0.04	(0.01	0.10	(0.02	(0.01	(0.002	9200	0.02	+209
4E0	MS 104.1	83/09/21	264	62375	110000	0.235	360	8.6	5.40	[illegible]5832	26.2	14.0	(0.002	23000	(0.01	(0.01	(0.04	(0.01	1.3	0.07	0.10	(0.002	15000	0.01	+422
4E0	MS 104.1	83/12/16	330	66720	120000	0.27	290	8.5	5.53	[illegible]5000	24	8.5	(0.02	5160	(0.01	(0.01	(0.040	(0.01	2.40	(0.02	0.10	(0.02	15000	0.13	-257
4E0	MS 104.1	84/03/22	323	na	100000	0.19	425	8.4	7.02	109652	29.0	9	(0.002	23000	(0.01	(0.01	(0.04	0.01	0.69	(0.02	0.05	(0.02	1402.0	(0.01	+255
4E0	MS 104.1	84/06/19	270	66220	120000	0.125	714	8.4	5.58	1657-0	28.0	[illegible].0	(0.002	222.0	(0.01	(0.01	(0.04	0.03	3.5	(0.02	0.04	0.002	12400	0.04	+169
4E0	MS 104.1	84/09/26	184	81200	120000	0.14	350	7.8	4.58	113200	13.0	11.0	(0.002	23200	(0.01	(0.05	(0.04	(0.03	1.4	0.02	1.0	(0.002	11200	(0.01	+234
4E0	MS 104.1	84/12/11	140	61000	110000	0.03	420	7.2	5.25	112848	11	12	(0.002	22000	(0.01	(0.05	0.04	0.04	3.5	0.02	1.0	(0.002	10200	0.10	+395
4E0	MS 104.1	85/02/19	208	68300	110000	0.23	614	7.3	5.03	1086-8	16	10	0.02	31200	(0.01	(0.05	(0.04	(0.03	7.9	0.03	4.0	(0.002	14500	(0.01	+31
4E0	MS 104.1	85/05/21	174	75800	110000	0.11	487	6.8	5.25	112500	4.4	[illegible]	0.002	23500	0.01	0.05	0.04	(0.03	5.9	0.02	3.7	0.002	13200	0.05	+59
4E0	MS 104.1	85/08/13	170	72000	110000	0.14	379	6.7	5.15	1287 0	12	11	(0.002	23000	(0.01	0.05	(0.04	0.03	9.8	0.02	4.2	(0.002	13000	0.12	+30
4E5																									
4E0	MS 104.2	82/08/27	na	61300.	100000	0.29	81.0	11.7	1.63	na	na	na	na	na	na	(0.01	(0.01	na	0.07	0.02	na	na	na	na	na
4E0	MS 104.2	82/12/22	1700	72890	110000	0.320	68.0	11.1	2.46	2175-8	34.2	12.0	0.002	23000	0.01	0.01	0.04	(0.01	0.25	0.02	0.09	0.002	16000	0.27	-16
4E0	MS 104.2	83/03/24	1710	73921	112000	0.115	94.0	11.0	2.53	1773[illegible]	81.0	9.0	(0.002	21600	0.01	0.01	(0.01	(0.01	0.25	(0.02	0.01	(0.002	16700	(0.01	na
4E0	MS 104.2	83/06/21	1550	776-0	115000	0.045	91.0	11.5	2.69	126552	61.0	13.0	(0.002	20600	0.01	0.01	0.04	0.01	0.10	0.03	0.01	0.002	15500	0.15	+110

CRU[illegible]LE [illegible]DFILL QUARTERLY MONITORING PROGRAM
CALDERINGS & SPINA CONSULTING ENGINEERS

PAGE... 3 DATE...07-Oct-85 SOURCE FILE.../usr/incy/crucible/QRTR.dat
FORMAT FILE.../usr/incy/crucible/QRTR.for

CODE	WELL	DATE	TOT.ALK.	CHLOR.	CONDUCT	CYANIDE	TOC	pH	PHEN.	TDS	SULFATE	TEMP	ARSENIC	CALCIUM	CADMIUM	CHROM.(T)	CHROM.(HEX)	COPPER	IRON	LEAD	MANG.	MERCURY	SODIUM	ZINC	REDOX
460	MS 104.2	83/09/21	830	74600	120000	0.360	100	11.2	2.40	298163	70.0	13.0	<0.002	28000	<0.01	0.01	<0.04	<0.01	1.70	<.02	0.05	<0.002	.7000	<0.01	-150
461	MS 104.2	83/12/16	1750	78900	120000	0.38	65.5	11.3	2.21	293300	59	10.5	<0.02	29300	<0.01	<0.01	<0.040	<0.01	2.56	<0.02	0.19	<0.02	15000	0.07	-101
462	MS 104.2	84/03/22	1620	na	115000	0.36	96	11.1	4.87	142216	38.2	10	<0.002	28000	<0.01	<0.01	<0.04	0.02	1.1	<0.02	0.08	<0.02	17000	<0.01	-065
463	MS 104.2	84/06/19	1950	76000	140000	0.23	86.5	11.5	2.36	155200	37.0	15.0	<0.002	28000	<0.01	<0.01	<0.04	<0.01	2.80	<0.02	0.14	<0.002	14600	0.06	-160
464	MS 104.2	84/09/25	1750	78000	130000	0.27	85.0	11.6	2.35	256256	37.0	12.5	<0.002	31000	<0.01	<0.01	<0.04	<0.01	1.9	<0.02	0.15	<0.002	19000	<0.01	-218
465	MS 104.2	84/12/11	1700	78000	110000	0.21	80	11.5	2.47	231920	35	11	<0.002	30000	<0.01	<0.05	<0.04	<0.01	1.2	<0.02	0.50	<0.002	14000	0.05	-222
466	MS 104.2	85/02/19	1900	74300	120000	0.24	33	11.5	2.42	179628	77	10	<0.02	32000	<0.01	0.05	<0.04	<0.01	.	<0.02	0.06	<0.002	15000	<0.01	-164
467	MS 104.2	85/05/21	1920	96620	120000	0.31	79	11.7	2.37	266000	68	11	<0.002	22500	<0.01	<0.05	<0.04	<0.01	..0	<0.02	0.04	<0.002	15520	0.04	-18
468	MS 104.2	85/08/13	1850	89700	140000	0.30	81	11.4	2.39	194000	53	11	<0.002	27000	<0.01	<0.05	<0.04	<0.01	1.6	<0.02	0.08	<0.002	14500	0.07	-159
469																									
470	MS 104.3	82/09/27	na	15340.	72000.	0.17	53.0	12.0	0.87	na	na	na	na	na	na	<0.01	<0.01	na	0.05	<0.02	na	na	na	na	na
471	MS 104.3	82/12/22	1320	30004	62000	0.055	38.0	11.5	0.77	72464	49.4	10.0	<0.002	13000	<0.01	<0.01	<0.04	<0.01	<0.01	<0.02	0.04	<0.002	5620	0.02	-52
472	MS 104.3	83/03/24	1727	40959	77500	0.045	57.0	11.9	1.14	84940	93.0	9.0	<0.002	14500	<0.01	<0.01	<0.04	<0.01	0.26	<0.02	<0.01	<0.002	7220	<0.01	na
473	MS 104.3	83/06/21	1650	24450	60000	<0.02	42.0	11.5	0.66	66188	51.0	13.0	<0.002	15120	<0.01	<0.01	<0.04	<0.01	0.29	<0.02	<0.01	<0.002	4140	0.01	-81
474	MS 104.3	83/09/21	1625	31935	66000	0.055	52.0	11.5	0.86	83736	51.0	13.5	<0.002	13000	<0.01	<0.01	<0.04	<0.01	0.60	<0.02	0.04	<0.002	5520	0.03	-240
475	MS 104.3	83/12/16	1535	33900	66000	0.038	33	11.4	0.894	79960	71	10.5	<0.02	12700	<0.01	<0.01	<0.020	<0.01	0.47	<0.02	0.08	<0.02	5100	0.06	-145
476	MS 104.3	84/[illegible]/22	1754	na	72000	0.050	44.5	11.8	1.05	69460	76.2	10.0	<0.002	15000	<0.01	<0.01	<0.04	0.01	0.55	<0.02	0.07	<0.002	7400	<0.01	-136
477	MS 104.3	84/[illegible]/19	1800	64000	75000	0.050	45.0	11.8	0.89	79500	71.0	12.0	<0.002	14500	<0.01	<0.05	<0.04	<0.01	1.4	<0.02	0.07	<0.002	6600	0.17	-170
478	MS 104.3	84/09/25	1400	34720	72000	<0.04	45.0	11.9	2.93	100460	79.0	13.0	<0.002	15200	<0.01	<0.05	<0.04	<0.01	1.0	<0.02	0.02	<0.002	6700	<0.01	-121
479	MS 104.3	84/12/11	1700	33000	60000	0.43	54	11.9	2.33	56504	78	11	<0.002	14000	<0.01	<0.05	<0.04	<0.01	0.54	<0.02	0.04	<0.002	5000	0.11	-27
480	MS 104.3	85/02/19	1710	32720	70000	0.05	17	11.7	0.92	76856	75	10	<0.02	11700	<0.01	<0.05	<0.04	<0.01	0.57	<0.02	0.20	<0.002	4520	<0.01	-38
481	MS 104.3	85/05/21	1800	41200	72000	0.06	26	11.9	0.61	67600	78	11	<0.002	10000	<0.01	<0.05	<0.04	0.03	0.94	<0.02	0.08	<0.002	5300	0.04	-12
482	MS 104.3	85/08/13	1860	42600	80000	0.04	45	11.8	0.67	54100	84	11	<0.002	9000	<0.01	<0.05	<0.04	<0.01	0.54	<0.02	0.20	<0.002	5700	0.05	-103
483																									
484	MS 104.4	82/09/27	na	7000.	21000.	<0.004	24.0	12.5	0.150	na	na	na	na	na	na	<0.01	<0.01	na	<0.01	<0.02	na	na	na	na	na
485	MS 104.4	82/12/22	1435	4653	17000	<0.005	17.0	12.1	0.082	14960	24.8	10.0	<0.002	3330	<0.01	<0.01	<0.04	<0.01	<0.01	<0.02	0.02	<0.002	620	<0.01	-89
486	MS 104.4	83/03/24	1645	5940	18000	<0.008	20.0	12.3	0.069	12300	25.9	9.0	<0.002	3110	<0.01	<0.01	<0.01	<0.01	2.03	<0.02	<0.01	<0.002	420	0.11	na
487	MS 104.4	83/06/21	1570	5570	19000	<0.02	24.5	11.6	0.10	13824	32.0	14.0	<0.002	4100	<0.01	<0.01	<0.04	<0.01	0.17	<0.02	<0.01	<0.002	455	<0.01	-52
488	MS 104.4	83/09/21	1570	4257	17000	0.040	28.0	11.1	0.115	11238	26.2	15.2	<0.002	2700	<0.01	<0.01	<0.04	0.02	0.18	<0.02	<0.01	<0.002	420	0.02	-125
489	MS 104.4	83/12/16	1625	5110	18000	0.012	15.0	11.9	0.066	14420	44	10.5	<0.02	4760	<0.01	<0.01	<0.0.0	<0.01	0.22	<0.02	0.06	<0.02	569	0.35	-135
490	MS 104.4	84/03/22	1565	na	18000	0.015	17.0	12.7	0.120	11720	29.0	10.5	<0.002	3200	<0.01	<0.01	<0.04	<0.01	0.18	<0.02	0.02	<0.02	570	<0.01	-256
491	MS 104.4	84/06/19	1850	4360	17000	0.012	17.5	12.2	0.090	15548	29.0	11.5	<0.002	2600	<0.01	<0.01	<0.008	<0.01	0.17	<0.02	0.03	<0.002	560	0.08	+54
492	MS 104.4	84/09/25	1600	3960	15000	<0.04	20.0	12.4	0.077	17376	28.0	13.0	<0.002	2700	<0.01	<0.05	<0.04	<0.01	0.18	<0.02	0.02	<0.002	510	0.01	-69
493	MS 104.4	84/12/11	1800	4200	18000	<0.04	31	12.4	0.071	3548	29	11	<0.002	2400	<0.01	<0.05	<0.04	<0.01	0.50	<0.02	0.04	<0.002	570	0.19	-4
494	MS 104.4	85/02/19	1850	4050	16000	<0.04	17	12.2	0.123	9444	29	10	<0.02	2350	<0.01	<0.05	<0.04	<0.01	2.7	<0.02	0.12	<0.002	530	0.03	-41
495	MS 104.4	85/05/21	1660	5260	16000	<0.04	24	12.4	0.066	9740	35	11	<0.002	2800	<0.01	<0.05	<0.04	<0.01	0.48	<0.02	0.05	<0.002	350	0.06	+21
496	MS 104.4	85/08/13	1820	4460	13000	<0.04	20	12.4	0.085	11800	33	11	<0.002	2500	<0.01	<0.05	<0.04	<0.01	0.10	<0.02	0.04	<0.002	360	0.03	-45
497																									
498	MS 104.5	82/09/27	na	1980.	11500.	0.05	5.0	12.3	0.049	na	na	na	na	na	na	<0.01	<0.01	na	0.06	<0.02	na	na	na	na	na
499	MS 104.5	82/12/22	1725	1946	12000	0.029	11.3	12.2	0.029	7844	25.0	10.5	<0.002	1750	<0.01	<0.01	<0.04	<0.01	0.23	<0.02	<0.01	<0.002	151	0.03	-37
500	MS 104.5	83/03/24	1770	1347	12000	0.028	78	12.5	0.022	4560	59.5	9.0	<0.002	1350	<0.01	<0.01	<0.01	<0.01	0.07	<0.02	<0.01	<0.002	175	<0.01	na
501	MS 104.5	83/06/21	1640	1370	11200	0.025	15.3	11.5	0.016	4840	32.0	13.5	<0.002	1250	<0.01	<0.01	<0.04	<0.01	0.28	<0.02	<0.01	<0.002	230	<0.01	-91
502	MS 104.5	83/09/21	1875	1466	10500	0.055	19.5	12.3	0.036	5736	60.0	14.0	<0.002	1320	<0.01	<0.01	<0.04	<0.01	0.20	<0.02	<0.01	<0.002	180	0.02	-140
503	MS 104.5	83/12/16	1620	1420	9400	0.038	9.0	11.9	0.016	4010	51	10.5	<0.02	1000	<0.01	<0.01	<0.0.0	<0.01	0.10	<0.02	<0.02	0.02	114	0.03	-113
504	MS 104.5	84/03/22	1615	na	12000	0.013	9.0	12.9	0.0.9	4340	31.0	10	<0.002	940	<0.01	<0.01	0.04	<0.01	0.02	<0.02	<0.01	<0.02	120	0.01	-115
505	MS 104.5	84/06/19	1950	1150	11000	0.022	13.0	12.4	0.050	5560	33.0	12.0	<0.002	1200	<0.01	0.03	<0.004	<0.01	0.12	<0.02	0.01	<0.002	146	0.04	-121
506	MS 104.5	84/09/25	1920	1978	3320	<0.04	15.0	12.5	0.013	5612	32.0	13.0	<0.002	1400	0.01	<0.05	<0.04	0.03	0.04	<0.02	0.01	<0.002	170	0.01	-81
507	MS 104.5	84/12/11	1900	1400	9520	<0.04	16	12.5	0.017	4704	56	11	<0.002	1300	<0.01	<0.05	<0.04	<0.01	0.13	<0.02	0.02	<0.002	150	0.15	+1
508	MS 104.5	85/02/19	1950	1330	9700	0.12	13	12.2	0.027	4324	37	10	<0.02	1270	<0.01	0.05	<0.04	<0.01	0.11	<0.02	0.04	<0.002	142	<0.01	-101
509	MS 104.5	85/05/21	2260	16.0	10000	<0.04	23	12.6	0.027	5520	39	11	<0.002	1120	0.01	0.05	0.04	0.05	1.6	<0.02	0.03	<0.002	150	0.02	+6
510	MS 104.5	85/08/13	2040	1460	11200	<0.04	14	12.5	0.018	5550	37	11	<0.002	1100	0.01	0.05	<0.04	0.06	0.26	<0.02	0.03	<0.002	130	0.02	-7

PAGE... 4 DATE...07-Oct-85 SOURCE FILE.../usr/indy/crucible/QRTR.dat
FORMAT FILE.../usr/indy/crucible/QRTR.for

CODE	WELL	DATE	TOT.ALK.	CHLOR.	CONDUCT	CYANIDE	TOC	pH	PHEN.	TDS	SULFATE	TEMP	ARSENIC	CALCIUM	CADMIUM	CHROM.(T)	CHROM.(HEX)	COPPER	IRON	LEAD	MANG.	MERCURY	SODIUM	ZINC	REDOX
485																									
500	MS 105.1	82/08/27	na	11400.	28000.	0.22	90.0	12.3	1.12	na	na	na	na	na	na	(0.01	(0.01	na	0.06	(0.02	na	na	na	na	na
500	MS 105.1	82/12/21	764	14670	32000	(0.020	121	11.5	1.23	39916	18.4	10.5	(0.002	7120	(0.	(0.01	(0.24	(0.21	(0.02	0.02	(0.02	0.002	9500	0.03	-204
500	MS 105.1	83/ /25	1063	14495	27500	(0.020	119	11.8	1.24	37[illegible]0	71.0	9.0	0.002	5[illegible]0	(0.01	(0.01	(0.01	(0.01	0.03	(0.02	(0.02	(0.002	8900	(0.01	na
500	MS 105.1	83/06/22	800	21400	48000	0.03	131	11.3	1.46	36635	58.0	13.0	(0.002	8500	(0.01	(0.	(0.24	(0.01	0.3	(0.02	(0.01	(0.002	4200	0.02	-207
500	MS 105.1	83/09/21	275	22954	50000	0.030	167	10.5	2.02	49600	11.3	13.0	(0.002	8500	(0.01	(0.01	(0.04	(0.01	0.00	(0.02	0.01	(0.002	5900	(0.01	-165
500	MS 105.1	83/12/15	152	25900	58000	0.07	184	8.7	2.58	58520	24	10.[illegible]	(0.02	12000	(0.01	(0.01	(0.220	(0.01	1.75	(0.02	0.14	(0.02	6600	0.05	-225
500	MS 105.1	84/03/22	138	na	53000	0.018	161	9.0	3.94	46660	11.5	11	(0.002	8500	(0.01	(0.01	(0.04	0.01	0.02	(0.02	0.07	(0.02	5900	(0.01	-116
500	MS 105.1	84/06/19	120	23000	60000	0.025	170	7.4	2.24	47960	7.1	13.0	(0.002	9900	(0.01	(0.03	(0.24	(0.01	0.77	(0.02	0.08	(0.002	5500	0.16	-115
500	MS 105.1	84/09/25	250	20800	47200	(0.04	85	10.9	1.91	35680	9.4	12.0	(0.002	8000	(0.01	(0.05	(0.24	(0.01	0.51	(0.02	0.15	(0.002	4200	(0.01	-210
500	MS 105.1	84/12/11	338	2300	50000	(0.04	100	11.0	1.96	42024	10	11	(0.002	8500	(0.01	(0.05	(0.24	(0.03	0.43	(0.02	0.0	(0.002	4300	0.11	-195
500	MS 105.1	85/02/19	410	22500	45000	(0.04	73	11.2	2.00	38600	8.1	10	(0.02	7500	(0.01	(0.05	(0.[illegible]	(0.[illegible]	0.74	(0.02	0.03	(0.002	3800	(0.01	+2
500	MS 105.1	85/05/21	340	26320	52000	(0.04	76	10.4	1.55	39900	6.3	9	(0.002	8200	(0.01	(0.05	(0.04	(0.03	0.52	(0.02	0.16	(0.002	5120	0.03	-119
500	MS 105.1	85/08/13	185	27100	55000	(0.04	168	9.2	2.21	41500	8.3	11	(0.002	7000	(0.01	(0.05	(0.04	(0.05	0.39	(0.02	0.15	(0.002	4620	0.02	-50
505																									
510	MS105.2R	84/12/11	1700	30000	60000	0.36	56	11.8	0.76	73724	34	11	(0.002	12000	(0.01	(0.05	(0.04	(0.03	0.53	(0.02	0.12	(0.002	4200	0.12	-140
510	MS105.2R	85/02/19	1820	27700	57000	(0.04	20	11.8	0.73	43420	32	10	(0.02	11000	(0.01	(0.05	(0.24	(0.03	0.06	(0.02	0.03	(0.002	3[illegible]0	(0.01	-115
510	MS105.2R	85/05/21	1790	35000	60000	0.04	26	11.6	0.69	99100	39	9	(0.002	10500	(0.01	(0.05	(0.04	(0.03	0.53	(0.02	0.19	(0.002	4300	0.04	-84
510	MS105.2R	85/08/14	1810	36300	65000	0.04	44	11.7	0.75	58700	31	11	(0.002	9500	(0.01	(0.05	(0.04	(0.05	0.44	(0.02	0.00	(0.002	3900	0.02	-103
514																									
515	MS 105.3	82/08/27	na	7620.	23000.	(0.004	29.0	12.5	0.183	na	na	na	na	na	na	(0.01	(0.01	na	0.03	(0.02	na	na	na	na	na
515	MS 105.3	82/12/21	1575	6939	21000	(0.008	15.0	11.9	0.137	13620	27.2	11.0	(0.002	4900	(0.[illegible]	(0.01	(0.24	(0.01	0.03	(0.02	(0.01	(0.002	720	0.05	-106
515	MS 105.3	83/03/25	1650	8300	24000	(0.008	27.0	12.2	0.162	19750	28.4	9.[illegible]	(0.002	4210	(0.01	(0.01	(0.01	(0.01	0.25	(0.02	(0.01	(0.002	820	(0.01	na
515	MS 105.3	83/06/21	1670	8450	26000	(0.02	31.5	11.6	0.18	15748	24.1	14.0	(0.002	5000	(0.01	(0.01	(0.04	(0.01	0.04	(0.02	(0.01	(0.002	5210	(0.01	-132
515	MS 105.3	83/09/21	1760	9153	27000	0.005	34.0	11.9	0.214	19226	24.7	12.5	(0.002	4400	(0.01	(0.01	(0.24	(0.01	0.19	(0.02	0.01	(0.002	1220	(0.01	-116
515	MS 105.3	83/12/15	1740	8180	24000	(0.020	19.0	11.8	0.175	20820	24	11.0	(0.02	3150	(0.01	(0.01	(0.220	(0.01	0.14	(0.02	(0.01	(0.02	665	0.05	-133
515	MS 105.3	84/03/21	1624	na	26000	0.010	28.5	10.8	0.267	17765	25.5	11.0	(0.002	3520	(0.01	(0.01	(0.02	(0.01	(0.01	(0.02	0.05	(0.02	1120	(0.01	-171
515	MS 105.3	84/06/19	1680	9400	40000	(0.02	25.0	12.1	0.196	27650	29.0	12.0	(0.002	[illegible]	(0.01	(0.03	(0.24	(0.01	0.36	(0.02	0.03	(0.002	770	0.10	-174
515	MS 105.3	84/09/25	1800	7900	24000	(0.04	28.0	12.2	0.199	28724	25.0	13.0	(0.002	[illegible]	(0.01	(0.05	(0.24	0.05	0.03	(0.02	0.07	(0.002	700	(0.01	-153
515	MS 105.3	84/1[illegible]/11	17[illegible]0	5620	17000	0.10	35	12.2	0.127	14212	25	10	(0.002	3[illegible]0	(0.01	(0.05	(0.24	(0.03	0.34	(0.02	0.04	(0.002	[illegible]20	0.05	-80
515	MS 105.3	85/02/19	1730	6240	16200	0.18	17	11.3	0.337	13128	25	10	(0.02	3100	(0.01	(0.05	(0.04	(0.03	0.45	(0.02	0.28	(0.002	520	0.03	-73
515	MS 105.3	85/05/21	1770	6710	18000	(0.04	40	12.3	0.188	11620	23	9	(0.002	3200	(0.01	(0.05	(0.04	(0.03	0.17	(0.02	0.24	(0.002	520	0.23	-10
515	MS 105.3	85/08/14	1820	7970	20000	(0.04	23	12.2	0.122	16220	24	11	(0.002	3500	(0.01	(0.05	(0.04	(0.03	0.17	(0.02	0.03	(0.002	480	0.02	-158
517																									
520	MS 105.4	82/08/27	na	2670.	13000.	(0.004	19.0	12.6	0.043	na	na	na	na	na	na	(0.[illegible]	(0.01	na	0.03	(0.02	na	na	na	na	na
520	MS 105.4	82/12/21	1695	2245	12500	(0.004	13.0	12.1	0.031	6396	27.0	11.0	(0.002	2200	(0.01	(0.01	(0.04	(0.01	0.02	(0.02	0.04	(0.002	820	0.03	-51
520	MS 105.4	83/03/25	1790	3700	14000	(0.008	15.0	12.5	0.065	10320	34.0	9.0	(0.002	2520	[illegible]01	(0.01	(0.01	(0.01	0.05	(0.02	(0.01	(0.002	920	0.02	na
520	MS 105.4	83/06/21	1960	3290	15000	(0.008	21.5	11.6	0.042	8972	20.0	15.0	(0.002	2320	(0.01	(0.01	(0.24	(0.01	0.04	(0.02	(0.01	0.002	1050	(0.01	-119
520	MS 105.4	83/09/21	1890	2270	13500	0.025	20.5	12.2	0.053	7320	23.1	13.0	(0.002	1670	(0.01	(0.01	(0.04	(0.01	0.03	(0.02	(0.01	(0.002	550	(0.01	-102
520	MS 105.4	83/12/15	2000	2080	12200	0.012	9.0	11.6	0.011	7560	35	11.0	(0.02	1600	(0.01	(0.01	(0.224	(0.01	0.10	(0.02	(0.01	0.02	674	0.09	-103
520	MS 105.4	84/03/21	1812	na	14000	(0.008	17.0	10.9	0.052	7974	21.0	11.0	(0.002	1420	(0.01	(0.01	(0.02	(0.01	(0.01	(0.02	0.03	(0.002	550	(0.01	-112
520	MS 105.4	84/06/19	1915	2770	15000	(0.004	18.0	12.3	0.060	10500	23.0	[illegible]0	(0.[illegible]	2400	(0.01	(0.05	(0.004	(0.01	0.11	0.02	0.01	(0.002	650	0.07	-105
520	MS 105.4	84/09/25	1950	2970	12000	(0.04	19.0	12.4	0.045	5488	28.0	15.0	(0.002	2221	(0.01	(0.05	(0.24	(0.03	0.05	(0.02	0.04	(0.002	550	(0.01	-141
520	MS 105.4	84/12/11	2.30	1950	10000	0.04	16	12.4	0.029	6548	28	11	(0.002	1660	0.01	(0.05	(0.24	(0.03	1.2	(0.02	0.07	(0.002	650	0.05	-67
520	MS 105.4	85/02/19	1990	2080	10500	0.06	18	12.3	0.050	5328	24	10	(0.02	1520	0.01	(0.05	(0.04	(0.03	0.02	0.03	0.05	0.002	670	(0.01	-12
520	MS 105.4	85/05/21	1980	2420	12000	(0.04	27	12.4	0.070	6210	34	9	(0.002	1[illegible]0	(0.01	(0.05	(0.24	(0.03	0.09	(0.02	0.03	(0.002	550	0.04	+35
520	MS 105.4	85/08/13	2050	2520	13000	(0.04	21	12.3	0.023	7540	30	11	(0.002	150[illegible]	(0.01	(0.05	(0.04	(0.03	0.08	(0.02	0.02	(0.002	680	0.03	-175
523																									
525	MS 105.5	82/08/27	na	1150.	10500.	(0.004	22.0	12.4	0.015	na	na	na	na	na	na	(0.01	(0.01	na	(0.01	0.02	na	na	na	na	na
525	MS 105.5	82/12/21	2080	1198	10000	0.010	7.0	12.1	0.013	4164	26.6	10.5	(0.002	1530	[illegible]01	0.01	(0.04	(0.01	0.02	(0.02	0.02	0.002	522	0.02	-35
525	MS 105.5	83/03/25	2022	1150	10000	0.010	9.0	12.5	0.[illegible]9	4230	51.5	9.0	(0.00	[illegible]0	0.01	(0.01	(0.01	(0.01	0.03	(0.02	0.01	(0.002	510	(0.01	na

CRUCIBLE LANDFILL QUARTERLY MONITORING PROGRAM
CALDERINOS & SPINA CONSULTING ENGINEERS

PAGE... 5 DATE...07-Oct-85 SOURCE FILE.../usr/incy/crucible/GRTR.cat
FORMAT FILE.../usr/incy/crucible/GRTR.for

CODE	WELL	DATE	TOT.ALK.	CHLOR.	CONDUCT	CYANIDE	TOC	pH	PHEN.	TDS	SULFATE	TEMP	ARSENIC	CALCIUM	CADMIUM	CHROM.(T)	CHROM.(HEX)	COPPER	IRON	LEAD	MANG.	MERCURY	SODIUM	ZINC	REDOX
525	MW 105.5	83/06/21	2310	1020	11000	0.049	17.1	11.6	(0.0.0	6396	39.0	15.0	(0.002	2150	(0.01	(0.01	(0.04	(0.01	0.13	(0.02	0.02	(0.002	430	0.03	-71
525	MW 105.5	83/09/21	2185	1116	11500	0.065	15.5	12.2	0.035	5152	35.2	13.5	(0.002	930	(0.01	(0.01	(0.04	(0.01	0.09	(0.02	(0.01	(0.002	460	(0.01	-364
525	MW 105.5	83/12/1.	2340	946	11600	0.018	6.5	11.7	(0.010	2783	39	11.0	(0.02	874	(0.01	(0.01	(0.224	(0.01	0.26	(0.02	(0.01	(0.02	636	0.04	-037
525	MW 105.5	84/03/21	2138	na	11000	0.015	11.5	11.1	0.013	17463	22.5	11.0	(0.002	618	(0.01	(0.01	(0.02	(0.01	0.04	(0.02	(0.01	(0.02	610	(0.01	+025
525	MW 105.5	84/06/19	2450	na	7000	0.15	10.0	12.5	0.014	3600	23.0	13.0	(0.002	900	(0.01	(0.03	(0.004	0.02	0.13	(0.02	0.15	(0.002	560	0.04	-72
525	MW 105.5	84/09/25	2350	990	10000	(0.04	13.0	12.6	0.058	3916	42.0	13.0	(0.002	930	(0.01	(0.05	(0.04	(0.05	0.03	(0.02	0.03	(0.002	620	0.02	-64
525	MW 105.5	84/12/11	2400	1400	10000	(0.04	20	12.5	0.017	4224	49	11	(0.002	.800	(0.01	(0.05	(0.04	(0.03	1.5	(0.02	0.09	(0.002	500	0.04	-68
525	MW 105.5	85/02/19	2220	693	11500	0.07	13	12.3	0.015	3824	38	10	(0.02	850	(0.01	(0.05	(0.04	(0.03	0.08	(0.02	0.03	(0.002	550	0.03	-79
525	MW 105.5	85/05/21	2470	1150	11500	(0.04	29	12.6	0.010	3850	44	10	(0.002	825	(0.01	(0.05	(0.04	(0.03	0.13	(0.02	(0.01	(0.002	600	0.02	+48
525	MW 105.5	85/08/13	2390	1340	13000	(0.04	16	12.5	0.016	3750	37	12	(0.002	900	(0.01	(0.05	(0.04	(0.03	0.05	(0.02	(0.01	(0.002	630	0.04	-166
527																									
530	CW 201	82/08/27	na	3370.	15000.	(0.004	8.0	12.5	0.074	na	na	na	na	na	na	(0.01	(0.01	na	0.03	(0.02	na	na	na	na	na
530	CW 201	82/12/21	1660	4691	16000	(0.004	17.0	12.0	0.083	9784	28.0	10.0	(0.002	3330	(0.01	(0.01	(0.04	(0.01	0.05	(0.02	(0.01	(0.002	143	0.03	-24
530	CW 201	83/03/22	1840	3564	15000	(0.008	20.0	12.4	0.138	10368	32.1	9.0	(0.002	2210	(0.01	(0.01	(0.01	(0.01	0.05	(0.02	(0.01	(0.002	320	(0.01	na
530	CW 201	83/06/22	1670	2670	12000	0.038	18.0	11.6	0.037	7176	25.0	12.5	(0.002	2010	(0.01	0.68	0.53	(0.01	0.03	(0.02	(0.01	(0.002	261	(0.01	-61
530	CW 201	83/09/21	1875	3578	16000	0.030	24.0	12.1	0.073	10224	30.1	13.5	(0.002	2300	(0.01	0.19	0.19	(0.01	0.11	(0.02	(0.01	(0.002	350	(0.01	-208
530	CW 201	83/12/16	1900	4200	16400	0.080	17.0	11.5	0.055	12700	28	10.5	(0.02	4300	(0.01	0.35	0.30	(0.01	0.30	(0.02	0.02	(0.02	461	0.05	-052
530	CW 201	84/03/21	1924	na	12500	0.020	17.0	11.8	0.042	6405	25.8	10.5	(0.02	1220	(0.01	0.14	0.20	(0.01	(0.01	(0.02	0.03	(0.02	260	(0.01	+020
530	CW 201	84/06/20	1850	2700	14000	0.007	20.0	11.9	0.047	9820	26.0	11.0	(0.002	2400	(0.01	(0.03	0.013	(0.01	0.10	(0.02	0.03	(0.002	150	0.06	+169
530	CW 201	84/09/25	1850	2970	13200	(0.04	22.0	12.4	0.056	11004	31.0	10.0	(0.002	2200	(0.01	(0.05	(0.04	(0.03	0.06	(0.02	0.03	(0.00.	630	(0.01	-33
530	CW 201	84/12/12	1800	2700	9000	0.05	20	12.1	0.057	8416	26	11	(0.002	2020	0.01	(0.05	0.04	(0.03	0.15	(0.02	0.02	(0.002	250	0.13	-138
530	CW 201	85/02/20	1810	2180	11500	(0.04	40	12.2	0.062	6460	27	10	(0.02	1700	(0.01	(0.05	(0.04	(0.03	0.19	(0.02	0.05	(0.002	190	(0.01	+54
530	MW 201	85/05/21	1920	2640	13000	0.04	35	11.7	0.044	7620	37	9	(0.002	2150	(0.01	(0.05	(0.04	(0.03	0.12	(0.02	0.04	(0.002	220	0.04	-48
530	CW 201	85/08/14	1960	4150	14000	(0.04	19	12.3	0.068	10820	28	11	(0.002	2100	(0.01	(0.05	(0.04	(0.03	0.10	(0.02	0.05	(0.002	240	0.22	-130
532																									
530	SG 2	82/08/26	na	25245.	58000.	0.027	49.0	12.0	0.80	na	na	na	na	na	na	(0.01	(0.01	na	0.03	(0.02	na	na	na	na	na
530	SG 2	82/12/20	196	7286	18000	0.012	13.0	11.1	0.077	14152	85.0	7.0	(0.002	3360	(0.01	(0.01	(0.04	(0.01	(0.01	(0.02	0.23	(0.002	1120	0.25	+53
530	SG 2	83/03/24	1390	27445	58000	(0.020	44.0	12.1	0.722	51740	18.5	5.0	(0.002	9300	(0.01	(0.01	(0.01	(0.01	0.08	(0.02	(0.01	(0.002	5220	(0.01	na
530	SG 2	83/06/20	1150	19460	50000	(0.02	41.0	11.4	0.61	.5536	17.6	16.0	(0.002	11620	(0.01	(0.01	(0.04	(0.01	0.21	(0.02	(0.01	(0.002	4110	0.03	-059
530	SG 2	83/09/21	96	14970	34000	0.270	19.5	10.0	0.125	36130	219.0	15.0	(0.002	5600	(0.01	(0.01	(0.04	(0.01	0.21	(0.02	(0.01	(0.002	3420	0.20	-64
530	SG 2	83/12/15	560	8610	21000	0.04-5	9.5	11.4	0.223	21420	48	6.0	(0.02	3150	(0.01	(0.01	(0.020	(0.01	0.13	(0.02	(0.01	(0.02	1760	0.26	-024
530	SG 2	84/03/20	447	na	17000	(0.01	12.0	11.3	0.221	12273	35.3	5.0	(0.002	1720	(0.01	(0.01	(0.02	(0.01	0.02	(0.02	0.02	(0.02	1320	(0.01	+032
530	SG 2	84/06/19	1500	na	na	(0.02	33.0	11.9	0.53	52650	17.0	13.0	(0.002	8620	(0.01	(0.03	(0.04	0.02	0.73	(0.02	0.26	(0.002	3720	0.13	-10
530	SG 2	84/09/25	950	16380	36000	(0.04	29.0	11.8	0.49	56420	16.0	15.0	(0.002	7500	(0.01	(0.05	(0.04	(0.03	0.42	(0.02	0.15	(0.002	4120	(0.01	-19
530	SG 2	84/12 9	800	15000	30000	(0.04	28	11.7	0.373	29764	38	7	(0.002	4520	(0.01	(0.05	(0.04	(0.03	0.18	(0.02	0.05	(0.002	1900	0.03	-41
530	SG 2	85/02/12	836	11900	30000	(0.04	11	11.7	0.35	22388	26	9	(0.02	4530	(0.01	(0.05	(0.04	(0.03	0.24	(0.02	0.10	(0.002	1920	(0.01	+98
530	SG 2	85/05/21	1200	26320	20000	(0.04	24	11.4	0.61	37900	18	7	(0.002	8500	(0.01	(0.05	(0.04	(0.03	0.42	(0.02	0.13	(0.002	3750	0.03	-78
532																									
530	SG 4	82/12/20	56.0	339	1820	0.048	2.0	8.6	(0.01	1428	190	7.0	(0.002	289	(0.01	(0.01	(0.04	(0.01	0.04	(0.02	(0.01	(0.002	134	0.02	+220
530	SG 4	8 0/24	49.0	324	1310	0.025	65.0	9.9	(0.01	850	123	5.0	(0.002	250	(0.01	(0.01	(0.01	(0.01	(0.01	(0.02	(0.01	(0.002	100	(0.01	na
530	SG 4	83/06/20	400	1490	5650	0.024	4.0	11.2	(0.010	3432	98.0	15.0	(0.002	930	(0.01	(0.01	(0.04	(0.01	0.30	1.01	(0.01	(0.002	440	(0.01	+025
530	SG 4	83/12/15	46	154	880	0.030	(3.0	9.2	(0.010	668	82	6.0	(0.02	82.0	(0.01	(0.01	(0.010	(0.01	0.40	(0.02	(0.01	(0.02	36.3	0.26	+070
530	SG 4	84/03/20	39.0	na	1800	0.011	4.0	8.0	(0.01	703	61.6	6.0	(0.002	1010	(0.01	(0.01	(0.02	(0.01	0.01	(0.02	0.01	(0.02	76	(0.01	+276
530	SG 4	84/06/19	34	327	1300	0.018	3.5	8.0	(0.01	1190	49.0	13.0	(0.002	170	(0.01	0.23	(0.024	(0.01	0.25	(0.02	0.01	(0.002	(120	0.02	+413
530	SG 4	84/09/25	142	1930	1100	0.11	32	8.0	0.269	1300	44.0	15.0	(0.002	120	0.01	0.25	0.04	(0.03	0.27	0.03	0.25	(0.002	70	0.01	+99
530	SG 4	84/12 12	120	170	730	0.06	17.0	8.3	(0.010	692	110	3	0.004	120	(0.01	(0.05	(0.04	(0.03	0.07	0.02	0.03	(0.002	28	0.07	na
530	SG 4	85/05/22	50	190	1200	0.018	(10	6.6	0.021	760	51	10	(0.002	95	(0.01	(0.05	(0.04	(0.03	0.05	(0.02	(0.01	(0.002	15	0.05	+32
535																									
530	SG 5	82/12/20	145	534	2700	0.039	(3.0	11.1	(0.01	2238	530	7.0	(0.002	310	(0.01	(0.01	(0.04	0.01	(0.01	(0.02	0.01	(0.002	133	(0.01	-33
530	SG 5	83/03/24	312.5	354	2150	0.236	4.0	12.1	(0.010	920	91.0	5.0	(0.002	320	(0.01	0.01	0.01	(0.01	0.06	(0.02	(0.01	(0.002	95.0	(0.01	na
530	SG 5	83/06/21	+80	1350	6400	0.035	4.3	11.5	(0.010	3182	37.0	14.5	(0.002	813	(0.01	0.01	(0.04	(0.01	0.13	(0.02	(0.01	(0.002	370	0.01	-102

CRUCIBLE QUALITY TOPIC PROGRAM

CALDERONS & SPINA CONSULTING ENGINEERS

PAGE... 6 DATE...07-Oct-85 SOURCE FILE.../usr/incy/crucible/QRTR.dat
FORMAT FILE.../usr/incy/crucible/QRTR.for

CODE	WELL	DATE	TOT.ALK.	CHLOR.	CONDUCT	CYANIDE	TOC	pH	PHEN.	TDS	SULFATE	TEMP	ARSENIC	CALCIUM	CADMIUM	CHROM.(T)	CHROM.(HEX)	COPPER	IRON	LEAD	MANG.	MERCURY	SODIUM	ZINC	REDOX
620	SG 5	83/12/15	130	364	1950	0.023	<3.0	11.7	0.014	1420	177	6	<0.02	251	<0.01	<0.01	<0.010	<0.01	0.46	<0.02	<0.01	0.02	56.3	0.24	-282
620	SG 5	84/03/21	38.0	na	475	0.007	6.5	8.6	<0.010	344	32.8	6.0	0.002	710	<0.01	<0.01	<0.02	<0.01	<0.01	<0.02	0.02	<0.02	63	<0.01	-325
620	SG 5	84/12/12	240	99	1500	<0.04	<5	12.0	0.011	912	85	8	0.002	150	<0.01	<0.05	<0.04	<0.03	2.1	<0.02	<0.01	<0.002	26	0.03	+11

APPENDIX C

GEOTECHNICAL ENGINEERING REPORT

RAY M. TEETER, P.E.
CONSULTING GEOTECHNICAL ENGINEER

SETTLEMENT AND STABILITY INVESTIGATION

CRUCIBLE LANDFILL

GEDDES, NEW YORK

For

Calocerinos & Spina
Consulting Engineers

Liverpool, New York

Job Number RMT-84-4A

October 1985

P.O. BOX 6175 TEALL STATION
SYRACUSE, NEW YORK 13217

315-437-8225

SETTLEMENT AND STABILITY INVESTIGATION

CRUCIBLE LANDFILL

GEDDES, NEW YORK

INTRODUCTION

General

This report presents the results of a geotechnical investigation of the Crucible Landfill. The landfill is located on the southwest side of Onondaga Lake, approximately two miles northwest of Syracuse.

The Crucible Landfill is unique in that it is situated atop an abandoned Solvay Process waste bed. This waste material, and the natural soils underlying the bed, therefore govern the settlement and stability of the landfill. The Solvay Process waste in particular is a material whose behavior is complex and not widely understood.

Since the writer's initial involvement with this project, two additional and significant restrictions have been imposed on the operation and closure of the landfill. The first of these is the requirement for an impervious cap, which places additional emphasis on the adequacy of settlement estimates, and will affect the groundwater conditions beneath the landfill. The second is an accelerated schedule of closure, which limits the opportunity for monitoring and corrective adjustments as the development of the site proceeds. The expanded geotechnical investigation discussed in this report is a direct result of these restrictions.

Purposes and Scope of Work

The purposes of this investigation were to:

- Estimate settlements.
- Examine various modes of instability.
- Assist in the development of a site grading/drainage plan compatible with the estimated settlement and stability restrictions.
- Assist in the development of a practical system of closure.
- Develop a detailed program of geotechnical monitoring.

To fulfill these purposes, the writer's scope of work included:

- Making a reconnaissance of the site.
- Reviewing the previous reports, papers, and correspondence applicable to the project. A listing of all references is provided in Appendix G.
- Coordinating a program of exploratory drilling and field testing, the details and results of which are presented and discussed in subsequent sections.
- Coordinating a program of geotechnical laboratory testing, the details and results of which are presented and discussed in subsequent sections.
- Conducting a program of geotechnical engineering analyses, directed primarily at the settlement and stability characteristics of the landfill.

FIELD AND LABORATORY WORK

Field Work

The field work included:

- A 52-foot boring (B-85-1) through the interior Solvay Process waste, drilled on June 13, 1985. The boring was advanced by a truck-mounted rotary drill rig and hollow-stem auger casing, and three-inch thin-walled tube samples were taken at depths of approximately 11, 21, 31, 41, and 51 feet.
- A 102-foot boring (B-85-2) through the exterior dike along Nine Mile Creek and into the underlying natural soils, drilled between June 17 and June 21, 1985. The boring was advanced by a track-mounted drill rig utilizing driven casing and the rotary wash method of cleanout. Standard split spoon samples were taken at five-foot intervals throughout the Solvay Process waste and at five other depths in the underlying natural soils. Three-inch thin-walled tube samples were taken only in the natural soils, at depths of approximately 61, 81, and 91 feet. Vane shear tests were also taken only in the natural soils, at depths of approximately 75, 85, and 95 feet.
- Four 125-foot borings (INC-1 through INC-4) through the perimeter Solvay Process waste and into the underlying natural soils, drilled between July 22 and August 1, 1985. The borings were advanced by a track-mounted rotary drill rig utilizing spun-in flush-joint casing. Standard split spoon samples were taken at five-foot intervals in two of the borings (INC-1 and INC-2), below depths of approximately 48 feet. An inclinometer casing was installed in each of

the four borings.

- A test pit (TP-85-1) in the Solvay Process waste, located immediately south of and approximately midway along the southern edge of the Crucible Landfill. The pit was excavated and backfilled by Crucible personnel on July 17, 1985. A visual examination and several rapid field tests were performed by the writer. The findings are presented in Appendix D.

The drilling, sampling, vane shear testing, and inclinometer casing installation work was contracted to Empire Soils Investigations, Inc. Their subsurface logs and inclinometer casing details are presented in Appendix C. The results of the three vane shear tests, as computed by the writer, are presented in Table 1.

The locations of the six borings and the single test pit were determined and placed on drawings by representatives of Crucible and Calocerinos & Spina, and are shown in Figure 1. Surface elevations at these locations were estimated by the writer, using existing topographic maps of the site.

All samples obtained in the field were retained by the writer, for visual examination and laboratory testing.

Laboratory Work

The laboratory work included:

- 61 natural moisture content determinations, including samples of both the Solvay Process waste and the underlying natural soils.
- 33 "Pocket Penetrometer" shear strength determinations, including samples of both the Solvay Process waste and the underlying natural soils.
- 33 "Torvane" shear strength determinations, including samples of both the Solvay Process waste and the underlying natural soils.
- 17 Atterberg limits determinations, including samples of only the natural soils.
- 13 density determinations, including samples of both the Solvay Process waste and the underlying natural soils.
- Eight rapid unconfined compression tests, including samples of only the natural soils.

- Six consolidation tests, including samples of only the Solvay Process waste. Each of these tests was performed in less than eight hours and with no additional water, so that the undesirable effects of sample dissolution were eliminated.

- Three sieve analyses, including samples of only the natural soils.

Much of the laboratory work was performed by Parratt-Wolff, Inc. Some of the more unusual testing, however, was performed directly by the writer, utilizing the laboratory and testing equipment of Parratt-Wolff, Inc.

The results of all laboratory tests are summarized in Table 1. More detailed profile sketches of the eight thin-walled tube samples, including test results, are presented in Appendix E. Curves resulting from the six consolidation tests are presented in Appendix F.

SITE PROFILES AND PROPERTIES SELECTED FOR ANALYSES

General

The general surface and subsurface conditions at this site have been well documented in previous reports by Thomsen Associates and Calocerinos & Spina, and are therefore not discussed here.

The critical profile, in terms of both geometry and the properties of the subsurface materials, remains that along Nine Mile Creek, and is shown in simplified form in Figure 2. A reexamination of other portions of the site has confirmed this assumption.

The properties tabulated in Figure 2 reflect the current field and laboratory test results, previous work, the writer's experience, and an amount of reasonably conservative engineering judgment. These properties are discussed further in the following sections.

Geotechnical Properties and Behavior of Solvay Process Waste

The Solvay Process waste is a bone white, fine-grained, and cemented chemical by-product of the Solvay Process. Hydraulic placement has resulted in horizontal bedding, while the random deposition of flyash has resulted in numerous darker and more heavily cemented layers. Numerous generally vertical discontinuities also exist, although no dipping discontinuities (sloping cracks, which might increase the potential for sliding instability) have been noted.

The shear strength of the intact Solvay Process waste was estimated in the laboratory by both "Pocket Penetrometer" and "Torvane" testing on undisturbed samples. The average "Pocket Penetrometer" shear strength is approximately 1900 pounds per square foot, while the average "Torvane" shear strength is approximately 700 pounds per square foot.

More confidence is held in the 1900 pounds per square foot value, for several reasons. First, the "Pocket Penetrometer" appears to provide a better model of the actual field problem than the "Torvane." The failure mechanism appears to be one of punching, in which the cemented strength of the Solvay Process waste is exceeded, the skeletal structure of the loaded waste collapses, and the waste beyond the loaded area remains relatively uninvolved. Second, insertion of the multi-bladed "Torvane" involves a significant amount of disturbance, meaning that much of the cementation is lost before the test is actually conducted. Third, in-situ vane shear tests performed by Thomsen Associates (1982) yielded strengths ranging between 1858 and 3353 pounds per square foot, and averaging 2540 pounds per square foot. Fourth and finally, the "Pocket Penetrometer" results provide excellent correlation with the values of apparent preconsolidation pressure (Pc) determined by consolidation testing.

Summarizing, the average cemented shear strength of the intact Solvay Process waste selected for analysis was 1900 pounds per square foot. This value was then adjusted substantially downward (to less than 1400 pounds per square foot), to account for the effects of strain incompatibility and the presence of vertical discontinuities.

The compressibility characteristics of the Solvay Process waste were investigated in the laboratory by performing six consolidation tests on undisturbed samples. As noted in a previous section, each of these tests was performed in less than eight hours and with no additional water, so that the undesirable effects of sample dissolution were eliminated. Curves of strain versus stress (on a log scale) are presented in Appendix F. Each curve yields the following information:

- Pc, the apparent preconsolidation pressure. This is the effective vertical stress beyond which most of the cementation is destroyed, the skeletal structure of the waste begins to collapse, and the irrecoverable compressive strains increase dramatically.

- Kr, the relative recompressibility. This is the slope (change in strain over change in log of stress) of the portion of the curve below Pc.

- Kc, the relative compressibility. This is the slope of the portion of the curve beyond Pc.

The average value of Pc obtained from consolidation testing is approximately 3600 pounds per square foot. The ratio of the individual Pc values to "Pocket Penetrometer" shear strengths determined for immediately adjacent sample sections, however, was found to be consistently near 2.00. Therefore, the 23 "Pocket Penetrometer" results could be extended to estimate a value of Pc for analysis (and to provide general confirmation of the Pc values obtained through consolidation testing). This value is 3800 pounds per square foot. (It should be noted that each of the 23 "Pocket Penetrometer" results represents an average of about five individual tests. Also, the "Pocket Penetrometer" yields an approximate value of unconfined compressive strength. Shear strengths are obtained by dividing this value by two.)

Further combining the discussions of strength and compressibility, it has been a concern throughout this project that stresses in excess of Pc (or excessive shear strains) could cause a drastic reduction in strength, which in turn could result in a flow slide type of failure. Field and laboratory tests conducted during this investigation, however, have not confirmed that this concern is valid. Furthermore, the Solvay Process waste has been conservatively assumed to possess no frictional strength. At effective vertical stresses in excess of 3800 pounds per square foot, however, and assuming a relatively slow rate of load application, such a frictional component would tend to compensate for any cementation destroyed. Kulhawy, Sangrey, and Grove (1977) measured effective stress friction angles of approximately 32 degrees, for both undisturbed and remolded samples.

Geotechnical Properties and Behavior of Underlying Natural Soils

The critical soils underlying the Solvay Process waste bed are generally dominated by silts of low plasticity. Zones of more plastic clay, however, as well as some organic soils, were also encountered.

The shear strength characteristics of the natural soils were estimated on the basis of the results summarized in Table 1. The significant amount of scatter in the shear strength data is attributable to the low plasticity of the soils tested. As plasticity and cohesion decrease, frictional resistance and drained strength generally increase. Therefore, to the extent that drainage and consolidation will occur as the actual field loads are applied over time, higher drained strengths will prevail, and the undrained strength parameters selected will actually be conservative.

In the particular case of the natural soils lying between elevation 340 and the Solvay Process waste, both drained and undrained strength parameters were used in the stability analysis. The condition yielding lower strength was always assumed to govern.

In consideration of the sizeable settlements estimated to be possible within the Solvay Process waste, the comparative compressibility of the underlying natural soils is assumed to be negligible.

Groundwater

The current maximum mean groundwater elevation at the site is approximately 405. It has been estimated by Calocerinos & Spina that, by placement of an impervious cap, the groundwater could drop to as low as elevation 375. For purposes of analyzing the critical profile, it has been assumed that the groundwater elevation will be no higher than 390.

DISCUSSIONS, RESULTS, AND IMPLICATIONS OF ANALYSES

General

The settlement and stability analyses indicate that a scheme of surface water removal is preferable to one of surface water infiltration. The infiltration scheme involves a number of concerns and uncertainties, including the adverse effects of potentially higher hydrostatic pressures on stability, the uncertain long-term effects of concentrated leaching, and the potential problems associated with clogging and maintenance of infiltration galleries. These concerns and uncertainties would be difficult to resolve, particularly within the accelerated schedule of closure now imposed.

From a settlement standpoint alone, the current analyses indicate that there is relatively little to be gained from maintaining high groundwater levels. It should also be noted that, with the requirement for an impervious cap, virtually any grading plan will create effective vertical stresses in excess of the currently estimated value of Pc.

The site grading/drainage plan discussed in subsequent sections was necessarily developed in unison with the estimated settlements. These settlements, and in particular the final drainage slopes which they so strongly affect, are considered acceptable by Calocerinos & Spina. The grading/drainage plan was also strongly influenced by stability considerations, particularly within the two southernmost landfill sections.

Settlement

The estimated maximum total settlements within the landfill, based on the proposed design configuration and thicknesses, are as follows:

Thickness of Crucible Waste and Cap	Estimated Settlement: Drop Groundwater 405 to 390 Edge	Drop Groundwater 405 to 390 Interior	Drop Groundwater 405 to 375 Edge	Drop Groundwater 405 to 375 Interior
0'	½'	½'	½'	½'
7'	2'	3'	2½'	4'
10'	2½'	4'	3'	5'
13'	3'	5'	3½'	6'

It should be noted that the relative compressibility (Kc) was applied within the upper four feet of frost-disturbed Solvay Process waste, as well as within any waste subjected to an effective vertical stress in excess of 3800 pounds per square foot. As is noted in a previous section, the compressibility of the underlying natural soils has been assumed to be relatively insignificant.

Stability

The stability computations were performed with the aid of an electronic calculator, and combined chart solutions, the wedge method, and the ordinary method of slices. Although more sophisticated (and less conservative) methods of analysis are available, they are considered unwarranted by the conditions at this site.

The two critical modes of instability are:

- o A deep circular failure involving much of the underlying natural soil.
- o A sliding failure along the interface between the Solvay Process waste and the underlying natural soil.

The configuration of the deep circular failure is shown in Figure 2. As is noted in a previous section, the cemented shear strength of the intact Solvay Process waste was adjusted substantially downward, to account for the effects of strain incompatibility and the presence of vertical discontinuities. The resulting factor of safety is 1.25, an acceptable value.

The sliding mode of failure would be of increased importance if

the interior Solvay Process waste underwent a loss of strength. In any case, the computed factor of safety is greater than 1.50.

During the course of this project, the wisdom of continued landfilling has been questioned, particularly in consideration of the concerns regarding stability. In response to this, it can be stated that stability is not a major concern for most of the site, and that the concerns regarding stability are to a great extent related to the impervious cap and the accelerated schedule of closure. In the two southernmost landfill sections, where the stability concerns are the greatest, waste is no longer being placed, and some will in fact be removed.

Closure Schedule and Monitoring Program

The closure schedule and monitoring program are critical aspects of this project, and detailed recommendations are provided in a subsequent section. Briefly, the four northern landfill sections (Stage A) must be completed well before the four southern landfill sections (Stage B), so that the full-scale performance can be adequately observed before proceeding to the potentially more critical areas of the site. Also, the rough grading of each stage should be completed well before that stage is capped, to reduce the potential for differential settlement and resulting cap damage. Waste thicknesses, vertical and horizontal movements, strengths, and groundwater levels (reflecting both seasonal variations and the effects of capping) must all be carefully monitored throughout the development of the landfill, so that any potential difficulties can be effectively identified and treated.

CONCLUSIONS

- The average cemented shear strength of the intact Solvay Process waste selected for analysis is 1900 pounds per square foot. This value was adjusted substantially downward, to account for the effects of strain incompatibility and the presence of vertical discontinuities.
- The average apparent preconsolidation pressure of the Solvay Process waste selected for analysis is 3800 pounds per square foot.
- Neither the average shear strength nor the average apparent preconsolidation pressure appears to vary with depth.
- The current field and laboratory testing have not confirmed the potential for a flow slide type of failure.
- The critical profile remains that along Nine Mile Creek.

- The computed factor of safety against a deep circular failure is 1.25.
- The computed factor of safety against a sliding failure is greater than 1.50.
- Settlements as great as approximately six feet have been estimated.
- A scheme of surface water removal is preferable to one of surface water infiltration.
- The closure schedule and monitoring program are critical aspects of the project.

RECOMMENDATIONS

- No Crucible waste or cap material should be placed within 100 feet of the crest of the upper Solvay "plateau."
- No slopes of the completed cap or drainage channels should be steeper than one vertical on three horizontal.
- The maximum combined thickness of Crucible waste and cap material should not exceed 13 feet along the central longitudinal ridge of each of the eight 500 foot by 250 foot landfill sections.
- The combined thickness of Crucible waste and cap material should not exceed seven feet along the interior drainage swales and at the crests of the perimeter slopes.
- The average combined thickness of Crucible waste and cap material should not exceed 10 feet.
- For the two southernmost landfill sections (those nearest Nine Mile Creek), the combined thickness of Crucible waste and cap material should increase uniformly from zero feet, along a line at least 100 feet from the crest of the upper Solvay "plateau," to 13 feet, along a line at least 225 feet from the crest of the upper Solvay "plateau."
- The longitudinal ridges and interior drainage swales should run east-west, parallelling Nine Mile Creek and Route 690.
- Each landfill stage should be rough graded at least nine months before it is capped.
- Capping of the four southern landfill sections (Stage B) should not be started until the four northern landfill

sections (Stage A) have been fully capped for at least nine months.

- To prevent the localized and concentrated infiltration of water near the edges of the landfill, drainage channels should be lined with impervious material.

- No part of any perimeter drainage channel should lie within 50 feet of the crest of the upper Solvay "plateau."

- Uncontrolled runoff over the crest of the upper Solvay "plateau" should not be permitted.

- Prior to the closure of any landfill section, 39 horizontal steel plates with attached vertical steel rods or pipes should be installed at the Crucible/Solvay interface, at the approximate locations shown in Figure 1. The plates should be at least three feet by three feet in plan view, and at least .25 inch in thickness. The rods or pipes should be at least 16 feet in length and one inch in diameter, should be marked in one foot increments, and should be brightly painted and flagged. The purposes of these devices are to monitor settlements and horizontal movements at the Crucible/Solvay interface, and to limit the combined thicknesses of the Crucible waste and cap material. Upon installation, the elevations of the tops of the rods or pipes should be determined to an accuracy of .1 feet, using conventional differential leveling techniques and at least two stable (distant) benchmarks. Also upon installation, the 34 horizontal distances shown in Figure 1 should be determined by steel tape to an accuracy of .1 feet. The horizontal measurements should be made at the ground surface at the time of the measurements, and should represent the distances between the centers of the adjacent rods or pipes. (It is recognized that these horizontal measurements may not be entirely meaningful for tilted rods or pipes not yet surrounded by appreciable thicknesses of fill. Nevertheless, the measurements are neither costly nor time consuming, and should be made.

- Plate readings (both vertical and horizontal), inclinometer readings, and groundwater level readings should be scheduled for repetition at three month intervals.

- The quarterly sets of readings should include general visual inspections of the landfill and its surrounding slopes.

- At least six months after capping of the four northern landfill sections (Stage A), but prior to capping of any other landfill sections, a boring should be advanced through the center of each of the four northern landfill sections. In each boring, vane

shear testing should be performed throughout the Solvay Process waste, at intervals of five feet.

- Between six and nine months after capping of the four southern landfill sections (Stage B), a similar vane shear boring should be advanced through the center of each of these landfill sections.

- All field monitoring and strength testing data should be evaluated by a licensed geotechnical engineer familiar with the site. Based on this data, the engineer may elect to maintain, increase, or decrease the frequency of monitoring. The engineer may also elect to recommend additional investigative and/or corrective action. Additional investigative action could include field vane shear testing, undisturbed sampling, and laboratory testing. It could be necessitated by projected settlements greater than those estimated, horizontal movements in excess of six inches, unfavorable groundwater level readings, or an apparent loss of strength. Corrective action would probably consist primarily of a modification of the site grading/drainage plan.

- Any adjustments in the final grading should generally be achieved through excavation only, rather than through the placement of additional fill.

RISKS AND LIMITATIONS

From a geotechnical standpoint, the Crucible Landfill is unique, and the work behind this report may represent the furthest extent to which the behavior of the Solvay Process waste is understood.

Nevertheless, it must also be acknowledged that the capped landfill will result in the greatest subsurface pressures ever imposed on Solvay Process waste. There are no comparable full-scale case histories, and the opportunity for monitoring and corrective adjustments is limited by an accelerated schedule of closure.

This report has been prepared for the exclusive use of Caloceri-nos & Spina, for specific application to the Crucible Landfill, in accordance with geotechnical engineering practices and standards generally accepted at the time the report was prepared. No other warranty, expressed or implied, is made.

o O o

The following are attached, and complete this report:

Appendix A: Table 1, Summary of Field and Laboratory Test Results

Appendix B: Figures (2)

Appendix C: Boring Logs

Appendix D: Test Pit Findings

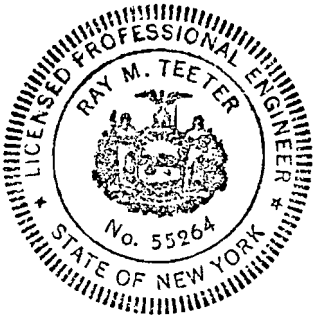
Appendix E: Tube Sample Profiles (8)

Appendix F: Consolidation Curves (6)

Appendix G: References

Respectfully submitted,

RAY M. TEETER, P.E.



Appendix A

Table 1

Summary of Field and Laboratory Test Results

BS-1	1	11	415		186	78				(Solvat	2283	567			3200	.033	560
BS-1	2A	21	405		287	72				Process	1830	730			3200	.243	502
BS-1	2B	21	405		287	72				Waste)	1830	730			4600	.217	500
BS-1	3	31	395		284	74				"	1638	700			3200	.267	503
BS-1	4	41	385		258	75				"	1733	700			4000	.253	583
BS-1	5	51	375		166	77				"	2000	733			2800	.043	.400
BS-2	1	1	410	2	198					"							
BS-2	2	6	405	8	108					"							
BS-2	3	11	400	3	135					"							
BS-2	4	16	395	11	136					"							
BS-2	5	21	390	11	85					"							
BS-2	6	26	385	7	116					"							
BS-2	7	31	380	3	179					"							
BS-2	8	36	375	3	177					"							
BS-2	9	41	370	2	140					"							
BS-2	10	46	365	2	144					"							
BS-2	11	51	360	0	150					"							
BS-2	12	56	355	0	50				75	ML							
BS-2	T-1A	60	351		20	132	Non	Plastic		ML	1725	850	1656				
BS-2	T-1B	61	350		21	129	Non	Plastic		ML	1500	1000	1242				
BS-2	T-1C	62	349		19	131	Non	Plastic		ML	2600	1150	621				
BS-2	13	66	345	57	21				75	ML							
BS-2	14	71	340		22		Non	Plastic		ML							
BS-2		75	336											893			
BS-2	15	76	335		33		35	17		CL							
BS-2	T-2A	80	331		22	128	21	4		ML	650	700	897				
BS-2	T-2B	81	330		22	127	Non	Plastic		ML	650	700	966				
BS-2	T-2C	82	329		22	127	18	5		CL-ML	575	650	1035				
BS-2		85	326											926			
BS-2	T-3A	90	321		22	128	Non	Plastic		ML	725	600	794				
BS-2	T-3B	91	320		22	131	Non	Plastic		ML	325	350	259				
BS-2		95	316											1323			
BS-2	16	101	310	41	20				39	SM							
INC-1	1	49	376	6	158					(Solvat							
INC-1	2	54	371	14	56					Process							
INC-1	3	59	366	18	47					Waste)							
INC-1	4	64	361	17	28		39	15		CL							
INC-1	5	69	356	6	31		29	10		CL							
INC-1	6	74	351	3	33					SM							
INC-1	7	77	346	11	12					SM							
INC-1	8	85	340	6	22					ML							
INC-1	9	90	335	7	21					ML							
INC-1	10	95	330	7	22					ML							
INC-1	11	99	326	25	21					SM							
INC-1	12	104	321	21	22					SM							
INC-1	13	109	316	22	22					SM							
INC-1	14	114	311	30	21					SM							
INC-1	15	119	306	27	18					SM							
INC-1	16	124	301	25	21					SM							
INC-2	1	49	376	2	203					(Solvat							
INC-2	2	59	366	7	179					Process							
INC-2	3A	64	361	18	125					(Waste)							
INC-2	3B	65	360	18	50		50	2		OL							
INC-2	4	69	356	9	31		27	4		ML							
INC-2	5	74	351	20	24					ML							
INC-2	6	79	346	36	19					ML							
INC-2	7	84	341	Piso	31		34	14		CL							
INC-2	8	90	335	7	22		22	7		CL							
INC-2	9	95	330	9	21		19	5		CL-ML							
INC-2	10	99	326	5	21					ML							
INC-2	11	104	321	11	20					ML							
INC-2	12	109	316	26	18					ML							
INC-2	13	114	311	19	22					SM							
INC-2	14	119	306	20	22					SM							
INC-2	15	124	301	24	22					SM							

Appendix B

Figures

FIGURE 1

SITE MONITORING AND BORING LOCATION PLAN

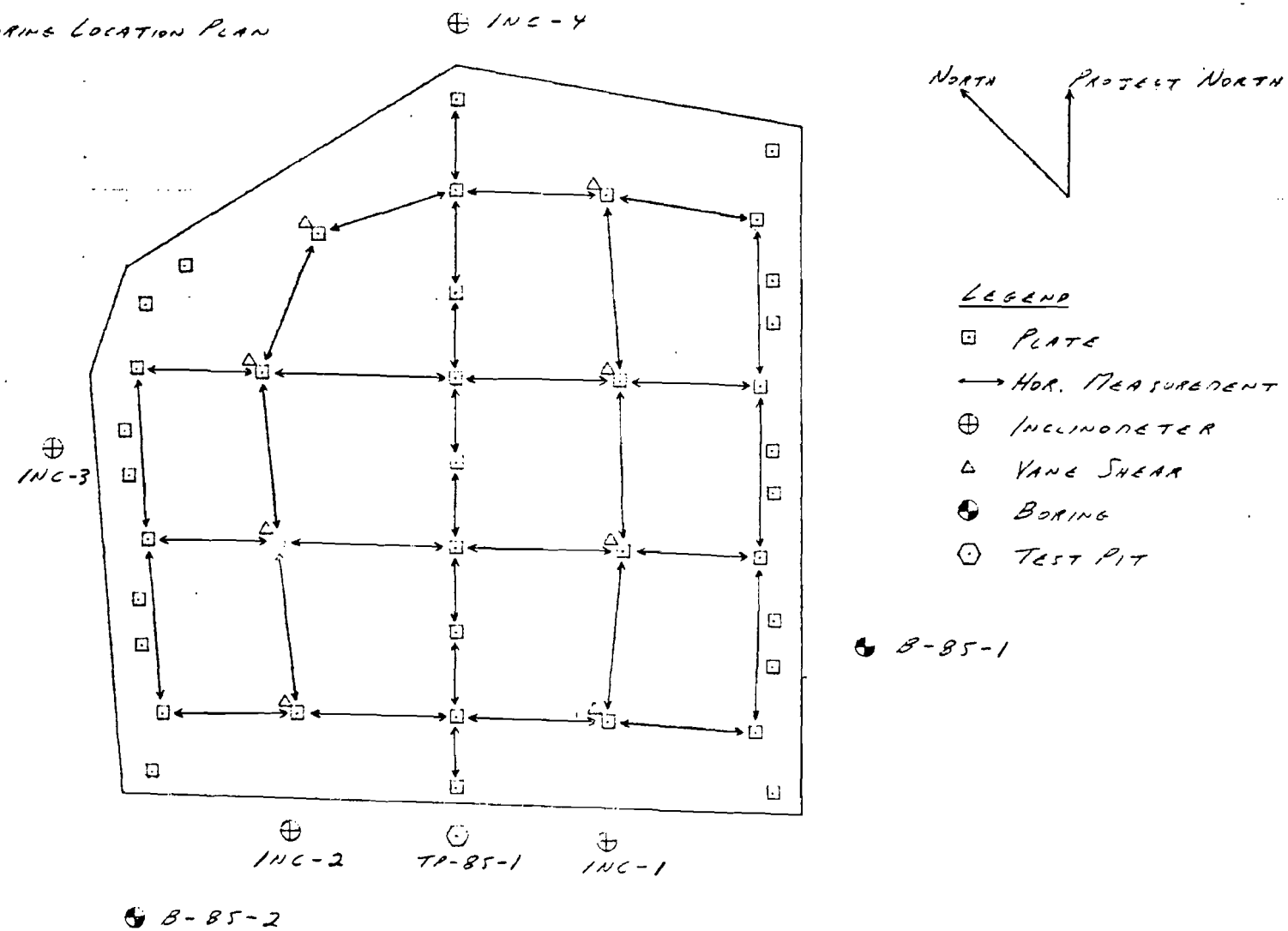
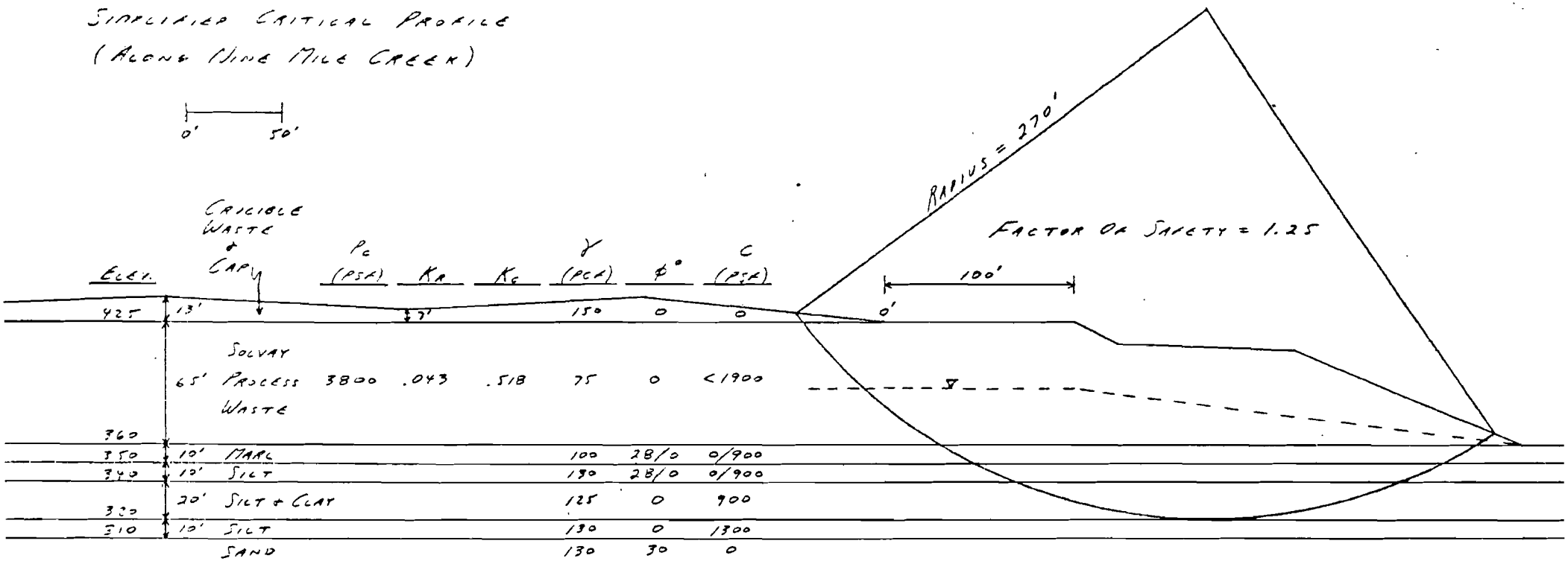


FIGURE 2

SIMPLIFIED CRITICAL PROFILE

(ALONG NINE MILE CREEK)



Appendix C

Boring Logs

DATE
STARTED 5-13-85
FINISHED 5-13-85
SHEET 1 OF 2

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO. B-85-1
SURF. ELEV.
G. W. DEPTH

PROJECT Subsurface Investigation
LOCATION Crucible Landfill

DEPTH FEET	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6 6/12 12/18 N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0						
10		1U	10.0'-12.0' 2.0' Recovery			
20		2U	20.0'-22.0' 2.0' Recovery			
30		3U	30.0'-32.0' 2.0' Recovery			
40						

N = No. blows to drive _____" spoon _____" with _____ lb pin wt falling _____" per blow
C = No. blows to drive _____" casing _____" with _____ lb weight falling _____" per blow.

CLASSIFICATION none

METHOD OF INVESTIGATION 3¼" I.D. Hollow Stem Augers/ 3" dia. thin- wall tube sample

DATE
STARTED 5-13-85
FINISHED 5-13-85
SHEET 2 OF 2

EMPIRE SOILS INVESTIGATIONS INC SUBSURFACE LOG

HOLE NO. B-85-1 cont'd
SURF. ELEV. _____
G. W. DEPTH _____

PROJECT Subsurface Investigation
LOCATION Crucible Landfill

DEPTH FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
40		4U	40.0'-42.0'						
			1.0' Recovery						
45									
50			50.0'-52.0'						
			1.0' Recovery						
								Boring Terminated @51.0'	
55									

N = No blows to drive _____" spoon _____" with _____lb pin wt falling _____"per blow CLASSIFICATION none

C = No blows to drive _____" casing _____" with _____lb weight falling _____"per blow.

METHOD OF INVESTIGATION 3¼" I.D. Hollow Stem Augers/3" dia. thin-wall tube sample

DATE
STARTED 6-17-85
FINISHED 6-20-85
SHEET 1 OF 3

EMPIRE SOILS INVESTIGATIONS INC.

SUBSURFACE LOG

HOLE NO. B-85-2
SURF. ELEV.
G. W. DEPTH Not Recorded

PROJECT Subsurface Investigation
LOCATION Crucible Landfill

DEPTH FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	Sample Rec.	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	1	1	1	2	18"	Solvay Waste	
5		2	2	3	5	8	18"		
10		3	2	1	2	3	15"		
			2						
15		4	6	5	6	11	18"		
			6						
20		5	6	8	3	11	6"		
			1						
25		6	4	5	2	7	20"		
			2						
30		7	2	1	2	3	24"		
			1						
35		8	1	1	2	3	18"		
			1						
40									

N = No. blows to drive 2 " spoon, 12 " with 140 lb pin wt falling 30 "per blow

C = No. blows to drive _____ " casing _____ " with _____ lb weight falling _____ "per blow.

CLASSIFICATION Visual by Driller

METHOD OF INVESTIGATION 4" I.D. Flush Joint Casing/Standard Penetration Test

DATE
STARTED 6-17-85
FINISHED 6-20-85
SHEET 2 OF 3

EMPIRE SOILS INVESTIGATIONS INC. SUBSURFACE LOG

HOLE NO. B-85-2 cont
SURF. ELEV.
G. W. DEPTH

PROJECT Subsurface Investigation
LOCATION Crucible Landfill

DEPTH FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	Sample Rec.	SOIL OR ROCK CLASSIFICATION	NOTES
40		9	1 1	1	1	2	24"	Solvay Waste	
45		10	1 1	1	1	2	24"		47.0'-6-17-85 6-18-85
50		11	WR WR	WR	WR	-	24"		WR-Weight of Rod
							Casing Blows	54.0'	
55								Black PEAT 55.0'	
		12	WR WR	WR	WR	-	40	SILT w/shell-Marl	
							41		
							35		
							50		
60							51		
		1U	60.0'-62.0'				140		
			2.0' Recovery				151		
							145	Friction on Vane Shaft @ 63.2'	
							140		
65							167		
		13	24 30	29	30	59	92	Attempted Vane Shear Test @ 65.0'± couldn't push vane	
			30				91		67.0'-6-18-85 6-19-85
							100	fine SAND & SILT	
							61		
70							55		
							100		Attempted Tube from 70.0'-72.0'- No Recovery
							55		
							51		
							61		
75							60		
							88	Vane Shear Test @ 75.0'±	
							65		
							55		
							45		
80							53		

N = No blows to drive 2 " spoon 12 " with 140 lb pin wt falling 30 "per blow
C = No blows to drive 4 " casing 12 " with 300 lb weight falling 30 "per blow.
CLASSIFICATION Visual by Driller
METHOD OF INVESTIGATION 4" I.D. Flush Joint Casing/Standard Penetration Test

DATE
STARTED 6-17-85
FINISHED 6-20-85
SHEET 3 OF 3

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO. B-85-2 cont'd
SURF. ELEV.
G. W. DEPTH

PROJECT Subsurface Investigation
LOCATION Crucible Landfill

DEPTH	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6 6/12 12/18 N	Blow on casing C	SOIL OR ROCK CLASSIFICATION	NOTES
80		2U 80.0'-82.0'		75		
		2.0' Recovery		60		
				65	Friction on Vane Shaft @ 83.2'	
				31		
				30	Vane Shear Test @ 85.0'±	
85				85		
				61		87.0' 6-19-85
				75		6-20-85
				50		
				51		
90		3U 90.0'-92.0'		60		
		2.0' Recovery		65		
				71		
				70		
				70		
95					Vane Shear Test @ 95.0'±	
100		14 14 21 20 41			fine SAND & SILT	
		25				
					Boring Terminated @ 102.0'	Vane Shear Test data recorded on accompaning Field Vane Shear Test Forms.

N = No. blows to drive 2 " spoon 12 " with 140 lb pin wt falling 30 "per blow
C = No. blows to drive 3 " casing 12 " with 300 lb weight falling 30 "per blow

CLASSIFICATION Visual by Driller

METHOD OF INVESTIGATION 4" I.D. Flush Joint Casing/3" I.D. Thin-walled tubes/Standard Penetration Test

B T Form H

DATE
STARTED 7-25-85
FINISHED 7-26-85
SHEET 1 OF 4

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO. INC-1
SURF. ELEV.
G. W. DEPTH N/A

PROJECT Inclinometer Installation

LOCATION Crucible Landfill
Solvay, NY

DEPTH-FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0								SOLVAY WASTE	No sampling from 0'-48'
5									
10									
15									
20									
25									
30									
35									
40									

N = No. blows to drive _____" spoon _____" with _____lb pin wt falling _____"per blow

C = No. blows to drive _____" casing _____" with _____lb weight falling _____"per blow.

CLASSIFICATION Visual by Driller

METHOD OF INVESTIGATION HW Flush Joint Casing Drilled w/water

DATE
STARTED 7-25-85
FINISHED 7-26-85
SHEET 2 OF 4

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO. INC-1 .cont'd
SURF. ELEV. _____
G. W. DEPTH N/A

PROJECT Inclinometer Installation

LOCATION Crucible Landfill
Solvay, NY

DEPTH FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
40									
45									
		1	2	3	3	6			
			4						
50									
		2	4	8	6	14			
			10						
55									
		3	8	8	10	18			
			15						
60									
								62.0'	
								Grey-Brown, saturated varved SILT & CLAY	
		4	6	7	10	17			
			14						
65									
								68.0'	
		5	3	3	3	6		dark Brown, saturated Organic SILT & CLAY(moderate organic odor)	
			3						
70									
		6	1	2	1	3			
			2						
75									
								78.0'	
		7	6	6	5	11		Black, saturated coarse-fine SAND & CLAY w/decaying wood(strong organic odor	
			5						
80								80.0'	

N = No blows to drive 2 " spoon 12 " with 140 lb pin wt falling 30 "per blow CLASSIFICATION Visual by Driller

C = No blows to drive _____ " casing _____ " with _____ lb weight falling _____ "per blow.

METHOD OF INSTALLATION HW Flush Joint Casing drilled w/water from 0-125' & mud from 100'-125'

DATE
STARTED 7-25-85
FINISHED 7-26-85
SHEET 3 OF 4

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO. INC-1 - cont'd
SURF. ELEV. _____
G. W. DEPTH _____

PROJECT Inclinometer Installation

LOCATION Crucible Landfill
Solvay, NY

DEPTH FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
80								Grey, saturated SILT, little clay, trace fine sand	
85		8	3	3	3	6			
			4						
		9	2	3	4	7			
90			3						
		10	3	4	3	7			
95			4						
								97.0'	
		11	10	12	13	25		Grey, saturated fine SAND & SILT	
			14						
100									
		12	9	11	10	21			
			10					grades little silt	
105									
		13	8	9	13	22			
			11						
110									
		14	12	15	15	30			
			16					grades trace silt	
115									
		15	11	13	14	27			
120			15						

N = No blows to drive 2 " spoon 12 " with 140 lb pin wt falling 30 "per blow CLASSIFICATION Visual by Driller

C = No blows to drive _____ " casing _____ " with _____ lb weight falling _____ "per blow. _____

METHOD OF INVESTIGATION HW Flush Joint Casing Driller w/water from 0'-125' & mud from 100'-125'

DATE
STARTED 7-25-85
FINISHED 7-26-85
SHEET 4 OF 4

EMPIRE SOILS INVESTIGATIONS INC.

SUBSURFACE LOG

HOLE NO. INC-1 cont'd
SURF. ELEV.
G. W. DEPTH N/A

PROJECT Inclinometer Installation

LOCATION Crucible Landfill
Solvay, NY

DEPTH FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
120								Grey, saturated fine SAND, trace silt	
			16	10	10	15	25		
				21					
125								Boring Terminated @ 125.0'	Inclinometer installed to 124'. See accompanying detail.
130									

N = No blows to drive 2 " spoon 12 " with 140 lb pin wt falling 30 "per blow

C = No blows to drive ____ " casing ____ " with ____ lb weight falling ____ "per blow

CLASSIFICATION Visual by Driller

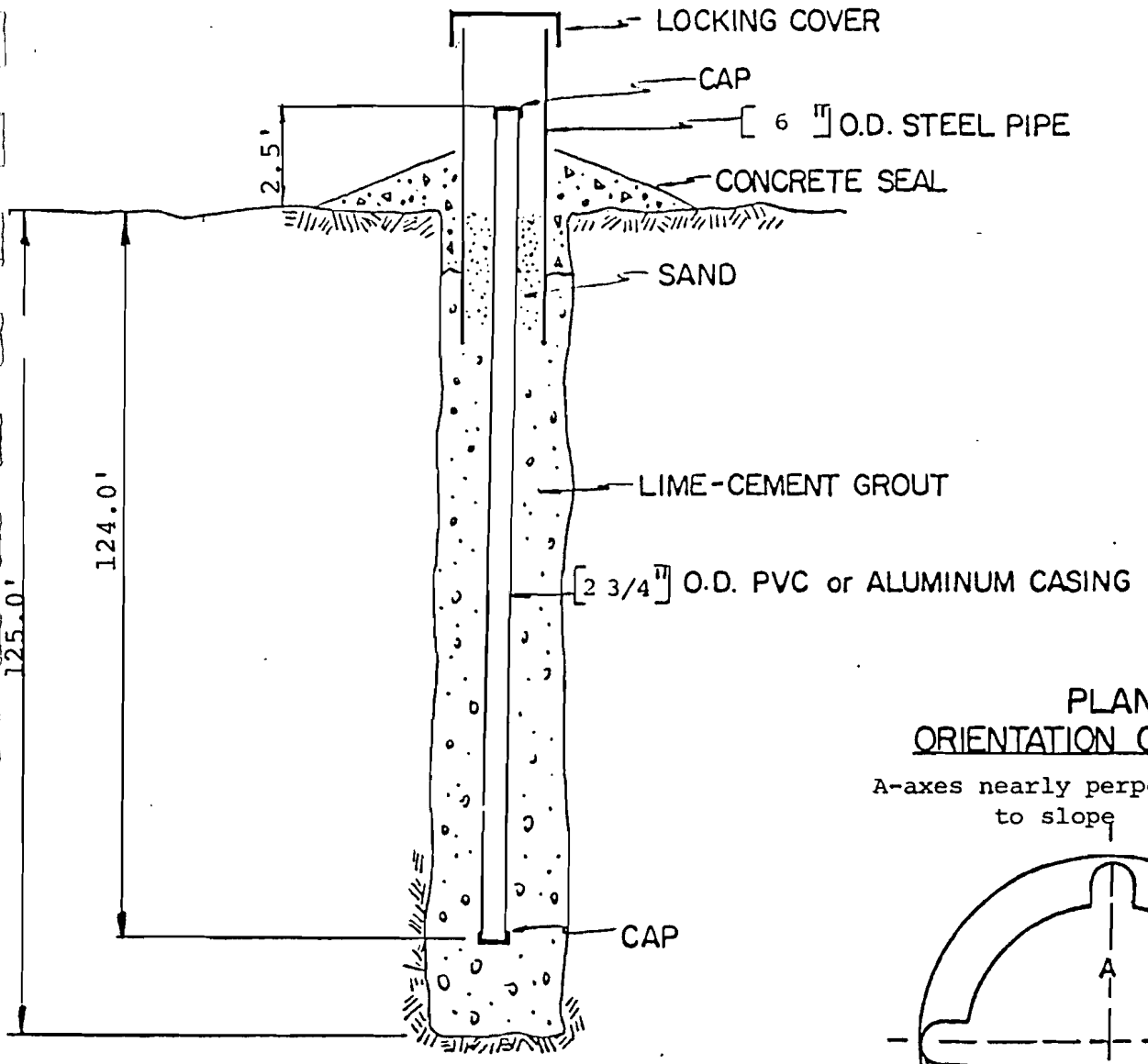
METHOD OF INVESTIGATION HW Flush Joint Casing Driller w/water & mud

PROJECT INCLINOMTER'INSTALLATION BORING NO. INC-1

LOCATION CRUCIBLE LANDFILL SOLVAY, NY INSTALLATION NO. INC-1

TOP GROUND ELEV.

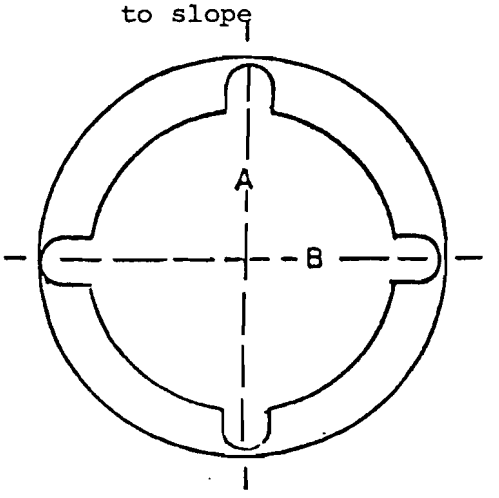
INCLINOMETER CASING DETAILS



PLAN

ORIENTATION OF AXES

A-axes nearly perpendicular to slope



DATE
STARTED 7-22-85
FINISHED 7-24-85
SHEET 1 OF 4

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO. INC-2
SURF. ELEV.
G. W. DEPTH N/A

PROJECT Inclinometer Installation

LOCATION Crucible Steel
Solvay, NY

DEPTH FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER (0/6 | 6/12 | 12/18 | N)	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0					SOLVAY WASTE	No sampling from 0-48'
5						
10						
15						
20						
25						
30						
35						
40						

N = No blows to drive_____" spoon _____" with_____lb pin wt falling_____"per blow

C = No blows to drive_____" casing_____" with_____lb weight falling_____"per blow

CLASSIFICATION Visual by Driller

DATE
STARTED 7-22-85
FINISHED 7-24-85
SHEET 2 OF 4

EMPIRE SOIL INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO. INC-2 cont'd
SURF. ELEV.
G. W. DEPTH

PROJECT Inclinometer Installation
LOCATION Crucible Landfill, Solvay, NY

DEPTH FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
40								SOLVAY WASTE	
45									
		1	2	1	1	2			48.0' 7-22-85 / 7-23-85
			2						
50									
55									
		2	3	3	4	7			
60			4						
		3A	1	7	11	18		64.0'	
		3B	16					Black, saturated Organic SILT & CLAY	
65									
		4	3	4	5	9			
70			7						
								74.0'	
		5	7	9	11	20		Grey, saturated SILT & fine SAND	
75			11						
80		6	18	20	16	36			

N = No blows to drive 2 " spoon 12 " with 140 lb pin wt falling 30 "per blow
C = No blows to drive ____ " casing ____ " with ____ lb weight falling ____ "per blow

CLASSIFICATION Visual by Driller

HW Flush Joint Casing drilled w/water

DATE
STARTED 7-22-85
FINISHED 7-24-85
SHEET 3 OF 4

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO. INC-2 cont'd
SURF. ELEV.
G. W. DEPTH

PROJECT Inclinometer Installation
LOCATION Crucible Landfill, Solvay, NY

DEPTH FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
80			12					Grey, saturated SILT & fine SAND	
								83.5'	
85		7	PUSH*					Grey, saturated CLAY & SILT	Casing dropped 3ft. when uncoupled, obtained S-7 by pushing spoon inside casing.
90		8	3	3	4	7			
			4						
95		9	5	5	4	9		grades SILT, Some Clay	
			7						
100		10	3	2	3	5		grades SILT, little clay	100.5' 7-23-85 / 7-24-85
			2						
105		11	5	6	5	11		grades SILT, little fine sand	
			6						
110		12	9	13	13	26		grades fine SAND, little silt	
			10						
115		13	8	9	10	19		grades fine SAND, trace silt	
			11						
120		14	10	10	10	20			
			12						

N = No. blows to drive 2" spoon 12" with 140 lb pin wt falling 30" per blow CLASSIFICATION Visual by Driller

C = No. blows to drive ____" casing ____" with ____ lb weight falling ____" per blow.

METHOD OF INVESTIGATION HW Flush Joint Casing Driller w/water

DATE
STARTED 7-22-85
FINISHED 7-24-85
SHEET 4 OF 4

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO. INC-2 cont'd
SURF. ELEV.
G. W. DEPTH

PROJECT Inclinometer Installation

LOCATION Crucible Landfill
Solvay, NY

DEPTH FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
120									
	/	15	11	12	12	24		Grey, saturated fine SAND, trace silt	
			13						
125								Boring Terminated @ 125.0'	Inclinometer installed to 125. See accompanying detail.
130									

N = No blows to drive 2 " spoon 12 " with 140 lb pin wt falling 30 "per blow
C = No blows to drive _____ " casing _____ " with _____ lb weight falling _____ "per blow

CLASSIFICATION Visual by Driller

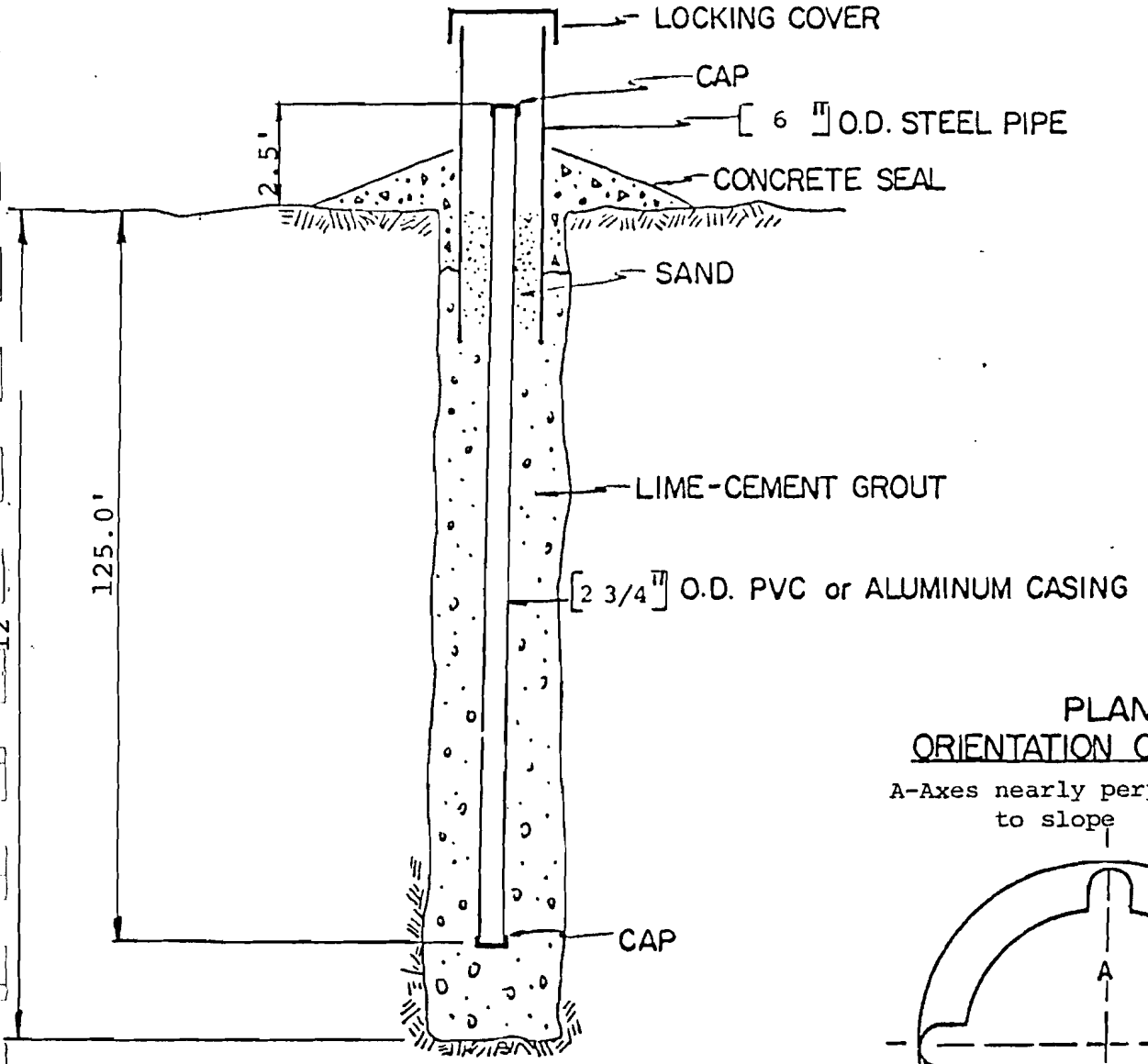
METHOD OF INVESTIGATION HW Flush Joint Casing drilled w/water

PROJECT INCLINOMTER INSTALLATION BORING NO. INC-2

LOCATION CRUCIBLE LANDFILL SOLVAY, NY INSTALLATION NO. INC-2

TOP GROUND ELEV.

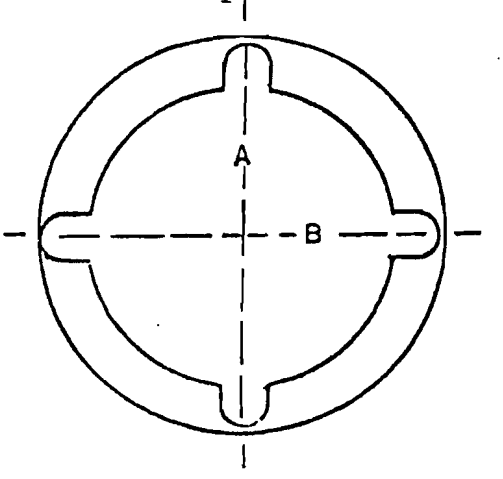
INCLINOMETER CASING DETAILS



PLAN

ORIENTATION OF AXES

A-Axes nearly perpendicular to slope



DATE
STARTED 7-29-85
FINISHED 7-30-85
SHEET 1 OF 1

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO. INC-3
SURF. ELEV.
G. W. DEPTH N/A

PROJECT Inclinometer Installation

LOCATION Crucible Landfill
Solvay, NY

DEPTH FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
								Drilled without sampling from 0'-125.0'	Inclinometer installed to 125'. See accompanying detail.

N = No. blows to drive _____" spoon _____" with _____ lb. pin wt. falling _____" per blow

C = No. blows to drive _____" casing _____" with _____ lb. weight falling _____" per blow

CLASSIFICATION None

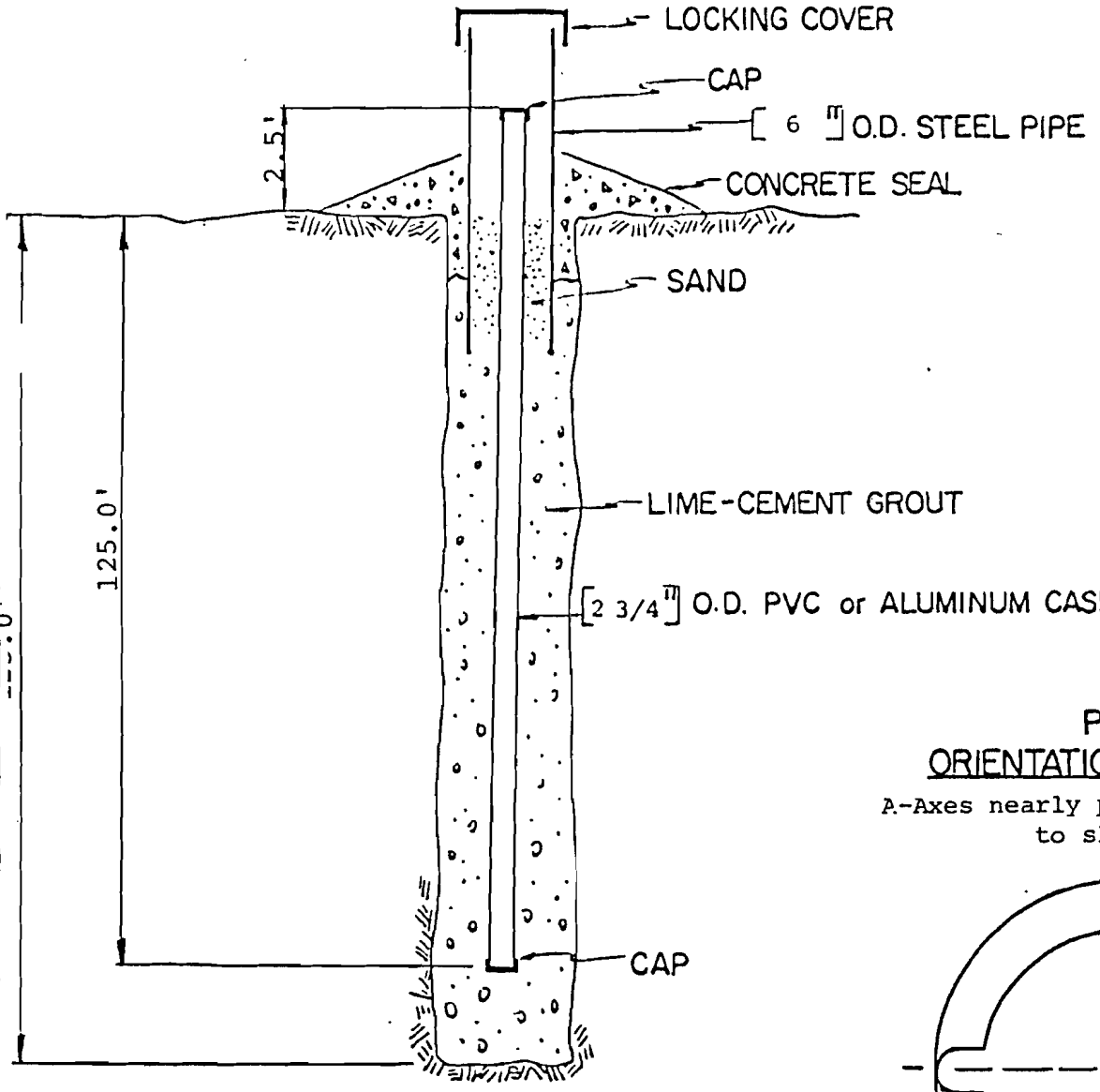
METHOD OF INVESTIGATION: HW Flush Joint Casing Drilled with Water from 0-100' and Mud 100'-125'

PROJECT INCLINOMTER INSTALLATION BORING NO. INC-3

LOCATION CRUCIBLE LANDFILL SOLVAY, NY INSTALLATION NO. INC-3

TOP GROUND ELEV.

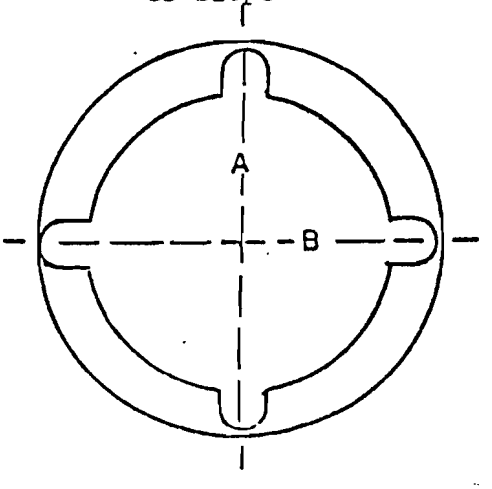
INCLINOMETER CASING DETAILS



PLAN

ORIENTATION OF AXES

A-Axes nearly perpendicular to slope



DATE
STARTED 7-30-85
FINISHED 8-01-85
SHEET 1 OF 1

EMPIRE SOILS INVESTIGATIONS INC

SUBSURFACE LOG

HOLE NO. INC-4
SURF. ELEV.
G. W. DEPTH N/A

PROJECT Inclinometer Installation

LOCATION Crucible Landfill
Solvay, NY

DEPTH FT	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
								Drilled without sampling from 0'-125.0'	Inclinometer installed to 125'. See accompanying detail.

N = No blows to drive_____" spoon_____" with_____lb pin wt falling_____"per blow

C = No blows to drive_____" casing_____" with_____lb weight falling_____"per blow.

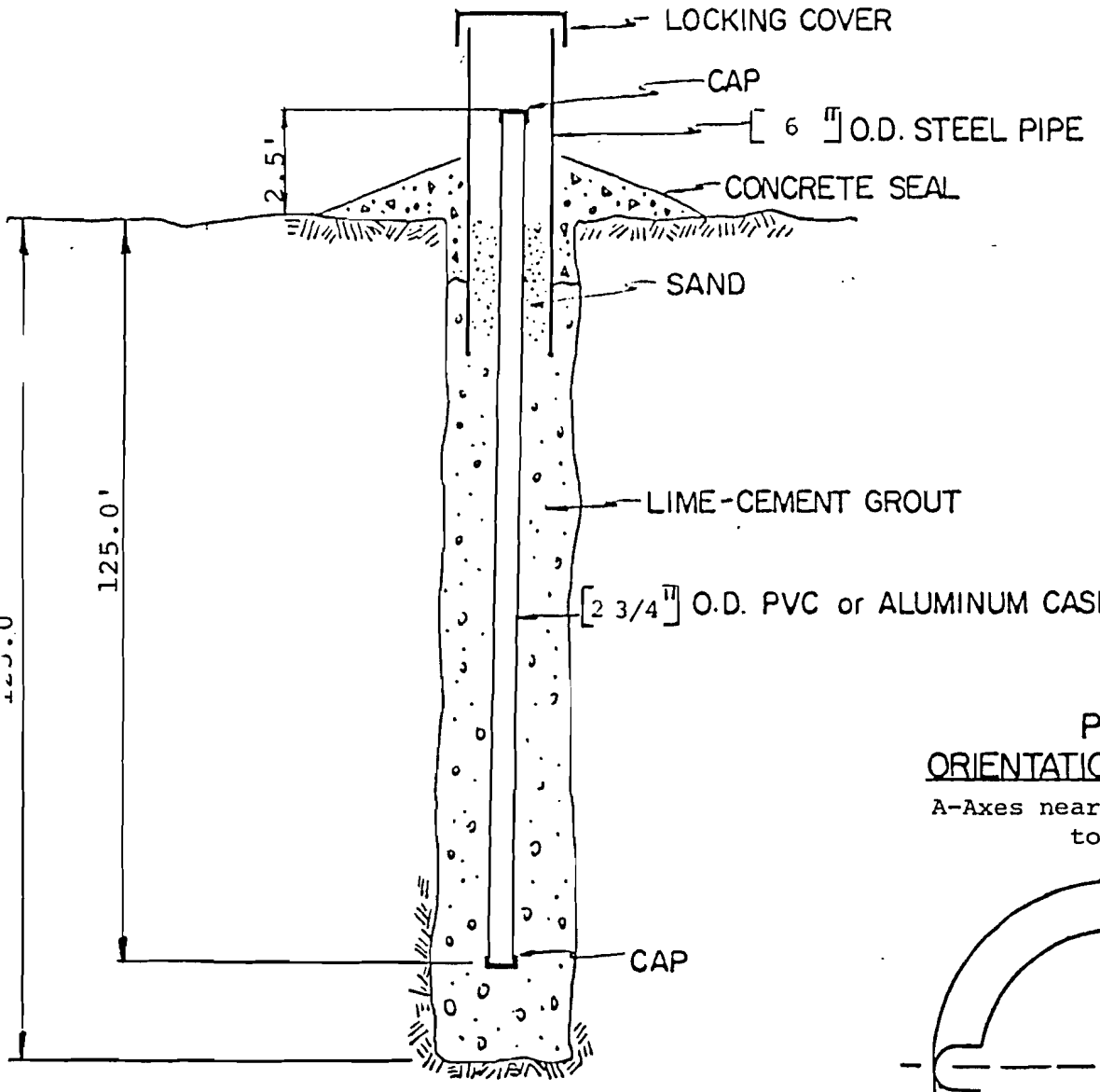
CLASSIFICATION None

PROJECT INCLINOMTER INSTALLATION BORING NO. INC-4

LOCATION CRUCIBLE LANDFILL SOLVAY, NY INSTALLATION NO. INC-4

TOP GROUND ELEV.

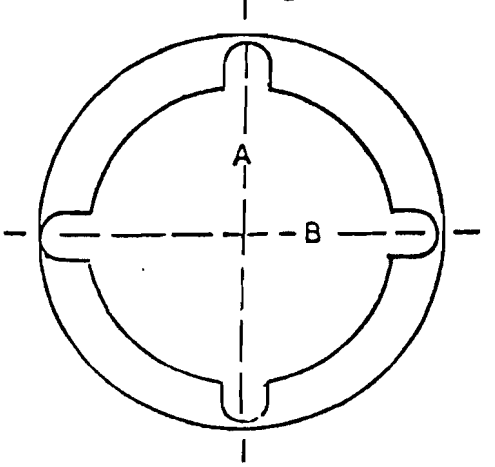
INCLINOMETER CASING DETAILS



PLAN

ORIENTATION OF AXES

A-Axes nearly perpendicular to slope



Appendix D

Test Pit Findings

Findings From Test Pit TP-85-1

(Excavated and Backfilled on July 17, 1985)

Approximate Depth (Feet)	Average Shear Strength (psf)			
	Pocket Penetrometer		Torvane	
	Vertical (Floor)	Horizontal (Wall)	Vertical (Wall)	Horizontal (Floor)
4	2250	1850	800	900
5-6	2000	1750	-	-

Approximate Crudely Applied Vertical Load (psf)	Approximate Disturbed Pocket Penetrometer Shear Strength (psf)
4,000	2250
6,000	2000
8,000	2250
10,000	2500
12,000 (failed)	2500
12,000	3000
16,000 (failed)	2500

Notes

1. The Solvay Process waste is horizontally bedded.
2. Numerous vertical discontinuities also exist.
3. No dipping discontinuities were noted.
4. The strengths of the intact Solvay Process waste in the test pit are similar to those measured in tube samples.
5. The intact Solvay Process waste has generally isotropic strength characteristics.
6. In the absence of a normal confining stress, the strengths along discontinuities are significantly less than those through the intact waste.
7. After loading the Solvay Process waste to and beyond 4000 pounds per square foot, there does not appear to be a significant loss in strength.

Appendix E

Tube Sample Profiles

Key to Tube Sample Profiles

MC: Moisture content (percent)

WD: Wet density (pounds per cubic foot)

PI: Plasticity index (percent)

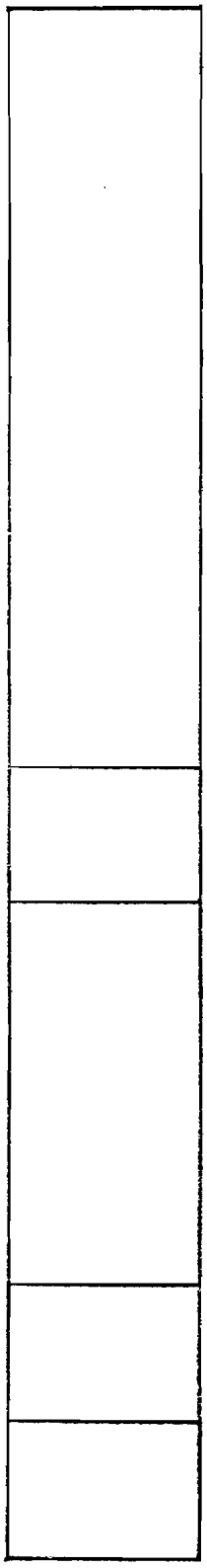
PP: Unconfined compressive strength (tons per square foot), measured by Pocket Penetrometer

TV: Undrained shear strength (tons per square foot), measured by Torvane

UC: Unconfined compressive strength (pounds per square foot)

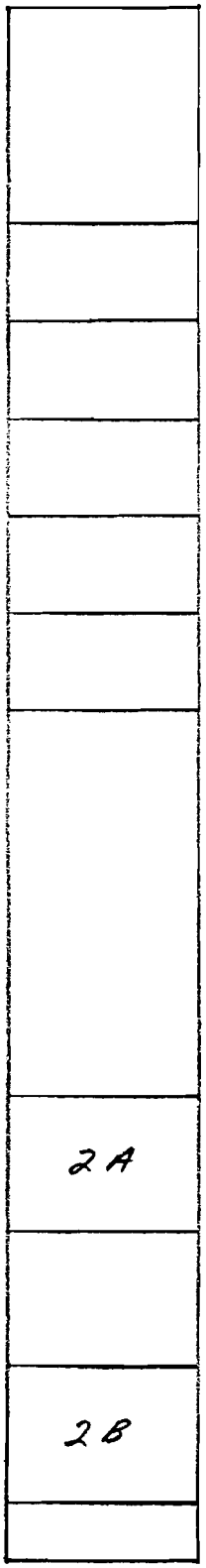
Pc: Apparent preconsolidation pressure (tons per square foot), measured by consolidation testing

BORING B-85-1
TUBE 1
10.0' – 12.0'
ALL MATERIAL BONE WHITE SOLVAY PROCESS WASTE



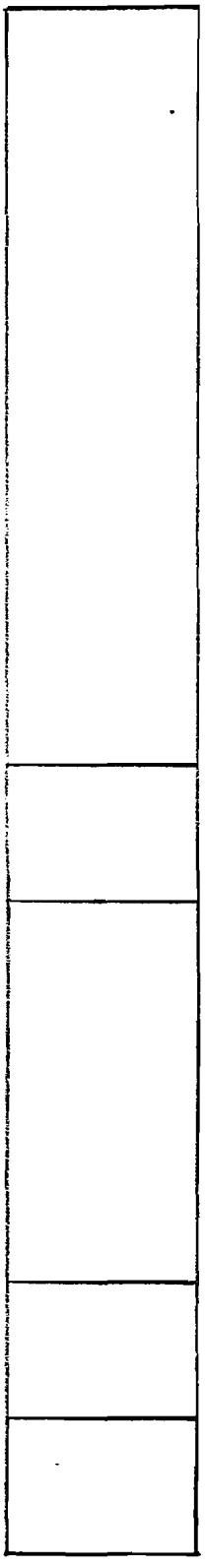
MC (%)	WD (PCF)	PP (TSF)	TV (TSF)	Pc (TSF)
		1.7	.3	
		–		1.6
		3.5	.3	
186	78			
		1.65	.25	
		TOO HARD TO TEST		

BORING B-85-1
TUBE 2
20.0'-22.0'
ALL MATERIAL BONE WHITE SOLVAY PROCESS WASTE



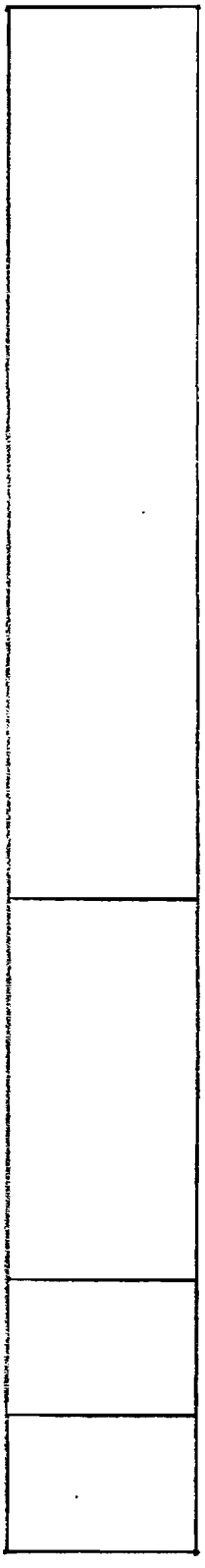
	MC (%)	WD (PCF)	PP (TSF)	TV (TSF)	Pc (TSF)
			2.05	.4	
			1.4	.3	
			1.55	.35	
			1.65	.4	
			1.65	.35	
			2.2	.3	
	287	72			
			2.1	.3	
2A					1.7
			1.75	.4	
			1.8	.35	
2B					2.3
			2.15	.5	

BORING B-85-1
TUBE 3
30.0'-32.0'
ALL MATERIAL BONE WHITE SOLVAY PROCESS WASTE



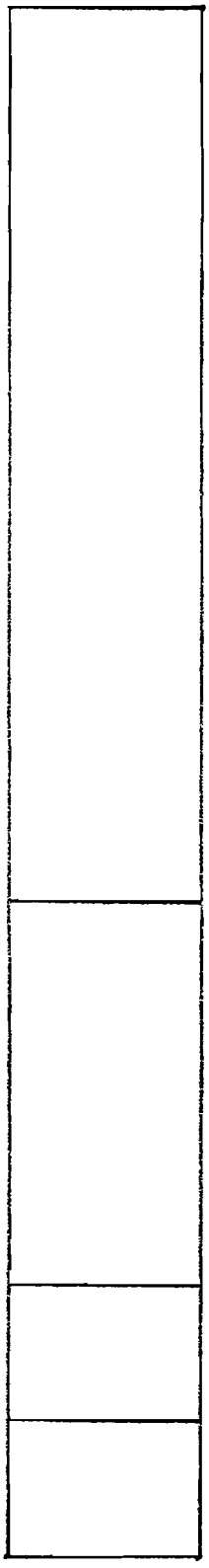
MC (%)	WD (PCF)	PP (TSF)	TV (TSF)	P_c (TSF)
		1.5	.4	
		1.9	.3	
284	74			
		1.65	.35	
				1.7
		1.5	.35	

BORING B-85-1
TUBE 4
40.0' – 42.0'
ALL MATERIAL BONE WHITE SOLVAY PROCESS WASTE



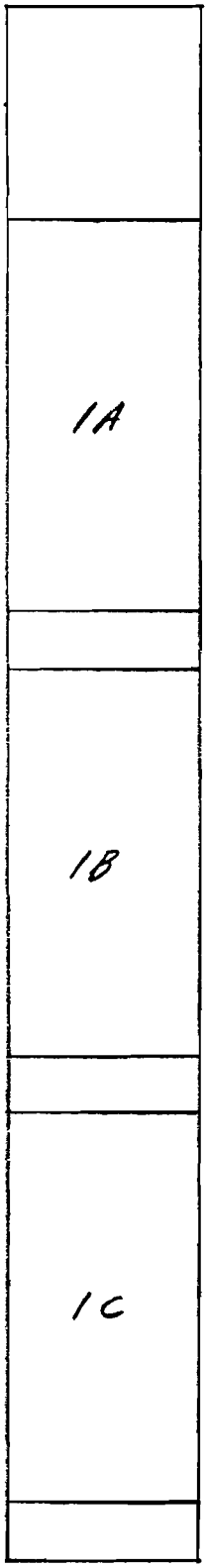
	MC (%)	WD (PCF)	PP (TSF)	TV (TSF)	Pc (TSF)
			1.8	.35	
	258	75			
			1.8	.35	
					2.0
			1.6	.35	

BORING B-85-1
TUBE 5
50.0' - 52.0'
ALL MATERIAL BONE WHITE SOLVAY PROCESS WASTE



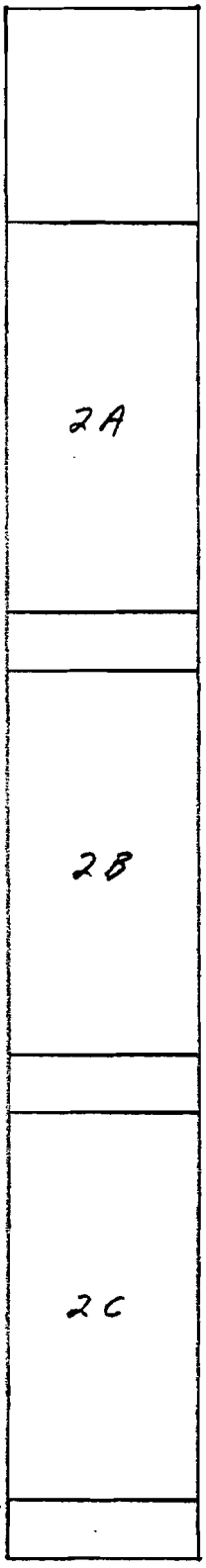
MC (%)	WD (PCF)	PP (TSF)	TV (TSF)	Pc (TSF)
		TOO HARD	.3	
166	79			
		2.5	.5	
				1.4
		1.5	.3	

BORING B-85-2
TUBE 1
60.0' - 62.0'
ALL MATERIAL BROWN SILT



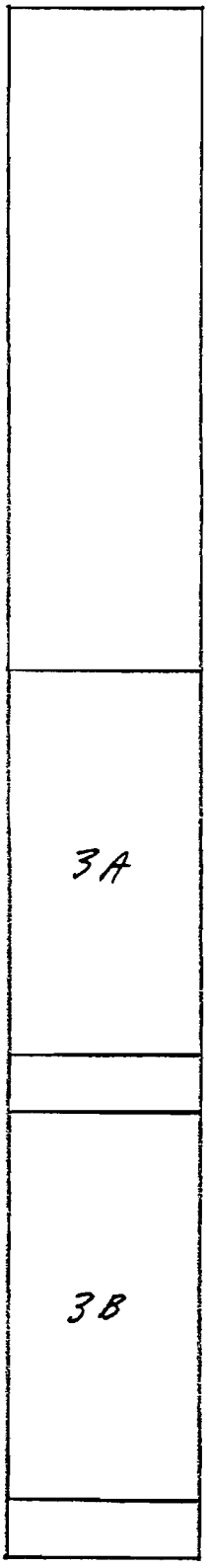
	WD (PCF)	MC (%)	PI (%)	PP (TSF)	TV (TSF)	UC (PSF)
				1.8	.45	
1A	132	19.5	NP			3312
				1.65	.4	
1B	129	21.1	NP			2484
				1.35	.6	
1C	131	18.9	NP			1242
				3.85	.55	

BORING B-85-2
TUBE 2
80.0' - 82.0'
ALL MATERIAL BROWN SILT



	WD (PCF)	MC (%)	PI (%)	PP (TSF)	TV (TSF)	UC (PSF)
2A	128	21.8	4			1794
				.65	.35	
2B	127	22.2	NP			1932
				.65	.35	
2C	127	21.7	5			2070
				.5	.3	

BORING B-85-2
TUBE 3
90.0' - 92.0'
ALL MATERIAL BROWN SILT

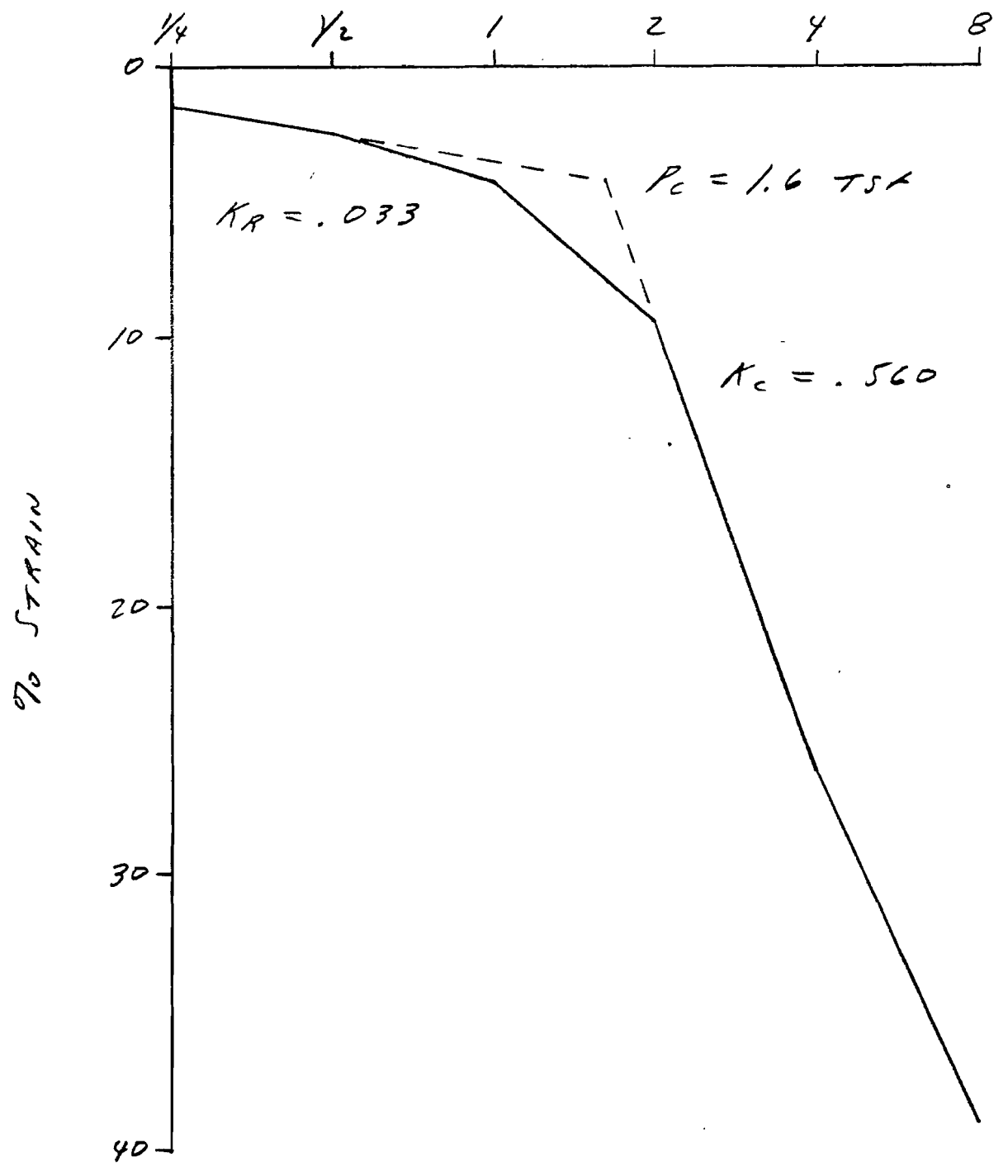


	WD (PCF)	MC (%)	PI (%)	PP (TSF)	TV (TSF)	UC (PSF)
				1.2	.4	
3A	128	22.0	NP			1588
				.25	.2	
3B	131	21.6	NP			1518
				.4	.15	

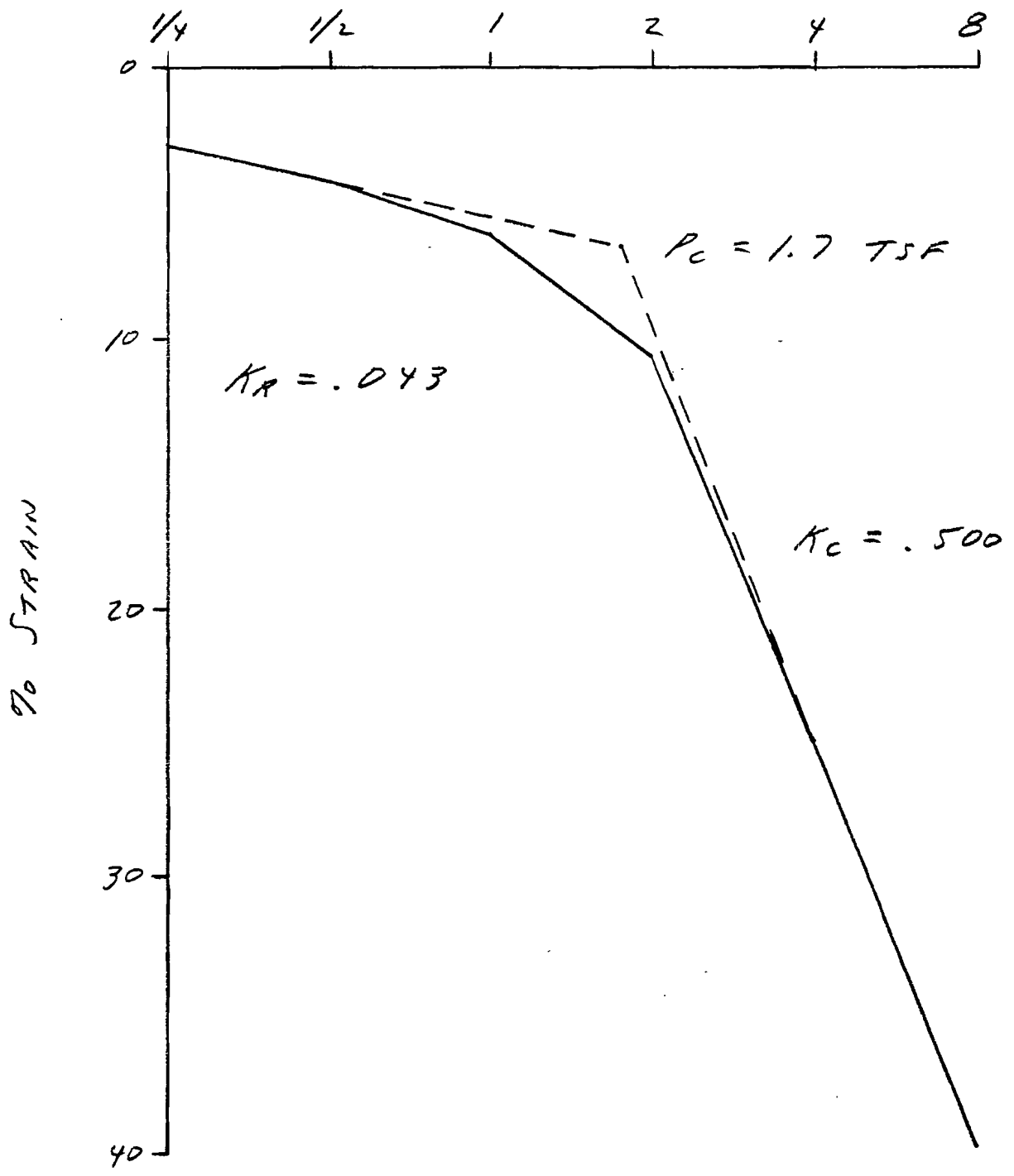
Appendix F

Consolidation Curves

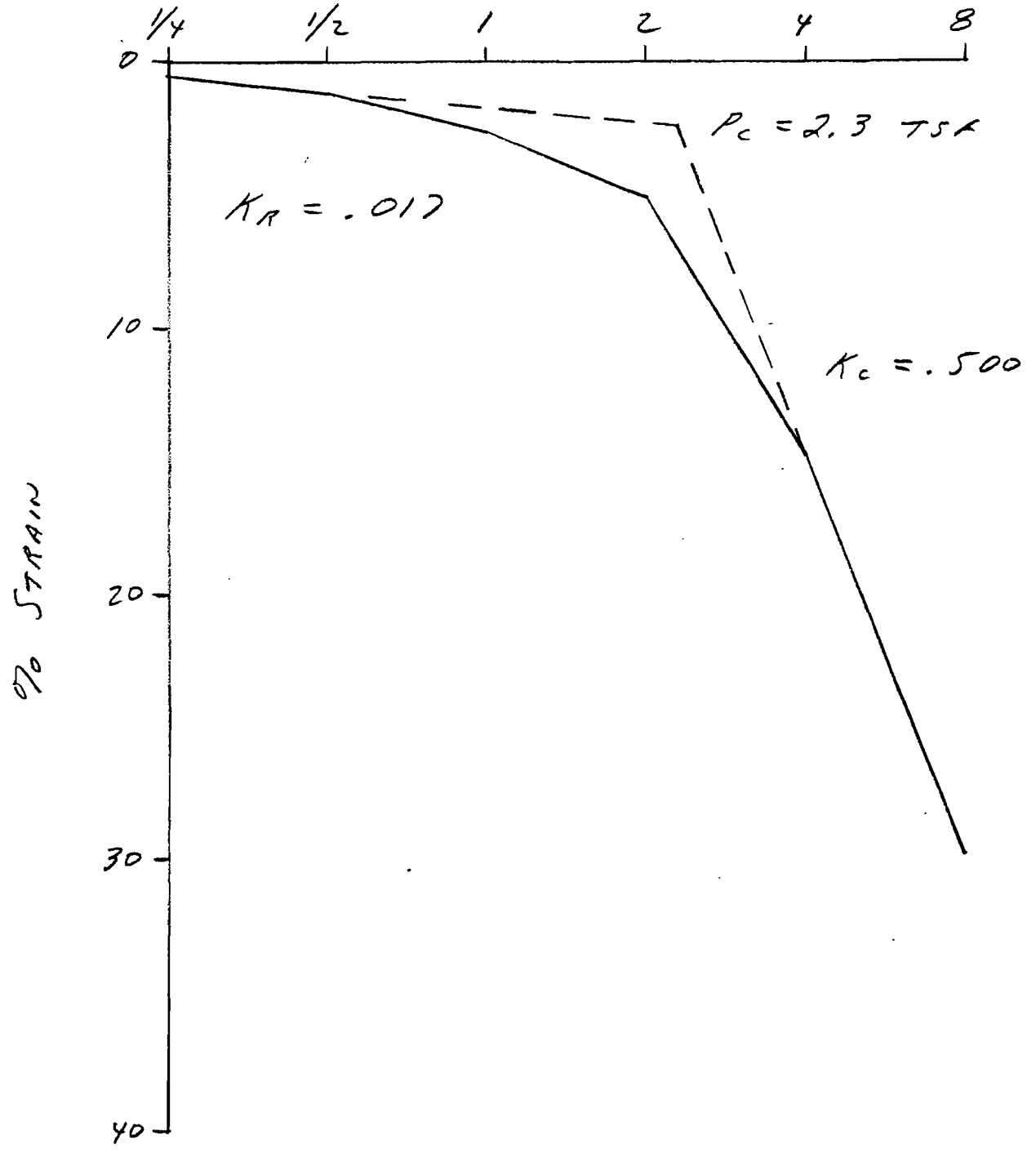
BORING B-85-1
TUBE SAMPLE 1
10.0' - 12.0'



BORING B-85-1
TUBE SAMPLE 2A
20.0' - 22.0'

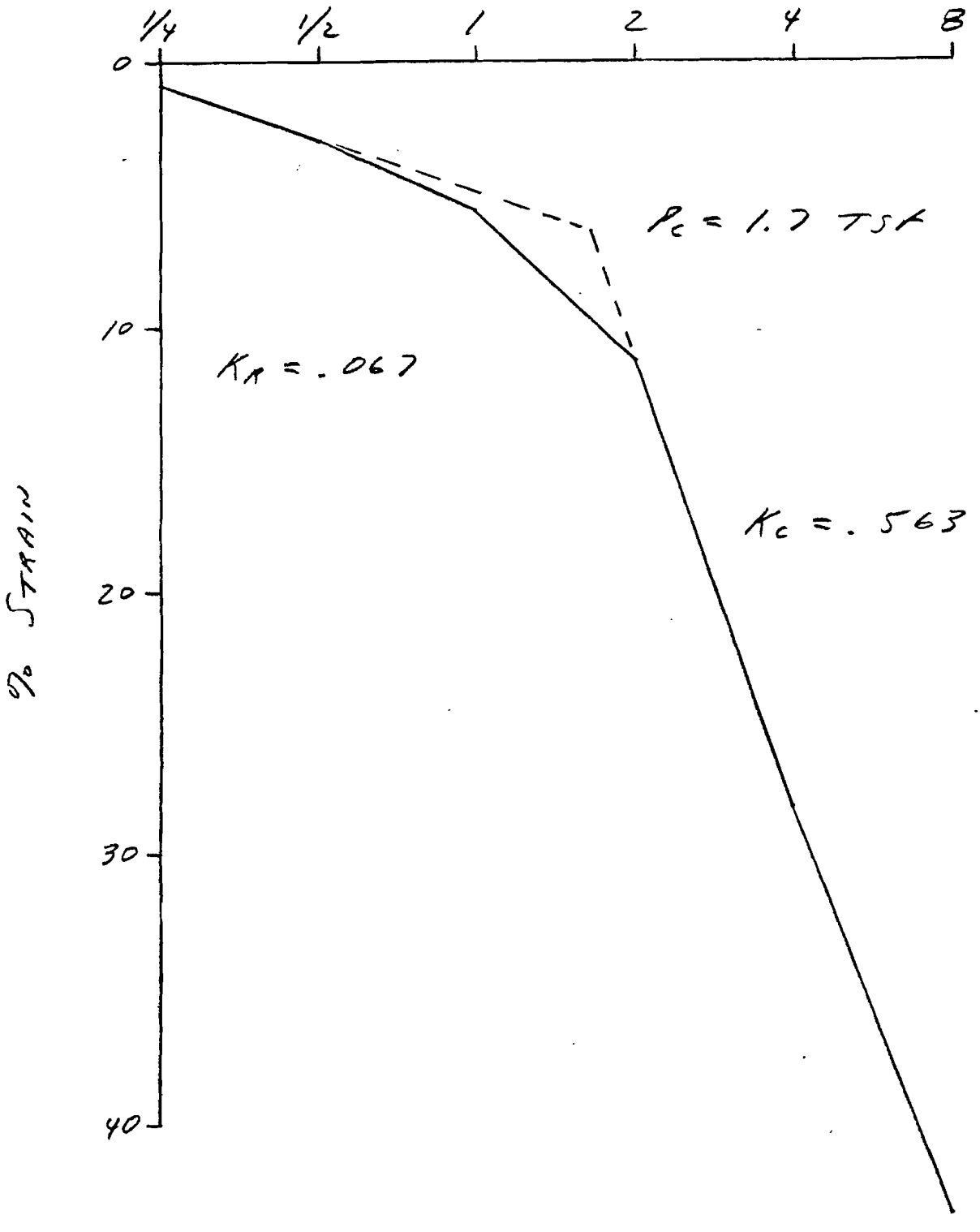


BORING B-85-1
TUBE SAMPLE 2B
20.0' - 22.0'



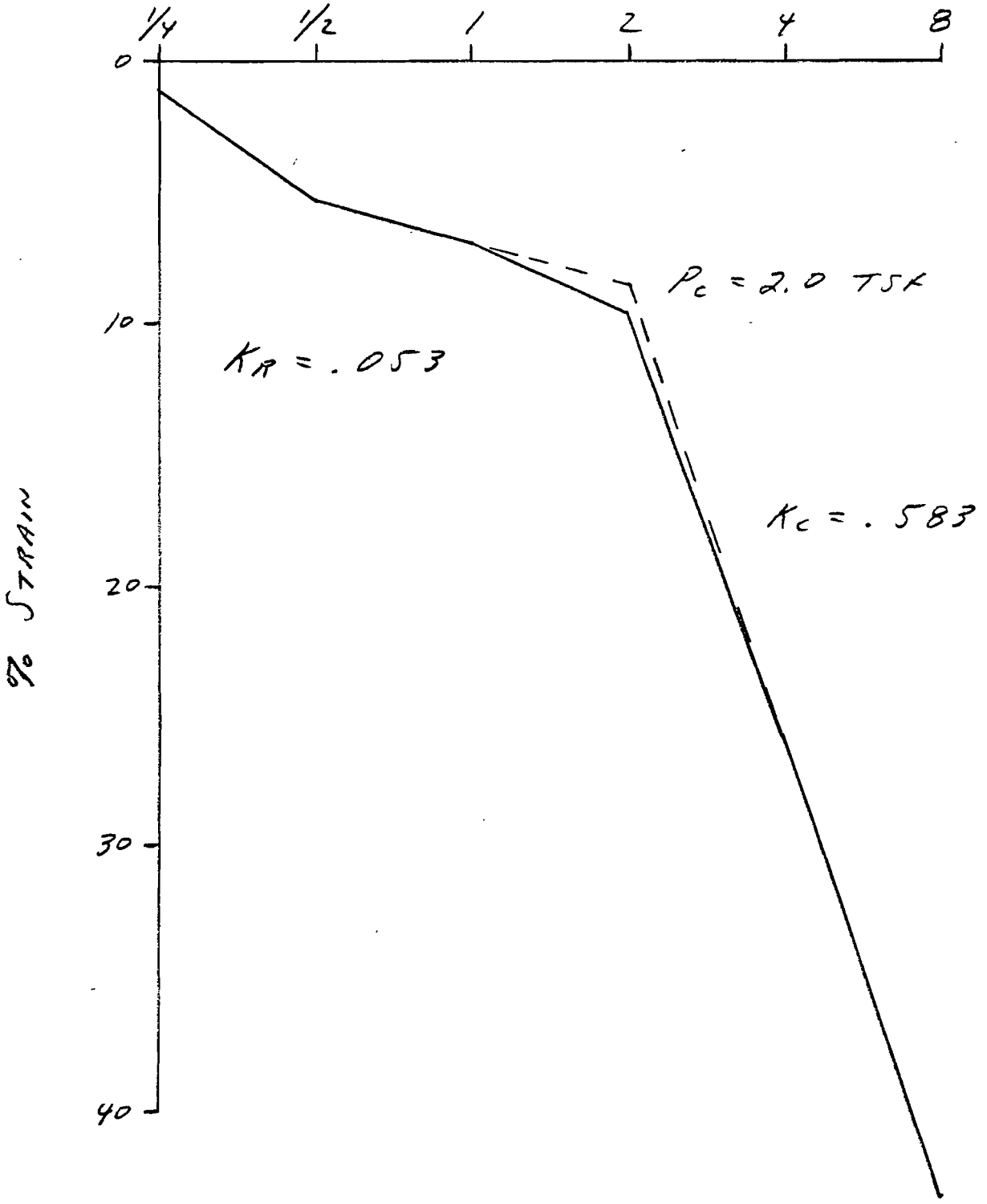
BORING B-85-1
TUBE SAMPLE 3
30.0' - 32.0'

EFFECTIVE VERTICAL STRESS (TSF)



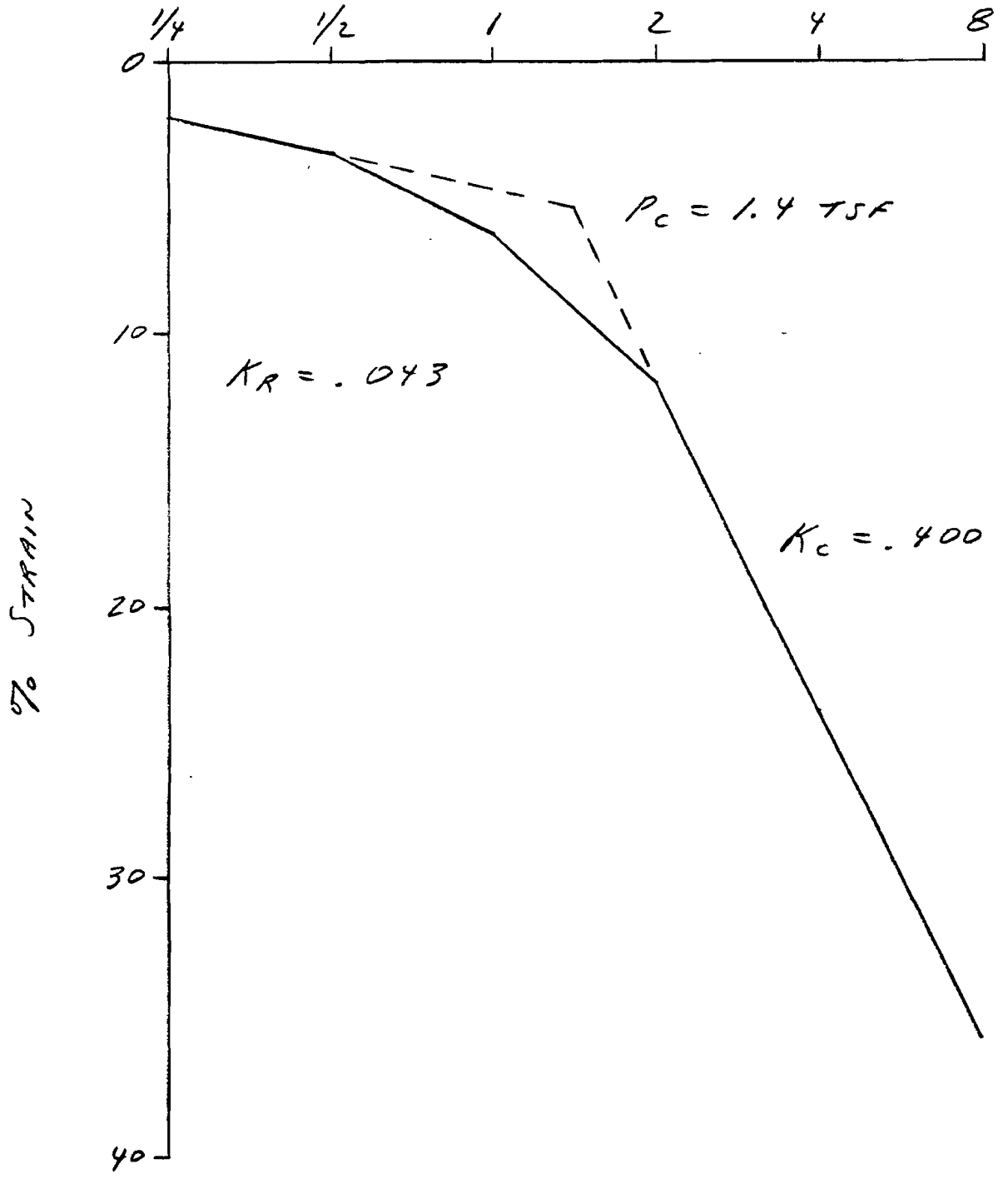
BORING B-85-1
TUBE SAMPLE 4
40.0' - 42.0'

EFFECTIVE VERTICAL STRESS (TSF)



BORING B-85-1
TUBE SAMPLE 5
50.0' - 52.0'

EFFECTIVE VERTICAL STRESS (TSF)



Appendix G

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APPENDIX D

TYPICAL QUALITY ASSURANCE PROGRAM

(LINER MANUFACTURE AND INSTALLATION)

APPENDIX D

CONSTRUCTION QUALITY ASSURANCE PLAN

FOR THE

CRUCIBLE LANDFILL CLOSURE

JANUARY 1986

CQA PLAN

TABLE OF CONTENTS

CQA PLAN

TABLE OF CONTENTS
(Continued)

CQA PLAN

TABLE OF CONTENTS
(Continued)

SECTION 1

INTRODUCTION

1.1 GENERAL

This Construction Quality Assurance (CQA) Plan is for the construction activities relative to the closure of the landfill used by Crucible Specialty Metals for disposal of its manufacturing wastes. This plan has been prepared as an appendix to "Revised Landfill Closure Plan" which is the engineering report for the landfill closure project. The engineering report contains background information on the landfill, and the details and technical justification for the closure project. It is assumed that the reader of this CQA plan is familiar with the details of the Crucible Landfill closure project.

1.2 PURPOSE

This CQA plan is intended to provide a planned and systematic pattern of all means and actions designed to provide adequate confidence that items or services meet contractual and jurisdictional requirements and will perform satisfactorily in service.

1.3 SCOPE

The preliminary technical specifications for the various construction services are attached to this plan. This plan will describe the steps which will be taken to insure that the construction activities are performed in accordance with the specifications. Reference is made to individual specification sections as appropriate. Additionally the proposed CQA record-keeping methods will be described.

SECTION 2

RESPONSIBILITY AND AUTHORITY

2.1 Parties

The parties who may be involved with the landfill closure are defined and when possible identified below.

2.1.1 Approval Agency

The Approval Agency is authorized by law and regulation to approve the plan of closure of a hazardous waste land disposal facility. It is the responsibility of the Approval Agency to review the facility owner/operator's closure plan, including the site-specific CQA plan, for compliance with the agency's requirements and to approve or disapprove the closure plan based on this review. The agency will have the responsibility and authority to review and accept or reject any design revisions or request for changes that are submitted by the facility owner/operator after the approval is granted. The agency also may review CQA records during or after facility construction to confirm, with a reasonable degree of certainty, that the facility was constructed so that it meets or exceeds all design criteria, plans and specifications.

The Approval Agency is:

New York State Department
of Environmental Conservation
Bureau of Hazardous Waste Technology
Division of Solid and Hazardous Waste
50 Wolf Rd.
Albany, NY 12233-0001

Contact: Mr. Harvey King
(518) 457-9253

2.1.2 Facility Operator

The Facility Operator is responsible for the hazardous waste landfill facility. He is also responsible for the operation of the facility. This responsibility includes complying with the requirements of the Approval Agency in order to obtain closure approval and assuring the agency, by the submission of CQA documentation, that the facility was constructed, with a reasonable degree of certainty, to meet or exceed all design plans, criteria and specifications.

The Operator of this facility is:

Crucible Speciality Metals Division
Crucible Materials Corporation Inc
PO Box 977
Syracuse, NY 13201

Contact: Mr. Robert H. Wills, Jr.

Additionally, as explained in Section 5 and Appendix I of the Revised Closure Plan, Colt Industries Inc. is the former operator of the facility and remains financially responsible for closure and post-closure costs and liability coverage for accidental occurrences.

2.1.3 Project Manager

The Project Manager is the official representative of the operator. He will be in charge of coordinating field activities.

The Project Manager will be an employee of the Operator who will be assigned the duties of Project Manager for the landfill closure construction.

2.1.4 Design Engineer/Inspector

The Design Engineer is responsible for the design, drawings, plans and specification of the landfill closure system and the supporting soil. Design activities do not end until closure is completed; the Design Engineer may have to change some design elements if unexpected site conditions are encountered or changes in construction methodology occur that could adversely affect performance of the closed landfill.

The Inspector is a party independent from the Manufacturer, Fabricator, Installer or Contractor who is responsible for observing and documenting activities related to the quality assurance of all construction components related to the landfill closure. He is also responsible for issuing a certification report, sealed by a registered Professional Engineer.

The Design Engineer/Inspector is the firm Calocerinos & Spina Consulting Engineers.

2.1.5 Contractors

The specific responsibilities of the contractors will be enumerated in the contract specifications. In general the construction contractor shall perform the landfill closure in strict accordance with design criteria, plans and specifications, using the necessary construction procedures and techniques. Additionally the contractors will be required to formulate and implement plans for construction quality control. The construction contractor has the authority to direct and manage his employees and the equipment they use to accomplish the construction.

Individual contractors are defined below. It is anticipated that there will be only two prime contracts, one for earthwork and one for supply and installation of the geomembrane, with several subcontractors.

2.1.5.1 Earthwork Contractor

The earthwork contractor is responsible for grading the Crucible wastes and underlying materials to final grade, preparing the supporting surface for the geomembrane, backfilling the geomembrane anchor trenches, and placing granular materials and final cover system on the geomembrane liner.

2.1.5.2 Resin Supplier

The Resin Supplier will produce and deliver HDPE resin to the Manufacturer.

2.1.5.3 Manufacturer

The Manufacturer is responsible for production of geomembrane rolls from resin.

2.1.5.4 Fabricator

The fabricator is responsible for the fabrication of geomembrane blankets from geomembrane rolls.

2.1.5.5 Transporter

The Transporter will transport geomembrane rolls or blankets between the Manufacturer, Fabricator and/or the site, as appropriate.

2.1.5.6 Installer

The Installer is responsible for field handling, storing, placing, seaming and other site aspects of the geomembrane panels.

2.2 Meetings

2.2.1 Resolution Meeting

Following the completion of the design criteria, plans and specifications and this CQA plan, a meeting will be held to resolve any uncertainties. The required attendees are: Project Manager and Design Engineer/Inspector. The following items will be accomplished:

A. Provide each party with all relevant documents and supporting information.
B. Review the design criteria, plans and specifications.
C. Review the CQA Plan.
D. Make any appropriate modifications to the design criteria, plans and specification so that the fulfillment of all design specifications or performance standards can be determined through the implementation of the CQA Plan.
E. Make any appropriate modifications to the CQA plan to ensure that it specifies all CQA activities that are necessary to determine if design criteria, plans and specifications can be measured.

The meeting will be documented by the Design Engineer/Inspector, and minutes transmitted to all parties and made part of the CQA record.

2.2.2 Initial Meeting

Following completion of the final design plans and specifications for the project and selection of the contractors an initial meeting will be held including the Project Manager, Design Engineer/Inspector, Earthwork Contractor, and Installer. The following items will be covered in the initial meeting:

A. Communicate to all parties any relevant documents.
B. Review critical design details of the project.
C. Review the seam layout drawing provided by the Installer.
D. Make any appropriate modification to the Quality Assurance Plan.
E. Establish a final understanding on the Quality Assurance Plan and quality control procedures.
F. Assign responsibilities of each party.
G. Decide the number of spare seaming units to be maintained on site by the Installer (this number depends on the number of seaming crews and on the type of seaming equipment).
H. Establish methods for documenting and reporting, and for distributing documents and reports.
I. Establish rules for writing on the geomembrane, i.e., who is authorized to write, what can be written and in which color.
J. Outline procedures for packaging and storing archive samples.
K. Establish lines of authority and communication.
L. Prepare a time schedule for all operations.

The meeting will be documented by the Design Engineer/Inspector, and minutes transmitted to all parties and made part of the CQA record.

2.2.3 Pre-Construction Meeting

The Pre-Construction Meeting will be held at the site. It will be attended by the: Project Manager, Design Engineer/Inspector, Earthwork Contractor and Installer. The following items will be accomplished:

A. Make any appropriate modification to the Quality Assurance Plan.
B. Review the responsibilities of each party.
C. Review lines of authority and communication.
D. Review methods for documenting and reporting, and for distributing documents and reports.
E. Review rules for writing on the geomembrane, i.e., who is authorized to write, what can be written and in which color.
F. Review the time schedule for all operations.
G. Conduct a site walk-around to verify that the design plans and specifications are reasonable, and to review material storage location.
H. Review panel layout and numbering systems for panels and seams.
I. Establish procedures for use of the extrusion welding apparatus, if applicable.
J. Establish procedures for use of the fusion welding apparatus, if applicable.

K. Review seam testing procedures.
L. Review repair procedures.
M. Review seam and sheet inspection procedure.

The meeting will be documented by the Design Engineer/Inspector, and minutes transmitted to all parties, and made part of the project CQA record.

2.2.4 Progress Meetings

A progress meeting will be held each day at the work site. At a minimum it will be attended by the Project Manager, Design Engineer/ Inspector and the construction contractor(s) currently working on the project. At this meeting the following items will be accomplished:

A. Review the previous day's activities and accomplishments.
B. Review the work location and activities for the day.
C. Identify the contractor's personnel and equipment assignments for the day.
D. Discuss any potential construction problems.

The meeting will be documented by the Design Engineer/Inspector and made part of the project CQA record.

2.2.5 Problem or Work Deficiency Meetings

A special meeting may be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting should be attended by the construction contractor(s), the Design Engineer/Inspector and the Project Manager. The purpose of the meeting is to define and resolve the problem or recurring work deficiency in the following manner:

A. Define and discuss the problem or deficiency.
B. Review alternative solutions.
C. Implement a plan to resolve the problem or deficiency.

The meeting will be documented by the Design Engineer/Inspector and made part of the project CQA record.

SECTION 3

QUALIFICATIONS OF PARTIES

3.1 Earthwork Contractor

Prior to confirmation of any contractual agreements, the Earthwork Contractor shall submit the following written information:

A. Corporate background and information.
B. A list of at least ten completed projects involving the movement of at least 5000 yd^3 of material. For each project, the following information shall be provided:

1. Name and purpose of project, its location and date of construction.
2. Name of Owner.
3. Description of earthwork performed including quantities.
4. Available information on the performance of the project.

3.2 HDPE Manufacturer

Prior to confirmation of any contractual agreements, the Manufacturer shall submit the following written information:

A. Corporate background and information.
B. Manufacturing capabilities:

1. Information on plant size, equipment, personnel, number of shifts per day and capacity per shift.
2. Daily production quantity available for this contract.
3. Quality control manual for manufacturing.
4. List of material properties including certified test results, to which are attached geomembrane samples.

C. A list of at least ten complete facilities totaling a minimum of 2,000,000 $ft.^2$, for which the Manufacturer has manufactured an HDPE geomembrane. For each facility, the following information shall be provided:

1. Name and purpose of facility, its location and date of installation.
2. Name of Owner, Project Manager, Designer, Fabricator (if any), and installer.
3. Thickness of HDPE geomembrane, surface area of geomembrane manufactured.
4. Available information on the performance of the lining system and the facility.

3.3 HPDE Fabricator

This section is not applicable if geomembrane rolls are not fabricated into blankets in a factory.

The Fabricator shall be trained and qualified to fabricate HDPE blankets from HDPE rolls. The Fabricator shall be a well established firm able to provide sufficient fabrication capacity and qualified personnel to meet the demands of the project. The Fabricator shall be approved and/or licensed by the Manufacturer. A copy of the approval letter(s) or license(s) shall be submitted by the Fabricator.

Prior to the confirmation of any contractual agreements, the Fabricator shall submit the following written information:

A. Corporate background and information.
B. Fabrication capabilities:

    1. Information on factory size, equipment, personnel, number of shifts per day and capacity per shift.
    2. Daily fabrication quantity available for this contract.
    3. Quality control manual for fabrication.
    4. Certified test results and samples of fabricated seams.

C. A list of at least ten completed facilities for which the Fabricator has fabricated HDPE geomembrane blankets, totaling a minimum of 2,000,000 ft.^{2}. For each fabrication, the following information shall be provided:

    1. Name and purpose of facility, its location, and date of installation.
    2. Name of owner, project manager, designer, manufacturer, and installer.
    3. Thickness of HDPE geomembrane, surface area of geomembrane fabricated.
    4. Type of seaming and type of seaming apparatus used.
    5. Available information on the performance of the lining system and the facility.

3.4 HDPE Installer

The Installer shall be trained and qualified to install HDPE geomembranes. The Installer shall be approved and/or licensed by the Manufacturer and/or Fabricator. A copy of the approval letter(s) or license(s) shall be submitted by the Installer.

Prior to confirmation of any contractual agreements, the Installer shall submit the following written information:

A. Corporate background and information.
B. Installation capabilities:

    1. Information on equipment and personnel.
    2. Daily anticipated production.

3. Quality control manual for installation.
4. Samples of field seams and certified test results.

C. A list of at least ten completed facilities, totaling a minimum of 2,000,000 ft^2 for which the Installer has installed an HDPE geomembrane. For each installation, the following information shall be provided:

1. Name and purpose of facility, its location, and date of installation.
2. Name of Owner, Project Manager, Designer, Manufacturer and Fabricator (if any).
3. Name and qualifications of the supervisor(s) of the Installer's crew(s).
4. Thickness of geomembrane, surface area of the installed geomembrane.
5. Type of seaming and type of seaming apparatus used.
6. Duration of installation.
7. Available information on the performance of the lining system and the facility.

3.5 Review of Qualifications of Parties

The Design Engineer/Inspector will review and evaluate the data submitted by the various parties and present its conclusions to the Project Manager.

SECTION 4

INSPECTION ACTIVITIES

4.1 General

This section addresses the inspection activities that are necessary to ensure, with a reasonable degree of certainty, that the completed facility meets the design criteria, plans and specifications. The first subsection addresses general pre-construction activities applicable to all facility components. The subsequent subsections address each facility component separately and are further subdivided into sections on pre-construction, construction and post-construction inspection activities unique to each component.

4.2 General Pre-Construction Activities

The Inspector will review the design drawings and specifications for the project to make certain they will be understandable to the inspection staff and the contractors. Any deficiencies or discrepancies will be presented to the Design Engineer who will resolve them and issue revised documents.

The initial meeting and the pre-construction meeting discussed in Sections 2.2.2 and 2.2.3 will be held and documented.

Based on the qualifications and experience of the individual contractors in working with the specific materials and equipment to be used on this project, the Inspector will determine the amount of supervision that will be required for each construction phase. This determination will be subject to review and revision as construction proceeds.

The individual product specifications (draft copies are included in Attachment A) require certain submittals. Those which are required before construction will be reviewed for completeness and conformance with the specifications. Changes will be required for any items which are not in conformance.

4.3 Grading of Crucible Wastes

The waste materials are being placed to the design grades, relative to the "existing" grade, using strategically placed settlement plates for grade control. Once the landfill closure project commences, some of the Crucible wastes will have to be regraded because they pre-existed the closure plan.

4.3.1 Pre-Construction

Pre-Construction activities for the waste grading will consist of making sure the contractor understands the grading plan, and reviewing his proposed construction procedures and schedule. The field personnel

will be made aware of the many pipes that will be protruding from the landfill surface (settlement plates and observation wells).

4.3.2 Construction

Continuous observation during waste grading operations will be necessary to insure settlement plates and observation wells are not inadvertently destroyed or damaged. Any such inadvertent damage will be documented and appropriate actions ordered. Inspection activities during waste grading will also include:

A. Surveys of depth and slope of excavation.
B. Specified compaction tests.
C. Observations to insure the removal of projections which could penetrate the liner.

4.3.3 Post-Construction

Acceptance of the graded waste surface will require proof rolling. Any weak spots will be repaired and proof rolled again. Additionally the entire surface will be inspected for large protrusions which could possibly penetrate the buffer layer and liner. If found they will be buried or removed.

4.4 Placement of Buffer Layers

Two six-inch layers of buffer material will be placed on the graded wastes prior to waiting for the settlement period.

4.4.1 Pre-Construction

Pre-construction activities for the buffer layer placement include:

A. Verify that the material sources meet the specifications.
B. Review proposed construction procedures and schedule.
C. Make certain field personnel are aware of the many pipes that will protrude from the landfill surface (settlement plates and observation wells).

4.4.2 Construction

During placement of the buffer layers, inspection activities will include:

A. Verify that the materials being delivered meet the requirements of the specifications.
B. Observe that the materials are placed to the specified thicknesses.
C. Continuously observe construction activities to be certain the subgrade is not damaged.
D. Continuously observe construction activities to be certain landfill penetrations are not damaged or destroyed.
E. Perform specified density tests on the compacted fill.

4.4.3 Post-Construction

Since the closure plan calls for the buffer layer to sit for at least one winter season while settlement of the subgrade occurs, a detailed inspection of the surface will be required prior to final acceptance. The amount of settlement which will occur is unknown. A survey will be made and the results submitted to the design engineer to determine if the final grades will be sufficient to receive the HDPE membrane. The inspection will identify and document areas of weathering or erosion which must be repaired. Uneven or adverse grades will be discovered from the survey. Once all repairs and fine grading have been completed the surface will be proof rolled one final time.

4.5 Drainage System

The landfill drainage system will consist of interior and perimeter drainage swales at the landfill site and a series of pipes, ditches and energy dissipators necessary to convey site drainage to Onondaga Lake. The drainage outfall must be in place prior to placement of the HDPE liner. Only that portion of perimeter ditch for the section of landfill being closed will be necessary. Drainage from uncovered portions of the landfill will be excluded from the drainage outfall.

4.5.1 Pre-Construction

Pre-Construction activities for the drainage system include:

A. Review proposed construction procedures and schedule.
B. Review submitted materials for conformance with specifications.

4.5.2 Construction

Construction inspection activities for the drainage system include:

A. Observation of perimeter swale excavation to insure no misplaced Crucible wastes are present.
B. Verify that excavated perimeter swale is an acceptable surface for HDPE membrane line.
C. Survey to insure designed grades are accomplished.
D. Verify that delivered materials (pipes, precast structures, granular materials) are in conformance with the specifications.
E. Continuously observe to make certain buffer layer is not damaged.
F. Observations and measurements to ensure that the pipes are placed at specified locations and in specified configurations.
G. Observations and tests to ensure that all pipes are joined together as specified.
H. Observations to ensure that the placement of any filter materials around the pipe proceeds as specified in the design.
I. Observations and tests to ensure that backfilling and compaction are completed as specified in the design and that, in the process, the pipe is not damaged.

4.5.3 Post-Construction

Post-Construction inspection of the drainage system will include:

A. Visual inspection of the pipe for true alignment and grade.
B. Survey of pipes and channels to insure that all system components have been installed in proper location.

4.6 HDPE Flexible Membrane Liner

This is the most critical component of the landfill closure project. Therefore the largest and most detailed inspection effort will be spent on the HDPE Membrane Liner.

4.6.1 Pre-Construction

4.6.1.1 Panel Layout Plan

Verification of the panel layout plan is important because it will serve as the control for many inspection activities. The panel and seam numbers on this plan must coincide with those in the field to be able to verify product and test results.

A. Review the submittal panel layout plan for completeness (Specification Section 02271 1.05A).
B. Verify that the submitted plan is current and is for the specific project.
C. Require resubmittal if the plan is not approved.

4.6.1.2 Raw Materials

Review the submittal information on Raw Materials (Section 02271 1.05B) and insure that the submittals are complete and that they conform to the product specifications (Specification Section 02271 2.01).

4.6.1.3 Manufacturing

A. Review the submittal information on the manufacturing process (Specification Section 02271 1.05C).
B. Verify that the properties guaranteed by the manufacturer meet all the specifications.
C. Verify that the measurements of properties by the manufacturer are properly documented and the test methods used are acceptable.
D. Conduct a manufacturing plant visit prior to or during the manufacturing of the HDPE Membrane rolls for this project. During the plant visit the following will be accomplished:

1. Review the manufacturing process, quality control, laboratory facilities and testing procedures.
2. Verify that properties guaranteed by the Manufacturer meet all specifications.
3. Verify that the measurements of properties by the Manufacturer are properly documented and test methods used are acceptable.
4. Spot inspect the rolls and verify that they are free of holes, blisters, or any sign of contamination by foreign matter.
5. Review packaging and transportation procedures to verify that these procedures are not damaging the geomembrane.
6. Verify that roll packages have a label indicating the name of the manufacturer, type of geomembrane, its thickness and roll number.
7. Verify that extrusion rods and/or beads are derived from the same base resin type as the geomembrane.

A plant inspection report will be prepared and made part of the project CQA record.

4.6.1.4 Fabrication Process

A. Delete this section if rolls are not fabricated into blankets at a factory.
B. Review the submitted information of the fabrication process (Specification Section 02271 1.05D).
C. Verify that the qualifications of the seaming personnel are in accordance with the specifications.
D. Verify that the fabricator's quality control procedures are adequate.
E. Review the quality control certificates and verify that:

   1. Quality control certificates have been provided for all blankets.
   2. The test methods used are acceptable.
   3. The measured properties meet the specifications.
   4. Repairs are well documented.

F. Conduct a fabrication factory visit prior to or during the fabrication of the HDPE Membrane for this specific project. During the factory visit the following will be accomplished:

   1. Review the fabrication process.
   2. Verify all quality control procedures, such as non-destructive and destructive seam testing procedures, repair procedures, and documentation procedures for testing and repair.
   3. Review testing facilities of the Fabricator.
   4. Spot inspect the blankets and verify that they are free of holes, blisters, any sign of contamination by foreign matter, or improper patches or re-welds.
   5. Review packaging and transportation procedures to verify that these procedures are not damaging the geomembrane.

6. Verify that the blanket packages have a label indicating name of Fabricator, type of geomembrane, dimension and blanket number.
7. Verify that extrusion rods and/or beads are derived from the same base resin type as the geomembrane.

A fabrication factory inspection report will be prepared by the Design Engineer/Inspector and made a part of the project CQA record.

4.6.1.5 Transportation Handling and Storage

A. Verify that the provisions of Specification Section 02271 3.03 A and B are followed.
B. Observe the surface inspection (Specification Section 02271 3.03C) and document any damaged rolls or blankets. Classify any damaged packages as rejected or repairable.
C. Verify that the materials are properly stored (Specification Section 02271 3.03D).

4.6.1.6 Installation Process

A. Review the submitted information on the installation process (Specification Section 1.05 E).
B. Verify that the qualifications of the seaming personnel are in accordance with the specifications.
C. Verify that the proposed construction procedures are adequate.

4.6.2 Construction

4.6.2.1 Earthwork

A. Obtain a certificate of acceptance (as required by Specification Section 02271 1.05 E) from the installer.
B. Throughout the membrane installation continuously observe the subsurface to insure it remains adequate. Any changes will require repairs.
C. Verify that the anchor trench is according to the specifications and that no more trench is opened than required for a day's membrane installation.

4.6.2.2 Geomembrane Placement

A. Verify that the paneling numbering system agrees with the panel layout plan.
B. Verify membrane thickness of every panel. Take thickness measurements at appropriate intervals across the panel width and periodically along the panel length. Take thickness measurements across the panel width at any point where the panel has been cut.
C. Verify that the panels are located as indicated on the layout plan.
D. On a continuous basis evaluate the installation schedule and installer-proposed changes in light of varying weather conditions.

E. Verify that the condition of the supporting soil is adequate on the day of membrane placement.
F. Record the date of installation of each panel.
G. Verify that the specified (Specification Section 02271 3.05 C) weather conditions are met.
H. Verify that the specified (Specification Section 02271 3.05 D) placement procedures are employed.
I. Inspect each panel after placement and prior to seaming for damage. Document the defects and classify as rejected or repairable.
J. Verify that the rejected panels are removed and replaced and that the repairable defects are repaired.

4.6.2.3. Field Seaming

A. Verify that the conditions of the specifications regarding overlapping and temporary bonding (Specification Section 02271 3.06 B) are met.
B. Record the weather conditions and verify that they are appropriate for seaming (Specification Section 02271 3.06 C).
C. Verify that the seams are prepared according to the specifications (Specification Section 02271 3.06 D).
D. Verify that the seaming apparatus, procedures and equipment are as specified (Specification Section 02271 3.06 E or F) and the same as approved (Specification Section 02271 1.05 E4).
E. Log ambient temperatures, seaming apparatus temperatures, geomembrane surface temperatures, extrudate temperature (if applicable) and seaming apparatus pressures (if applicable) at appropriate intervals.
F. Observe and document each test seam procedure (Specification Section 02271 3.07 A). Document the test samples.
G. Verify that the seams are made in accordance with the specifications (Specification Section 02271 3.06 H) and the approved submittal.
H. Observe all non-destructive seam continuity testing.

1. Record location, date, test unit number, name of tester and outcome of testing.
2. Document and mark on the membrane the location of all required repairs.
3. Observe the repair and retesting of the repair.
4. Mark on the membrane that the repair has been made.
5. Document the results.

I. Observe all seams and cap seams which are located where non-destructive continuity testing cannot be done.

4.6.2.4 Destructive Seam Strength Testing

A. Within the limits of the specifications predetermine a destructive seam strength testing plan.

1. At least one test per 500 feet of field seam.
2. Allow for intuitive locations (where the inspector feels the seam integrity is suspect).

B. As seaming progresses determine additional test locations based on suspicion of excess crystallinity, contamination, offset welds, or any other cause of imperfect welding.

C. During sampling procedure.

1. Observe sample cutting.
2. Verify that specified procedures (Specification Section 02271 3.06 J2) are followed.
3. Assign a number to each sample and mark it accordingly.
4. Record sample location on layout drawing.
5. Record the reason for taking the sample at this location (i.e., statistical routine or suspicious feature).
6. Witness all field tests.
7. Log the date, time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description.
8. Verify that all holes are repaired and non-destructively tested as specified.

D. Laboratory Testing

1. Package and ship destructive test samples to the independent laboratory in a manner which will not damage the test sample.
2. Package and store the archival samples.
3. Laboratory test shall include "Seam Strength" and "Peel Adhesion" using specified tests.
4. Review independent laboratory tests and installer's laboratory tests (Specification Section 02271 1.05 E5) as soon as they become available.
5. Recommend course of action based on test results.

E. Verify that procedures for destructive test failure (Specification Section 02271 3.06 K and L) are followed.

1. The basic criteria is that any seam segment must be bounded by two successful tests.
2. Observe all repair procedures.
3. Document all actions taken in conjunction with destructive test failures.

4.6.2.5 Membrane Penetrations

A. Verify that all penetrations are constructed in accordance with the plans.
B. Observe and document all penetration seam non-destructive testing.

4.6.3 Post-Construction

4.6.3.1 Geomembrane Inspection

A. Prior to inspection the Installer shall clean the geomembrane to the satisfaction of the Inspector.

B. The Inspector will perform a visual inspection of all seam and non-seam areas of the installed geomembrane. The Inspector will document and mark on the geomembrane all suspected defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter.
C. The Inspector will observe the non-destructive testing of each suspected defect and document the results.
D. Each failed area will be marked on the geomembrane and slated for repair.

4.6.3.2 Geomembrane Repair

A. All identified defects shall be repaired as specified. (Specification Section 02271 3.08 C, D and E).
B. Inspector shall verify that the specified procedures are followed.
C. All patches will be numbered and logged.
D. Inspector will document all activities relative to repair procedures.
E. Inspector will observe and document all non-destructive testing and retesting of repairs. Documentation will include patch number, date, name of patcher and test outcome.

4.6.3.3 Geomembrane Acceptance and Certification

The Inspector shall verify that all elements of the geomembrane installation are complete including:

A. The installation is complete.
B. All required submittals have been received and reviewed.
C. Verification of the adequacy of all field seams and repairs, including associated testing, is complete.
D. Certification, including "as-built" drawings(s), sealed by a registered professional engineer has been submitted.

4.7 Drainage Layer

A six-inch layer of granular material will be placed over the HDPE geomembrane to convey incident precipitation which infiltrates the cover layer to the drainage swales. This layer is also the first part of the protective cover for the geomembrane.

4.7.1 Pre-Construction

Pre-Construction activities for the drainage layer include:

A. Verify that the material sources meet the specifications.
B. Review proposed construction procedures and schedule.
C. Make certain that field personnel are aware of the special precautions that are necessary when working near the exposed HDPE geomembrane.
D. Make certain field personnel are aware of the many pipes that will protrude from the landfill surface (settlement plates and observation wells).

4.7.2 Construction

To reduce the potential settlements a minimal thickness drainage material has been designed. It is important therefore that the inspection staff and construction personnel exercise care and caution when placing the material on the HDPE Membrane.

Inspection activities for the placement of the drainage layer include:

A. Verify that the materials being delivered meet the requirements of the specifications.
B. Verify that material is being placed to the required thickness.
C. Verify that ambient temperatures are not below 40°F nor above 104°F.
D. Verify that equipment used for placing granular material shall not be driven directly on the geomembrane.
E. Inspector will continuously observe the spreading operation and work with the machine operator as a "watcher" to insure the equipment does not come in contact with the HDPE Membrane.
F. Verify that a minimum thickness of 3' of granular material is placed in heavily trafficked areas such as access ramps, haul roads and turn around areas.
G. Verify that the specified compaction requirements are met.

4.7.3 Post-Construction

A. Verify that the required material thickness has been achieved.
B. Inspect the graded surface for signs of potential membrane failure and investigate.
C. Verify that rain or wind has not disturbed the surface prior to placement of the upper soil layer.

4.8 Geotextile

A plastic filter fabric has been designed to act as a filter between the drainage layer and the surface layer of granular material in the internal drainage swales where infiltrated water will be discharged to the surface drainage system.

4.8.1 Pre-Construction

A. Verify that the proposed materials are on the New York State approved lists under the specified subheading.
B. Review the proposed construction procedures and schedule.
C. Verify that the surface to receive the geotextile has been prepared satisfactorily.

4.8.2 Construction

A. Examine the rolls upon delivery and verify that they are properly labeled and not damaged.
B. Verify that the labels indicate the same material has been supplied as submitted.

C. Verify that handling and placement is accomplished in accordance with specifications (Specification Section 02275 3.04).
D. Verify that seams and overlaps are as specified (Specification Section 02275 3.05).

4.8.3 Post-Construction

A. Inspect the finished surface for tears or other defects.
B. Document defects and order repairs.
C. Observe repairs and verify they are in accordance with specification (Specification Section 02275 3.06).
D. Observe the placement of cover materials and verify that they are placed in conformance with specifications (Specification Section 02275 3.07).

4.9 Vegetative Support Layer

The 18 inch vegetative support layer will provide protection for the drainage layer and support vegetation which will provide further protection and an acceptable aesthetic environment.

4.9.1 Pre-Construction

A. Verify that soil source meets specifications.
B. Review proposed construction procedures and schedules.
C. Determine if soil will require fertilization.
D. Make field personnel aware of the many pipes that will be protruding from the landfill surface (Settlement plates and observation wells).

4.9.2 Construction

A. Verify that soil delivered to the site meets the specifications.
B. Observe placement activities.
C. Insure that no damage is done to underlying layers.
D. Verify that weather conditions are appropriate.
E. Verify that placement depth and compaction meet the specifications.
F. Verify that seed and fertilizer (if any) materials meet the specifications.
G. Insure that seed and fertilizer are applied at the specified rate and in the specified manner.

4.9.3 Post-Construction

A. Inspect completed cover for any visual indication of failures.
B. Inspect the completed cover after one year for visual indication of failures and condition of vegetation.

SECTION 5

DOCUMENTATION

5.1 General

The CQA record keeping will result in a final CQA report which will contain copies of all CQA documents. The primary purpose of the final documentation is to maintain confidence in the constructed facility through written evidence that the CQA plan was implemented as proposed and that construction proceeded in accordance with project design criteria, plans and specifications.

5.2 Daily Record Keeping

The Design Engineer/Inspector will prepare a daily summary report and attach supporting inspection data sheets, meeting minutes, problem identification reports, and corrective measure reports.

5.2.1 Daily Summary Report

A summary report will be prepared by the Design Engineer/Inspector which will provide a chronologic framework for identifying and recording all other reports. The reports will include the following:

A. Unique identifying sheet number for cross-referencing and document control.
B. Date, project name, location and other identification.
C. Data on weather conditions.
D. Reports on any meetings held and their results, or cross reference to meeting minutes file.
E. Unit processes, and locations, of construction underway during the time frame of the daily summary report.
F. Equipment and personnel being worked in each unit process, including subcontractors.
G. Descriptions of areas or units of work being inspected and documented.
H. Description of offsite materials received, including any quality verification (vendor certification) documentation.
I. Calibrations, or recalibrations, of test equipment, including actions taken as a result of recalibration.
J. Decisions made regarding approval of units of material or of work, and/or corrective actions to be taken in instances of substandard quality.
K. Unique identifying sheet numbers of inspection data sheets and/or problem reporting and corrective measures reports used to substantiate the decisions described in the preceding item.
L. Signature of the Inspector in charge.

5.2.2 Inspection Data Sheets

All observations, and field and/or laboratory tests, should be recorded on an inspection data sheet. Recorded observations may take the form of notes, charts, sketches, photographs, or any combination of these. For each type of inspection activity a data sheet will be developed which will include the following as well as items specific to the test or observation being conducted.

A. Unique identifying sheet number for cross-referencing and document control.
B. Description or title of the inspection activity.
C. Project identification.
D. Date of sample and date of test performance if different.
E. Location of the inspection activity or location from which the sample increment was obtained.
F. Type of inspection activity; procedure used (reference to standard method when appropriate).
G. Recorded observation or test data, with all necessary calculations.
H. Results of the inspection activity; comparison with specification requirements.
I. Personnel involved in the inspection activity.
J. Signature of the appropriate inspection staff member and concurrence by the Inspector in charge.

Samples of Inspection Data Sheets to be used for the HDPE Membrane Liner inspections are included in Attachment B.

5.2.3. Problem Identification and Corrective Measures Reports

A problem is defined herein as material or workmanship that does not meet the design criteria, plans and specifications. Problem Identification and Corrective Measures Reports will be cross-referenced to specific inspection data sheets where the problem was identified. They will include the following information:

A. Unique identifying sheet number for cross-referencing and document control.
B. Project Identification.
C. Date of report.
D. Detailed description of the problem.
E. Location of the problem.
F. Probable Cause.
G. How and when the problem was located (reference to inspection data sheets)
H. Estimation of how long problem has existed.
I. Suggested corrective measure.
J. Documentation of correction (reference to inspection data sheets).
K. Final results.
L. Suggested methods to prevent similar problems.
M. Signature of the appropriate inspection staff member and concurrence by the Inspector in charge.

5.3 Photographic Record Keeping

Photographs will serve as a pictorial record of work progress, problems and corrective measures. They will be of both the instant and the processed variety. Each photograph will be labeled with the following information:

A. A unique identifying number for cross-referencing and document control.
B. Project Identification.
C. The date, time and location where the photograph was taken and weather conditions.
D. The size, scale and orientation of the subject matter photographed.
E. Location and description of the work.
F. The purpose of the photograph.
G. Signature of the photographer.

The photographs will be kept in a permanent protective file in the chronological order in which they were taken. The basic file will contain prints; negatives will be stored in a separate file in chronological order.

Photograph logs will also be kept as a catalog of the photographs. The log will contain the following information:

A. Unique identifying number on each sheet of the log for cross-referencing and document control.
B. Project identification.
C. Photograph identification number.
D. Date of each photograph.
E. Brief description of the subject of the photograph. More detailed information is on the back of each photograph.
F. Signature of the Inspector in charge.

The photograph logs will be included in the final CQA report. The Photograph prints and negatives will be stored with the final report original documents.

5.4 Final Documentation

The Design Engineer/Inspector will assemble all of the CQA documentation into a final CQA report. This report will be certified correct by the Design Engineer/Inspector and reviewed and signed by the Contractors and Project Manager. A copy will be submitted to the Approval Agency.

5.5 Storage of Records

During construction all CQA documents will be kept by the Design Engineer/Inspector either at the site or at his offices. This includes originals of all data sheets, reports and facility drawings. Upon completion of the project and the final CQA report, the documents will be kept by Crucible's Environmental and Energy Engineer at the production facility. An additional copy will be submitted to the Approval Agency.

ATTACHMENT A

PRELIMINARY TECHNICAL SPECIFICATIONS

SECTION 02271

FLEXIBLE GEOMEMBRANE LINER

PART 1 GENERAL

1.01 WORK INCLUDED

A. Manufacture, fabrication and installation of flexible geomembrane liner.

1.02 RELATED WORK

A. Section 03300 - Cast-In-Place Concrete.

1.03 REFERENCES

A.	ASTM D413-82	"Test Methods for Rubber Property - Adhesion to Flexible Substrate".
B.	ASTM D638-84	"Test Method for Tensile Properties of Plastics".
C.	ASTM D746-79	"Test Method for Brittleness Temperature of Plastics and Elastomers by Impact".
D.	ASTM D792-66 (1979)	"Test Method for Specific Gravity and Density of Plastics by Displacement".
E.	ASTM D1004-66 (1981)	"Test Method for Initial Tear Resistance of Plastic Film and Sheeting".
F.	ASTM D1204-84	"Test Method for Linear Dimensional Changes for Nonrigid Plastic Sheeting or Film at Elevated Temperature".
G.	ASTM D1238-82	"Test Method for Flow Rates of Thermoplastics by Extrusion Polymer".
H.	ASTM D1505-68 (1979)	"Test Method for Density of Plastics by the Density - Gradient Technique".
I.	ASTM D1593-81	"Specification for Nonrigid Vinyl Chloride Plastic Sheeting".
J.	ASTM D1603-76 (1983)	"Test Method for Carbon Black in Olefin Plastics".
K.	ASTM D1693-70 (1980)	"Test Method for Environmental Stress - Cracking of Ethylene Plastics".
L.	ASTM D3015-72 (1978)	"Recommended Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds".

SECTION 02271

FLEXIBLE GEOMEMBRANE LINER

PART 1 GENERAL (Continued)

1.03 REFERENCES (Continued)

M. ASTM D3083-76 (1980) "Specification for Flexible Poly (Vinyl Chloride) Plastic Sheeting for Pond, Canal and Reservoir Lining".

N. FMTS 101 B/2065 Federal Test Methods Standards.

O. National Sanitation Foundation (NSF), "Standards for Flexible Membrane Liners", Standard 54.

1.04 QUALITY ASSURANCE

A. Follow the requirements of the Construction Quality Assurance Plan.

1.05 SUBMITTALS

A. Panel Layout Plan

1. Layout and dimension for each panel in the structure.

2. Label for each panel

3. Differentiate between fabricated and field seams.

B. Raw Materials

1. Origin (Resin Supplier's name, resin production plant), identification (brand name, number) and production date of the High Density Polyethelene (HDPE) resin.

2. Copy of quality control certificates issued by the HDPE Resin Supplier.

3. Reports on the tests conducted by the Manufacturer to verify the quality of the HDPE resin used to manufacture the geomembrane rolls assigned to the considered facility.

4. Statement that no reclaimed polymer is added to the resin.

C. Manufacturing Process

1. Properties sheet including at least all specified properties, measured using the specified test methods.

2. Sampling procedure and results of testing.

PART 1 GENERAL (Continued)

1.05 SUBMITTALS (Continued)

C. Manufacturing Process (Continued)

3. Statement that property values given in the properties sheet are guaranteed by the Manufacturer.

4. Quality control certificate for each shift's production.

a. Signed by responsible party employed by manufacturer.
b. Roll numbers and identification.
c. Sampling procedures and results of quality control tests; as a minimum, thickness, tensile strength, and tear resistance, conducted with the specified methods.

D. Fabrication Process (if fabrication is proposed)

1. Narrative of proposed seaming process (extrusion or fusion), including make and model number of equipment to be used.

2. List of proposed seaming personnel and their professional records.

3. For the extrusion process.

a. Certification that the extrudate is compatible with the specifications.
b. Quality control records.
   1. Apparatus temperatures.
   2. Extrudate temperatures.
   3. Ambient temperatures.

4. For the fusion process.

a. Quality Control Records.
   1. Ambient temperature.
   2. Apparatus temperatures and pressures.

5. Certification that the membrane rolls are overlapped as specified.

6. Certification that the procedure used to temporarily bond adjacent rolls together does not damage the geomembrane.

7. Certification that no solvent or adhesive is used.

PART 1 GENERAL (Continued)

1.05 SUBMITTALS (Continued)

D. Fabrication Process (if fabrication is proposed) (Continued)

8. Quality Control Certificate for each shift's production of blankets.

a. Signed by a responsible party employed by fabricator.
b. Blanket numbers and identification.
c. Results of quality control tests including sampling procedures.
d. Documentation of repairs and non-destructive testing of the repairs.

E. Installation Process.

1. Certification by installer that surface is acceptable.
2. Proposed installation schedule.
3. List of proposed seaming personnel and their professional records.
4. Narrative of proposed seaming process (extrusion or fusion) including make and model number of equipment to be used.
5. Results of installer's destructive seam strength laboratory testing.

F. Certification, including "as-built" drawings sealed by a professional engineer registered in the State of New York.

PART 2 PRODUCT

2.01 RAW MATERIALS

A. New, first-quality resin, designed and manufactured specifically for the intended purpose.

B. The HDPE resin shall meet the following specifications:

1. Specific Gravity	(ASTM D792 Method A, or ASTM D1505)	0.93
2. Melt Index	(ASTM D1238 Condition E)	1.1g/10 min.

C. Reclaimed polymer shall not be added to the resin (however, the use of polymer recycled during the manufacturing process shall be permitted if done with appropriate cleanliness and if recycled polymer does not exceed 2% by weight).

SECTION 02271

FLEXIBLE GEOMEMBRANE LINER

PART 2 PRODUCT (Continued)

2.02 ROLLS

A. Unreinforced high density polyethylene (HDPE) containing 3% by weight maximum additives, fillers or extenders.

B. Contain carbon black for ultra-violet light resistance.

C. Not have striations, roughness, pinholes or bubbles on the surface.

D. Free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.

E. Meet or exceed the following specifications.

1.	Sheet thickness	(continuous physical or ASTM D1593 para. 8.1.3)	60 mils ± 10%
2.	Force per unit width at yield	(ASTM D638)	120 lb/in
3.	Force per unit width at break	(ASTM D638)	225 lb/in
4.	Elongation at yield	(ASTM D638)	10%
5.	Elongation at break	(ASTM D638)	500%
6.	Modulus of elasticity	(ASTM D638)	100,000 psi
7.	Tear resistance	(ASTM D1004 Die C)	40 lb
8.	Puncture resistance	(FTMS 101 B/20 65)	60 lb
9.	Resistance to soil burial Maximum change	(ASTM D3083 as modified in NSF Appendix A)	10%
10.	Dimensional Stability (each direction) Maximum change	(ASTM D1204, 212°F, 15 min.)	3%

PART 2 PRODUCT (Continued)

2.02 ROLLS

E. Meet or exceed the following specifications. (Continued)

11.	Environmental Stress Crack	(ASTM D1693 as modified in NSF Appendix A)	2000 hours
12.	Low Temperature Brittleness	(ASTM D746 Procedure B)	-40°F
13.	Carbon Black Content	(ASTM D1603)	2 - 3% (by weight)
14.	Carbon Black Dispersion	(ASTM D3015)	A-1

2.03 PANELS

A. The geomembrane shall be supplied as blankets or in rolls. A panel is the unit area of geomembrane which is to be seamed in the field. Two cases can be considered:

1. If the geomembrane is not fabricated into blankets in a factory, a panel is a roll or a portion of roll cut in the field.

2. If the geomembrane is fabricated into blankets in a factory, a panel is a blanket or a portion of blanket cut in the field.

B. Panel size shall be determined by approved layout plans showing layout and dimensions of panels in the structure.

C. Labels on each roll or blanket shall identify the thickness of the material, the length and width of the roll, the manufacturer and directions to unroll the material.

D. Labels shall be consistent with the layout plan.

2.04 FABRICATED SEAMS AND FIELD SEAMS

A. Fabricated seams (if applicable) and field seams shall meet the following specification.

1.	Seam Strength (at yield point)	(ASTM D3083 as modified in NSF Appendix A)	120 lb/in and Film Tear Bond

SECTION 02271

FLEXIBLE GEOMEMBRANE LINER

PART 2 PRODUCT (Continued)

2.04 FABRICATED SEAMS AND FIELD SEAMS (Continued)

2. Peel Adhesion (ASTM D413 or ASTM Film Tear Bond D638 as modified in NSF Appendix A)

(Both tests shall be run on 5 replicate specimens. To be acceptable, 4 out of the 5 replicates must pass the seam strength and peel adhesion criteria.)

B. Approved fabricating and field seaming processes are extrusion welding and fusion welding.

C. Resin used for extrusion welding shall be HDPE produced from the same resin as the geomembrane. Physical properties shall be the same as those of the resin used in the manufacture of the HDPE geomembrane.

PART 3 EXECUTION

3.01 MANUFACTURE

A. Perform quality control procedures on raw materials.

B. Perform quality control procedures on manufactured products.

C. Label rolls as specified in 2.03 C and D.

3.02 BLANKET FABRICATION

A. Delete 3.02 if rolls are not fabricated into blankets in a factory.

B. Requirements of personnel performing seaming.

1. Must be qualified by experience or pass seaming tests.
2. At least one seamer shall have experience seaming a minimum of 1,000,000 ft.^{2} of HDPE geomembrane using the same type of seaming apparatus to be used to fabricate the geomembrane for this project.
3. The most experienced seamer, the "master seamer", shall provide direct supervision over less experienced seamers.

PART 3 EXECUTION (Continued)

3.02 BLANKET FABRICATION (Continued)

C. Seaming by the Extrusion Process.

1. Use welding apparatus equipped with gauges giving the extrudate temperature in the apparatus and at the nozzle.
2. Follow quality control procedures.

D. Seaming by the Fusion Process.

1. Apparatus must be automated vehicular-mounted devices which produce a double seam with an enclosed space.
2. Apparatus shall be equipped with gauges giving the applicable temperatures and pressures.
3. Follow quality control procedures.

E. Weather Conditions for Seaming.

1. No seaming shall be attempted below 5°C (40°F) nor above 40°C (104°F).
2. Between 5°C (40°F) and 10°C (50°F), seaming is possible if the geomembrane is preheated by either sun or hot air device, and if there is no excessive cooling.
3. Above 10°C (50°F), no preheating is required.
4. In all cases, the geomembrane shall be dry and protected from wind damage.

F. Perform test strip process as specified in 3.07 A.

G. Overlapping and Temporary Bonding.

1. Minimum Overlap.
   a. extrusion process - 3 inches
   b. fusion process - 5 inches
2. Temporary bonding methods shall not damage the geomembrane.
3. No solvent or adhesives shall be used.

H. Non destructively test all fabricated seams over their full length in accordance with 3.07 B.

PART 3 EXECUTION (Continued)

3.02 BLANKET FABRICATION (Continued)

I. Destructive Seam Strength Testing.

1. Perform destructive seam strength tests on two samples per blanket.
2. Samples taken from beginning or end of blanket seams such that blanket is not damaged and blanket geometry is not altered.
3. Fabricator to choose and document sample location.
4. Sample size: 1' x 1' with seam centered.
5. One half sample for testing and one half submitted to owner (for archival) with documentation.

J. Repairs

1. Perform in accordance with Section 3.08.
2. Document each repair by location and type.
3. Non destructively test all repairs in accordance with Section 3.07 B.

3.03 TRANSPORTATION HANDLING AND STORAGE

A. Handling equipment shall not pose any risk of damage to the geomembrane.

B. Handle geomembrane with care.

C. Conduct surface inspection of all rolls or blankets for defects or damage.

1. without unrolling rolls or unfolding blankets unless defects or damages are found or suspected.

D. Storage space shall be protected from theft, vandalism, passage of vehicles, dirt, shock and other sources of damage.

3.04 EARTH WORK

A. Inspect surface on which the geomembrane will be installed and certify that it is acceptable, including anchorage trench.

B. After initial acceptance identify any change in the supporting soil condition that may require repair work.

PART 3 EXECUTION (Continued)

3.05 GEOMEMBRANE PLACEMENT

A. Each panel shall be given an "identification code" consistent with the layout plan.

1. As simple and logical as possible.
2. Prepare table or chart showing correspondence between blanket or roll numbers and panel identification code.

B. Place according to layout plan and schedule.

1. In general, seams should be oriented parallel to the line of maximum slope, i.e, oriented along, not across, the slope.
2. In corners and odd-shaped geometric locations, the number of field seams should be minimized.
3. No horizontal seam should be less than 5' from the toe of the slope.

C. Weather Conditions.

1. Geomembrane placement shall not proceed at an ambient temperature below 5°C (40°F) or above 40°C (105°F) unless otherwise specified.
2. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., dew), in an area of ponded water, or in the presence of excessive winds, as determined by the Inspector.

D. Placement

1. Equipment used shall not damage the geomembrane by handling, trafficking, leakage of hydrocarbons or other means.
2. All personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane.
3. The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil.
4. Minimize wrinkles (especially differential wrinkles between adjacent panels).
5. Place adequate loading (e.g., sand bags, tires), not likely to damage the geomembrane, to prevent uplift by wind (in case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels).

PART 3 EXECUTION (Continued)

3.05 GEOMEMBRANE PLACEMENT

D. Placement (Continued)

6. Minimize direct contact with the geomembrane. Protect the geomembrane in traffic areas by geotextiles, extra geomembrane, or other suitable materials.

3.06 FIELD SEAMING

A. Requirements of Personnel

1. Must be qualified by experience or by successfully passing seaming tests.
2. At least one seamer shall have experience seaming a minimum of 1,000,000 ft.^{2} of HDPE geomembrane using the same type of seaming apparatus in use at the site.
3. The most experienced seamer, the "master seamer", shall provide direct supervision, as required, over less experienced seamers.
4. No field seaming shall take place without the master seamer being present.

B. Overlapping and Temporary Bonding.

1. Minimum Overlap.
   a. Extrusion process - 3 inches
   b. Fusion process - 5 inches
2. Temporary bonding methods shall not damage the geomembrane.
3. No solvent or adhesives shall be used.

C. Weather Conditions for Seaming.

1. No seaming shall be attempted below 5°C (40°F) nor above 40°C (104°F).
2. Between 5°C (40°F) and 10°C (50°F), seaming is possible if the geomembrane is preheated by either sun or hot air devices, and if there is not excessive cooling resulting from wind (as determined by the Inspector).
3. Above 10°C (50°F), no preheating is required.
4. In all cases, the geomembrane shall be dry and protected from wind damage.

PART 3 EXECUTION (Continued)

3.06 FIELD SEAMING (Continued)

D. Seam Preparation.

1. Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
2. If seam overlap grinding is required, the process shall be completed according to the Manufacturer's instructions and in a way that does not damage the geomembrane or cause removal of less than minimum thickness.
3. Seams shall be aligned with the fewest possible number of wrinkles and "fishmouths".

E. Seaming by the Extrusion Process.

1. Use welding apparatus equipped with gauges giving the temperature in the apparatus and at the nozzle.
2. Follow quality control procedures.
3. Maintain on-site the number of spare operable seaming apparatus decided at the Initial Meeting.
4. Use equipment that is not likely to damage the geomembrane.
5. Purge the extruder prior to beginning a seam until all heat degraded extrudate has been removed from the barrel.
6. Place the electric generator on a smooth base such that no damage occurs to the geomembrane.
7. Place a smooth insulating plate or fabric beneath the welding apparatus after usage.
8. Protect the geomembrane from damage in heavily trafficked areas.

F. Seaming by the Fusion Process

1. Apparatus must be automated vehicular-mounted devices which produce a double seam with an enclosed space.
2. Apparatus shall be equipped with gauges giving the applicable temperatures and pressures.
3. Follow quality control procedures.
4. Maintain on-site an adequate number of spare operable seaming apparatus.
5. Use equipment that is not likely to damage the geomembrane.
6. For cross seams, grind the edge of the cross seams to a smooth incline (top and bottom) prior to welding.
7. Place the electric generator on a smooth base such that no damage occurs to the geomembrane.

PART 3 EXECUTION (Continued)

3.06 FIELD SEAMING (Continued)

F. Seaming by the Fusion Process (Continued)

8. Place a smooth insulating plate or fabric beneath the hot welding apparatus after usage.
9. Protect the geomembrane from damage in heavily trafficked areas.
10. Use a movable protective layer as required by the Inspector directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets.

G. Perform test strip process as specified in 3.07 A.

H. General Seaming Procedure.

1. For fusion welding, a movable protective layer of plastic may be required, as recommended by the Inspector, to be placed directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture buildup between the sheets to be welded.
2. Seaming shall extend to the outside edge of panels to be placed in the anchor trench.
3. If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.
4. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6" beyond the cut in all directions.

I. Non-destructively test all field seams over their full length in accordance with 3.07 B.

1. Testing shall proceed immediately after each seam has been made not after all seams are complete.
2. Where seams cannot be non-destructively tested.
   a. Cap-strip the seam with the same geomembrane.
   b. If the seam is accessible to testing equipment prior to final installation, the seam shall be non-destructively tested prior to final installation.

PART 3 EXECUTION (Continued)

3.06 FIELD SEAMING (Continued)

J. Destructive Seam Strength Testing.

1. Location and Frequency.

a. Location at direction of Owner.
b. Minimum frequency one test location per 500' of seam length.
c. Maximum frequency one test location per 250' of seam length (average for all seams).
d. Pre-determined test locations will not be made known to the installer prior to seaming.

2. Sampling Procedure.
a. Cut samples as seaming progresses.
b. Sample size: 12" wide by 44" long with the seam centered lengthwise.
c. One 1" wide strip shall be cut from each end of the sample.
d. Field test one sample for shear and one sample for peel adhesion.
e. Cut remaining sample into three parts.
1. One portion (12" x 15") for installer's laboratory testing.
2. One portion (12" x 15") for independent laboratory testing.
3. One portion (12" x 12") to Owner for archival.

3. Patch each sample location in accordance with 3,08 D.

4. Non-destructively test each patch in accordance with 3.07 B.

K. Procedures for destructive test failure (field test).

1. Any segment of seam must be bounded by two passed tests.
2. Option A - Reconstruct the seam at the failed section between any two passed tests.
3. Option B -
a. Retrace the seam to intermediate locations a minimum of 10' from either side of the failed test location and small samples for additional field tests.
b. If the additional sample passes then reconstruct the seam between passed locations.

PART 3 EXECUTION (Continued)

3.06 FIELD SEAMING (Continued)

K. Procedures for destructive test failure (field test). (Continued)

c. If the additional sample fails then continue to retrace the seam until a passed test sample is taken.

4. Make another test sample on the reconstructed seam.
5. Non-destructively test the entire reconstructed seam according to 3.07 B.

L. Procedures for destructive test failure (laboratory tests).

1. Procedure applies if either the installer's or the independent laboratory's tests indicate a failure.
2. Follow the procedures outlined above 3.06 K 1 to 5 considering only the results of laboratory tests as a basis for passing.

3.07 TEST PROCEDURES

A. Test Seams for Fabrication or Installation Seams.

1. Prepare test seams at beginning of each seaming period and once each four hours for each seaming apparatus.
2. Each seamer shall make at least one test seam each day.
3. Use fragment pieces of geomembrane.
4. Prepare test seams under same condition as fabrication or field seams.
5. Test seam sample size: 2' long x 1' wide with seam centered lenghtwise.
6. Cut two adjoining samples 1" wide from test seam.
7. Test one sample for shear and one sample for peel adhesion using the specified tests.
8. If specimen fails repeat test strip process.
9. If additional specimen fails the seaming apparatus or seamer shall not be used for seaming until two consecutive successful test seams are achieved.

B. Non-Destructive Seam Continuity Testing

1. Test all seams (fabricated or installed) over their full length.
2. Failed seams should be repaired and retested.

PART 3 EXECUTION (Continued)

3.07 TEST PROCEDURES (Continued)

B. Non-Destructive Seam Continuity Testing (Continued)

3. Vacuum testing.
   a. Equipment.
      1. Vacuum box assembly consisting of rigid housing, transparent viewing window, soft neoprene gasket, port hole or valve assembly and vacuum gauge.
      2. Steel vacuum tank and pump assembly with pressure controller and pipe connections.
      3. Rubber pressure/vacuum hose with fittings and connections.
      4. Bucket and wide paint brush.
      5. Soapy solution.
   b. Energize the vacuum pump and reduce the tank pressure to approximately 10" of mercury, (i.e., 5 psi absolute).
   c. Wet a strip of geomembrane approximately 12" by 48" with the soapy solution.
   d. Place the box over the wetted area.
   e. Close the bleed valve and open the vacuum valve.
   f. Ensure that a leak tight seal is created.
   g. For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
   h. If no bubble(s) appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 75mm (3") overlap and repeat the process.
   i. All areas where soap bubbles appear shall be marked and repaired in accordance with Section 3.08.

4. Air Pressure Testing (For Double Fusion Seam Only).

   a. Equipment.
      1. Air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi.
      2. Rubber hose with fittings and connections.
      3. Sharp hollow needle, or other approved pressure feed device.
   b. Seal both ends of the seam to be tested.
   c. Insert needle or other approved pressure feed device into the tunnel created by the fusion weld.

PART 3 EXECUTION (Continued)

3.07 TEST PROCEDURES (Continued)

4. Air Pressure Testing (For Double Fusion Seam Only). (Continued)

d. Energize the air pump to a pressure between 25 and 30 psi close valve, and sustain pressure for approximately 5 minutes.
e. If loss of pressure exceeds 2 psi or does not stabilize, locate faulty area and repair in accordance with Section 5.4.
f. Remove needle or other approved pressure feed device and seal.

3.08 DEFECTS AND REPAIRS

A. Inspection

1. All seams and non-seam areas will be inspected.
2. Installer must clean surface of geomembrane prior to inspection.

B. Every suspected defect both seam and non-seam will be non-destructively tested according to 3.07 B.

C. Repair Procedures.

1. Defective seams - reconstruction (see Section 3.08 E).
2. Tears or pinholes - seaming or patching.
3. Blisters, larger holes, undispersed raw materials, and contamination by foreign matter-patching (see Section 3.08D).
4. Where excessive extrudate surface occurs, the affected seam length, as determined by the Inspector, shall be cap-stripped.

D. Patching.

1. Abrade surfaces of HDPE geomembrane no more than one hour prior to the repair.
2. Shape: round or oval.
3. Material: same geomembrane.
4. Size: extend minimum of 6" beyond edge of defects.
5. Use approved methods only.

PART 3 EXECUTION (Continued)

3.08 DEFECTS AND REPAIRS (Continued)

E. Seam Reconstruction.

1. Seam reconstruction for the extrusion welding process shall be achieved by grinding the existing seam and rewelding a new seam.
2. Seam reconstruction for the fusion process shall be achieved by cutting out the existing seam and welding in a replacement strip.

F. All repairs shall be non-destructively tested according to Section 3.07 B.

3.09 PENETRATIONS

A. All penetrations through the HDPE geomembrane shall be constructed as detailed in the drawings.

B. All penetration seams will be non-destructively tested in accordance with Section 3.07 B.

SECTION 02275

GEOTEXTILE

PART 1 GENERAL

1.01 WORK INCLUDED

A. Plastic Filter Fabric.

1.02 REFERENCES

A. "Approved Lists, Materials and Equipment for use on New York State Department of Transportation Projects" New York State Department of Transportation, Materials Bureau, Albany, NY 12232. October 1, 1985.

1.03 SUBMITTALS

A. Manufacturer's list of "minimum average roll value" properties for the geotextile to be delivered.

B. Manufacturer's certification signed by a responsible party that the materials actually delivered have property "minimum average roll values" which meet or exceed all guaranteed property values for that type of geotextile.

C. Samples from the rolls as specified.

1.04 TESTING

A. The Owner will sample every 10,000 square yards or every lot whichever is least for product conformance.

PART 2 PRODUCTS

2.01 PLASTIC FILTER FABRIC

A. The plastic filter fabric used will be evaluated on its ability to provide a permeable layer which allows water but not soil particles to pass through.

B. To be acceptable the material must be included on New York State Department of Transportation approved lists under the Subheading 7.42-2-1 [21] Geotextiles for Highway Construction, Subheading B Geotextiles - Undercut.

C. Additionally the material shall contain stabilizers and an inhibitor added to the base plastic to make the filaments resistant to deterioration due to ultra-violet and/or heat exposure.

SECTION 02275

GEOTEXTILE

PART 3 EXECUTION

3.01 PACKAGING

A. Each roll of geotextile shall be identified with the following.

1. Manufacturer's name.
2. Product Identification.
3. Lot Number.
4. Roll Number.
5. Roll Dimensions.

B. Special handling requirements shall also be marked on each package.

3.02 SHIPMENT AND STORAGE

A. Ship in relatively opaque and watertight wrappings.

B. Protect from: ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

3.03 SAMPLING

A. Cut samples 3' long by the width of the roll.

B. The sample shall not include the first 3' of any roll.

C. Take samples for every 10,000 square yards or every lot which ever is least.

3.04 HANDLING AND PLACEMENT

A. Handle all geotextiles in such a manner as to insure the geotextiles are not damaged in any way.

B. On slopes, the geotextile shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.

C. In the presence of wind, all geotextiles shall be weighted with sand bags or the equivalent. Such sand bags shall be installed during placement and shall remain until replaced with cover material.

D. If white colored geotextile is used, precautions shall be taken against "snowblindness" of personnel.

PART 3 EXECUTION (Continued)

3.04 HANDLING AND PLACEMENT (Continued)

E. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

F. During placement of geotextiles, care shall be taken not to entrap in the geotextile stones, excessive dust, or moisture that could damage the geomembrane, generate clogging, or hamper subsequent seaming.

G. Geotextiles shall not be exposed to precipitation prior to being installed, and shall not be exposed to direct sunlight for more than 15 days (unless otherwise specified).

H. No traffic or construction equipment will be permitted directly on the geotextile.

3.05 SEAMS AND OVERLAPS

A. On slopes steeper than ten horizontal to one vertical.

1. All geotextiles shall be seamed.
2. Seaming shall be accomplished by sewing.
3. All seams shall be continuously sewn.
4. Sewn seams shall be overlapped a minimum of six inches and double sewn.
5. Thread shall be nylon or polypropylene.
6. No horizontal seams shall be allowed on slopes steeper than ten horizontal to one vertical.

B. On slopes less steep than ten horizontal to one vertical.

1. Geotextiles may be seamed as indicated in 3.05 A.
2. Otherwise overlap shall be a minimum of 18".
3. Orient overlaps in the direction of earth filling.

C. Pay particular attention at seams and overlaps to ensure that no cover material is inadvertently inserted beneath the geotextile.

3.06 GEOTEXTILE REPAIR

A. Geotextile which becomes torn or damaged shall be replaced or patched.

B. Should any tear exceed 10% of the width of the roll, that roll shall be removed and replaced.

PART 3 EXECUTION (Continued)

3.06 GEOTEXTILE REPAIR (Continued)

C. Patches on slopes.

1. Patches shall be sewn in place.
2. Double sewn lock stitches (1/4" to 3/4" apart).
3. No closer than 1" from any edge.
4. Minimum overlap from edge of tear or damage: 6".

D. Patches not on slopes.

1. Use sewn patches as in 3.06 C or
2. Use patch with minimum 3' overlap beyond perimeter of tear or damage.
3. Spot sew the patch in place.

E. Remove any soil or other material which may have penetrated the torn geotextile.

3.07 PLACEMENT OF COVER MATERIALS

A. Insure the geotextile is not damaged.

B. Insure minimal slippage of the geotextile on underlying layers.

C. Insure no excess tensile stresses in the geotextile.

D. No construction equipment with ground pressure greater than 8 psi shall operate on slopes unless they are more than 10' from exposed geotextiles and are operating on 2' or more of cover.

E. Maximum ground pressure of the equipment used to place the cover shall not exceed 4 psi.

F. The cover shall be placed in one 12" lift.

ATTACHMENT B

SAMPLE DATA SHEETS

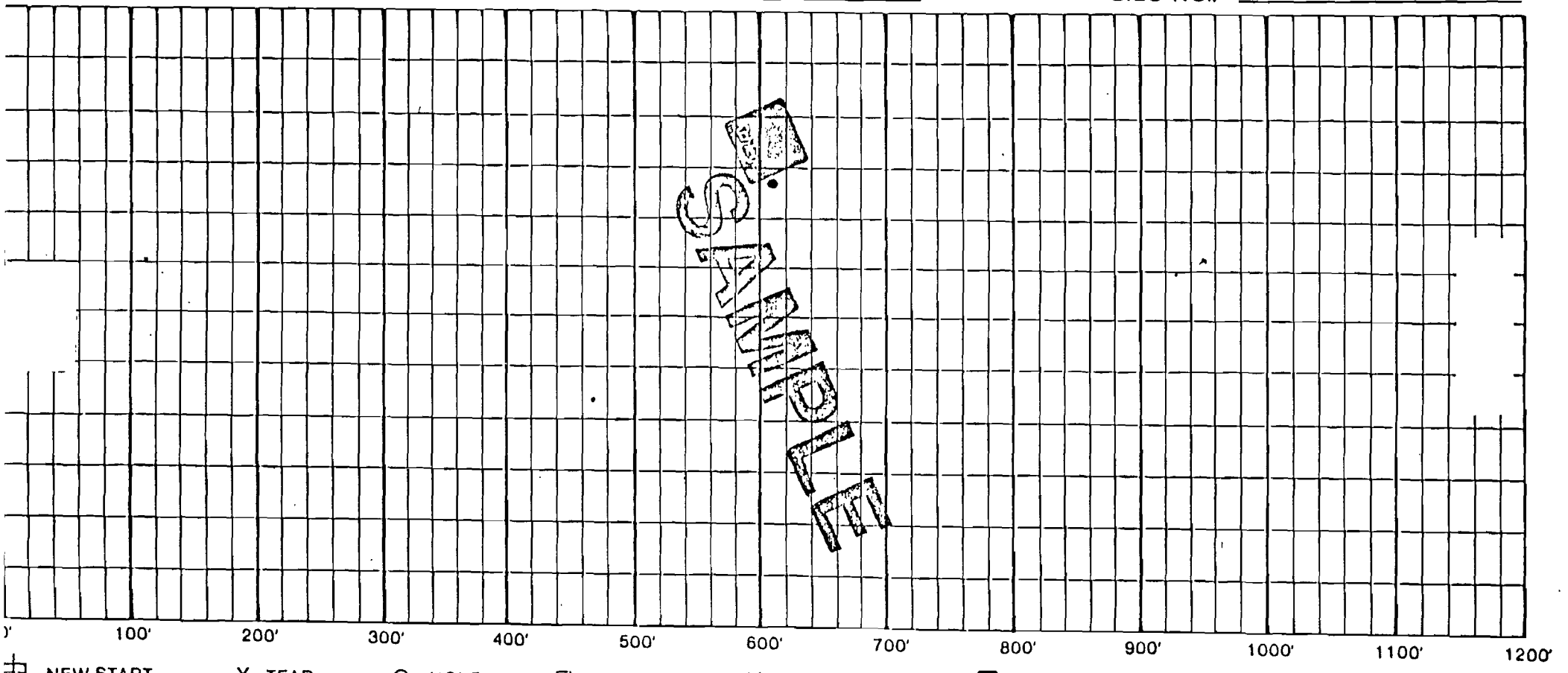
SCHLEGEL LINING TECHNOLOGY, INC.

SHEET QUALITY CARD

DATE: _____ LENGTH: _____ FT. THICKNESS: _____ MM

ROLL NO.: _____ WIDTH: _____ FT. WEIGHT: _____ LBS.

LOT NO.: _____ SQUARE FEET: _____ SILO NO.: _____



- NEW START
X - TEAR
O - HOLE
□ - DOUBLE LAYER
V - NOTCH ON BACK OF FLOW MARK
⬡ - WATER BUBBLE
COLD WRINKLE
△ - SCUFF MARK

	ACCEPTED	REJECTED
	GOOD	POOR
MELT BEHAVIOR:		
MELT APPEARANCE:		
FORMING BEHAVIOR:		

COMMENTS: _____

WELD TEST RECORD

JOB NUMBER: _____

PROJECT: _____

WELDER ID #: _____

TYPE WELDER: _____

TECHNICIAN: _____

Time	Seam Location	Preheat Temp.°C	Extrudate Temp.°C	Ambient Temp.°C	Weld Speed	Peel Test Results

REPORT OF ULTRASONIC EXAMINATION OF WELDS

Date_____

PROJECT : _____

WELD LOCATION (AREA) : _____

EQUIPMENT (NAME & TYPE) : KRAUTKRAMER USM2/US K6.

TRANSDUCER (COMPRESSION): 4 MHz, 10 MM, TWIN CRYSTAL.

CALIBRATION : 10 MM LINEAR TIME BASE. 46 DB.
100% FSD BACK WALL ECHO.

ACCEPTANCE CRITERIA : 10 MM MINIMUM CONTINUOUS FUSION IN CROSS-SECTION AREA OF WELD.

Seam No.	Number of Repairs Required	Number of Repairs Made	Acceptance Date	Comments
TOTALS:				

We, the undersigned, certify that the statements in this record are correct and that the welds were prepared and tested in accordance with manufacturer's recommendations.

_____
Schlegel Lining Technology, Inc.

REPORT OF WELD IMPACT TESTING AND VISUAL INSPECTION

Date: _____

Project: _____

Weld Location (Area): _____

Method (Impact or Visual): _____

Seam No.	Number of Repairs Requ'd	Number of Repairs Made	Acceptance Date	Comments
TOTALS:				

We, the undersigned, certify that the statements in this record are correct and that the welds were prepared and tested in accordance with manufacturer's recommendat

_____

Schlegel Lining Technology, Inc.

Schlegel

PHYSICAL TESTING

WELD SEAM QUALITY CONTROL

Job Number: _____ Evaluation: _____

Test Performed by: _____ Action Required: _____

	PEEL TEST	TENSILE TEST	
Sample (From Seam # N/N)	Failure Mode	Weld Tensile Strength	$\frac{\text{Weld Tensile Strength}}{\text{Liner Tensile Strength @ Yield}}$ X 100

REPORT OF VACUUM TESTING OF WELDS

Date: _____

Project: _____

Weld Location (Area): _____

Equipment (Name & Type): _____

Seam No.	Number of Repairs Requ'd	Number of Repairs Made	Acceptance Date	Comments
TOTALS:				

We, the undersigned, certify that the statements in this record are correct and that the welds were prepared and tested in accordance with manufacturer's recommendat

_____

Schlegel Lining Technology, Inc.

SCHLEGEL LINING TECHNOLOGY, INC.

200 South Trade Center Parkway
P.O. Box 7730
The Woodlands, Texas 77380

Tel: (713) 273-3066 (Conroe)
(713) 350-1813 (Houston)
Telex: 792745

NON-CONFORMANCE REPORT

TO PROJECT ENGINEER: _____

FROM SITE SUPERINTENDENT: _____

NON-CONFORMING CONDITION:

_____

_____

_____

_____

_____

DISPOSITION: REPAIR_____ REPLACE_____

OTHER: _____

_____

ACCEPTANCE OF DISPOSITION_____ DATE_____

SITE SUPERINTENDENT

(11) "Construction and demolition debris" means wastes resulting from construction, remodeling, repair and demolition of structures, road building and land clearing. Such wastes include but are not limited to bricks, concrete and other masonry materials, soil, rock and lumber, road spoils, paving material and tree and brush stumps.

(12) "Container" means any portable device in which a material is stored, transported, treated, disposed of, or otherwise handled.

(13) "Contingency plan" means a document acceptable to the department setting out an organized, planned and coordinated course of action to be followed in case of a fire, explosion, or other incident that could threaten human health or the environment.

(14) "Cover material" means soil and/or other suitable material acceptable to the department that is used to cover compacted solid waste, including hazardous waste, in a land disposal site.

(15) "Daily cover" means a compacted layer of at least six inches of cover material that is placed on all exposed solid waste in a landfill at the end of each day of operation (except for recyclable materials properly located in a salvage area).

(16) "Department" means the New York State Department of Environmental Conservation.

(17) "Dike" means an embankment or ridge of either natural or man-made materials used to prevent the movement of liquids, sludges, solids or other materials.

(18) "Discharge" means the accidental or intentional spilling, leaking, pumping, pouring, emitting, emptying, or dumping of solid waste, including leachate, into or on any land or water.

(19) "Disposal" means the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste into or on any land or water, so that such waste or any constituent thereof may enter the environment, or be emitted to the air, or discharged to any waters, including groundwaters, of the state.

(20) "Disposal facility" means a facility or part of a facility at which solid waste is intentionally placed into or on any land or water, and at which waste will remain after closure.

(21) "Division" means the Division of Solid and Hazardous Waste of the New York State Department of Environmental Conservation.

(22) "ECL" means Chapter 43-B of the Consolidated Laws of New York State, entitled the Environmental Conservation Law.

APPENDIX E

RECOMMENDATIONS OF DR. NORMAN RICHARDS

ON SOIL COVER

IC, IMPACT CONSULTANTS

507 E. FAYETTE ST.
SYRACUSE, N. Y. ~~13210~~ 13202
(315) 478-8994

— A team of advisors dealing with environmental impact —

June 15, 1984 5

To: Richard W. Klippel, P.E.
Calocerinos and Spina
1020 Seventh North Street
Liverpool NY 13088

From: Norman A. Richards
156 Westminster Ave.
Syracuse NY 13210

Re: RECOMMENDATIONS FOR SOIL AND VEGETATION ASPECTS FOR REVISED CLOSURE PLAN FOR THE CRUCIBLE INC. SOLID WASTE FACILITY, GEDDES, NY.

As we discussed in our meeting of June 11, I have developed further recommendations on the soil and vegetation aspects of your revised closure plan for this facility. If further details are needed or you have other questions, please contact me again. I will be away most of the next two weeks, so it would be best to contact me June 24 or 25 when I know that I will be in Syracuse.

My recommendations are based on the following design assumptions which you outlined:

- That the re-shaped Crucible waste will be capped by a highly impermeable synthetic membrane overlaying a layer of porous, coarse sand, rather than a capping of low-permeability clay as previously proposed. The beds should be shaped and the sand layer placed as early as possible prior to placement of the membrane in order to allow for initial settlement after reshaping. Depth of potential freezing is very uncertain on this raised, exposed waste site, so any effects of freezing are to be avoided by the rapid permeability of the sand which will remove any moisture that may accumulate under the membrane. In contrast, clay under the liner would more likely be affected by freezing, and it also may crack upon drying so it would not necessarily maintain low permeability. In case of an accidental breakage of the synthetic membrane, the underlying Solvay waste would serve as a secondary protection system in absorbing any leachate through the Crucible waste.

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— A team of advisors dealing with environmental impact —

The relatively short slopes designed in the ridged final topography of the Crucible waste will limit the amount of water intrusion that might result from an accidental hole made in the synthetic membrane.

- That a six-inch layer of uniformly coarse sand will be placed over the synthetic membrane to assure rapid lateral drainage of precipitation permeating to this level. The soil layer placed over this sand must be stable and support satisfactory vegetation cover. Perennial herbaceous cover requiring minimum maintenance is desired. Woody plants are not desired because of a possibility of greater potential for woody roots to penetrate the synthetic membrane.

Recommended low-maintenance soil-vegetation system

1. The soil cover should be designed for good physical stability. Vegetation should not be relied on for erosion control and other stabilization of the site. Rather, its purpose is secondary protection, improved infiltration, and aesthetic enhancement of the site. The soil cover should be in the textural range of a coarse or sandy loam; ideally with 50-60% sand that is mostly in the medium or coarser size range. A soil of this textural range should maintain good infiltration and have low erodability on the slopes planned. Also, a medium to coarse sandy loam should not form a significant textural discontinuity with the underlying sand layer, as may occur with a finer soil. A moderate content of coarse fragments--gravel or larger in the range of 10% volume-- would be acceptable in this soil material, and may even increase soil stability. However, substantially greater stoniness would reduce effective soil volume for plants, so an increased depth of soil would be required.

2. In the textural range specified above, a cover of 18 inches of soil over the sand layer is believed to be adequate for the objectives of this closure plan. A sandy loam of this depth would hold a little over 2 inches of water available for plant growth after drainage of gravitational water. This is marginal for plant growth in central New York; that is, it can support drought-tolerant perennial grasses and forbs, but is unfavorable for plants with higher moisture demands--notably vigorous annuals and most

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woody plants. This marginal moisture availability should reduce the need for mowing or other treatment to control invading woody plants and noxious weeds that could become a problem on a deeper, more favorable soil for plant growth. There is no assurance that a porous soil depth of 18 or even 24 inches over 6 inches of sand will prevent plant roots from reaching the membrane surface. However, root growth is expected to be weak in the sand layer in comparison with the more favorable soil above.

3. The concept of placing two layers of soil, so-called "subsoil" and "topsoil", on reclamation sites is obsolete for sites where high-productivity vegetation is not needed or desired. The main value of "topsoil" is higher fertility usually associated with higher organic content. However, soil fertility can be amended easily by fertilization, and the other values of organic matter are not critical in a soil of favorable texture. On the negative side, typically finer-textured topsoil is more subject to erosion, particularly if it causes a textural discontinuity with the underlying soil. Its use also depletes another area of topsoil.

I recommend use of a single soil layer selected for its textural composition as described above. Its fertility status is not important because this can be improved easily. In fact, high fertility is not desirable because it may encourage growth of vigorous annuals during favorable moisture periods, and these would interfere with slower-growing, more drought-tolerant species that would be more favorable on this site in the longer run. A soil pH in the range of 6.0 to 7.5 would be satisfactory here. If the pH is below 6.0, agricultural ground limestone should be spread at the rate of one ton/acre before seeding.

4. Perennial, sod-forming grasses would be best as the primary vegetative cover, because of their good protective cover and inhibition of woody plant invasion. The main requirements for species adaptation here are drought tolerance, cold hardiness, and ability to persist with minimal maintenance. A legume component mixed with the grass would be helpful to fix nitrogen and therefore reduce future fertilization needs for this nutrient. My species recommendations for the previous closure plan (my 7/20/84 letter to you) remain applicable to the revised plan. These were for "Kentucky 31" tall

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fescue seed at 20 lbs. per acre, with "Chemung" crownvetch innoculated seed at 15 lbs. per acre. I have observed that these species and varieties are fairly drought-tolerant in central New York, and both are currently growing well on the Solvay wastebeds. In view of the desire for a dense, low-maintenance sod to discourage woody plant invasion in the revised closure plan, I think that a slightly better alternative grass would be common red fescue (Festuca rubra); preferably not the new varieties developed for intensive lawn use. This grass forms a lower cover of denser sod, and is very drought-tolerant; so is particularly effective in inhibiting woody invasion. A disadvantage of red fescue is that it is slower to establish; typically, first-year cover is not dense, so soil conditions must be quite stable for successful establishment of this species. Crownvetch can also be mixed as a scattered component with red fescue. I recommend a seeding rate of 20 lbs. red fescue to 10 lbs. of crownvetch per acre. Because there is a large difference in seed weights, this mix provides a very small number of crownvetch seeds in relation to fescue seeds.

Either the red fescue or tall fescue mixtures would be best seeded in early spring. Alternatively, the grass could be seeded in September, with the crownvetch topseeded early the following spring. For the grasses alone, fertilization with seeding should be at the equivilent rate of about 1200 lbs. per acre of 10-10-10. If the legume is seeded with the grass, the proportion of nitrogen in the fertilizer should be reduced to about half. A light mulch layer at the time of seeding is desirable to conserve water and reduce crusting of the soil surface while the grass is becoming established. If the site is hydroseeded, a fibre mulch in the hydroseeding mix would be sufficient. Otherwise, chopped straw can be blown onto the site in a thin layer just sufficient to cover the surface after seeding.

5. The planted site may require a topdressing of more fertilizer the second year if plant cover is lighter than desired. If a legume is established in the cover, the topdressing should be at the equivilent rate of about 1000 lbs. 5-10-10 per acre. If there is no legume, more nitrogen should be added. Heavy fertilization is not recommended because it will foster invasion of

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of aggressive, noxious species such as ragweed. There is a large seed source of such noxious species around the State Fair parking areas, on the sewage sludge dump area, and on other poorly maintained sites near the Crucible landfill.

The vegetated site will need to be inspected in future years for significant invasion of woody plants. Maintenance of a moderately dense herbaceous cover should inhibit woody plant invasion, so only well-established plants would have to be removed. This could be done as needed by selective treatment with an appropriate herbicide. Alternatively, the site could be mowed about every other year to favor grass growth and discourage woody plants. One mowing in early summer at a fairly high setting of about 4 inches should be adequate. This mowing may also be useful to expose any damage to the soil cover, such as animal burrows, which may require attention.

Thomas A. Richards

APPENDIX F

REPORTS PERTAINING TO MEMBRANE LIFE

SCHLEGEL LINING TECHNOLOGY, INC.

200 South Trade Center Parkway
P.O. Box 7730
The Woodlands, Texas 77380

Tel: (409) 273-3066 (Conroe)
(713) 350-1813 (Houston)
Telex: 792745

October 3, 1985

Mr. Richard W. Klippel, P.E.
Calocerinos & Spina
Consulting Engineers
1020 Seventh North St.
Liverpool, NY 13088

Dear Mr. Klippel,

It was a pleasure meeting your acquaintance on Tuesday. Please find attached nine (9) reports covering all subjects discussed during our meeting.

Report #1 is a Confidential technical report issued by The International Technical Center for Rubbers and Plastics, Shawbury, England. This report addresses the issue of the service life or durability of SCHLEGEL® sheet HDPE liner.

Report #2 - Effects of burrower attack on liners clearly indicating that polyethylene liners were unattacked when exposed to addicted rats. The report also compares performances of other liners. This report was abstracted from a German plastics engineering book published in 1968.

Report #3 - Published by Public Materials Testing Bureau of North Rhine-Westphalia, Dortmund, Germany and translated into English; shows the performance of Schlegel HDPE liner when exposed to rodents. Both German and English translations are enclosed.

Report #4 - Published by another German independent institute; shows the performance of Schlegel HDPE when exposed to rodents. The rodents species used in this case are called "muskrats" and considered as Germany's most dangerous gnawing and burrowing animals.

Report #5 - Published by West German Federal Institute for Material Testing; shows the performance of Schlegel HDPE liner when exposed to termites. The species used are aggressive termites from South Carolina, U.S.A. and Northern India.

Report #6 - Long term performance of Schlegel HDPE liner under different types of stresses. Issued by Schlegel Lining Technology, Inc. This report covers properties such as creep, relaxation, flexural fatigue and environmental stress cracks.

Report #7 - Weathering resistance of Schlegel HDPE liner discusses the performance of SCHLEGEL® sheet, both during laboratory and actual field exposure to weathering factors. The weathering factors consist of photochemical attack, thermal oxidative attack and a combination of both. Increased temperature and ultraviolet radiation were utilized to facilitate ageing.

Report #8 - Issued by the "South German Plastic Testing Institute"; this report evaluates the integrity of Schlegel HDPE liner after exposure at Galing disposal pit. Properties such as density, melt index and tensile testing were evaluated after exposure.

Report #9 - Issued by Austrian Plastics Institute, Vienna, Austria; this report discusses in depth the physical and chemical properties of Schlegel HDPE as tested by the Institute. Different types of field loadings and deformation factors were evaluated in regards to their effects on Schlegel HDPE.

I hope these reports will answer all your questions. If you have further questions or if I can be of any assistance, please call me.

Looking forward to working with you on this very important project.

Best regards,

Anthony O. Ojeshina
Quality Assurance Manager

led

cc: Morris Jett, SLT-Houston
Gene Connelly, SLT-New York
Jim Price, SLT-Houston

enclosures

rapra
The International Technical Centre for Rubbers and Plastics
Registered Office: Shawbury Shrewsbury Salop SY4 4NR England
Telephone: Shawbury (0939) 250383 Telex 35134

Confidential Technical Report 6071 Date 6.11.80

PROJECT NO: 180/C8319/3530 #1

ASSESSMENT OF SCHLEGEL AREA SEALING SYSTEM

SCHLEGEL LINING TECHNOLOGY GmbH,
Bredow Strasse 33,
D2000,
Hamburg 74,
West Germany.

For the attention of Dr. F.W. Knipschild

B.J. Wain
Author

R.P. Brown
Manager

This report relates to the specimen(s) or instrument(s) submitted for test and no others
Your attention is particularly drawn to Condition 13 overleaf

rapra
Rubber and Plastics Research Association of Great Britain
— A company limited by guarantee Registered in England: No. 159453

CONTENTS

ASSESSMENT OF SCHLEGEL AREA SEALING SYSTEM

1. Introduction

The Schlegel Area Sealing System is based on the use of high density polyethylene sheet of thickness between 1.5 mm and 3.5 mm as an impermeable membrane in the construction of reservoirs, storage lagoons, pollutant containment pits and the like. The system is manufactued by Schlegel Lining Technology GmbH, Bredow Strasse 33, D2000, HAMBURG 74, West Germany and the United Kingdom and Ireland is served by Schlegel Lining Technology GmbH, 53, New Street, CHELMSFORD, Essex CM1 1NG. The manufacturers offer an installation service including the laying and welding of the sheet with complete testing of the welds made on site by both mechanical stressing and ultrasonic techniques.

The Rubber and Plastics Research Association (hereinafter abbreviated to RAPRA) have carried out an independent assessment of the system including:

1.1 The manufacture of the sheet.

1.2 The installation of the sheet as an area liner.

1.3 The physical and mechanical properties of the sheet and welds produced under typically standard conditions and the relationship of their properties to the parent high density polyethylene.

1.4 The quality control applied to the polyethylene granulate, the sheet manufacture and to the subsequent installation on site.

This reports gives the details and the results of the test programme and the assessment.

2. Assessment

2.1 General

RAPRA, having carried out the assessment and test programme described in section 4 and having drawn the conclusions set out in section 3 of this report, are satisfied that the area sealing system offered by Schlegel Lining Technology GmbH meets, in every respect, the claims made in their published technical literature.

2.2 Material

The high density polyethylene used for the manufacture of the sheet is a carefully chosen grade obtained from one supplier only. Antioxidant and UV stabiliser (i.e. carbon black) are added and compounded by the resin manufacturers and it is the opinion of RAPRA that the quantities added are adequate to stabilise the material for its use as a sealant liner.

The sheeting, made by a unique extrusion/casting technique, is essentially strain free and its tensile properties at ordinary temperatures in both directions are almost identical to those published by the resin manufacturers as determined on laboratory prepared test pieces. At sub ambient temperature (-10°C) there is an increase in tensile strength and a slight loss in elongation. As would be expected, at an above ambient temperature (70°C) there is loss of tensile strength without much increase in elongation at break; at this temperature the sheet does not have a recognisable yield point. It is the opinion of RAPRA that the tensile properties of the sheet at temperatures between -10°C and 70°C coupled with the high softening point of the material (120°C), low thermal shrinkage and very good low temperature brittleness (lower than -90°C) will ensure that the liner has adequate strength during installation and use as an area sealing medium over a wide range of climatic conditions.

2.3 Installation

Installation of the Schlegel Area Sealing System is always carried out and supervised by Schlegel personnel. Having visited completed sites and those under construction, RAPRA are satisfied that the laying and welding of the sheet into a complete liner is carried out using the best state-of-the-art techniques. Welds are produced using purpose designed semi-automatic welding machines or by hand with skilled operators where there is inaccessibility for the machines. All welds are tested ultrasonically (non-destructive testing) and random samples are also taken and the weld strength determined in both shear and peel on site. Laying and welding is never carried out in wet weather.

During installation the risk of damage to the polyethylene sheet is, perhaps, higher than at any other time during its service life. There is the possibility of damage by the passage of earth moving equipment driving small stones through the sheet and the dropping of sharp pointed instruments by workmen. It is the opinion of RAPRA that the punch shear strength and impact strength of the sheet is adequate to resist such casual damage. Furthermore, if a puncture does occur then the damage is confined to the area of the puncture and there is no evidence of radiating crack propagation from the damaged site. The repair of such damage by the welding on of a patch is readily effected.

2.4 Chemical Resistance

RAPRA are satisfied that the resistance of the HD polyethylene sheet to water, strong mineral acids and alkali and oil is adequate for the application. The published literature both by polyethylene manufacturers and others, e.g. RAPRA (2) documents the resistance of polyethylene to a wide range of chemicals hence there is no difficulty in deciding the suitability of the system for the containment of particular chemicals. The environmental stress cracking resistance of the sheet is excellent and it is unlikely that the sheet will fail in this mode during service.

2.5 Quality Assurance

RAPRA, having inspected the quality assurance schedules for the control of quality of the base HD polyethylene compound and its manufacture into sheet and installation on site, are satisfied that Schlegel rigidly apply these schedules, retain samples for at least two years and records for at least 5 years. There is no doubt that the level of quality assurance applied to the Schlegel Area Sealing System is adequate for its application.

2.6 Service Life

It would be unwise to make any firm prediction of service life on the basis of the assessment and short term tests which form the subject of this report. Nevertheless, RAPRA feel that the high quality of the whole system coupled with the known behaviour of polyethylene in pipe applications over the last 30 years is sufficient to indicate that the Schlegel Area Sealing System should have a service life of at least 50 years.

THE EFFECT OF BURROWER ATTACK ON DIKE LINERS

Translation
D. Etter, March 7
Wo

#2

taken from "Wasser und Boden" (1968) No. 8, page 239
Author: F. Steiniger

The author carried out applied behavioral research to determine the resistance to burrower attack of dike liners, both concrete liners and membrane liners. The investigations were carried out as part of the planning work for the Aller-Leine-Oker (rivers) project in the West German province of Niedersachsen.
Only rodents were to be taken into account for the conditions prevailing in West Germany. Carnivores (fox, badger, marten, weasel, etc.) and insect eaters (mole, shrew, etc.) were not included as they do not attack surfaces, although they do bite off relatively small roots when burrowing. This holds for rodents, even rabbits. Of course, these burrowers can all tear open soft, paper-thin membranes with their claws.

The most important type of burrower for testing burrower-proof dike construction materials is the rat (sewer rat, large vole, and muskrat). Long-tailed mice (house mouse, forest mouse, yellow-necked mouse, Brandmaus, and dwarf mouse) are for the most part only active in destroying membranes above ground level. The small vole (field mouse, ground mouse, ochre mouse) is numerous but does not burrow deep enough and gnaws membranes at a very slow rate. Underground mice and Rattenkopf are difficult to obtain as experimental subjects and are not abundant enough in nature to be of importance.

The purely physical standpoint that only those substances harder than the burrower's tooth enamel are burrower-proof is an underestimation of the possibilities of the situation. For instance, an artificial slate produced in Latvia in 1942 was found to be a suitable material for a large sewer rat cage although the material could be sawed and nailed without difficulty. Observations showed that, as soon as they took a full bite, the rats could not pull their teeth out of the material; several died as a result of this. The others soon realized that the gnawing would endanger their survival and thus refrained from further gnawing as a self-protective measure. Even a soft material can prevent gnawing if its surface is smooth and there is no nearby supporting surface for the animal to push off on.

.../2

Tests: sewer rates were confined in an open air enclosure with an area of 100 m^2. Membranes (thickness less than 1 mm) of PVC with plasticizer additive were buried vertically beneath the enclosure; the rats broke through the membranes when they obstructed burrowing. The rats also gnawed on PVC membranes (thinner than 1 mm) merely placed on the ground and swallowed some of the debris. The undigested debris could be detected in their excrement which had a very unusual appearance. The animals soon developed an addiction to PVC which is analogous in certain respects to gum chewing by humans, e.g. in America. Both phenomena are referred to in animal psychology as "purposeless habitual behavior". A rat must instictively gnaw for a certain amount of time each day and thus often gnaws objects without serving any purpose whatsoever. For the PVC material, it was apparently the plasticizers causing the animals to become addicted, since PVC without plasticizers was not attacked. At the moment it has not been determined whether the addiction is of a chemical or a tactile nature.

Bad-tasting and poisonous additives to PVC did not harm the addicted rats; when a steel wire mesh was present in the membrane, the rats cleaned off the PVC down to the mesh. On the other hand, the forest mouse, the large forest mouse and the muskrat did not display the same addiction.

As opposed to soft PVC, membranes of polyethylene were not attacked by rats, not even addicted ones. This was proved in extensive testing with VK 1531 dike liner membrane ..... This membrane, tested for the most part as specimens of 1 mm thickness, was buried vertically and was not penetrated by the burrowing rats. One section was placed in a cage containing 50 to 100 rats for a period of 20 months and showed no signs of gnawing when examined afterwards. Wild rats were enclosed in small cages of this membrane and could not break through, not even when faced with starvation.

.../3

Two model dikes were constructed in a 60 m^2 pond sealed with welded section of VK-1531 membrane. The models were oriented perpendicular to each other; VK-1531 was used to line both, in one case without any additional protection and in the other with a covering of Pectacrete Cement (.....) In three months exposure, neither the covered nor the unprotected membrane was penetrated either on the membrane surface or below water level. Gnawing damage was only observed on the edge of the unprotected membrane, causing leakage in one instance. Experiments were conducted on membrane samples in small rodent cages; here, as with the Latvian articicial slate, the rodents' teeth were observed to stick fast in the membrane surface.

In practice, rodent attack on the edge of a large area welded membrane is not a substantial point. If edge protection seems nonetheless necessary, a concrete covering can be used to secure the edge. From the standpoint of effectiveness, there is certainly still tight competition between a burrower-proof membrane and a burrower-proof concrete layer; the selection of one system or the other would be based on cost factors.

Translation

STAATLICHES MATERIALPROFUNGSAMT NORDRHEIN-WESTFALEN

(Public Materials Testing Bureau of North Rhine-Westphalia)

DORTMUND

#3

TEST CERTIFICATE

No. 32 0202 9 81

Commissioning Firm: Schlegel Lining Technology GmbH
Bredowstr. 33
2000 Hamburg 74

Receipt
of Test Commission: April 27, 1981
of Test Material: : June 4, 1981

Type and Designation
of Test Material : SCHLEGEL sheet, 2 mm thick

1. Test Commission

Testing of rodent resistance

2. Test Procedure

The experiment was conducted according to the "Construction and Testing Guidelines for Plastic Liners of Indoor and Outdoor Basins and Tanks for Storage of Potential Ground Water Pollutants " (CTG Plastic Liners) November 1981 version, Section 4.8.

The specimen exposed to water rat attack in the experiment was the liner of a basin constructed for the test as described in section 4.8 of the above guidelines, with approximately 2.40 m of fillet weld seams (corners) and approximately 3.20 m of overlap weld seams (2 seams, oriented parallel to the longer basin side). The overlap width of the lengthwise welds was

...

The test certificate comprises 2 pages and 4 photos. ../2

about 40 mm. The overhanging length of unwelded material was 180-200 mm in length. The liner material was relatively stiff and was thus anchored in the subgrade earth without need of folding (dimensions of basin floor: 500 mm x 500 mm).

A basin of the dimensions of the test specimen was excavated in the water rat cage. The test specimen was placed in the basin and subsequently covered with a layer of earth 5-10 cm in depth. In addition, several unsecured strips of the liner material approximately 5 cm in width were placed on the cage floor.
A nonrigid PVC liner test specimen of the same dimensions was employed as a control specimen for evaluation of the water rat attack.

3. Test Results

The test specimen was removed from the basin after an exposure period of 6 months. The damage to the above-ground sections of the test specimen had been determined over this time. Evidence of extensive burrowing activity in the covering layer and subgrade was observed during the removal of the specimen. The test specimen was observed to have sunk somewhat into the subgrade; in addition numerous tunnels were observed under the 500 mm x 500 mm basin floor. The control specimen had been completely destroyed in the experiment and was found in small shreds spread throughout the entire cage.
The unsecured strips of the test material had been carried off by the water rates and could not be located.

Inspection of the test specimen (Figure 1) after removal revealed apart from numerous minor indications of gnawing attack (Figures 2 and 3), only one spo with any significant gnawing damage (Figure 4), extending over approximately 25 cm of an outer edge up to a depth of 7 cm. No other damage to the test specimen was observed.

(signed)

Dr. Weisheit
Dortmund, West Germany
May 24, 1982

Translation D. Etter, August 1983

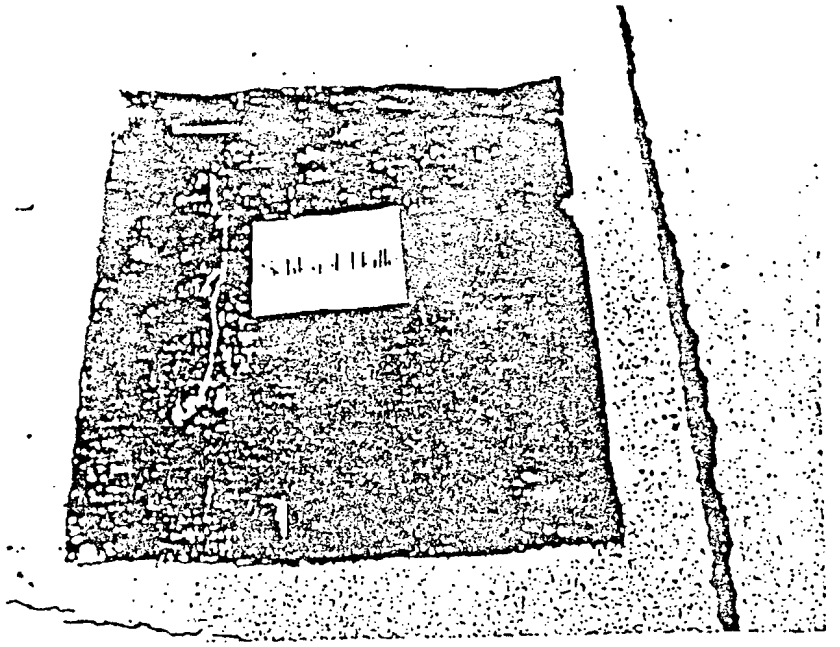


Figure 1

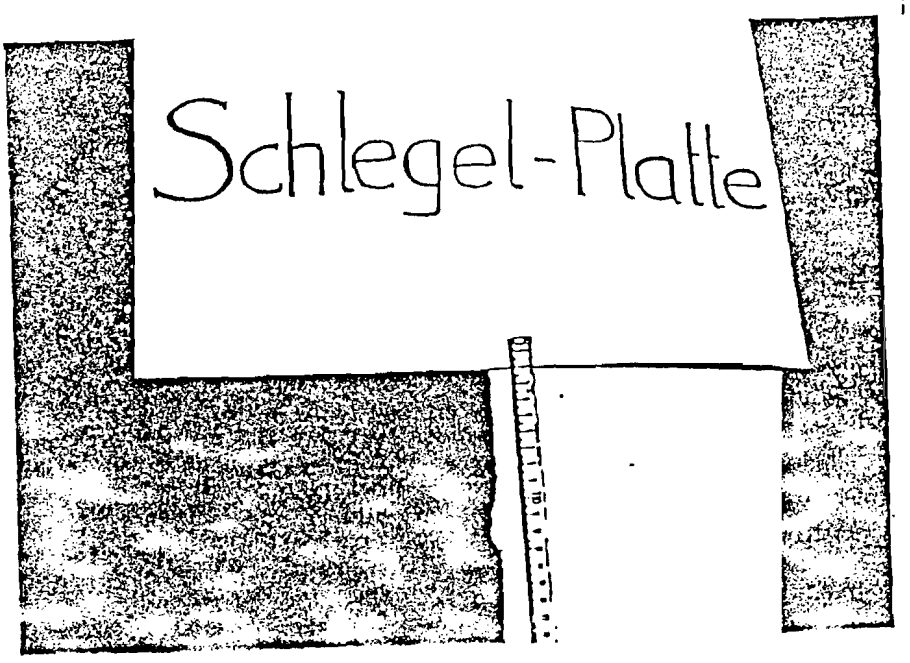


Figure 2

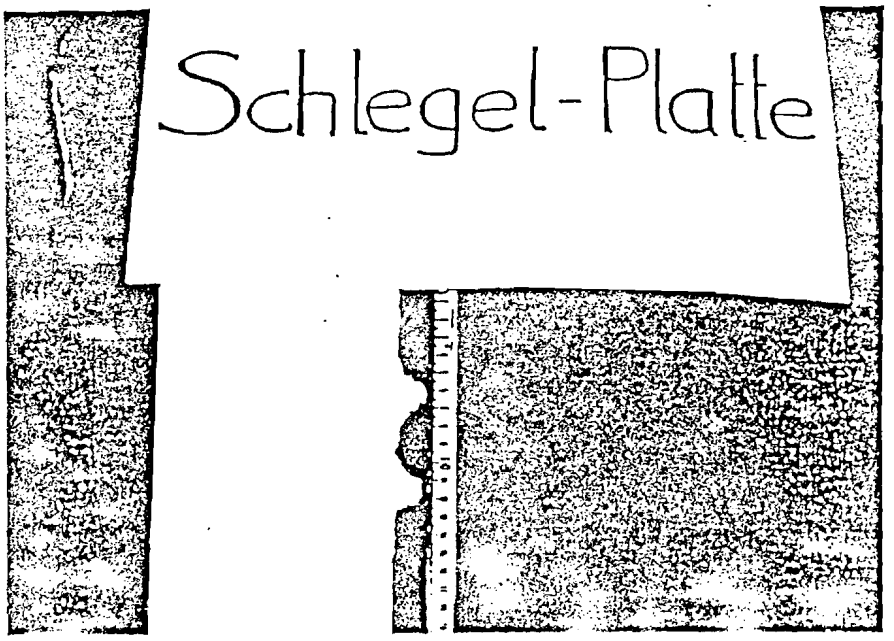


Figure 3

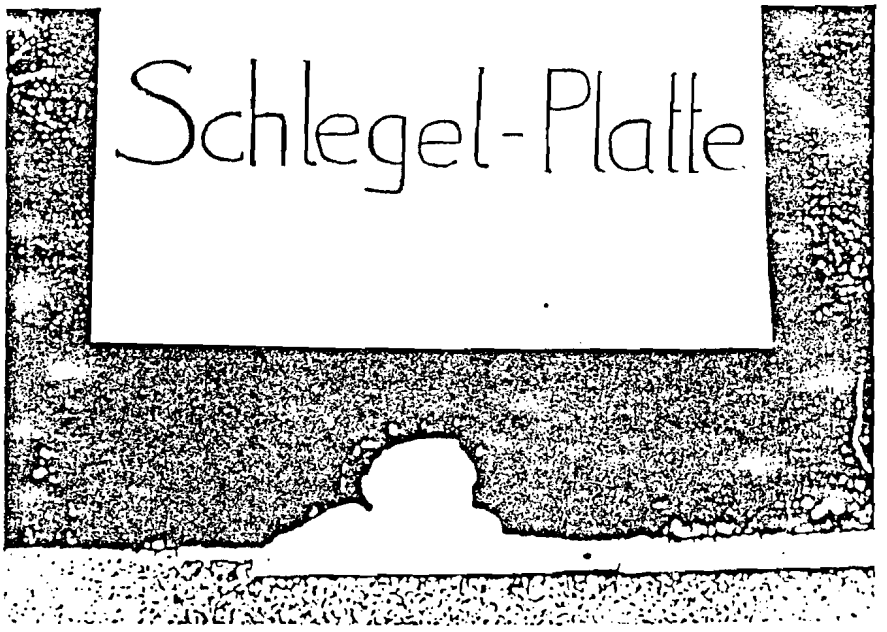


Figure 4

Prof. Dr. med. Hans J. Einbrodt
Vorstand der Abteilung
Hygiene und Arbeitsmedizin
der Rheinisch-Westfälischen Technischen Hochschule

51 Aachen, March 13,1979
Lochnerstr. 4 - 20
Telephone (0241) 80 89 1

#4

Commission: Test of the resistance of the SCHLEGEL sheet "VESTOLEN A 3512 black" to rodents in an open preserve

Reference : Your request from April 17,1978

Professional Opinion

Based on observations made during laboratory tests (see report from April 11, 1978) we recommended an open enclosure experiment to reconfirm our results.

On April 24,1978, employees of your firm installed in accordance wit our specifications the above mentioned SCHLEGEL sheeting A 3512 in a open preserve in Aachen. The material to be tested was a high densit material (HDPE - low pressure polyethylene) of ϱ = 0.94 g/cm³ with an elastiticity modulus of 900 N/mm², which according to the producer's specifications has the following characteristics:

- sufficient mechanical solidity, a good elastic behaviour when deformed
- high plastic deformability, good relaxation characteristics
- high chemical durability and tensile cracking strength.
- high thermal durability and UV stability
- resistance to micro and macro organisms and root penetration.
- simple and reliable production and connecting techniques
- simple and reliable proof of material quality and functionabili of the sealing system.

The testing program should determine whether and to what degree a destruction of the examined material by rodents after a given installation can be expected. We followed the testing program for the obtaining of an expert opinion from the ad hoc working committee "Rodent resistancy of plastic-sheeting used as a water-secure sealer from July 15,1975 as well as a review on September 13,1977 at Aacher We used muskrats (Ondathra zibethica), that are for water constructi Germany's most dangerous gnawing and burrowing animals.

Testing Facility

The material lay evenly in two walled fields (4.5 x 2 m and 6.5 x 2 with entrance posssibilities from above over catwalks as well as underneath the liner through ground level openings in the walls (cre tubes). The total size of the test basin was 35.12 m^2. From the 60 cm high wall brims the sheeting was first of all layed out on an embankment with a gradient of 1 : 2 and then at the height of 40 cm horizontally. The rounding off radii were on the floor edges 0.5 m and on the brim 0.25 m. The material was provided with high quality liner connections (weld seams with overlaps) moving out from the corners in the extrusion direction. The welding temperature was 230°C. On two sides of each field,the sheets were connected without protection but directly onto the boundary walls. The subfloor was composed of a mixture of gravel and topsoil which was covered with a fine grained gravel of about 10 cm. The liner was also covered with an up to 20 cm thick layer of low adhesive gravel. A water level of 30 cm was maintained in the preservation so that the test material was always at least 10 cm above the water line.

Behaviour of the Animals

After completing the facility, 12 wild muskrats were introduced that immediately entered the offered facility through the creep tubes.

Due to their natural shyness, the muskrats were only to be seen during the night in the open water and feeding places. Their activity however, could be recognized by their appetites as well as their intensive burrowing that was easily observed by the size of the soil carried out through the creep tubes and deposited in the open part of the enclosure.

Remarkable was that in spite of the great amount of soil carried out, no sinking of the liner could be found. On one corner where a portion of the liner was not properly secured onto the surrounding wall, the animals managed to gain exit to the top by pushing the sheet on one side. Upon finding this defect, the exit was sealed up again. Traces of the rodents were not found at this location.

Material Behaviour

After the hottest days of the summer 1978 protrusions in open lying or thinly covered areas of the liners had appeared, that had apparent been caused by the heat. These areas were not used by the animals as exits.

Because in the course of the rainy summer it was determined time and again that the water saturated ground did not dry out from run off or out flow and hence that the investigation was intact, the investigation was extended a further two months i.e. till November 8,1

During this period, it was attempted through short term increases in water level to force the animals towards the top and induce new confrontations with the test material.

Uncovering

On November 11,1978 the test material was removed from the installation. At that point of time no signs of change or damage to the liner except for small weather caused deformations could be seen. After removing the sand-gravel covering from the liner, further minor welling ups were found. These were caused in the case of a regular pattern from burrowing underneath the material. When irregular in shape, the deformations were traced back to temperature effects.

In the case of a regular shaped protrusion the sheets formed the upper boundary of the tunneling system. In these areas no more soil adhered to the raised material which points toward a direct contact of the animals with the covering liner. The rest of the ground was burrowed and full of tunnels much like a natural muskrat landscape. There were many food catches in the labyrinth. The liners were then checked for traces of gnawing or scratching. No changes could be found in the material.

In Conclusion:

In the time between April 24,1978 and November 8,1978 the SCHLEGEL sheets "VESTOLEN A 3512, black" was layed out in an enclosure with captured wild muskrats. Based on the animals' behaviour, their intens burrowing activities, their creation of an exit to above by pushing the edge of the sheeting out of the way as well as their tunnel construction in which the sheet was the roof, there existed sufficient possibilities of aggression for the animals that were not utilized.

Looking back on the laboratory tests (see the report from April 11, in which breeded rats attacked the material but did not damage it, VESTOLEN A 3512 can be judged under the depicted conditions and a correct installation technique to be resistant to native rodents.

Signature

Signature

#5

TRANSLATION:

BUNDESANSTALT FÜR MATERIALPRÜFUNG
(BAM)

- West German Federal Institute for Materials Testing -

TEST REPORT

No.: 5.1/2453

1. Draft

Applicant firm: Schlegel Engineering GmbH
Sonninstrasse 18 - 26
2 Hamburg 1

Applied for in letter of: June 30, 1975 Received on: July 2, 1975

Test material received on: July 2, 1975

The test material consists of four identical sections taken from one specimen of high density polyethylene 'SCHLEGEL-Sheet', as it is called by the applicant firm. The size of the test sections conforms to the specifications of the German Industry Standard DIN A 4 (20,0 x 29.7 cm).
The sections are approx. 2 mm thick, coloured black and very slightly rough on one side, which will hereafter be called the 'upper' side in this report.

Qualities to be tested

The samples will be tested for their resistance to termites with a) forced eating testing and b) selective eating testing.

../2

1. Experimental conditions:

The test material was cut into sections of 3 cm x 3 cm and subjected to 'forced eating testing', where the termites have no other food supply and must attack the sheet to survive, and also subjected to 'selective eating testing', where the termites have an alternate food source. The testing lasted 8 weeks. The ambient temperature and the relative humidity were 26°C (79°F) and 90-95%, respectively. At the conclusion of the testing, the samples were examined under a binocular microscope for traces of gnawing damage.

1.1 Forced Eating Test Procedure:

This testing was conducted with Mediterranian dry wood-termites of the species Kalotermes flavicollis (Fabr.). K.flavicollis is well known for its destruction, resistance to various poisonous substances, and its ability to survive in small groups, and is therefore quite suitable for use in testing materials and/or termite-proofing methods.

For two tests 10 termites (5 larva and 5 pupa) were placed in the middle of the section in a cylindrical glass pipe section (Ø 1.3 cm). For the other four, the termites (once again, 5 larva and 5 pupa per test section) were placed on the outer areas of the test section, so that they could gnaw on the edge.

1.2 Selective Eating Test Procedure:

These tests were conducted with two species of ground termites 'Reticulitermes flavipes (Kollar)'(Origin: South Carolina, USA) and 'Heterotermes indicola (Wasman)' (Origin: Northern India).

The alternate food source, a piece of wood attacked by fungus, was placed in a glass beaker (Ø 9 cm, h = 12 cm). Over that came an approx. 4 cm thick layer of 'Vermiculit' (an expanding aluminium-iron-magnesium silicate with high water absorption) moistened with 300% water, when Reticulitermes was used, or with 350%, when Heterotermes was used.

This served as a layer for the termites to live in, as well as sources of material for construction of their passages, and water. The sheet samples were placed on a glass ring in such a manner that their lower surface coincided with the upper surface of the 'Vermiculit'

For each test with Reticulitermes flavipes 200 workers, 5 soldiers and 2 pupa were put in the beaker. The beaker was then covered with a perforated screw-on top. For the tests with Heterotermes indicola, a group of 650 mg. (approx. 500 termites) with a natural composition was used. Three tests were carried out per species, six in all.

The termites (and the extent of their tunnel building) were checked twice a week and weighed (in the case of R. flavipes also counted) at the conclusion of the test.

A supplementary selective eating test consisted of the following: a 4 cm x 29 cm strip of test material was placed between two pieces of wood in a Heterotermes indicola breeding basin for 12 days, and thus subjected to attack from thousand of termites.

2. Test Results

2.1 Forced Eating Testing

The results of the forced eating testing are presented in Table 1.

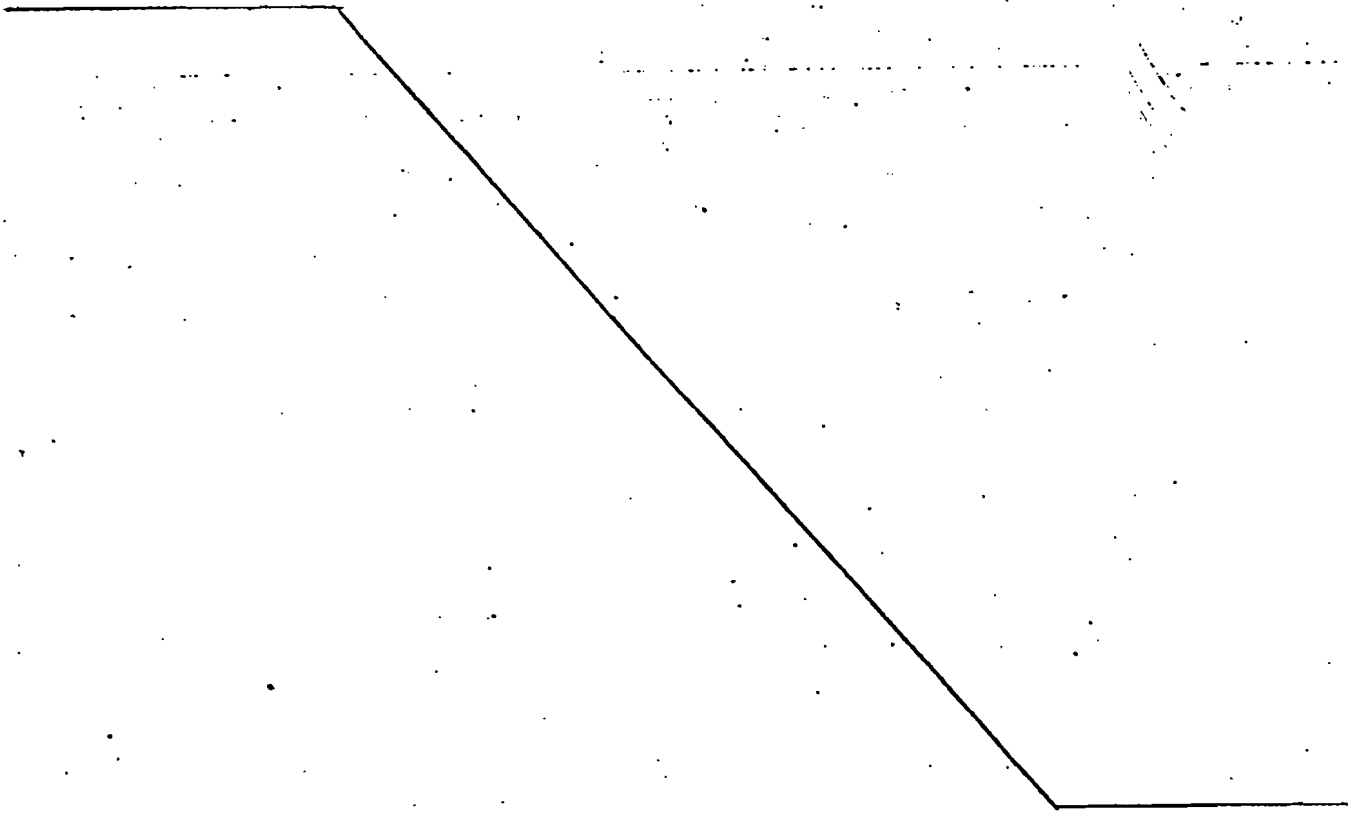


Table 1: Results of forced eating testing on 'SCHLEGEL-Sheet', termite species used: the dry wood termite Kalotermes flavicollis (Fabr.).

Test No.	Exposed Section	Weight of termites placed on exposed section mg	Number of termites alive, per 10 original termites - after 4 weeks	after 8 weeks	Damage to Exposed Section
1	edge of upper side	120	8	0	no trace of gnawing
2	edge of upper side	120	9	0	light traces gnawing vis to the naked
3	edge of upper side	120	10	0	light traces gnawing vis to the nake
4	edge of lower side	121	10	0	light traces gnawing vis to the nake on sheet su
5	middle	119	10	0	very slight of gnawing
6	middle	120	10	3	no trace of gnawing
Termite starvation test		120	8	0	(nothing in container)

The sample material was not poisonous to the termites. The survival rate in the first six tests corresponded to that in the starvation test. When traces of gnawing were detectable, they appeared as rounded-off edges or slightly roughened surfaces, on both the upper and the lower sample sides.

2.2. Selective eating test

The results of this testing are compiled in table 2.

Table 2: Results of the selective eating testing with 'SCHLEGEL-Sheet' termite species used: Reticulitermes flavipes (Kollar) and Heterotermes indicola (Wasman).

Termites	Test	Weight and Number of Termites at start+	after 8 weeks	Damage to Sample
R. flavipes	1	534 mg 200 W, 5 S, 2 P	453 mg 145 W, 7 S, 1 P, 1 Neo	no damage
	2	554 mg 200 W, 5 S, 2 P	479 mg 155 W, 7 S, 2 P	no damage
	3	549 mg 200 W, 5 S, 2 P	524 mg 166 W, 7 S, 1 P	no damage
H. indicola	1	650 mg (500)	490 mg	slight traces of gnawing
	2	650 mg (500)	470 mg	no damage
	3	650 mg (500)	466 mg	no damage

+) W = workers, S = soldiers, P = Pupa, Neo = Neophyte

As in the previous test, the sample had no detectable poisonous effect on the termites, the moderate decline in the number of living termites is normal for small groups such as these. At the conclusion of testing, there were detectab gnawing traces on only one sample.

As for the supplementary test with the sample strip, gnawing traces were detected at several points. This damage, however, did not extend beyond a light rounding-off of the sheet edge for a length of a few mm.

Summary and Conclusion:

The high-density polyethylene 'SCHLEGEL-Sheet' samples, in factory condition, were subjected to forced eating tests with the dry wood termite Kalotermes flavicollis (Fabr.) and to selective eating tests with two

different termite species, Reticulitermes flavipes (Kollar) and Heterotermes indicola (Wasman). In that, what little damage that occured was limited to very light rounding-off of edges and weak surface roughening, the sheet is considered termite-proof.

The traces pf gnawing that were detected could have no significance for practical considerations.

The German test is comprised of 6 pages.

Berlin-Dahlem, October 1, 1975
Unter den Eichen 87
Bundesanstalt für Materialprüfung (BAM)
Department 5, Technical Group 5.1

(signed)
Gersonde

(signed)
Kühne

July 15, 1976
Et/Lo

#6

SCHLEGEL LINING TECHNOLOGY, INC.

200 South Trade Center Parkway
P.O. Box 7730
The Woodlands, Texas 77380

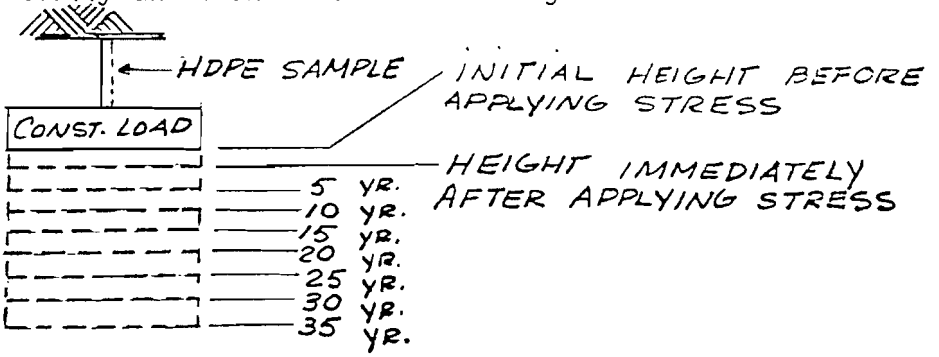
Tel: (409) 273-3066 (Conroe)
(713) 350-1813 (Houston)
Telex: 792745

LONG TERM PHYSICAL PROPERTIES OF SCHLEGEL HDPE LINER UNDER DIFFERENT TYPES OF STRESSES

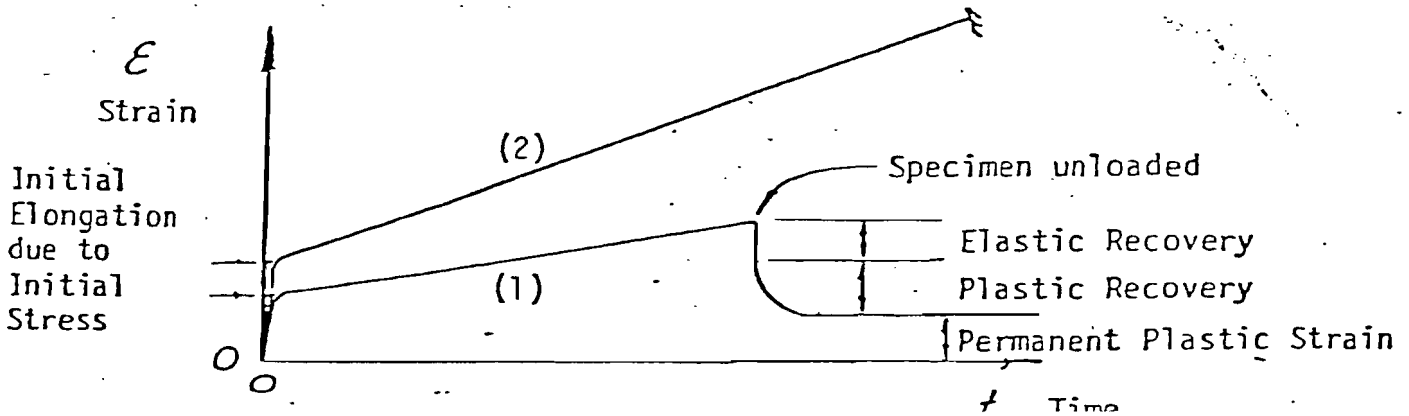
(1) Creep
(2) Relaxation
(3) Flexural Fatigue
(4) Stress Crack

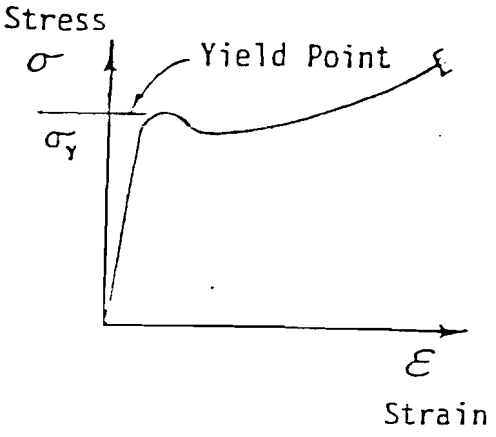
Creep: Creep is the continued elongation of a plastic material under load for an extended period of time.

For example if you have a plastic sample under constant nominal stress, the sample would elongate initially and then continue to elongate as shown in the following diagram.



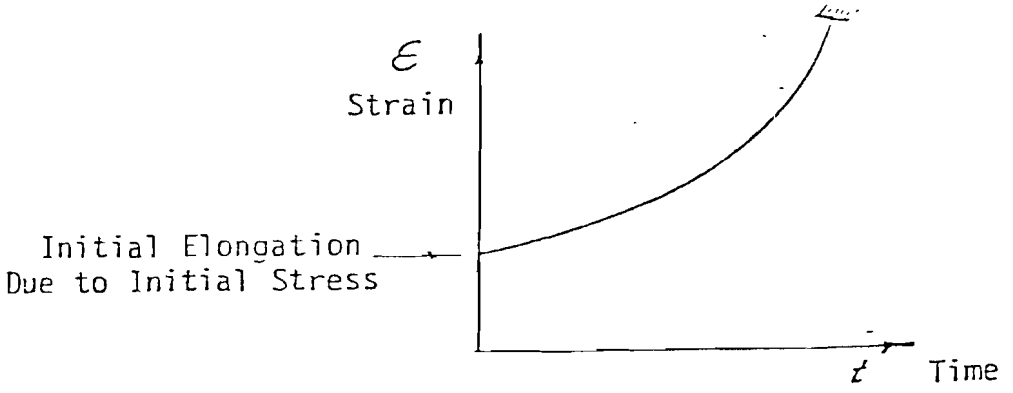
Notice that the increase in elongation is proportional to the change in time. This means that the relationship between elongation and time is linear as shown in (1) of the time vs strain curve. Line (1) shows how a sample will develop permanent plastic strain.





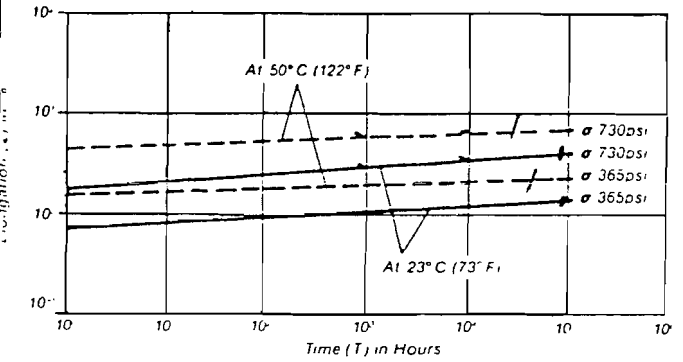
When the amount of constant load is increased, then the initial strain is increased and the rate of elongation or strain per unit time is increased as shown in line (2). The slope of this line is greater than that of line (1).

When the stress approaches the yield point on the stress-strain curve, the rate of strain per unit time is no longer linear. The strain vs time curve will become curved as shown.



The reason for this is that you are not in the area of the stress-strain curve where there will be an increase in strain without any increase in stress. This will occur generally in a short period of time.

Temperature has an effect on creep in that creep rate increases with increased average temperature. Creep is a very slow process, a phenomenon that is affected by temperature and amount of stress. The next diagram shows the behavior of Schlegel HDPE under "creep" based on laboratory testing; however, this data cannot be used for dimensioning calculation as the exact stress levels present in field applications are generally not available. The test was carried out under a constant stress equal to 30% of yield strength in a 5% wetting agent solution without any resulting fracture.



Typical deformation (ε) vs time (T) under constant load (σ).

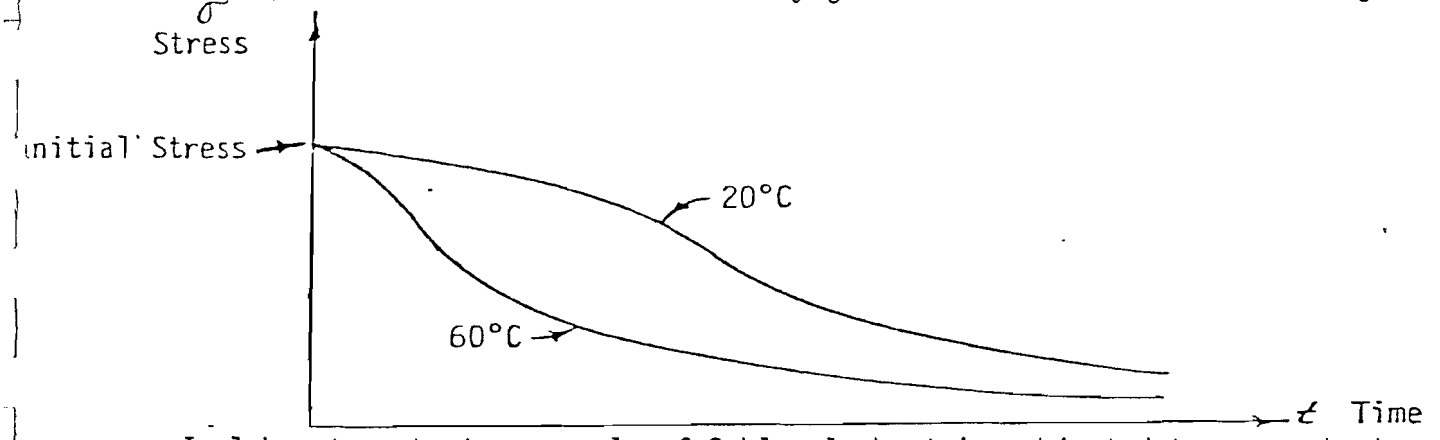
Creep Behavior

In creep testing, a specimen is subjected to a constant nominal stress and the deformation determined as a function of time. The rate of deformation will increase for increased stress and/or increased test temperature.

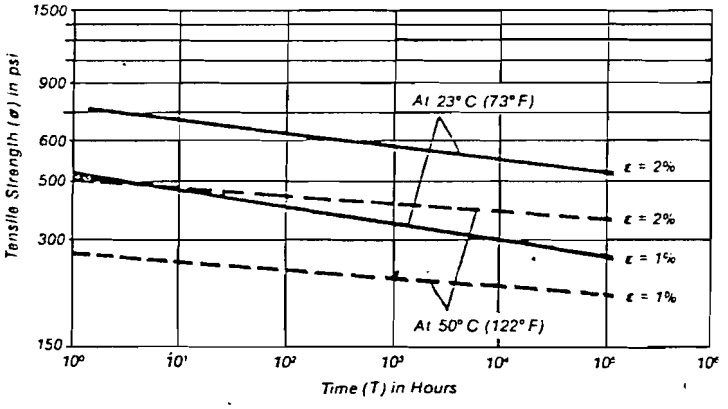
*In general from above chart it is evident that creep will have a very negligible effect on Schlegel sheet for its design life.

RELAXATION

Relaxation is the ability of a plastic material to realign its crystalline structure in order to relieve itself of stress over a long period of time. If you were to take a piece of HDPE sheet and put a constant strain on it, there would be an initial stress in the sample due to the strain. If the relaxation time is long enough the specimen will return to the unstressed state, i.e. the stress will eventually go to 0 as shown in the next diagram.



In laboratory tests a sample of Schlegel sheet is subjected to a constant deformation and the stress is determined as a function of time; see figure below.



Typical tensile stress (ε) vs time (T) under constant load (σ).

Relaxation Behavior

In relaxation testing, a specimen is subjected to a constant deformation and the stress is determined as a function of time. If the deformation is small enough or the relaxation time long enough, relaxatic will be complete, i.e. the specimen will return to th unstressed state.

As you increase the temperature, the length of time required for relaxation will be decreased. This ability of HDPE to relieve itself of stress is very important. In a situation of differential settling in a basin or a landfill, the sheet will have some initial stress but would eventually relieve itself of this stress. Other types of material will either maintain the stress or the stress will increase in the material.

In general Schlegel® sheet has an optimal combination of both creep and relaxation properties. Because of the excellent elongation properties of Schlegel® sheet, its creep characteristics (behavior under constant stress) are unimportant compared to its relaxation characteristics (behavior under constant elongation).

FLEXURAL FATIGUE

Due to its high coefficient of thermal expansion Schlegel® sheet shows pronounced waviness when exposed to cyclical temperature fluctuations or high-intensity sunlight. In order to simulate the flexural loading found under these conditions, sheet and weld samples are periodically flexed in a special test apparatus. This test determines mechanical degradations of the liner resulting from daily thermally induced expansion and contraction simulating a temperature change of 100°C, i.e. ΔT = 100°C (-30°C to +70°C). The Schlegel flex test cycles up and down once every second. The flexing action causes expansive stress on the outer surface and compressive stress on the inner surface. "Hysterisis" a form of heat is generated by stressing polyethylene molecules. Hysterisis gradually weakens the material over a long period of time and causes flexural fatigue which results in cracking of the material.

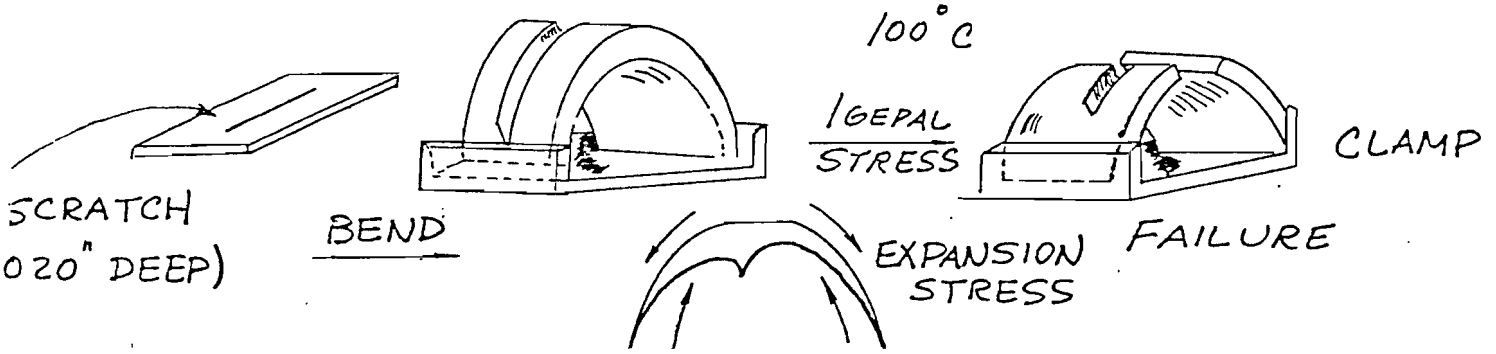
Schlegel® sheet typically shows time to failure (flexing before crack) above 20,000 cycles which gives an expected service life of approximately 25 years under this condition.

STRESS CRACK

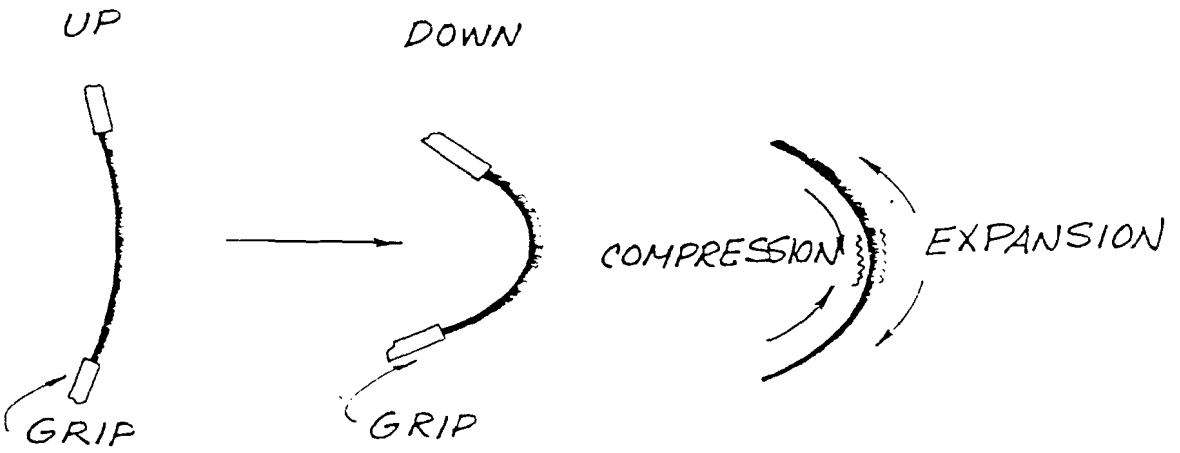
This is the susceptibility of plastic materials to environmental stress cracking under the constant influence of a surface active agent. In general it is the failure of a material due to combined effects of corrosion and stress.

The stress-crack properties of Schlegel® sheet are determined in the Bell test according to ASTM D1693. Samples are subjected to constant deformation in a 100% wetting solution (100% Igepal) at 100°C. No fractures are observed even after 1000 hours. Minimum acceptable test period is however 500 hours.

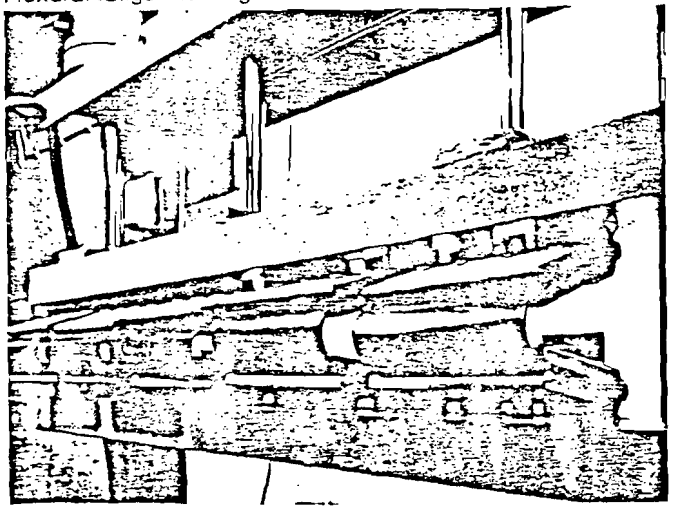
The following diagram shows sample formation and conditioning.



FLEXURAL FATIGUE TESTING



Flexural fatigue testing



Anthony Ojeshina
12/83

WEATHERING RESISTANCE OF SCHLEGEL© SHEET FROM HDPE (HIGH DENSITY POLYETHYLENE VESTOLEN A 315?

#7

Comments of Schlegel Engineering GmbH, Hamburg

1. Weathering and other environmental effects which cause lasting material changes are generally known under the term ageing. The material changes can be noticed through a change in the mechanical properties. Under certain conditions, a change of the mechanical characteristics can permit an estimation of the material's life span.

Increased temperature and UV radiation, are with polyolefins, the primary cause of ageing. The effect of temperature increase is termed thermal-oxydative, and that of UV radiation as photochemical deterioration. Both modes of attack can be simulated in laboratory tests. Previous experiences show also how the results of such lab tests can be transferred into practice.

The SCHLEGEL® Sheet is produced from Vestolen A 3512 (High Density Polyethylene), a relatively low density HDPE with a resulting increased flexibility to which is added a 2 % by weight carbon black to increase the ageing resistance (UV stability).

The Chemische Werke Huls AG (Veba-Chemie) carried out extensive laboratory long term ageing tests on these SCHLEGEL® Sheets.

In addition to this, Schlegel Engineering took material from projects completed up to 4 years earlier for ageing tests.

2. Laboratory tests by the Chemische Werke Huls AG (Veba-Chemie) on Vestolen A 3512, black

Normal photochemical attack (Xenon test 450 according to DIN 53387

By up to 5,000 hours (this period of testing can be compared to some 25 years under mid-European climatic conditions), no deterioration could be determined in the mechanical properties.

Thermal-oxydative attack

The results of these tests allow an extrapolation by purely

thermal attack of 50°C, for a life span of more than 50 years.

Combined attack (thermal-oxydative with increased photo chemical attack, Xenon test 150)

After a test period of 10,000 hours, no change could be determined up to the yield point in the behaviour of the material. However, the elongation at break reduced by 50% of its original value.

A corresponding evaluation of these test results shows that, with photochemical and thermal-oxydative ageing up to an average temperature of 50°C in a mid-European climate, a life span of more than 20 years can be expected.

3. Determination of the weathering resistance of Vestolen A 3512 from already installed projects.

For the past 5 years, the material Vestolen A 3512 has been used to produce SCHLEGEL© Sheet. During this time, more than 2 million square meters have been installed, without any case of failure due to the material (through ageing) having occured.

Two projects from arid climate (Basrah, Iraq, and Sar Chesmeh, Iran) and three projects in Europe (Burghausen and Galing, Germany, as well as Vienna, Austria) were used for this purpose.

After certain periods, samples were taken from these basins and short time tensile tests according to DIN 53455 were carried out on these samples at the Schlegel Engineering laboratory; the mechanical properties such as elongation at yield and break tensile stress at yield and break were determined.

The resulting properties are resumed in Table 1:

	Sample Taken	Yield		Break	
		Tensile Stress	Elongation	Tensile Stress	Elongation
Project	Years	PSI	%	PSI	%
Bashrah	1	2745	15.5	4394	880
Sar Chesmeh	1	2531	15.0	3200	760
Burghausen	3	3057	13.8	4550	860
Galing	3	3228	13.0	4181	830
Wien	2	2588	15.4	3967	850
	4	2616	15.0	3854	855
Virgin Test	0	2560	14.0	3413	800

Table 1

Mechanical properties from the short time tensile test according to DIN 53455, determined on SCHLEGEL® Sheet at different exposure times.

The last row in Table 1 shows the original typical values.

When comparing these with the determined values, one may conclude that no significant material changes occurred. All values are within the range which is determined by discrepancies when carrying out and evaluating the tests as well as by the fluctuations in the base material values.

It has, therefore, been proven that the properties of SCHLEGEL® Sheet, determined in the short time tensile test, had not yet undergone any prejudical changes, even after up to 4 years of weathering in different climatic conditions.

Hamburg, August 1980

KM/mm

Dr. F. W. Knipschild
Schlegel Engineering GmbH

Translation:

8

Süddeutsches Kunststoff-Zentrum Würzburg
South German Plastics Center Würzburg

Institute for Plastics Processing, Application, and Testing.
officially recognized Plastics Testing Institute

TEST REPORT

No.: 7446/77

Commissioning firm: Schlegel Engineering GmbH
Bredowstrasse 33
2000 Hamburg 74

Date of Commission: May 26, 1977 Reference: Kni/By

Commission: Testing of SCHLEGEL Sheet samples from Galing disposal pit, Stage 2, (Lot 4)

This report is comprised of 6 typed pages and - appendices

Würzburg, August 2, 1977

Acting Institute Director

(signed)

Dr.-Ing.J. Zöhren

Group Leader

(signed)

Dipl.-Phys.G.Poschet

(SEAL)

1. Testing Commission

On May 26, 1977 Schlegel Engineering GmbH, Bredowstrasse 33, 2000 Hamburg 74 commissioned the Süddeutsche Kunststoff-Zentrum - SKZ - to conduct tests on SCHLEGEL Sheet samples from Section 2 (Lot 4) of the Galing disposal pit.

2. Test Material

The following test material was sent to SKZ by Wersche Consulting Engineers, Bahnhofstrasse 14, 2900 Oldenburg on July 15 and 18, 1977:

Sample No.	Roll No.	Description	Date of Excision	Comments
1	R 412	-	July 12,77	-
2	R 413	-	''	-
3	R 415	-	''	-
4	R 416	-	''	-
5	R 418	-	''	-
6	R 419	-	''	-
7	R 420	-	''	-
8	R 422	-	''	-
9	R 423	-	''	-
10	R 424	-	''	-
11	R 426	-	''	-
12	R 427	-	''	-
13	R 428	-	''	-
14	R 433	-	''	-
15	R 434	-	''	-
16	R 435	-	''	-
17	S14/S15emb./seam		''	-
18	W18/W17emb./seam		''	-
19	N14/N15emb./seam		''	-

Sample No.	Roll No.	Description	Date of Excision	Comment
20	-	Berm seam North embankment/West	July 12,1977	x
21	-	Berm seam West embankment	''	x
22	-	Berm seam South embankment	''	xx
23	013/014	-	July 15,1977	-
24	N26/N26	-	''	-
25	-	Berm seam East embankment	''	-
26	-	Berm seam North embankment	''	-

An 'x' in the comments column indicates that the sample is mixed sheet material of 4541R and 3512 (4535) welded with 3512.

An 'xx' in the comments column indicates that the sample is sheet material of 4541R welded with 3512. All other samples are 3512 sheets welded with 3512.

Each sample was approximately 300 mm x 230 mm in size.

Samples 1-16: PE sheet with flow marking

Samples 17-26: PE sheet with overlap weld seam.

3. Testing Procedure

3.1 Thickness Determination

The thickness of the sheet (not including the flow mark area was determined as per DIN 53 370 (76). Each value given is an average value for 10 individual measurements.

3.2 Gross Density

The gross density was determined according to DIN 53 470 (54) Section 7.2. Each value given is an average for 3 individual measurements.

3.3 Melt Index

The melt index was measured according to DIN 53 735 (70). Each value given is an average for 5 individual values. The melt was cut off every 30 seconds.

3.4 Tensile Testing

The tensile testing was conducted according to DIN 53 455 (68) under 23°/50% rel. hum. normal conditions specified by DIN 50 014 (70).

Samples 1 to 16 were No. 4 dogbone specimens taken parallel to the direction of extrusion. The test speed employed was Speed V. The properties determined were the yield strength σ_S, elongation at yield ε_S, the tensile strength at break σ_R and the elongation at break ε_R, each given as an average for 3 individual tests.

The specimens taken from samples 17-26 were No. 5 dogbone specimens with a weld seam in the middle of the gauge length running perpendicular to the axis of loading. The test speed used was Speed III; the yield strength σ_S was the property determined.

4. Results

4.1 Thickness

4.2 Gross Density

4.3 Melt Index

Sample No.	Thickness (mm)	Standard Deviation	Gross Density (g/cm³)	'Melt Inc MFI 190' (g/10mir
1	2.6	0.11	0.941	1.3
2	2.4	0.09	0.941	1.3
3	2.4	0.14	0.945	1.5
4	2.5	0.12	0.945	1.5
5	2.6	0.08	0.940	1.3
6	2.8	0.05	0.943	1.4
7	2.6	0.17	0.939	1.3
8	2.6	0.11	0.940	1.4
9	2.7	0.11	0.940	1.4
10	2.9	0.10	0.944	1.3
11	2.9	0.08	0.945	1.3
12	2.6	0.08	0.940	1.3
13	2.4	0.09	0.939	1.3
14	2.6	0.14	0.940	1.4
15	2.9	0.11	0.944	1.4
16	2.5	0.17	0.939	1.4

nsile Testing

No.		1	2	3	4	5	6	7	8	9	1o
Strength	(kp/cm²)	2o5	211	212	212	2o4	2o8	2o4	21o	2o5	2o5
rd Deviation	(kp/cm²)	4,8	1,7	4,2	6,7	3,5	2,o	5,1	2,6	6,7	1,6
tion at Yield	(%)	13	15	15	16	15	15	17	17	15	15
rd Deviation	(%)	1,2	1,2	1,2	o,5	1,2	1,2	1,2	1,2	1,2	1,2
e Strength at Break	(kp/cm²)	332	315	366	353	31o	312	318	31o	317	359
rd Deviation	(kp/cm²)	8,7	9,2	22,3	31,9	6,1	2o,4	13,8	18,3	6,1	27,7
tion at Break	(%)	911	882	996	984	871	895	92o	911	9oo	991
rd Deviation	(%)	32,1	42,4	32,7	54,1	28,1	36,1	28,1	5o,o	8,o	43,1

No.		11	12	13	14	15	16
Strength	(kp/cm²)	2o2	2o6	2o1	2o9	2o1	2o5
rd Deviation	(kp/cm²)	3,3	4,o	5,4	3,4	7,4	8,8
tion at Yield	(%)	14	15	14	15	16	16
rd Deviation	(%)	o,6	1,2	o,8	1,2	o,5	o,4
e Strength at Break	(kp/cm²)	324	315	294	311	334	318
rd Deviation	(kp/cm²)	17,4	4,3	6,9	2o,2	14,3	12,1
tion at Break	(%)	937	9o1	843	892	947	943
rd Deviation	(5)	36,1	16,2	24,1	36,7	14,1	2o,5

No.		17	18	19	2o	21	22	23	24	25	26
Strength	(kp/cm²)	182	185	179	225	197	187	18o	186	192	225
rd Deviation	(kp/cm²)	2,1	4,7	4,6	7,2	o,9	2,2	5,1	1,4	3,7	3,9

5. Summary

The gross density and thickness of the sheet showed deviations of the order to be expected for this type of production process. The deviations in the melt index values are normal for differing polyethylene batches. Samples 1 to 16 - sheet samples - showed good quality.
The weld seam quality was evaluated in tensile testing of samples 17 to 26. The yield point of the sheet material was attained; bottlenecking occured away from the weld seam.

translation by D.Etter
August 1978

9

ÖSTERREICHES KUNSTSTOFF INSTITUT
Austrian Plastics Institute
Authorized Testing Institute of the Federal
Ministry of Trade and Reconstruction of
February 17, 1955

Director: Baurat h.c. Dr.H. Tschlammer

Vienna, Austria
August 16, 1978

Test Certificate

Applicant Firm: Schlegel Engineering GmbH
Bredowstraße 33, D 2000 Hamburg 74

Testing Commission: Specified in letter of June 6, 1978 from Kni/by and in discussions with Dr.Ing.F. Knipschild and Prof. Dr.Ing. R. Tapproge.

Test Material: SCHLEGEL-Sheet of VESTOLEN 3512 with respect to use as a lining system for media potentially dangerous to ground water.

Samples submitted: SCHLEGEL-Sheet samples, both sheet and welding seam samples.

Date samples arrived: June 22, 1978 and July 27, 1978

Description of Commission:
1) Testing of materials properties specified and comparison with existing German Test Certificates
2) Description of the material
3) Evaluation of suitability for this

D 2000 Hamburg 74 - Bredowstraße 33

Description of Experimental Methods and Results

1. Physical Testing

1.1 Gross Density according to DIN 53479

The suspension method was used; the test medium was a mixture of methanol and distilled water.

Gross Density in g/cm³ : 0,941

1.2 Qualitative Carbon Black Detection

Samples of the sheet material were dissolved in tetrahydronaphtalene (tetralin) at its boiling point. The insoluble residue was collected by means of centrifuge and washed several times with the solvent. The dried residue was insoluble in inorganic nonoxiditing acids as well as in inorganic bases. Total insolubility was also observed for common organic solvents. Combustion of the product yielded only carbon dioxide.

Conclusion: The black coloring of the SCHLEGEL-Sheet is due to fine particles of atomic carbon (carbon black).

1.3 Melt Index according to DIN 53735

The test temperature was 190°C.

Melt Index 190/5 : 1,3 g/10 min
190/2,16 : 0,39 g/10 min

1.4 Crystalline Melting Range according to DIN 53736

The crystalline melting range was determined using a Kofler microheating table polarization microscope.

CRISTALINE MELTING RANGE IN °C: 122-125

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1.5 Thermal Shrinkage

The changes in linear dimensions after high temperature curing were determined as per DIN 16925. The specimens were cured at 105°C for 60 minutes.

a) Bubble formation was not observed on any of the specimens after cooling.

b) The average change in length along two perpendicular axes (A and B) were as follows:
Change in length for A (parallel to extrusion) : -0,6%
Change in length for B (Perpendicular to ") : -0,1%

1.6 Tensile Properties according to DIN 53455 including Modulus of Elasticity

The tensile testing was carried out according to DIN 53455 using a precalibrated electronic tensile testing machine at two test speeds. The specimens were taken along both the parallel and the perpendicular axes and were dimensioned according to specimens size No.5

Each value given below is an average value for 5 individual test runs.

Direction	Parallel	Perpendicular	Testing Sp
Yield Strength in N/mm² :	16,6	16,2	10 mm/min
Elongation at Yield in %:	13,6	12,9	10 mm/min
Ultimate Tensile Strength in N/mm² :	26,9	27,6	100 mm/min
Tensile Strength at Break in N/mm² :	26,9	27,6	100 mm/min
Elongation at Break in %:	1000	960	100 mm/min
Modulus of Elasticity in N/mm² :	770	740	10 mm/min

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1.7 Tear Propagation Force according to DIN 53356

Specimen thickness (Average) in mm: 3,2

Tear Propagation Force in N: 932 (Notch parallel to the direction of the extrusion)

Tear Propagation Force in N: 925 (Notch perpendicular to the direction of the extrusion)

Testing Speed 100 mm/min

1.8 Chemical Resistance

The sheet's chemical resistance was determined using the testing procedures of the "Design and Testing Guidelines for Indoor and Outdoor Plastic Liners of Catchment Basins or Areas Containing Potential Groung Water Pollutants" (June 1977, sections 4.4 and 4.11) as a general guideline. Two types of specimens were used: No. 5 tensile test specimens according to DIN 53455 taken in the direction parallel to extrusion as well as square specimens 50 mm by 50 mm. These specimens were cured in the testing media listed below for 28 days at a temperature of +23°C $\pm$ 1°C. The changes in weight of the square specimens were measured at 4, 7, 14 and 28 days. Each time, the specimen was removed from the testing medium, rinsed with distilled water, dried with filter paper and then weighed at room temperature for a duration of 1 minute.
The No.5 tensile specimens were removed after 28 days from the respective testing media, rinsed with distilled water and temperature cured for 72 hours at the DIN 50014 normal conditions (23°C/50% relative humidity). Tensile testing only was carried out for the samples covered in sections 1.8.1 and 1.8.2 (distilled water and EL heating oil).

1.8.1 Distilled Water

Immersion:	28 days
Tensile Strength at Break in N/mm²:	27,1 (control value 26,9)
Elongation at break in %:	860 (control value 1000)

1.8.2 EL Heating Oil

Immersion: 28 days
Tensile Strength at Break in N/mm²: 24,6 (control value 26,9)
Elongation at Break in %: 850 (control value 1000)

1.8.3 Mono- and Difunctional Alchohols, Ethylene Glycol

Test Medium: 48 Vol % Methanol
48 Vol % Isopropanol
4 Vol % Water

Immersion in days:	4	7	14	28	Control value
Change in Weight in %:	+0,050	+0,052	+0,070	+0,090	-
Tensile Strength at Break in N/mm²:				27,4	26,9
Elongation at Break in %:				900	1000

1.8.4 Aliphatic Chlorinated Hydrocarbons (C2)

Test Medium: Ethylene trichloride

Immersion in days:	4	7	14	28	Control value
Change in Weight in %:	+18,4	+19,0	+19,2	+19,8	-
Tensile Strength at Break in N/mm²:				26,9	26,9
Elongation at Break in %:				980	1000

1.8.5 Aliphic Ester and Ketones

Test Medium: 50 Vol % Ethyl acetate
50 Vol % Methylisobutylketone

Immersion in days:	4	7	14	28	Control value
Change in Weight in %:	+0,79	+1,36	+1,82	+2,76	-
Tensile Strength at Break in N/mm²				25,3	26,9
Elongation at Break in %				940	1000

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1.8.6 Aliphatic Aldehydes

Test Medium: 40% aqueous solution of Formaldehyde

Immersion in days:	4	7	14	28	Control Value
Change in Weight in %:	0,39	+0,60	+0,81	+0,92	-
Tensile Strength at Break in N7mm²				27,2	26,9
Elongation at Break in %				910	1000

1.8.7 Aqueous Solutions in Organic Acids, up to 10%

Test Medium: 10 wt % aqueous solution of acetic acid

Immersion in days:	4	7	14	28	Control Value
Change in Weight in %:	+0,025	+0,055	+0,081	+0,021	-
Tensile Strength in N/mm²:				23,8	26,9
Elongation at Break in %				920	1000

1.8.8 Inorganic Acids - except for Hydrofluoric Acid - and Acidic Salts (pH 6) in Aqueous Solution up to 20%

Test Medium: 20 wt % aqueous solution of sulfuric acid

Immersion in days:	4	7	14	28	Control value
Change in Weight in %:	+0,028	+0,11	+0,12	+0,13	-
Tensile Strength in N/mm²:				27,9	26,9
Elongation at Break in %				930	1000

1.8.9 Inorganic Bases and Alkali Salts (pH 9) in Aqueous Solution up to 20%

Test Medium: 20 wt % aqueous solution of sodium hydroxide

Immersion in days:	4	7	14	28	Control value
Change in Weight in %:	+0,017	+0,021	+0,058	+0,19	-
Tensile Strength in N/mm²:				26,4	26,9
Elongation at Break in %:				930	1000

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1.8.10 Aqueous Solution in Phenol

Testing Medium:5 wt % aqueous solution of phenol

Immersion in days:	4	7	14	28	Control value
Change in Weight in %:	+0,15	+0,17	+0,19	+0,24	-
Tensile Strength in N/mm²:				27,7	26,9
Elongation at Break in %:				850	1000

1.8.11 Aqueous Chloric Base

Test Medium: aqueous solution of sodium hypochlorite, 5 % active chlorine

Immersion in days:	4	7	14	28	Control value
Change in Weight in %:	+0,030	+0,033	+0,036	+0,059	-
Tensile Stregth in N/mm²:				29,0	26,9
Elongation at Break in %:				940	1000

1.9 Vicat Softening Temperature according to DIN 53460

The Vicat Softening Temperature VST was determined using the loading force specified in Procedure B. The heat transfer medium employed was a special parrafin oil.
Result:
VST/B = 72°C.

1.10 Cold Shortness Properties

The material's cold shortness properties were investigated by means of rod-base flexural testing as per DIN 51949. The test specimens were strips 25 mm X 250 mm, taken from the sheet samples parallel to the direction of the extrusion. The thickness of the specimens was the same as the sheet samples (average 3.0 mm)

The flexural testing was conducted in a large refrigirated chamber. Each strip specimen was flexed by hand in a period of 5 seconds (following a 1 hour curing period at the test temperature) to an arc of 180°C around a rod.

Results: No fracture or cracking was determined, even under the most extreme test conditions of -30°c (ambiant temperature) and a 2 mm diameter rod.

1.11 Penetration Resistance

The penetration resistance was tested in such a manner as to reflect localized compressive tressing to the sheet due to sharp objects, such as cracked rocks. Square sheet samples 50 mm X 50 mm in their original thickness (approximately 3 mm) were placed flush on a 20 mm thick concrete slab. A universal testing machine was used to load each specimen with asteel wedge of the following dimensions:

Length of loading surface : 18 mm
Radins of curvature of edge: r = 0,5 mm

The wedge was symmetrical and was angled at 60°. It was pressed perpendicularly into the sheet with a speed of 3 mm/min.

Results: The average force necessary to penetrate the 5 individual specimens (23°C $\pm$ 1°C) was 5600 N.

1.12 Strength of Welding Seams

The applicant firm supplied several weld seam samples, in each case with the seam running parallel to the direction of the extrusion. Tensile testing as per DIN 53455 was conducted at a speed of 100 mm/min in order to evaluate the weld strength.

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The welds were tested as 50 mm wide strip samples taken across the weld and such that the weld (overlap with a width of approximately 50 mm) was located in the middle of the specimen. Control specimens were also tested; they differed only in that they had no weld.

Results of Tensile Testing:

Specimen type:	With Weld	Without Weld
Yield Strength in N/mm² :	18,6	18,1

Conclusions from Section 1 (Material Testing)

The quality of SCHLEGEL-Sheet, made from VESTOLEN A 3512 HDPE, is described in many test reports by officially recognized plastics testing laboratories in Germany. The foremost among these is the South German Plastics Center (SKZ) in Würzburg. This German testing institution is very well known for its exact testing work. The materials testing described in Section 1 of this report, which in some cases had not been previously conducted and in some cases repeated tests carried out in the Federal Republic of Germany as a check, confirmed these previous quality evaluations. Emphasis was placed on the materials properties covered in the Design and Testing Guidelines of the Berlin Institute for Construction Engineering, "Design and Testing Guidelines for Indoor and Outdoor Plastic Liners of Catchment Basins or Areas Containing Potential Ground Water Pollutants."

Thus, the following German Test Certificates have been confirm in their content and can be recommended for unconditional approval to the Austrian Authorities.

1. Test Certificate No. 7402-1/77 of the SKZ Würzburg, Aug.26,19
2. Test Certificate No. 7402-3/77 of the SKZ Würzburg, Aug.30,19
3. Test Certificate No. PA6654/76 Of the SKZ Würzburg, June 9,19
4. Test Certificate No. PA5043/73 of the SKZ Würzburg, May 10,19

2. Description of the SCHLEGEL - Sheet

2.1 Sheet Material

SCHLEGEL - Sheet is produced by the applicant firm using a patented extrusion process in sections 10 m wide and of any length desired for a particular project. The person whose signature is on the right (Dr. Moros) was given the opportunity to observe the SCHLEGEL-Sheet production process on March 2, 1978.

The resin employed is a special high density polyethylene (low pressure production process) from VESTOLEN GmbH (subsidiary of CHEMISCHE WERKE HÜLS AG and VEBA CHEMIE AG) with the designation VESTOLEN A 3512. VESTOLEN A 3512 has a relatively high molecualr weight and a narrow molecular weight distribution. The special molecular structure of this resin gives it high resistance to stress crack corrosion.

VESTOLEN A 3512 contains finely divided carbon black added by the manufacturer as protection against the effects of ultraviolet radiation.

The tensile behavior of SCHLEGEL-Sheet produced from VESTOLEN A 3512 is characterized by an elastic region up to the yield point of about 15%. The modulus of elasticity is relatively low at about 800 N/mm². This is favorable in light of the application fields of the material, as mechanical loading can be offset by elongation, thus all but eliminating the possibility of internal stresses.

The plastic zone follows the elastic zone and extends to the materials extremely high elongation at break of over 800%. In addition, the material shows a good tensile strength at break over 25N/mm².

The material also shows excellent cold-crack properties. Fracture due to simultaneous mechanical loading and low temperature embrittlement is not to be expected for Central

SCHLEGEL-Sheet's penetration resistance, measured at about 5.6 KN/18 mm, provides protection against penetration damage caused by sharp rock fragments. Any damage which may occur in spite of this is limited in scope by the materials relatively high tear propagation resistance.

Chemical Corrosion: Attack to SCHLEGEL-Sheet by most chemical reagents found in applications is either non-existant or very limited. This is founded on our own experimental findings (section 1.8 of this report), as well as on the content of German Test Certificates concerning SCHLEGEL-Sheet and pertinent technical literature on the subject. Most of the chemicals cause swelling, which for all practical purposes disappears after contact with the chemical is discontinued and the absorbed liquid evaporates. Significant chemical attack is observed for strong oxidizing agents at high concentrations, especially at high temperatures. Pronounced dissolving or swelling effects are also observed due to contact with aromatic hydrocarbons, chlorinated hydrocarbons, or certain solvents (such as hydrated naphtalene derivatives), especially at high temperatures.

2.2 Jointing Technology

Extrusion welding proved to be a site jointing method especially suited for SCHLEGEL-Sheet with regard to mechanical strength and complete watertightness. In this method, the sheet sections are first positioned such as to give a certain amount of overlap. After the contacts surfaces are cleaned, they are preheated with a hot air jet; the welding material, which is the same as the base material for the sheet (VESTOLEN A 3512), is then injected as a melt between the surfaces, all in one process. A pressure roller system then presses the sheets together, giving a homogeneous bond. Welds produced by means of this process were investigated and found to have high strebgth and to be free of bubbles, voids, or other inhomogeneities affecting quality.

3. Application Fields of SCHLEGEL-Sheet

The main application in which SCHLEGEL-Sheet is used as a liner for system containing potential ground water pollutants are as follows:

Disposal pits for municipal, sewage, or industrial wastes
Holding basins for impure surface water in industrial plants
Oil sludge basins
Tanks and relay points
Catchment areas in tank systems

A list of liquid reagents to which SCHLEGEL-Sheet has satisfactory chemical resistance as per the "Design and Testing Guidelines of the Berlin Institute of Construction Engineering" (June 1977) for Plastic liners has been established as a result of testing described in section 1.8 of this report and the SKZ reports mentioned previously:

Distilled water
El heating oil
All hydrocarbons
Mono- and difunctional alchohols, ethylene glycol
Aliphatic esters and ketones
Aliphatic aldehydes
Organic acids in aqueous solution up to 10 %
Inorganic acids except for hydrofulfuric acid and acidic salts (pH 6) in aqueous solution up to 20 %
Inorganic bases and alkali salts (pH 9) in aqueous solution up to 20 %
Saturated salt solution
Phenol and derivatives in aqueous solution up to 5 %
Lime milk
Wetting agents in aqueous solution up to 5 %

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The chemical resistance of SCHLEGEL-Sheet was tested primarily at 23°C, the temperature specified in the 23/50 normal conditions of DIN 50014. Actual experience has nonetheless shown that the resistance is maintained to a satisfactory extent in the moderately high temperatures found in Central Europe. On the other hand, the chemical resistance is not disadvantageously affected in any way by lower temperatures.

Mechanical Loading of various types is encountered in applications where SCHLEGEL-Sheet is installed as a disposal pit liner, of which the following are of particular interest.

a) Constant Loading

These include loading due to drainage layers, protection layers or structures on the sheet.

b) Time - Variable Loading

This group consists mainly of those loads dependent on the level of the disposal pit contents as well as compressive loading caused by changing ground water level. Short term loading caused by transport and installation equipment is also included here.

c) Mechanical Loading Caused by Uneven Settling in the Subgrade

This effect can be caused either by soil layers in the subgrade with different settling behavior or by significant differences in the level of the disposal pit contents.

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d) Localized Compressive Loading

This result from loading by sharp objects such as installation equipment or rocks fragments and is most likely to occur during the installation phase.

The favorable physical properties of SCHLEGEL-Sheet give high security under these types of loading in field conditions. Of course, the disposal pit design must take all possible types of mechanical loading into consideration and ensure that none exceeds the physical properties of the sheet. In addition, the weld seams must be carried out properly, exactly as provided for by the installation procedures set by the manufacturer, in order to garantee the soundness of the sealing system.

Resistance to Weathering and Sunlight

The material used in the manufacture of SCHLEGEL-Sheet (VESTOLEN A3512) contains a carbon black component which provides a stabilizing effect against high-energy radiation bands. Sunlight and weathering exposure occurs particularly when liners have partial covering layers (e.g. at basins edges) or before the covering layer is applied. The applicant firm has indicated that a separate testing commission will begin with respect to the shett's long-term resistance to sunlight and weathering exposure, which will be conducted as a supplement to this test report.

Laboratory Technicians		Department Supervisor of the Government authorized Testing Institution
(signed)	(signed)	(signed)
(G. Wonisch)	(P. Pavlowski)	(Dr. W. Moros)

Translated by D. Etter

APPENDIX G

LANDFILL MONITORING REPORTS

CRUCIBLE LANDFILL INSPECTION

Date_____ Time_____

Inspectors_____

I. Crucible Landfill Proper

A. Is all waste placed within those areas specified in the permit application?_____

B. Are any wastes deposited in the landfill that are not included in the permit application?_____

C. Are there any blowing papers and litter beyond the landfill boundary?

_____

D. Are there any vectors, dust or odor present?_____

Are they controlled?_____

E. Is salvaging taking place?_____

Is it controlled?_____

F. Is there any indication that open burning has taken place?_____

G. Is there any indication of decomposition gases being generated?

_____

II. Crucible Landfill - General

A. Is access controlled by fences, gates, etc.?_____

Is access permitted only when an attendant is on duty?_____

B. Are on-site roads passable and safe?_____

C. Is adequate equipment available for proper operation of the landfill?

_____

D. Is shelter provided for those personnel assigned to the landfill?

_____

E. Are sound levels excessive beyond the facility line?_____

F. Is there any indication of runoff from the landfill?_____

III. General

A. Are there any unusual areas of dead vegetation on the Solvay Waste dikes?_____

B. Are there any areas of settling or fracturing on the Solvay Waste dikes?_____

C. Is there evidence of severe dike erosion that needs immediate remedial attention?_____

GROUNDWATER MONITORING INSTALLATIONS

Well No.	Well Cover Closed & Locked	Well Is Numbered	Well Casing Is Intact	No Sign Of Settling or Heaving
1.1				
1.2				
1.3				
2.1				
2.2				
2.3				
3.1				
3.2				
4.1				
4.2				
4.3				
5.1				
5.2				
5.3				
5.5				
5.6				
6.1				
6.2				
7.1				
7.2				
7.3				
8.1				
8.2				
9.1				
9.2				
10.1				
10.2				
11.1				
11.2				
13.1				
13.2				
14.1				
15.1				
16.1				

Well No.	Well Cover Closed & Locked	Well Is Numbered	Well Casing Is Intact	No Sign Of Settling or Heaving
17.1				
18.1				
18.2				
18.3				
18.4				
101.0				
101.1				
101.2				
101.3				
102.0				
103.0				
104.1				
104.2				
104.3				
104.4				
104.5				
105.1				
105.2				
105.3				
105.4				
105.5				
106.1				
106.2				
106.3				
106.4				
106.5				
107.0				
108.0				
109.0				
201.0				
201.1				
201.2				
201.3				
201.4				

C.S.M.D. OBSERVATION WELL READINGS

PROJECT ______________________ LOCATION ______________________

METHOD OF READING ______________________

REFERENCE POINT ______________________

DATE __________ TIME (START) __________ TIME (END) __________ INITIALS __________

WEATHER CONDITIONS ______________________

WELL NO.	DEPTH TO WATER	REF. ELEV.	ELEV.	WELL NO.	DEPTH TO WATER	REF. ELEV.	ELEV.

INSTRUCTIONS FOR OBSERVATION WELL READINGS

1.	Project:	List objective of monitoring, for example, "Landfill Quarterly Monitoring".
2.	Location:	General location of wells to be monitored, such as landfill, plant, etc.
3.	Method of Reading:	Equipment used for measurements, such as water level indicator.
4.	Reference Point:	Description of reference elevations, such as "Top of Casing".
5.	Date:	Date measurement occurred.
6.	Time (Start):	Time of first measurement.
7.	Time (End):	Time of last measurement.
8.	Initials:	Initials of all personnel involved with measurements.
9.	Weather Conditions:	General description of weather conditions - sunny, cloudy, etc.
10.	Well No.:	Number of each specific installation monitored.
11.	Depth to Water:	Measured length from water level to reference point.
12.	Reference:	Elevation of reference point.
13.	Elevation:	Reference elevation minus depth to water.

CRUCIBLE SPECIALTIES METALS DIVISION

Inclinometer Data Sheet

Observation Well No.

Sheet ____ of ____

DATE ________ INSTR. ____________ READ _______ CALC. ______ CHKD. ______

DEPTH	1st	2nd	AVG.	1st	2nd	AVG.	DIFF.	1st	2nd	AVG.	1st	2nd	AVG.	DI

Calocerinos & Spina
CONSULTING ENGINEERS

PROJECT CRUCIBLE LANDFILL — SHEET ____ OF ____

SETTLEMENT MONITORING RECORDS — FILE NO. ____

PREPARED BY ____ DATE ____ CHECKED BY ____ DATE ____

SURVEY DATA — DATE / /

PLATE NO	REFERENCE MARK		NET SETTLEMENT	CRUCIBLE WASTE		
	NEW ELEV.	CHANGE (+/−)		NEW THICKNESS	CHANGE (+/−)	

Calocerinos & Spina
CONSULTING ENGINEERS

PROJECT CRUCIBLE LANDFILL SHEET ______ OF ______

SETTLEMENT MONITORING PLATES FILE NO. ______

PREPARED BY ______ DATE ______ CHECKED BY ______ DATE ______

INITIAL SURVEY DATA

PLATE NO.	DATE SURVEYED	SOLVAY WASTE ELEV.	CRUCIBLE WASTE THICKNESS		FUTURE REFERENCE MARK	
					HT ABOVE S.M.	ELEV

CALOCERINOS & SPINA, CONSULTING ENGINEERS

COST ESTIMATE

PROJECT Crucible Landfill SHEET NO.1 Of 3

LOCATION Geddes, New York ESTIMATE NO.434.062.003

ENGINEER R. W. Klippel OWNER Crucible Specialty Metals DATE 10/15/85

QUANTITIES BY PRICES BY EXTENSIONS BY CHECKED BY

DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL COST	REFERENCE
I. Waste Grading					
Rough Grade Wastes	42,600	c.y.	3.39	144,414	2.3-22-040
II. Excavation of Ditches					
Peripheral Ditches	16,000	c.y.	2.71	43,360	2.3-16-085
III. Buffer Layer					
Furnish and spread 6" layer 304 Type 2	17,750	c.y.	8.70	154,425	2.3-05-060
Compact 6" layer	17,750	c.y.	1.48	26,270	2.3-08-040
Furnish and spread 6" layer of 304 Type 2	17,750	c.y.	8.70	154,425	2.3-05-060
Compact 6" layer	17,750	c.y.	1.48	26,270	2.3-08-040
Fine grade and roll	106,480	s.y.	0.70	74,536	2.3-22-220
Subtotal Buffer Layer				435,926	
IV. Membrane Cover					
Furnish and Install 60 mil HDPE Material	121,000	s.y.	4.95	598,950	Schlegel Est.
V. Drainage Blanket Including Peripheral Ditches					
Furnish and Spread 6" layer of 703-07	20,000	c.y.	10.45	209,000	2.3-05-040

CALOCERINOS & SPINA, CONSULTING ENGINEERS

COST ESTIMATE

PROJECT Crucible Landfill SHEET NO. 2 of 3

LOCATION Geddes, New York ESTIMATE NO. 434.062.003

ENGINEER R. W. Klippel OWNER Crucible Specialty Metals DATE 10/15/85

QUANTITIES BY PRICES BY EXTENSIONS BY CHECKED BY

DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL COST	REFERENCE
VI. Vegetative Cover					
Includes Peripheral Ditches					
Furnish and spread 18" layer sandy loam	60,500	c.y.	9.35	565,675	2.3-05-080
Grading and Rolling	121,000	s.y.	0.70	84,700	2.3-22-220
Hydroseal and Fertilize	121,000	s.y.	0.41	49,610	2.8-45-100
Subtotal Vegetative Cover				699,985	
VII. Drainage Ditches away from Landfill					
Excavation of 4000 LF of Channel to Lake	4,400	c.y.	2.71	11,924	2.3-11-085
Dressing and Seeding of channel	3,550	c.y.	1.47	5,218	2.8-45-031
Structures - Top Dike	2	each	40,000	80,000	Engr Est.
Structures - Bottom Dike	1	each	50,000	50,000	Engr Est.
Structures - Shore Ditch	1	each	20,000	20,000	Engr Est.
Subtotal Drainage				167,142	
VIII. Subtotal Construction Cost				2,298,777	
Multiplied by City Cost Index				X .937	Page 345
IX. Adjusted Construction Cost				2,153,954	

CALOCERINOS & SPINA, CONSULTING ENGINEERS

COST ESTIMATE

PROJECT Crucible Landfill — SHEET NO. 3 of 3

LOCATION Geddes, New York — ESTIMATE NO. 434.062.003

ENGINEER R. W. Klippel — OWNER Crucible Specialty Metals — DATE 10/15/85

QUANTITIES BY — PRICES BY — EXTENSIONS BY — CHECKED BY

DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL COST	REFERENCE
Adjusted Construction Cost				2,153,954	
X. Plus Testing During Closure Period					
A. Vane Shear Tests	8	each	5,000	40,000	Empire Quote
B. Inclinometer Readings	18	each	750	13,500	Empire Quote
C. Surveying of Settlement	18	each	1,970	35,460	C&S Prices
C. Groundwater Monitoring	3	each	61,000	183,000	C&S Prices
and Inspection					
Subtotal Testing				271,960	
XI. Plus Engineering Costs for Contract Documents, Construction Supervision and Inspection (7% of Construction Cost)				150,777	
XII. Plus Legal and Administration Costs (15% of Construction Cost)				323,093	
XIII. Plus Contingency for Unanticipated Costs at 15% of Construction Cost				323,093	
XIV. Total Project Cost				3,222,877	

APPENDIX H

DETAILED COST ESTIMATE - CLOSURE

CALOCERINOS & SPINA, CONSULTING ENGINEERS

COST ESTIMATE

PROJECT Crucible Landfill SHEET NO.1 Of 3

LOCATION Geddes, New York ESTIMATE NO.434.062.003

ENGINEER R. W. Klippel OWNER Crucible Specialty Metals DATE 10/15/85

QUANTITIES BY PRICES BY EXTENSIONS BY CHECKED BY

DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL COST	REFERENCE
I. Waste Grading					
Rough Grade Wastes	42,600	c.y.	3.39	144,414	2.3-22-040
II. Excavation of Ditches					
Peripheral Ditches	16,000	c.y.	2.71	43,360	2.3-16-085
III. Buffer Layer					
Furnish and spread 6" layer 304 Type 2	17,750	c.y.	8.70	154,425	2.3-05-060
Compact 6" layer	17,750	c.y.	1.48	26,270	2.3-08-040
Furnish and spread 6" layer of 304 Type 2	17,750	c.y.	8.70	154,425	2.3-05-060
Compact 6" layer	17,750	c.y.	1.48	26,270	2.3-08-040
Fine grade and roll	106,480	s.y.	0.70	74,536	2.3-22-220
Subtotal Buffer Layer				435,926	
IV. Membrane Cover					
Furnish and Install 60 mil HDPE Material	121,000	s.y.	4.95	598,950	Schlegel Est.
V. Drainage Blanket Including Peripheral Ditches					
Furnish and Spread 6" layer of 703-07	20,000	c.y.	10.45	209,000	2.3-05-040

CALOCERINOS & SPINA, CONSULTING ENGINEERS

COST ESTIMATE

PROJECT Crucible Landfill SHEET NO. 2 of 3

LOCATION Geddes, New York ESTIMATE NO. 434.062.003

ENGINEER R. W. Klippel OWNER Crucible Specialty Metals DATE 10/15/85

QUANTITIES BY PRICES BY EXTENSIONS BY CHECKED BY

DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL COST	REFERENCE
VI. Vegetative Cover					
Includes Peripheral Ditches					
Furnish and spread 18" layer sandy loam	60,500	c.y.	9.35	565,675	2.3-05-080
Grading and Rolling	121,000	s.y.	0.70	84,700	2.3-22-220
Hydroseal and Fertilize	121,000	s.y.	0.41	49,610	2.8-45-100
Subtotal Vegetative Cover				699,985	
VII. Drainage Ditches away from Landfill					
Excavation of 4000 LF of Channel to Lake	4,400	c.y.	2.71	11,924	2.3-11-085
Dressing and Seeding of channel	3,550	c.y.	1.47	5,218	2.8-45-031
Structures - Top Dike	2	each	40,000	80,000	Engr Est.
Structures - Bottom Dike	1	each	50,000	50,000	Engr Est.
Structures - Shore Ditch	1	each	20,000	20,000	Engr Est.
Subtotal Drainage				167,142	
VIII. Subtotal Construction Cost				2,298,777	
Multiplied by City Cost Index				X .937	Page 345
IX. Adjusted Construction Cost				2,153,954	

CALOCERINOS & SPINA, CONSULTING ENGINEERS

COST ESTIMATE

PROJECT Crucible Landfill SHEET NO. 3 of 3

LOCATION Geddes, New York ESTIMATE NO. 434.062.003

ENGINEER R. W. Klippel OWNER Crucible Specialty Metals DATE 10/15/85

QUANTITIES BY PRICES BY EXTENSIONS BY CHECKED BY

DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL COST	REFERENCE
Adjusted Construction Cost				2,153,954	
X. Plus Testing During Closure Period					
A. Vane Shear Tests	8	each	5,000	40,000	Empire Quote
B. Inclinometer Readings	18	each	750	13,500	Empire Quote
C. Surveying of Settlement	18	each	1,970	35,460	C&S Prices
C. Groundwater Monitoring and Inspection	3	each	61,000	183,000	C&S Prices
Subtotal Testing				271,960	
XI. Plus Engineering Costs for Contract Documents, Construction Supervision and Inspection (7% of Construction Cost)				150,777	
XII. Plus Legal and Administration Costs (15% of Construction Cost)				323,093	
XIII. Plus Contingency for Unanticipated Costs at 15% of Construction Cost				323,093	
XIV. Total Project Cost				3,222,877	

APPENDIX I

FINANCIAL ASSURANCE DOCUMENTATION

Financial Review and Financial Statements

Results of Operations

Sales and Earnings

In 1984, the company's sales increased 19 percent to $1,868 million from $1,576 million in 1983. Net earnings of $132.2 million in 1984, equal to $5.99 a common share, were up 33 percent compared with 1983 net earnings of $99.3 million, or $4.01 a common share. Return on sales was 7.1 percent in 1984, the second highest in the company's history, and compares favorably with 6.3 percent for 1983. The company's strong performance in 1984 reflects the higher level of activity in the industrial sector of the U.S. economy. All four industry segments and most divisions achieved sales and earnings growth in 1984. The Automotive, Machinery and Equipment, and Materials and Components segments reported strong sales and earnings growth in 1984, while Aerospace segment growth was more modest. Gains in operating income were greater in the first three quarters of 1984 than in the fourth quarter, as the slowdown in the nation's economic recovery began to affect the performance of some divisions. Partially offsetting the 1984 earnings improvement were a higher effective tax rate, plant consolidation costs, and lower interest income.

The Automotive segment reported a 30 percent increase ir operating income in 1984 on a 21 percent increase in sales, reflecting improved business conditions in the North Americ automotive and truck markets. Performance by the Automoti segment was paced by Stemco Truck Products Division and the three Holley automotive products divisions.

Aerospace segment 1984 operating income rose by 5 perce on a 5 percent increase in sales, led by Delavan Gas Turbine Products Division, acquired for cash in July 1983, Menasco Aerospace Ltd in Canada, and the Crucible Compaction Met Operation. However, results at the Menasco Texas and Chand Evans Control Systems Divisions were down.

The Machinery and Equipment segment increased operati income by 43 percent on a 16 percent increase in sales. Lead ing these increases were the Central Moloney Transformer, Elox, Quincy Compressor, and Garlock Special Products Divi sions, with improvement also achieved by the Pratt & Whitney Machine Tool Division. Fairbanks Weighing Division operating income was down in 1984.

Operating income for the Materials and Components segment in 1984 was up 149 percent on a sales increase of 27 percent. Strong performances by Colt Firearms and Crucible

Selected Financial Data

(In thousands, except per share and employee data)	1984	1983	1982	1981	19
Sales	$1,868,267	$1,576,183	$1,511,594	$1,765,956	$1,682,7
Earnings from continuing operations	132,229	99,255	82,542	139,850	107,2
Earnings (loss) from discontinued operations	–	–	(243,900)	(30,300)	(9,5
Net earnings (loss)	132,229	99,255	(161,358)	109,550	97,7
Earnings (loss) per common share:					
Continuing operations	5.99	4.01	3.24	5.05	3.
Discontinued operations	–	–	(9.57)	(1.10)	(.
Net earnings (loss)	5.99	4.01	(6.33)	3.95	3.
Common share dividends:					
Total paid	48,766	48,484	44,834	41,470	37,5
Per share	2.27½	2.00	1.80	1.53¾	1.
Cash and marketable securities	6,515	164,881	145,243	181,846	134,1.
Working capital	272,904	409,974	513,131	594,411	540,3
Current ratio	1.87	2.28	2.94	2.91	2.
Quick ratio	.73	1.15	1.51	1.28	1.
Interest coverage ratio	11.5	7.8	5.4	8.4	7
Total assets	1,023,538	1,177,123	1,184,663	1,380,241	1,330,2
Long-term debt	124,587	147,123	193,397	239,897	263,0
Long-term debt to total capitalization	26.6%	24.0%	30.4%	24.6%	28.0
Shareholders' equity	343,719	466,831	443,490	735,715	677,6
Return on average shareholders' equity	32.6%	21.8%	17.7%	19.8%	16.5
Return on sales	7.1%	6.3%	5.5%	7.9%	6.4
Book value per common share	17.58	19.65	18.51	27.06	24.
Capital expenditures	50,431	36,300	40,554	54,079	59,8
Depreciation and amortization	41,834	37,653	34,595	31,148	27,3
Order backlog	851,820	809,582	637,164	705,079	792,1
Number of employees	22,400	22,100	20,600	25,100	26,5

Specialty Metals Divisions and an increase in operating income by the Trent Tube Division, on reduced sales resulting from consolidation of manufacturing facilities and elimination of several product lines, were the main factors contributing to the improvement of this segment.

In 1983, sales and earnings showed improvement over 1982 as many of the company's products benefited from an upturn in the automotive industry and increased defense spending. Also contributing to the increase in 1983 earnings were higher interest income and lower interest expense and pension cost. A higher effective tax rate, amounts equivalent to interest on the unfunded liability for facility disposition, plant relocation cost, and cost to consolidate and shut down marginal facilities had an unfavorable impact on 1983 earnings. Consolidated results in 1982 included a $243.9 million loss for discontinued steelmaking operations.

The effective tax rate for 1984 was 45¼ percent, compared with 44 percent in 1983. Reference is made to Note 3 of the Notes to Financial Statements on page 41 for additional tax information.

Costs and Expenses

Cost of sales increased 16 percent in 1984 and 3 percent in 1983. The 1984 increase is related to the increased volume of business, costs incurred in the consolidation of manufacturing facilities and elimination of certain product lines, higher depreciation expense resulting primarily from downward revision of the estimated remaining useful lives of certain assets, and higher costs for research and development. The 1983 increase was due mainly to increased volume and amounts equivalent to interest on the unfunded liability for facility disposition.

Selling and administrative expense was up 12 percent in 1984 and down slightly in 1983. Contributing factors to the rise in 1984 were increases in sales, employee-related costs, and state and local income taxes. The decrease in 1983 was due primarily to salary and employee-related cost reductions.

Interest expense declined 16 percent in 1984 and 17 percent in 1983. The reduction in both years was due to repayment of long-term debt. It was the third consecutive year in which interest expense decreased by more than 10 percent. The 1984 interest expense reduction was offset in part by commitment fees and interest expense on borrowings under a $750 million revolving credit agreement, entered into during 1984. Interest income declined 36 percent in 1984 compared with 1983 on lower cash balances during 1984. In 1983, interest income increased 25 percent due to higher cash balances throughout the year compared with 1982.

Segment Information

The company's operations are reported in four industry segments. Following are the major products included in each segment:

Automotive: Holley carburetors, special products, and replacement parts; Stemco truck products; Farnam sealing systems; and Fairbanks Morse engine accessories.

Aerospace: Menasco aircraft landing gear and flight control systems, Chandler Evans jet engine fuel controls, Delavan gas turbine products, and Crucible compaction metals.

Machinery and Equipment: Fairbanks Morse diesel engines and pumps, Central Moloney transformers, Fairbanks weighing systems, Quincy air compressors, Pratt & Whitney machine tools, Elox electrical discharge machining equipment, Garlock bearings and valves, and France compressor products.

Materials and Components: Crucible specialty steels and magnets; Trent tubing and pipe; Garlock seals, gaskets, and packings; Colt firearms; and Woodville rubber products.

The table on page 30 shows financial information by industry segment for the five years ended December 31, 1984.

The Automotive segment reported operating income of $106.4 million in 1984 compared with $81.6 million in 1983 and $45.3 million in 1982; or 38 percent, 40 percent, and 30 percent, respectively, of the company's total operating income in those years. Improved business conditions in the automotive market resulted in a substantial increase in demand for Holley carburetors and air pumps and Farnam sealing products; and in the truck market, for Stemco Guardian® hub-seals and truck exhaust system products. Demand for carburetors was strong from original equipment manufacturers and in the aftermarket. Higher operating margins and the acquisition in August 1984 of Engler Instruments, an operation of Stemco Truck Products Division, also contributed to the increase in 1984 segment operating income. Holley Carburetor Division sales were strong through nine months of 1984, but fourth quarter sales began to reflect the accelerated transition by U.S. car makers from carburetion to fuel injection. Holley is continuing its development of both fuel injection components and noncarburetor products. It is expected that sales of Holley carburetors to original equipment manufacturers will decline substantially over the next several years.

The increase in operating income in 1983 over 1982 for the Automotive segment was primarily due to improved margins and increased demand for segment products as a result of the upturn in the automotive market from the depressed levels of 1982. During 1983, the Crucible heavy-duty coil spring operation was shut down, and the Garlock oil seal operation was sold.

In 1984, the Aerospace segment had operating income of $66.6 million, or 24 percent of total company operating income. This compares with $63.4 million, or 31 percent, in 1983 and $49.9 million, or 33 percent, in 1982. Operating income for the Delavan Gas Turbine Products Division, acquired for cash in July 1983, was higher in 1984 on increased sales of its gas turbine products and oil burner nozzles. Higher profits in 1984 by Menasco Aerospace Ltd in Canada were due mainly to increased deliveries of landing gears for the Boeing 737 and to relocation costs incurred in 1983. Crucible Compaction Metals Operation achieved record sales and operating income for the second consecutive year on increased sales to the air-

Industry Segment Information

(In millions)	1984	1983	1982	1981	19
Sales					
Automotive	$ 580	$ 478	$ 405	$ 441	$ 4
Aerospace	314	299	241	260	2
Machinery and Equipment	467	401	415	480	4
Materials and Components	510	401	456	590	6
Intersegment elimination	(3)	(3)	(5)	(5)	
Total	$1,868	$1,576	$1,512	$1,766	$1,6
Operating income					
Automotive	$106.4	$ 81.6	$ 45.3	$ 59.0	$ 3(
Aerospace	66.6	63.4	49.9	51.2	3
Machinery and Equipment	54.6	38.2	35.8	53.4	5
Materials and Components	54.7	22.0	22.0	75.8	9
Total segments	282.3	205.2	153.0	239.4	22
Interest expense	(15.7)	(18.7)	(22.6)	(25.3)	(2
Interest income	16.3	25.3	20.3	29.7	1
Corporate unallocated	(41.4)	(34.6)	(19.7)	(24.4)	(2(
Gain on sale of leasehold	–	–	–	19.3	
Earnings from continuing operations before income taxes	$241.5	$177.2	$131.0	$238.7	$19
Total assets					
Automotive	$ 198	$ 214	$ 186	$ 188	$ 1
Aerospace	205	219	158	162	1
Machinery and Equipment	258	248	245	266	2
Materials and Components	313	308	336	364	3
Corporate unallocated	50	188	211	202	1
Continuing operations	1,024	1,177	1,136	1,182	1,1(
Discontinued operations	–	–	49	198	2
Total	$1,024	$1,177	$1,185	$1,380	$1,3
Depreciation and amortization					
Automotive	$ 11.1	$ 8.3	$ 8.4	$ 7.4	$ 6
Aerospace	7.9	6.3	5.0	4.3	3
Machinery and Equipment	9.8	10.0	8.7	7.4	6
Materials and Components	13.0	13.0	12.5	11.8	10
Corporate unallocated	–	.1	–	.2	
Total	$ 41.8	$ 37.7	$ 34.6	$ 31.1	$ 27
Capital expenditures					
Automotive	$ 8.1	$ 6.9	$ 6.6	$ 12.6	$ 14
Aerospace	13.7	7.3	7.7	10.0	12
Machinery and Equipment	14.8	9.7	8.0	10.2	14
Materials and Components	13.7	12.3	18.3	21.2	17
Corporate unallocated	.1	.1	–	.1	
Total	$ 50.4	$ 36.3	$ 40.6	$ 54.1	$ 59

raft jet engine and oil and gas industries. Menasco California ivision benefited in 1984 from increased sales to the military pares market. The 1984 earnings performance of these businesses was offset in part by lower sales and operating income r Chandler Evans Control Systems and Menasco Texas Divions. After ten years of growth, Chandler Evans sales and operating income declined in 1984 due to reductions in sales f the MFP-330 fuel pump. The lower 1984 results for Menasco exas reflected the phaseout of the Lockheed L-1011 program.

Operating income for the Aerospace segment in 1983 was igher due to the acquisition of Delavan, increased shipments Menasco landing gears and Chandler Evans fuel pumps to e military, and termination settlement on a commercial aircraft program. Earnings in 1983 for Menasco Aerospace Ltd were dversely affected by a work disruption that began in July, 1982 id by costs to relocate its manufacturing facility.

Operating income for the Machinery and Equipment segment 1984 was $54.6 million, up from $38.2 million in 1983 and 35.8 million in 1982. This represented 19 percent, 18 percent, and 23 percent of the company's total operating income in ose years. For the fourth consecutive year, the Central Moloney ansformer Division reported record operating income due continued demand from the housing and construction industries and to increased shipments to utility companies. Quincy mpressor, Elox, and Garlock Special Products Divisions ported increased earnings in 1984 due to general improvement in the industrial sector of the U.S. economy. The improved erformance of the Pratt & Whitney Machine Tool Division in 84 was due mainly to the strong demand from the automotive ndustry for Sterling and Haber tools and from the tool and die dustry for the Wolverine line of profile milling machines. This provement was offset in part by continued intense competin from imports and costs associated with rearrangement of anufacturing facilities. Fairbanks Weighing Division reported lower operating income in 1984 as it encountered aggressive market competition.

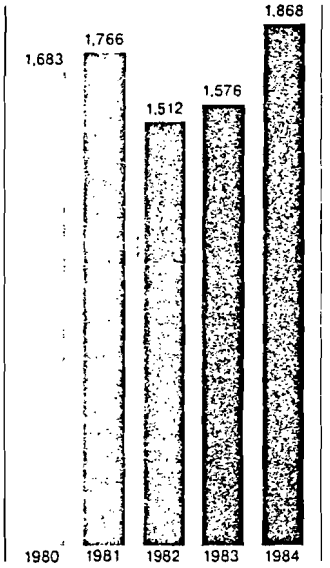
The 1983 increase over 1982 in segment operating income was due to record earnings for Central Moloney Transformer Division and improved performances by the Elox, Fairbanks Morse Pump, and Garlock Special Products Divisions. Depressed economic conditions in the machine tool industry resulted in a 1983 operating loss for Pratt & Whitney Machine Tool Division.

The Materials and Components segment had operating income in 1984 of $54.7 million, or 19 percent of total company operating income, compared with $22.0 million, or 11 percent, in 1983 and $22.0 million, or 14 percent, in 1982. All divisions in this segment had strong earnings gains in 1984. Crucible Specialty Metals Division income was up substantially from the depressed level of 1983, reflecting improved operating margins and higher sales volume on increased demand from the automotive and capital goods markets. Colt Firearms Division showed significant gains due to introduction of the M16A2 rifle for the military. Commercial firearms sales, however, continued to be soft. Trent Tube Division earnings were up on lower sales volume resulting from consolidation of manufacturing facilities and elimination of several product lines. The Garlock Mechanical Packing Division experienced sales increases in several product lines in 1984, resulting in higher operating income; and Crucible Magnetics Division earnings gains reflected the general improvement in the economy.

Operating income of the Materials and Components industry segment in 1983 was level with that of 1982. The Garlock Mechanical Packing, Crucible Specialty Metals, and Crucible Magnetics Divisions showed improved results; while Colt Firearms and Trent Tube Divisions results were down. Trent Tube Division had an operating loss in 1983 due to the low level of demand for stainless pipe and tubing, combined with pricing pressures and costs to consolidate facilities.

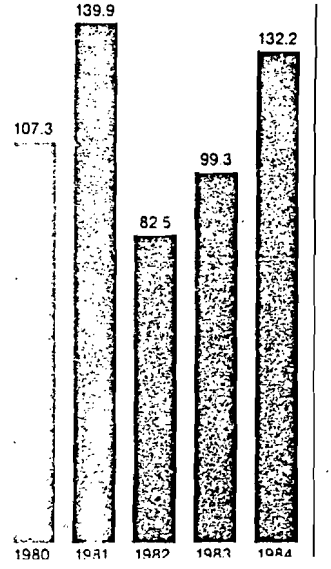
Sales

in millions of dollars



Earnings from Continuing Operations

in millions of dollars



Order Backlog

(In millions)	1984	1983
Automotive	$ 91.9	$ 94.7
Aerospace	503.9	488.0
Machinery and Equipment	157.3	115.1
Materials and Components	98.7	111.8
Total	$851.8	$809.6

Total new orders during 1984 were up 9 percent from the 1983 level, and backlog at year-end was up 5 percent. Of the December 31, 1984 backlog, approximately $318.9 million is scheduled to be shipped beyond 1985; and a portion of this backlog is subject to funding based upon Congressional budget authorization.

Sales by Markets Served

For the two years ended December 31, 1984:

	Percentage of Sales		
	Original Equipment	Aftermarket	Total
1984			
Automotive and Truck Products	24	10	34
Aerospace and Government	15	9	24
Industrial Machinery and Equipment	11	6	17
Utilities, Chemical, and Petroleum	11	5	16
All Other	6	3	9
% Totals	67	33	100
1983			
Automotive and Truck Products	23	9	32
Aerospace and Government	16	11	27
Industrial Machinery and Equipment	9	5	14
Utilities, Chemical, and Petroleum	11	5	16
All Other	8	3	11
% Totals	67	33	100

Quarterly Sales and Earnings

For the two years ended December 31, 1984:

(In thousands, except per share data)	Quarter			
	1st	2nd	3rd	4th
1984				
Net sales	$463,356	$502,315	$435,516	$467,080
Gross profit	112,920	122,589	111,296	118,758
Net earnings	32,476	37,355	30,037	32,361
Earnings per common share	1.35	1.61	1.44	1.60
1983				
Net sales	$365,097	$401,566	$391,734	$417,786
Gross profit	79,132	89,653	95,422	106,445
Net earnings	16,256	26,160	26,214	30,625
Earnings per common share	.66	1.06	1.06	1.23

Sales by Class of Products

The following table sets forth information on each class of similar products which accounted for at least 10 percent of company sales during any of the last three fiscal years:

	Percentage of Sales		
	1984	1983	198
Carburetors and Components:			
Carburetors—Original Equipment Manufacturers	11.6	11.4	9
Carburetors—Aftermarket	4.1	3.7	3
Components	2.6	2.4	2
Total	18.3	17.5	15
Landing gear assemblies	8.4	10.4	9

Financial Position

Cash and marketable securities were $6.5 million at December 31, 1984, a $158.4 million decrease from 1983. Working capital of $272.9 million was lower by $137.1 million, and the current ratio was 1.87 compared with 2.28 at year-end 1983.

Funds from operations continue to be the main source of financing for the company's businesses. In 1984, funds from continuing operations were $182.2 million compared with $160.0 million in 1983. The strength of the balance sheet and the company's liquidity is derived mainly from the strong cash flow generated by operations. Since the beginning of 1982, Colt has reduced total debt by $123.5 million, invested $127.3 million in capital expenditures, acquired Delavan Corporation and Engler Instruments for $61.6 million, paid $142.1 million in dividends to shareholders, and purchased 8,522,608 shares of the company's common stock for $335.5 million, while reducing cash and marketable securities by only $175.3 million. Effective management of receivables and inventories held their growth in 1984 to 8 percent and 1 percent, respectively, significantly below the 19 percent increase in sales. These efforts have resulted in receivable days outstanding of 46 days at the end of 1984 compared with 49 days at the end of 1983 and 52 days at the end of 1982. Inventory turnover improved to 3.66 times in 1984 compared with 3.12 times in 1983 and 2.68 times in 1982. The increases in accounts payable and accrued expenses reflected higher operating levels in 1984.

Notes payable to banks were $13.2 million at December 31, 1984 compared with $1.5 million at December 31, 1983. The average interest rate on such borrowings was 11.3 percent during 1984 and 9.3 percent at year-end 1984. Current maturities of long-term debt at December 31, 1984 were $4.2 million compared with $12.6 million at year-end 1983. During the five years ending December 31, 1989, the required mandatory repayment of long-term debt will be $46.5 million, with a maximum annual payment during the period of $21.3 million. Long-term debt was reduced by $22.5 million, or 15 percent, to $124.6 million at December 31, 1984.

This reduction resulted mainly from the repurchase of $50.7 million and the defeasance of $33.6 million of senior promissory notes, offset in part by $70.0 million of borrowing under a $750 million revolving credit agreement entered into in 1984. This replaced a $250 million revolving credit agreement. This bank credit and funds from operations are expected to be more than adequate to meet cash requirements in 1985. Long-term debt as a percent of total capitalization increased from 24.0 percent at the end of 1983 to 26.6 percent at the end of 1984,

Note 4 of the Notes to Financial Statements on page 41 for ditional information on long-term debt.

The remaining $201.9 million liability for facility disposition, ncluding the current portion of $17.3 million and after advance ıding of certain employee benefits during 1984, represents imarily reserves for employee benefits of the discontinued steelmaking facility stated, in accordance with generally accepted counting principles, at present value. These benefits are heduled to be paid over periods of up to 40 years. Manage-nent may decide in the future to fund such remaining reserves, whole or in part, in advance of scheduled payments. With pect to the reserve balances, company operations have en charged with amounts equivalent to interest thereon to ssure that the reserves meet estimated future requirements.

Shareholders' equity at December 31, 1984 of $343.7 million creased $123.1 million from year-end 1983. The decrease vas due to the purchase by the company of 4,470,653 shares its common stock for a total cost of $213.2 million. The com-ıy has authorization to purchase up to 13,000,000 shares. ıs of December 31, 1984, 3,154,485 shares remain to be pur-ıased under this authorization; and it is the company's intention continue to make such purchases as market conditions ..rrant. Shares repurchased will be retained as treasury shares ır use in the exercise of options, acquisitions, and other porate purposes. Book value per share was $17.58 at year-1 1984 compared with $19.65 at the end of 1983. Return n average shareholders' equity was 32.6 percent in 1984 mpared with 21.8 percent in 1983 and was the highest in company's history.

apital Expenditures

penditures for property, plant, and equipment during 1984 e $50.4 million compared with $36.3 million in 1983.

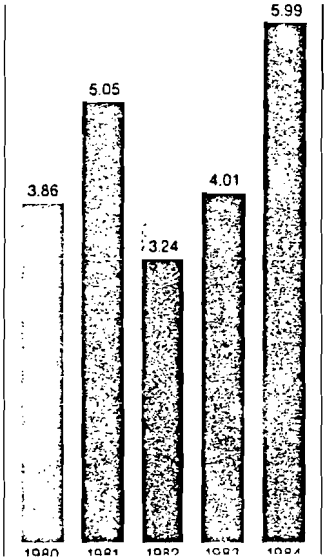
Menasco Aerospace Ltd of Canada completed a 180,000-square-foot manufacturing and office facility in Oakville, Ontario for the production of aircraft landing gear and flight control systems. A plating operation was also installed at this plant to enhance manufacturing capabilities. Stemco Truck Products Division constructed a 68,000-square-foot warehouse and manufacturing facility in Mississauga, Ontario. Central Moloney Division purchased eight acres of land adjacent to its existing property in Arcadia, Florida for expansion of its pole-type-transformer manufacturing facility. The Garlock Special Products Division expanded its Plastomer Products facility in Newtown, Pennsylvania by 14,000 square feet. Woodville Polymer Engineering Ltd expanded by 11,000 square feet the manufacturing and office space at its Herefordshire, England facility, primarily to produce wing slot seals for the U.S. Air Force B-1B strategic aircraft.

Consolidation of manufacturing and other facilities to provide more efficient operations were carried out by the Trent Tube, Fairbanks Weighing, and Quincy Compressor Divisions. The multiyear environmental protection and modernization program at the Crucible Specialty Metals Division is continuing to provide benefits as well as operating efficiencies. Menasco Texas Division installed equipment to upgrade machining capabilities to produce landing gear for the C-5B military transport program. Farnam Sealing Systems Division installed a second coating and curing production line to increase gasket volume. Colt Industries continued to upgrade computers and data processing systems to maintain optimum performance in such functions as production, engineering, and financial management.

The company is dedicated to a capital investment program that maximizes utilization of assets while meeting environmental protection requirements.

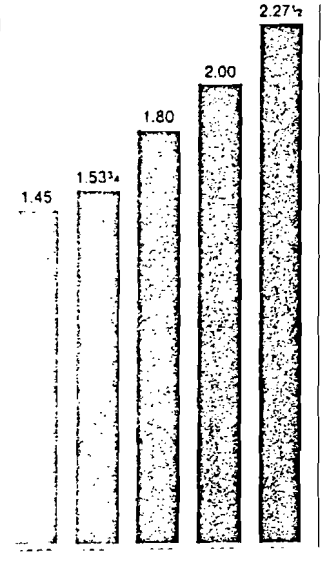
Earnings per Common Share from Continuing Operations

in dollars



Cash Dividends per Common Share

in dollars



Other Financial Information

Impact of Inflation

Over the years, the rate of inflation has had a significant impact on the U.S. economy and the historical financial reporting methods of business. As a result, companies are required to disclose the impact of inflation on operations. To combat the effects of inflation, Colt Industries has attempted to adjust selling prices to maintain profit margins, improve productivity of plant and equipment, and reduce and control costs. In future periods, the amount of capital available for reinvestment in the company and for dividend distribution will be dependent in large measure upon the impact of inflation on the economy and on the development of a national tax policy that recognizes this impact and provides for capital cost recovery required for reinvestment in new plant and equipment. Reference is made to Note 12 of the Notes to Financial Statements on page 44 for information on the effects of inflation on the company.

Dividends

Record dividends of $48.8 million were paid to the company's shareholders in 1984. Cash dividends were $2.27½ per share in 1984, an increase of 14 percent over the $2.00 paid in 1983. This increase marked the twelfth consecutive year in which shareholders received higher annual dividends. Over the past ten years, dividends have grown at a compound rate of 19 percent. The current dividend rate is $.62½ per share quarterly, or $2.50 annually.

Market Price of Colt Industries Common Stock

The company's common stock is listed on the New York, Midwest, Pacific, and London Stock Exchanges. The following table sets forth the high and low market prices, as reported by the Composite Tape Association ticker, of the stock for eac quarter during 1984 and 1983:

	1984		1983	
	High	Low	High	L
First quarter	57	45¾	36½	3
Second quarter	50¼	42⅝	44¾	3
Third quarter	52⅜	39⅞	49¼	3
Fourth quarter	55	49¼	54¾	4

Shareholder Information

At the end of 1984, there were 18,659 shareholders of record compared with 20,730 at the end of 1983. There were 19,556,6 shares of common stock outstanding at December 31, 1984 and 23,754,110 shares outstanding at the end of 1983, excludi 8,060,317 and 3,862,808 shares held in treasury at year-end in 1984 and 1983, respectively.

Dividend Reinvestment Program

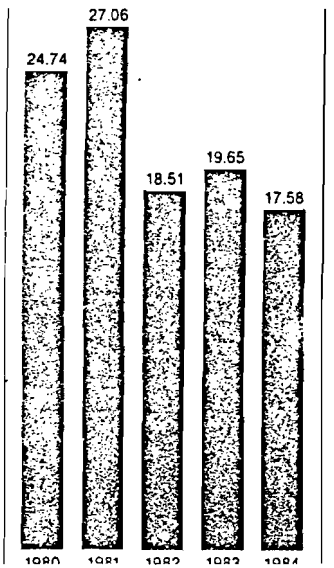
Shareholders may participate in the Colt Industries Dividend Reinvestment Plan in which the company pays brokers' commissions and bank service fees on purchases of common stock. Participation in the plan is voluntary, and participants may withdraw at any time. For more information about the voluntary Dividend Reinvestment Plan, or to participate in the plan, please write to Colt Industries Inc, Department FP, 430 Park Avenue, New York, N.Y. 10022.

Annual Report to the Securities and Exchange Commission on Form 10-K Available

The annual report on Form 10-K, without exhibits, will be made available free of charge to interested shareholders upo written request to the Corporate Secretary, Colt Industries Inc 430 Park Avenue, New York, N.Y. 10022.

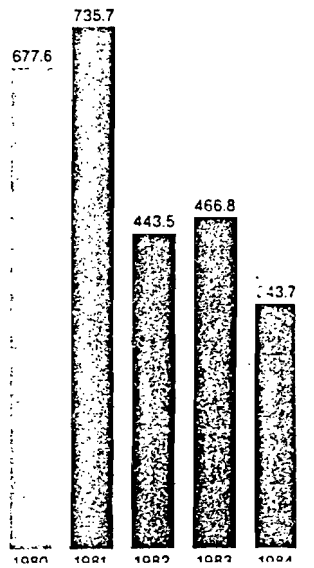
Book Value per Common Share

in dollars



Shareholders' Equity

in millions of dollars



Consolidated Statement of Earnings

For the three years ended December 31, 1984

(In thousands, except per share data)

		1984	1983	1982
Revenue	Net sales	$1,868,267	$1,576,183	$1,511,594
Costs and Expenses	Costs of sales	1,402,704	1,205,531	1,175,962
	Selling and administrative	224,644	200,010	202,293
	Interest expense	15,733	18,723	22,639
	Interest income	(16,329)	(25,321)	(20,317)
	Total costs and expenses	1,626,752	1,398,943	1,380,577
Earnings	Earnings from continuing operations before income taxes	241,515	177,240	131,017
	Provision for income taxes (Note 3)	109,286	77,985	48,475
	Earnings from continuing operations	132,229	99,255	82,542
	Discontinued operations (Note 2)	—	—	(243,900)
	Net earnings (loss)	$ 132,229	$ 99,255	$ (161,358)
Earnings Per Share Data (Note 1)	Earnings (loss) per common share—			
	Continuing operations	$5.99	$4.01	$ 3.24
	Discontinued operations	—	—	(9.57)
	Net earnings (loss)	$5.99	$4.01	$(6.33)
	Average number of common and common equivalent shares	22,093	24,778	25,502
	Cash dividends per common share	$2.27½	$2.00	$1.80

The accompanying notes to financial statements are an integral part of this statement.

Consolidated Balance Sheet

December 31

(In thousands

Assets		1984	198
Current Assets	Cash, including certificates of deposit of $2,141 and $21,494	$ 3,859	$ 23,07
	Marketable securities, at cost (approximates market)	2,656	141,80
	Accounts and notes receivable—		
	Trade	218,423	199,45
	Other	8,783	11,28
		227,206	210,73
	Less allowance for doubtful accounts	5,329	5,19
		221,877	205,53
	Inventories (Notes 1 and 12)—		
	Finished goods	91,510	81,82
	Work in process and finished parts	173,031	185,68
	Raw materials and supplies	65,932	59,82
		330,473	327,32
	Deferred income taxes (Note 3)	18,676	24,61
	Other current assets	8,143	8,56
	Total current assets	585,684	730,93
Property, Plant, and Equipment, at Cost (Notes 1 and 12)	Land and improvements	24,133	23,96
	Buildings and equipment	145,255	140,48
	Machinery and equipment	495,154	469,71
	Leasehold improvements	6,773	6,50
	Construction in progress	15,649	12,60
		686,964	653,27
	Less accumulated depreciation and amortization	349,906	320,35
		337,058	332,92
Other Assets	Funds held by trustee for capital projects	4,606	8,63
	Other assets (Note 1)	96,190	104,63
		$1,023,538	$1,177,12

Liabilities and Shareholders' Equity

(In thousands, except share data

		1984	1983
Current Liabilities	Notes payable to banks (Note 4)	$ 13,196	$ 1,492
	Current maturities of long-term debt (Note 4)	4,163	12,573
	Accounts payable	105,478	97,097
	Accrued expenses—		
	Salaries, wages, and employee benefits	54,269	56,027
	Taxes	81,336	68,257
	Other	36,988	34,854
		172,593	159,138
	Current portion of liability for facility disposition (Note 2)	17,350	50,662
	Total current liabilities	312,780	320,962
Noncurrent Liabilities	Long-term debt (Note 4)	124,587	147,123
	Deferred income taxes (Note 3)	4,059	14,441
	Minority interest in subsidiaries	4,114	3,280
	Other liabilities	49,712	21,997
	Noncurrent liability for facility disposition (Note 2)	184,567	202,489
	Commitments and contingencies (Note 11)		
Shareholders' Equity (Notes 1, 6, and 8)	Preferred stock— $1 par value, 10,000,000 shares authorized, shares outstanding—none	—	—
	Common stock— $1 par value, 100,000,000 shares authorized; 27,616,918 shares issued (including shares held in treasury of 8,060,317 in 1984 and 3,862,808 in 1983)	27,617	27,617
	Capital in excess of par value	142,321	140,909
	Retained earnings	504,402	420,939
	Foreign currency translation adjustments	(11,998)	(7,216)
		662,342	582,249
	Less cost of 8,060,317 and 3,862,808 shares of common stock in treasury	318,623	115,418
		343,719	466,831
		$1,023,538	$1,177,123

...ue accompanying notes to financial statements are an integral part of this statement.

Consolidated Statement of Retained Earnings

For the three years ended December 31, 1984

(In thousands)

		1984	1983	1982
Retained Earnings	Balance, beginning of period	**$420,939**	$370,168	$576,360
	Net earnings (loss) for the period	**132,229**	99,255	(161,358
	Dividends	**(48,766)**	(48,484)	(44,834
	Balance, end of period	**$504,402**	$420,939	$370,168

Consolidated Statement of Capital in Excess of Par Value

For the three years ended December 31, 1984

(In thousands)

		1984	1983	1982
Capital in Excess of Par Value	Balance, beginning of period	**$140,909**	$139,935	$140,357
	Excess of cost of treasury stock issued over proceeds from exercise of stock options	**(2,242)**	(3,343)	(880
	Income tax benefit from the exercise of stock options	**2,381**	3,626	458
	Excess of market value over cost of treasury stock issued to employee benefit plans	**1,273**	691	—
	Balance, end of period	**$142,321**	$140,909	$139,935

Consolidated Statement of Changes in Financial Position

For the three years ended December 31, 1984

(In thousands

		1984	1983	1982
Source of Funds	Earnings from continuing operations	**$132,229**	$ 99,255	$ 82,542
	Items not requiring use of funds—			
	Depreciation and amortization	**41,834**	37,653	34,595
	Deferred income taxes	**(10,382)**	19,771	(4,817
	Other operating items	**18,499**	3,343	13,092
	Funds provided from continuing operations	**182,180**	160,022	125,412
	Operating working capital—			
	Accounts and notes receivable	**(16,339)**	(31,395)	43,039
	Inventories	**(3,144)**	15,927	45,932
	Deferred income taxes	**5,943**	(8,711)	10,092
	Other current assets	**426**	(3,539)	1,364
	Accounts payable	**8,381**	24,544	(40,895
	Accrued expenses	**13,455**	37,519	(51,386
		8,722	34,345	8,146
	Funds from continuing operations and operating working capital	**190,902**	194,367	133,558
Use of Funds	Investments and other—			
	Acquisition of Delavan Corporation, net of working capital and debt	**—**	(51,585)	—
	Capital expenditures	**(50,431)**	(36,300)	(40,554)
	Dividends paid	**(48,766)**	(48,484)	(44,834)
	Increase in treasury stock—net	**(203,205)**	(25,964)	(80,835)
	Decrease (increase) in other assets	**8,440**	2,845	(6,237)
	Reclassification of pension and insurance liabilities	**9,216**	—	—
	Other—net	**5,954**	1,855	(2,669)
		(278,792)	(157,633)	(175,129)
	Funds from (used by) continuing operations before financing	**(87,890)**	36,734	(41,571)
	Financing—			
	Notes payable to banks	**11,704**	(1,113)	(4,329)
	Increase in long-term debt	**70,000**	5,270	—
	Reduction in long-term debt, including current maturities	**(100,946)**	(54,356)	(49,683)
	Total debt	**(19,242)**	(50,199)	(54,012)
	Funds from (used by) continuing operations after financing	**(107,132)**	(13,465)	(95,583)
	Funds from (used by) discontinued operations	**(51,234)**	33,103	58,980
Cash and Marketable Securities	Increase (decrease)	**(158,366)**	19,638	(36,603)
	At beginning of period	**164,881**	145,243	181,846
	At end of period	**$ 6,515**	$164,881	$145,243

The accompanying notes to financial statements are an integral part of this statement.

1. Summary of Accounting Policies

Principles of Consolidation: Investments in which the company's ownership of voting common stock is over 50 percent are consolidated in the financial statements, except for its finance business which is accounted for on the equity basis. Investments in which the company has stock ownership of at least 20 percent but not over 50 percent are accounted for on the equity basis. Intercompany accounts and transactions are eliminated.

Foreign Currency Translation: In accordance with Statement No. 52 of the Financial Accounting Standards Board (FASB), assets and liabilities of foreign subsidiaries are translated into U.S. dollars at year-end rates and income and expenses at monthly weighted average rates. For all foreign subsidiaries, except the Mexican subsidiaries, the local currencies have been designated as the functional currencies. The U.S. dollar is the functional currency for the Mexican subsidiaries. Changes in the foreign currency translation adjustment for 1984, 1983, and 1982, which are included in shareholders' equity, were as follows:

(In thousands)	1984	1983	1982
Balance, beginning of period	$ (7,216)	$(4,776)	$(1,707)
Translation adjustments for the period	(4,782)	(2,440)	(3,069)
Balance, end of period	$(11,998)	$(7,216)	$(4,776)

Foreign currency losses of $8,626,000, principally due to the devaluation of the Mexican peso, were included in earnings in 1982. In 1984 and 1983, such gains and losses were not significant.

Inventories: Inventories are valued at the lower of cost or market, less reserves of $43,377,000 and $43,284,000 at December 31, 1984 and 1983, respectively, for potential losses from excess and slow-moving inventories. Cost elements included in inventory are material, labor, and factory overhead, primarily using standard cost, which approximates actual cost. Cost on approximately 26 percent of the domestic inventory is determined on the last-in, first-out basis. Cost on the remainder of the inventory is generally determined on the first-in, first-out basis. The excess of current cost over last-in, first-out cost at December 31, 1984 and 1983 was approximately $46,000,000 and $52,000,000 respectively.

Property and Depreciation: Depreciation and amortization of plant and equipment are provided generally by using the straight-line method, based on estimated useful lives of the assets which, in some instances, may be less than the lives allowed for tax purposes. For federal income tax purposes, most assets are depreciated using allowable accelerated methods.

The ranges of estimated useful lives used in computing depreciation and amortization for financial reporting were as follows:

	Years
Land improvements	7-40
Buildings and equipment	10-40
Machinery and equipment	3-25
Leasehold improvements	Generally life of leas

The cost of special equipment and facilities purchased for specific contracts is amortized over a period not exceeding the lesser of the contract life or the estimated useful life of the asset.

Interest cost incurred during the period of construction of plant and equipment is capitalized as part of the cost of such plant and equipment.

Renewals and betterments are capitalized by additions to the related asset accounts, while repair and maintenance costs are charged against earnings. The company generally records retirements by removing the cost and accumulated depreciation from the asset and reserve accounts, reflecting any resulting gain or loss in earnings.

At December 31, 1984 and 1983, the company had the following assets recorded under capital leases:

(In thousands)	1984	198
Land and improvements	$ 1,083	$ 1,05
Buildings and equipment	19,847	19,30
Machinery and equipment	29,977	27,04
Leasehold improvements	1,084	1,02
Construction in progress	1,086	70
	53,077	49,13
Less—Accumulated depreciation and amortization	18,400	16,50
	$34,677	$32,62

Start-up Costs: Start-up costs related to new operations and major facilities are expensed as incurred.

Revenue Recognition: Revenue is recorded at the time deliveries or acceptances are made and the company has the contractual right to bill.

Excess of Cost Over Net Tangible Assets: It is the company's policy to amortize the excess costs arising from acquisitions on a straight-line basis over periods not to exceed 40 years. At December 31, 1984, $41,323,000 remains to be amortized and is included in Other Assets in the Consolidated Balance Sheet.

Earnings Per Share: Earnings per common share are computed by dividing net earnings by the weighted average number of common and common equivalent shares outstanding during each period. Common equivalent shares are shares issuable on the exercise of stock options when dilutive, net of shares assumed to have been purchased with the proceeds.

2. Discontinued Operations

In 1982, the company closed the Crucible Stainless and Alloy Division in Midland, Pennsylvania and entered into an agreement for the purchase of this steelmaking facility by Jones & Laughlin, a unit of LTV Corporation. The purchase was completed in February 1983. Consolidated results in 1982 included a $243,900,000 loss, after an income tax benefit of $182,273,000, for the discontinued steelmaking operations.

The remaining liability for facility disposition, after advance funding of certain employee benefits during 1984, represents primarily reserves for employee benefits of the former employees of the discontinued steelmaking facility, including certain benefits that are the subject of litigation, stated, in accordance with generally accepted accounting principles, at present value. These benefits are scheduled to be paid over periods of up to 40 years. Management may decide in the future to fund all or a portion of such remaining reserves in advance of scheduled payments. With respect to the reserve balances, company operations have been charged with amounts equivalent to interest thereon to assure that the reserves meet estimated future requirements.

Net sales of discontinued operations were $180,299,000 in 1982.

3. Income Taxes

The domestic and foreign components of earnings from continuing operations before income taxes were as follows:

(In thousands)	1984	1983	1982
Domestic	$226,404	$164,866	$115,352
Foreign	15,111	12,374	15,665
Total	$241,515	$177,240	$131,017

The provision for income taxes was as follows:

(In thousands)	1984	1983	1982
Current–			
Domestic	$107,071	$62,620	$33,335
Foreign	6,654	4,305	9,865
	113,725	66,925	43,200
Deferred–			
Domestic	(4,179)	10,423	8,223
Foreign	(260)	637	(2,948)
	(4,439)	11,060	5,275
Total	$109,286	$77,985	$48,475

Deferred income taxes result principally from timing differences in the recognition of revenue and expense for tax and financial reporting. Significant items were as follows:

(In thousands)	1984	1983	198
Depreciation	$ 5,047	$10,881	$ 6,23
Employee benefits	(7,838)	13,588	(5,66
Long-term program contracts	(4,212)	(16,733)	11,93
Inventory valuation	2,816	(716)	2,44
Other (not individually significant)	(252)	4,040	(9,66
Total	$(4,439)	$11,060	$ 5,27

The reconciliation of tax at the U.S. statutory income rate to the provision for income taxes was as follows:

(In thousands)	1984	1983	198
Tax at U.S. statutory income rate	$111,097	$81,530	$60,26
Investment tax credit	(2,700)	(2,500)	(6,56
DISC, foreign credits, etc.	889	(1,045)	(5,23
Provision for income taxes	$109,286	$77,985	$48,47
Effective tax rate	45.25%	44.0%	37.0%

4. Long-Term Debt

(In thousands)	1984	1983
Revolving credit agreement–10.6%*	$ 70,000	$ –
9¾% senior promissory notes	–	70,387
8½% senior promissory notes	–	20,996
Capital lease obligations 4.3%-12% due 1985-2070	44,257	47,110
8⅞% notes payable to insurance company in installments to 1990	11,000	13,000
Other due 1985-1994–9.1%*	3,493	8,203
	128,750	159,696
Less–Amounts due within one year	4,163	12,573
	$124,587	$147,123

*Indicates average interest rate for 1984.

a) The company's loan agreements include various covenants. Under the most restrictive of these covenants at December 31, 1984, working capital was $72,904,000 in excess of minimum requirements. The company is in compliance with all covenants under its loan agreements.

b) During 1984, the company entered into a $750,000,000 revolving credit agreement with various banks which replaced a $250,000,000 revolving credit agreement entered into in 1982. Under the agreement, the company may borrow, and repay and reborrow, at any time until June 30, 1988 amounts aggregating up to the committed amount of $750,000,000. Upon maturity on June 30, 1988, the company may, at its option, convert the outstanding unpaid principal amount into a four-year term loan, payable in equal semiannual principal installments commencing on December 30, 1988. At the option of the company, interest on the unpaid principal balances is calculated based upon either the prime rate, the certificate of deposit rate, or the London interbank rate. A commitment fee of ¼ of 1% per annum is payable quarterly on the daily average unused portion.

In addition, the company's foreign subsidiaries had unused lines of credit aggregating $13,000,000 for short-term bank borrowing at December 31, 1984.

c) During 1984, the company repurchased for early retirement $50,703,000 of its 8½% and 9¾% senior promissory notes and defeased the remaining $33,598,000 of 8½% and 9¾% senior promissory notes through the deposit of U.S. Treasury securities with a trustee. The U.S. treasury securities deposited are sufficient to pay the principal and interest on these notes as they become due. At December 31, 1984, the $33,598,000 outstanding balance of defeased notes has been offset against the trusteed funds in the Consolidated Balance Sheet.

d) The amounts payable under capital lease obligations are as follows:

(In thousands)	
1985	$ 5,457
1986	5,453
1987	5,143
1988	5,026
1989	4,936
Remainder	105,752
Total minimum lease payments	131,767
Less—Amount representing interest	87,510
Total minimum lease payments at present value, included in long-term debt	$ 44,257

e) Minimum payments on long-term debt, including capital lease obligations, due within five years from December 31, 1984 are as follows:

(In thousands)	
1985	$ 4,163
1986	4,511
1987	3,860
1988	12,608
1989	21,340

5. Finance Business

The condensed balance sheet at December 31, 1984 and 1983 is shown below for the company's finance business:

(In thousands)	1984	1983
Finance receivables	$33,373	$28,844
Other assets	608	520
	$33,981	$29,364
Notes payable	$25,200	$21,050
Other liabilities	1,273	1,339
Shareholder's equity	7,508	6,975
	$33,981	$29,364

The finance business note agreements with lenders provide that debt may not exceed 500 percent of net worth.

6. Common Stock

Changes in common stock for 1982, 1983, and 1984 were:

	Shares Issued $1 Par Value	Treasury Stock Shares	Treasury Stock Cost
Balance at January 1, 1982	$27,616,918	(425,100)	$ (8,619,000
Purchase of treasury stock	–	(3,317,242)	(83,005,000
Exercise of stock options	–	86,990	2,170,000
Balance at December 31, 1982	27,616,918	(3,655,352)	(89,454,000
Purchase of treasury stock	–	(734,713)	(39,292,000
Exercise of stock options	–	496,597	12,462,000
Stock issued to employee benefit plans	–	30,660	866,000
Balance at December 31, 1983	27,616,918	(3,862,808)	(115,418,000
Purchase of treasury stock	–	(4,470,653)	(213,173,000
Exercise of stock options	–	160,826	5,700,000
Stock issued to employee benefit plans	–	112,318	4,268,000
Balance at December 31, 1984	$27,616,918	(8,060,317)	$(318,623,000

At December 31, 1984, 1,357,883 shares of common stock were reserved for issuance under stock options.

7. Pension and Retirement Plans

The company and certain of its subsidiaries have in effect, for substantially all employees, pension and retirement plans under which funds are deposited with trustees. The actuarially computed present value, at January 1, 1984 and 1983, of accumulated vested benefits was $208,347,000 and $200,356,000 and of nonvested benefits was $15,863,000 and $13,330,000, respectively. The plans' net assets available for benefits at January 1, 1984 and 1983 were $309,465,000 and $278,326,000, resulting in an excess of net assets over vested benefits of $101,118,000 and $77,970,000. Pension expense of $12,269,000, $12,793,000, and $17,005,000 was charged to earnings in 1984, 1983, and 1982, respectively.

For determining accumulated benefits in accordance with Statement No. 35 of the FASB, a 10.4 percent interest factor was used, except for that portion of retiree benefits that are cash matched with bond maturities for which an interest factor of approximately 15 percent was used. The assets in bond portfolios matching such benefits having a present value of $64,121,000 are valued on a fixed-yield basis relating to their initially established rate of return.

Effective in 1983, as a result of continuing review of actuarial assumptions and historical performance, the assumed interest rate of return on investments for funding purposes was increased from 7 percent to 8 percent. The net effect of this change resulted in reducing pension expense in 1983 by $4,131,000, or $2,230,000 on an after-tax basis.

In addition to providing pension benefits, the company and certain of its subsidiaries have in effect plans that provide certain health care and life insurance benefits to eligible retired employees. The company recognizes the cost of providing the company-paid portion of these benefits by expensing the premiums, net of retiree contributions. The cost to the company of providing these benefits in 1984, 1983, and 1982 was not significant.

8. Stock Option Plans

Company stock option plans provide for the granting of options to officers and key employees at a price not less than 100 percent of the market price on the date of grant. Options are exercisable in cumulative annual installments of from 20 to 33⅓ percent, commencing at various dates from one year to approximately six years from date of grant. Shares available for grant at December 31, 1984 and 1983 were 403,069 and 541,495, respectively.

1984 Stock Option Transactions	Number of Shares	Option Price Range Per Share
Outstanding at December 31, 1983	977,214	$ 5.17-$52.25
Granted	150,400	48.06- 49.06
Exercised	(160,826)	5.17- 25.00
Canceled	(11,974)	24.13
Outstanding at December 31, 1984	954,814	11.98- 52.25
Exercisable at December 31, 1984	161,596	11.98- 29.66

The company also has in effect the 1981 Stock Option and Incentive Plan which, in addition to the granting of stock options, provides for the granting of incentive stock rights, stock appreciation rights, and dividend equivalents to officers and key employees. To date, only stock options have been granted under this plan.

9. Segment Information

Presented on page 30 is information on sales, operating income, total assets, depreciation and amortization, and capital expenditures by industry segment. The information for 1981 and 1980 is not covered by the auditors' report. The products of the company are described on page 29.

Information by geographic segments for the three years ended December 31, 1984 is as follows:

Geographic Segments (In millions)	Sales	Operating Income	Total Assets
1984			
Domestic operations	$1,752	$263.5	$ 94
Foreign operations	135	18.8	9
Intersegment elimination	(19)	—	(7
Total segments	1,868	282.3	97
Interest expense	—	(15.7)	-
Interest income	—	16.3	-
Corporate unallocated	—	(41.4)	5
Continuing operations	$1,868	$241.5	$1,02
1983			
Domestic operations	$1,473	$194.7	$ 96
Foreign operations	117	10.5	8
Intersegment elimination	(14)	—	(6
Total segments	1,576	205.2	98
Interest expense	—	(18.7)	-
Interest income	—	25.3	-
Corporate unallocated	—	(34.6)	18
Continuing operations	$1,576	$177.2	$1,17
1982			
Domestic operations	$1,386	$138.2	$ 90
Foreign operations	144	14.8	10
Intersegment elimination	(18)	—	(8
Total segments	1,512	153.0	92
Interest expense	—	(22.6)	-
Interest income	—	20.3	-
Corporate unallocated	—	(19.7)	21
Continuing operations	$1,512	$131.0	$1,13

10. Supplementary Earnings Information

(In thousands)	1984	1983	1982
Maintenance	$55,541	$48,078	$46,664
Depreciation and amortization	41,834	37,653	34,595
Taxes, other than federal income taxes—			
Payroll	43,672	37,380	35,122
Property	5,472	5,234	5,337
State and local	15,767	9,692	6,663
Other	6,310	6,072	7,066
	71,221	58,378	54,188
Rent	17,608	18,513	18,216
Rental income	(297)	(293)	(212
	17,311	18,220	18,004
Research and development costs	33,585	30,696	28,142

11. Commitments and Contingencies

The company and certain of its subsidiaries are contingently liable as guarantors of certain leases and are defendants in various lawsuits, including actions involving asbestos-containing products. In the opinion of management, these contingent liabilities are not significant in relation to the financial position of the company and its subsidiaries.

Under operating lease commitments, expiring on various dates after December 31, 1985, the company and certain of its subsidiaries are obligated to pay rentals totaling $21,374,000 as follows: $7,085,000 in 1985, $5,374,000 in 1986, $3,371,000 in 1987, $2,169,000 in 1988, $1,337,000 in 1989, and $2,038,000 in later years. These rent payments are before reduction for related sublease rental income of $2,772,000.

12. Supplementary Information on Changing Prices (Unaudited)

In compliance with the FASB rule, management has estimated the impact of inflation on the company's operations for the year ended December 31, 1984.

The objective of the FASB rule is to measure the estimated effects of inflation on business enterprises, inasmuch as it is generally recognized that financial statements, prepared under the traditional historical cost basis, do not adequately reflect the impact of inflation.

The reader is cautioned that the financial information presented below is determined in accordance with the experimental techniques set forth in the FASB rule. The information does not reflect all of the effects of inflation and other economic factors on the company's current costs of operating the business. In addition, the information required by the FASB rule does not recognize the customary business relationships between cost changes and changes in selling prices. The company has attempted over the years to adjust selling prices to maintain profit margins. Competitive conditions permitting, the company modifies its selling prices to recognize cost changes as incurred. Accordingly, it is management's view that the data presented below cannot be used alone to estimate the total effect of inflation on net earnings as reported.

The FASB rule requires that the effects of inflation on the company be measured under a method which involves the use of assumptions and estimates. Therefore, the resulting measurement should be viewed in that context and not as a precise indicator of all of the effects of inflation. The method of measurement used adjusts for changes in specific prices (current cost) related to individual assets and expenses. The objective is to reflect the effects of changes in specific prices on the resources actually used in the company's operations.

The current cost of inventories was estimated based on quantities on hand at the end of 1984 and costs in effect during the fourth quarter of 1984. Cost of sales was estimated by taking into account the approximate time lag between incurrin costs and their subsequent conversion into sales revenue. The current cost of property, plant, and equipment was estimated by adjusting historical cost by externally generated industrial price indices relevant to the plant and equipment of the company. Depreciation expense was computed by adjusting historical cost depreciation by the same indices used to develop the estimated current cost of property, plant, and equipment.

Following is the statement of earnings and shareholders' equity adjusted for changing prices for the year ended Decem ber 31, 1984:

(In thousands, except per share data)	As Reported in the Financial Statements (Historical Cost)	Adjuste for Changes Specific Price (Curre Cos
Net sales	$1,868,267	$1,868,26
Costs and expenses—		
Cost of sales	1,363,213	1,367,80
Selling and administrative	222,301	222,30
Depreciation and amortization	41,834	58,84
Interest—net	(596)	(59
Total costs and expenses	1,626,752	1,648,35
Earnings from continuing operations before income taxes	241,515	219,91
Provision for income taxes	109,286	109,28
Effective tax rate	45.25%	49.70
Net earnings	$ 132,229	$ 110,62
Earnings per common share— Continuing operations	$ 5.99	$ 5.0
Shareholders' equity at December 31, 1983	$ 466,831	$ 662,86
Net earnings (as reported above)	132,229	110,62
Gain from decline in purchasing power of net amounts owed	—	5,99
Excess of increase in general inflation ($29,108) over increase in current cost ($26,052)	—	(3,05
Dividends and other changes in shareholders' equity	(255,341)	(255,34
Shareholders' equity at December 31, 1984	$ 343,719	$ 521,08

At December 31, 1984, current cost of inventories and net property, plant, and equipment was $391,758,000 and $460,399,000, respectively. This compares with historical cost of inventories and net property, plant, and equipment at year-end of $330,473,000 and $337,058,000, respectively.

The decline in earnings from continuing operations before income taxes under the current cost method is primarily the result of increased depreciation expense, reflecting the higher values for property, plant, and equipment. The FASB rule does not, however, permit the offset of higher costs by any tax benefi

since such additional costs are not tax deductible. As a result, the effective tax rate for 1984 increases from 45.25 percent on an historical cost basis to 49.70 percent on a current cost basis. The gain from the decline in purchasing power of net amounts owed was determined by restating, in average 1984 dollars, the monetary assets and liabilities during the year. Monetary assets and liabilities are items that are or will be converted into a fixed number of dollars regardless of changes in prices and include cash, receivables, payables, and debt. Since the company held net monetary liabilities during 1984, a period in which the purchasing power of the dollar declined, a gain was recognized under the requirements of this FASB rule. Since this gain does not represent a receipt of cash, it should not be considered as providing funds for reinvestment or dividend distribution.

The previously stated increases in the effective tax rate emphasize the need to promulgate new tax policies giving recognition to the reality of inflation which has adverse effects on a company's ability to retain earnings to meet the escalating costs of replacing and expanding its production capacity.

Following are supplementary financial data for the five years ended December 31, 1984:

(In millions, except per share data)	1984	1983	1982	1981	1980
Net sales	$1,868.3	$1,576.2	$1,511.6	$1,766.0	$1,682.8
Current cost information					
Earnings from continuing operations	110.6	79.6	68.2	134.6	105.2
Earnings per common share—continuing operations	5.01	3.21	2.68	4.85	3.78
Shareholders' equity at year-end	521.1	662.9	667.2	996.9	972.3
Excess of increase in general inflation over increase in current cost	3.1	10.4	2.8	16.8	31.2
Other information					
Gain from decline in purchasing power of net amounts owed	6.0	5.7	8.1	20.8	32.5
Cash dividends per common share	2.27½	2.08½	1.93¾	1.75⅝	1.82¾
Market price per common share at year-end	50¾	54⅞	33	31	27¼
Average consumer price index	311.1	298.4	289.1	272.4	246.8

The five-year supplementary financial data show the effect of adjusting selected historical and current cost data for the years 1980 through 1984 to average 1984 dollars, as measured by the Consumer Price Index. The current cost amount for shareholders' equity was determined by adjusting shareholders' equity, as reported in the financial statements, for the difference between historical cost and the restated costs of monetary assets and liabilities; inventories; and property, plant, and equipment.

Auditors' Report

To the Board of Directors and Shareholders of Colt Industries Inc:

We have examined the consolidated balance sheet of Colt Industries Inc (a Pennsylvania corporation) and subsidiaries a of December 31, 1984 and 1983, and the related consolidated statements of earnings, retained earnings, capital in excess o par value and changes in financial position for each of the three years in the period ended December 31, 1984. Our examinations were made in accordance with generally accepted auditing standards and, accordingly, included such tests of th accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the financial statements referred to above present fairly the financial position of Colt Industries Inc and subsidiaries as of December 31, 1984 and 1983, and the results of their operations and the changes in their financial position for each of the three years in the period ended December 31, 1984, in conformity with generally accepted accounting principles applied on a consistent basis.

Arthur Andersen & Co.

New York, N.Y.,
January 25, 1985.

Directory of Operations

Automotive

Division	Principal Products, Markets
Holley Carburetor Division 11955 East Nine Mile Road Warren, Michigan 48089-2003 313/497-4000	*Products:* Automotive carburetors; fuel injection system components. *Markets:* Automotive manufacturers.
Holley Replacement Parts Division 11955 East Nine Mile Road Warren, Michigan 48089-2003 313/497-4000	*Products:* Replacement, performance carburetors; remanufactured carburetors; emissions control components; LPG fuel systems. *Markets:* Automotive aftermarket.
Holley Special Products Division 1748 Northwood Drive Troy, Michigan 48084 313/362-5300	*Products:* Emissions control air pumps, other nonfuel components. *Markets:* Automotive manufacturers.
Stemco Truck Products Division P.O. Box 1989 Longview, Texas 75606 214/758-9981	*Products:* Truck wheel lubrication, exhaust systems; replacement leaf springs; automotive instrumentation *Markets:* Truck manufacturers, truck fleet operations.
Farnam Sealing Systems Division P.O. Box 327 Necedah, Wisconsin 54646 608/565-2241	*Products:* Automotive and industrial gaskets, gasket assemblies. *Markets:* Automotive industry.
Fairbanks Morse Engine Accessories Operation 6402 Rockton Road Roscoe, Illinois 61073 815/389-3660	*Products:* Magnetos, ignition system other engine components. *Markets:* Manufacturers of internal combustion engines and aftermark distributors.

Aerospace

Division	Principal Products, Markets
Chandler Evans Control Systems Division Charter Oak Boulevard West Hartford, Connecticut 06101 203/236-0651	*Products:* Gas turbine engine fuel pumps, fuel control systems; projectile flight control systems. *Markets:* Aircraft engine manufacturers, projectile manufacturers.
Menasco California Division First and Cedar Streets Burbank, California 91510 818/842-9111	*Products:* Landing gear assemblies for such commercial aircraft as the Boeing 757, 767; Hughes AH-64A helicopter; Rockwell B-1B strategic aircraft. *Markets:* Aircraft manufacturers.
Menasco Texas Division P.O. Box 500 Euless, Texas 76039-0500 817/283-4471	*Products:* Landing gear for such aircraft as the General Dynamics F-16 and Lockheed C-5B. *Markets:* Aircraft manufacturers.
Menasco Overhaul Division 26 Providencia Avenue Burbank, California 91510 818/843-0611	*Products:* Landing gear overhaul. *Markets:* Airline operators throughout the free world; U.S. Government
Delavan Gas Turbine Products Division P.O. Box 100 West Des Moines, Iowa 50265 515/274-1561	*Products:* Gas turbine engine fuel injectors, components; spray nozzle valves. *Markets:* Aircraft engine manufacturers; agriculture; industry; comme cial, residential oil burners.
Crucible Compaction Metals Operation R.D. #1, McKee & Rob Hill Road Oakdale, Pennsylvania 15071 412/923-2670	*Products:* Powder metallurgy superalloys, hot isostatically pressed near-net shapes. *Markets:* Aircraft engine, airframe producers; oil and gas, chemical industries.

Machinery and Equipment

Division	Principal Products, Markets
Fairbanks Morse Engine Division 701 Lawton Avenue Beloit, Wisconsin 53511 608/364-4411	*Products:* Diesel, dual-fuel, and spark-ignited engines; diesel engine generator sets. *Markets:* Military, commercial shipbuilders; electric utilities.
Central Moloney Transformer Division 2400 West Sixth Avenue Pine Bluff, Arkansas 71601 501/534-5332	*Products:* Electrical distribution transformers, components. *Markets:* Electric utilities; transformer, switchgear producers.
Fairbanks Weighing Division 711 East St. Johnsbury Road St. Johnsbury, Vermont 05819 802/748-5111	*Products:* Electronic scales. *Markets:* Food and chemical processing, trucking, railroad, waste management, mining, industry, agriculture.
Pratt & Whitney Machine Tool Division Charter Oak Boulevard West Hartford, Connecticut 06101 203/236-6221	*Products:* Profile milling, other machine tools; measuring systems; metal-cutting tools and metal-forming dies. *Markets:* Automotive, aerospace, metalworking industries.
Quincy Compressor Division 217 Maine Street Quincy, Illinois 62301 217/222-7700	*Products:* Reciprocating and helical screw air compressors. *Markets:* Manufacturing, oil and gas, food processing, climate control.
Fairbanks Morse Pump Division 3601 Fairbanks Avenue Kansas City, Kansas 66110 913/371-5000	*Products:* Centrifugal, vertical turbir and axial flow pumps. *Markets:* Municipalities, industry, agriculture, residential.
Garlock Special Products Division Suite 1250, Midtown Tower Rochester, New York 14604 716/232-1400	*Products:* Bearings, butterfly valves, plastomer products, hydraulic/pneumatic cylinders. *Markets:* Automotive, chemical and food processing, other industries.
France Compressor Products Division 104 Pheasant Run Newtown, Pennsylvania 18940 215/968-5959	*Products:* Compressor and industri engine components. *Markets:* Compressor manufacturer users.
Elox Division P.O. Box 2227 Davidson, North Carolina 28036 704/892-8011	*Products:* Electrical discharge machining (EDM) equipment. *Markets:* Manufacturers; tool, die, mold producers.

Materials and Components

Division	Principal Products, Markets
Crucible Specialty Metals Division P.O. Box 977 Syracuse, New York 13201 315/487-4111	*Products:* CPM. conventional high-speed steel; tool, die steels; stainless bars, rods; valve, nuclear, high-temperature steels; titanium bar, rod, wire. *Markets:* Automotive, chemical, other industries; tool and die makers.
Garlock Mechanical Packing Division 1666 Division Street Palmyra, New York 14522 315/597-4811	*Products:* Industrial seals, gasketing, expansion joints. *Markets:* Chemical and food processing, manufacturing, marine, other industries.
Colt Firearms Division P.O. Box 1868 Hartford, Connecticut 06102 203/236-6311	*Products:* Military, security, sporting, and commemorative firearms. *Markets:* U.S. and foreign governments, law enforcement agencies, consumers.
Trent Tube Division 2188 Church Street East Troy, Wisconsin 53120 414/642-7321	*Products:* Stainless and special alloy welded pipe and tubing. *Markets:* Chemical processing, petroleum, aircraft, food processing, electric power industries.
Crucible Magnetics Division R.F.D. 2 Elizabethtown, Kentucky 42701 502/769-1333	*Products:* Alnico, ceramic, neodymium-iron-boron, and rare earth permanent magnets. *Markets:* Producers of electric motors, computers, home appliances home entertainment equipment; industry, medicine.

International Operations

Menasco Aerospace Ltd
1400 South Service Road, West
Oakville,Ontario
Canada L6L 5Y7
416/827-7777

Products: Landing gear assemblies and flight control systems, overhaul services.

Markets: Aircraft manufacturers in Canada, U.S., other countries; airline operators.

Garlock of Canada Ltd
66 Jutland Road
Toronto, Ontario
Canada M8Z 2H3
416/255-9114

Products: Molded and extruded rubber products, braided packings, compressor and industrial engine components, truck wheel lubrication and exhaust systems.

Markets: Automotive, manufacturing, chemical, other industries.

Woodville Polymer Engineering Ltd
Alton Lane, Ross-on-Wye
Herefordshire HR9 5NF
England

Products: High-technology molded rubber products.

Markets: Aerospace, automotive, defense, other industries.

Crusteel Limited
Rutland Way
Sheffield
Yorkshire S3 8DG
England

Products: Specialty steel, tubing distribution.

Markets: Automotive, appliance, chemical industries; tool, die, mold producers.

Delavan Limited
Gorsey Lane
Widnes
Cheshire WA8 0RJ
England

Products: Industrial, agricultural spray nozzles; other products.

Markets: Industry, agriculture.

Garlock (Great Britain) Limited
North Way, Andover
Hampshire SP10 5HN
England

Products: Seals, packings, truck wheel lubrication systems, compressor components.

Markets: Diverse industries; truck manufacturers, users; compressor manufacturers, users.

Garlock AG
Thurgauerstrasse 39
CH-8050 Zurich
Switzerland

Products: Stemco truck products.

Markets: Truck manufacturers, fleet operations.

Liard S.A.
49, Route Nationale
F-59570 Bavay, France

Products: Compressor and industrial engine components, truck wheel lubrication systems.

Markets: Diverse industries; truck manufacturers, fleet operations.

Garlock GmbH
Postfach 300 451
Scheffelstrasse 73
4000 Düsseldorf 30
West Germany

Products: Seals, gasketing, valves; truck products, compressor components.

Markets: Diverse industries; truck manufacturers, fleet operations; compressor manufacturers, users.

Garlock S.A.
Torre dels Pardals, 23
Barcelona 26, Spain

Products: Stemco truck products.

Markets: Truck manufacturers, fleet operations.

Garlock de Mexico, S.A. de C.V.
Poniente 116, No. 571
Mexico 15, D.F.

Products: Industrial packing and gasketing, compressor components, TFE specialty products, and molded rubber products.

Markets: Diverse industries.

Garlock Pty Ltd
P.O. Box 54
Arncliffe, N.S.W. 2205
Australia

Products: Seals, packings, hydraulic components.

Markets: Steel, aluminum, paper, petroleum industries.

Colt Industries Credit Corporation
630 Park Avenue
New York, New York 10022
212/940-0503

Colt Industries Credit Corporation of New Jersey
240 West Passaic Street
Maywood, New Jersey 07607
201/487-8765

Affirmative Action
In striving to develop and maintain an effective work force, the company provides employment, training, and advancement opportunities without regard to race, color, religion, sex, age, or national origin. The company's affirmative action programs cover the employment of minorities, women, handicapped persons, and veterans of the Vietnam conflict.

Directors and Officers

Directors

Robert A. Alberty
Professor of Chemistry
Massachusetts Institute
of Technology
School of Science
Cambridge, Massachusetts

William D. Ford
Senior Vice President
Legal and Secretary
Colt Industries Inc

David I. Margolis
President and
Chief Executive Officer
Colt Industries Inc

Paul W. MacAvoy
Dean, Graduate School
of Management
University of Rochester
Rochester, New York

William H. Rea
Former Chairman
Tyrone Hydraulics Inc.
Pittsburgh, Pennsylvania

William S. Schwab
Attorney
Chicago, Illinois

Louis T. Seith
General,
U.S. Air Force (Ret.)
Arlington, Virginia

George A. Strichman
Chairman of the Board
Colt Industries Inc

Max E. Wildman
Partner
Wildman, Harrold, Allen &
Dixon, Attorneys
Chicago, Illinois

Officers

George A. Strichman
Chairman of the Board

David I. Margolis
President and
Chief Executive Officer

Ben H. Cook
Executive Vice President

Salvatore J. Cozzolino
Executive Vice President

Andrew C. Hilton
Executive Vice President

Guy C. Shafer
Executive Vice President

William D. Ford
Senior Vice President
Legal and Secretary

Vincent H. Callahan
Senior Group Vice President

Ray C. Davis
Group Vice President

George W. Townsend
Group Vice President

C. Edward Warner
Group Vice President

Phil Berkowitz
Vice President
Personnel

John F. Campbell
Vice President
Public Relations

Anthony J. diBuono
Vice President
General Counsel

Julius Levinson
Vice President
Taxes

Joseph P. Lisa
Vice President and
Controller

James J. McHugh
Vice President
Labor Relations

Hershell B. Murray
Vice President
Government Relations

Transfer Agents
Manufacturers Hanover
Trust Company (New York)

The First National Bank
of Chicago

Bank of America
National Trust and Savings
Association (San Francisco)

Registrars
Mellon Bank, N.A.
(New York)

Harris Trust & Savings
Bank (Chicago)

First Interstate Bank
of California
(San Francisco)

Auditors
Arthur Andersen & Co.

Executive Offices
430 Park Avenue
New York, N.Y. 10022

Washington Office
1901 L Street, N.W.
Washington, D.C. 20036

APPENDIX J

NOTIFICATION IN DEED

SYRACUSE - ONONDAGA COUNTY PLANNING AGENCY

JOHN H. MULROY
COUNTY EXECUTIVE

LEE ALEXANDER
MAYOR

October 9, 1985

Mr. Robert J. Taggart, V.P.
Crucible Inc.
Box 977
Syracuse, NY 13201

This letter is to certify that proper notice, as required by 40 CFR 264.117 (C) has been filed with the deed (letters of patent), the local zoning authority and EPA Regional Administrator. Attached are copies of said notices.

Sincerely,

Michael J. Cunningham

Michael J. Cunningham
Supervisor, Planning Services

/lsh

SYRACUSE - ONONDAGA COUNTY PLANNING AGENCY

JOHN H. MULROY
COUNTY EXECUTIVE

LEE ALEXANDER
MAYOR

January 2, 1985

Regional Administrator
U.S. Environmental Protection Agency
26 Federal Plaza
New York, N.Y. 10007

Dear Sir:

The County of Onondaga has recently taken title to 252 acres of the Onondaga Lake wastebeds located in the Town of Geddes. This land is inclusive of the Crucible Materials Corporation, Specialty Metals Division industrial solid waste landfill.

Because hazardous wastes were deposited in the landfill from 1973 to 1982, Federal regulations (40CFR 264.117(c)) require a notice be filed with the deed, the local zoning authority (Town of Geddes) and the Regional Administrator of the U.S. Environmental Protection Agency. The enclosed notice should be maintained on file with the Town in perpetuity.

If you have any questions regarding this matter, please contact me.

Sincerely,

Michael J. Cunningham

Michael J. Cunningham

MJC/cjk/wp
Encls.

SYRACUSE - ONONDAGA COUNTY PLANNING AGENCY

JOHN H. MULROY
COUNTY EXECUTIVE

LEE ALEXANDER
MAYOR

December 27, 1984

Mr. Daniel Patalino, Supervisor
Town of Geddes Hall
1000 Woods Road
Solvay, N.Y. 13209

Dear Mr. Patalino:

The County of Onondaga has recently taken title to 252 acres of the Onondaga Lake wastebeds located in the Town of Geddes. This land is inclusive of the Crucible Materials Corporation, Specialty Metals Division industrial solid waste landfill.

Because hazardous wastes were deposited in the landfill from 1973 to 1982, Federal regulations (40CFR 264.117(c)) require a notice be filed with the deed, the local zoning authority (Town of Geddes) and the Regional Administrator of the U.S. Environmental Protection Agency. The enclosed notice should be maintained on file with the Town in perpetuity.

If you have any questions regarding this matter, please contact me.

Sincerely,

Michael J. Cunningham

Michael J. Cunningham

MJC/cjk/wp
Encls.

NOTICE FOR DEED

TO WHOM IT MAY CONCERN:

This notice is to certify that the specific parcel of land described below, and based on an actual survey by Calocerinos & Spina Consulting Engineers file number 434.066, has been utilized in the past for management of hazardous waste by Crucible Materials Corporation. Use of this parcel of land is restricted, under 40 CFR 264.117(c), to activities which are compatible with the Closure and Post Closure Plans for the site. A copy of the survey description and map along with a record of the type, location, and quantity of hazardous wastes disposed of within each cell or area of the facility required in 40 CFR 265.119 have been filed with the local zoning authority and with the Regional Administrator of the Environmental Protection Agency.

Permission for use of said parcel was originally granted to Crucible by the State of New York Department of Transportation. A New York State Department of Environmental Conservation Part 360 Operating Permit number 1573 was issued on November 3, 1982.

The specific parcel of land affected is described in the following description:

Boundary Description
Crucible Materials Corporation
Landfill Permit Limits

All that tract of land situated in the Town of Geddes, County of Onondaga and State of New York, being part of Farm Lot 27 and, being part of Fifteen Acre Pasture Lot 5 of said Town, being part of lands conveyed by Allied Chemical and Dye Corporation to the People of the State of New York, by deed dated December 20, 1953 and recorded in the Onondaga County Clerks Office December 30, 1953 in Book 1666 of deeds at page 241 and being more particularly described as follows:

Commencing at an angle on the northeasterly boundary of land acquired by the People of the State of New York for Interstate Route Connection 570, Northwest Arterial Connection S.H. 54-5, said point being 230 feet distant northeasterly,

measured at right angles, from station "L" 102+70 of a baseline for the reconstruction of said Route Connection 570, Northwest Arterial Connection, S.H. 54-5; thence S86° 54' 28" E, through said land conveyed to the People of the State of New York, a distance of 484.09 feet to the most westerly corner of the limits of the Crucible landfill; running thence along the boundary of said proposed Landfill permit limits, the Following six (6) courses and distances:

1) N36° 53' 21" E, a distance of 625.00 feet to an angle point;
2) N62° 25' 42" E, a distance of 150.00 feet to an angle point;
3) S80° 14' 38" E, a distance of 560.00 feet to an angle point;
4) S39° 25' 12" E, a distance of 506.36 feet to an angle point;
5) S41° 29' 23" W, a distance of 1000.00 feet to an angle point;
6) N47° 12' 08" W, a distance of 980.00 feet to the point of beginning, containing 22.380 acres,

All bearings referred to True north at the 76° 35' meridian of West Longitude.

434.066
9/12/84
R.J.C.

cjk/wp

DESCRIPTION OF HAZARDOUS WASTES AND NON-HAZARDOUS WASTES LANDFILLED BY CRUCIBLE MATERIALS CORPORATION, SPECIALTY METALS DIVISION AT THE ONONDAGA LAKE WASTEBEDS, GEDDES, NEW YORK BEGINNING IN 1973

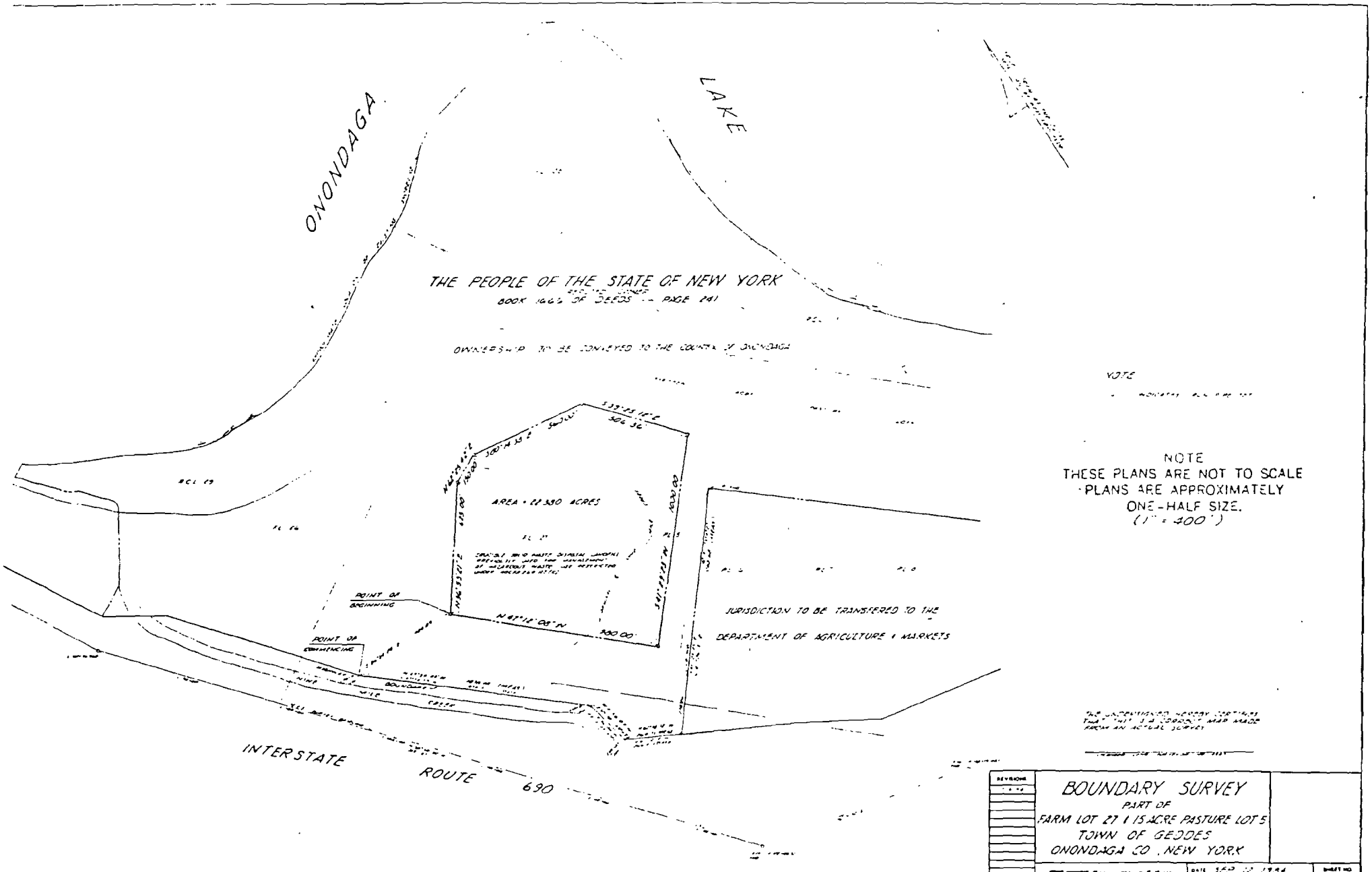
Crucible has utilized the Onondaga Lake Wastebed landfill site continuously since 1973. The site was owned by the State of New York from 1953 to 1984 and conveyed to the County of Onondaga in 1984.

The following wastes have been deposited at the landfill since 1973.

WASTE DESCRIPTION	APPROXIMATE ANNUAL QUANTITY ($YD.^3$)	PERCENTAGE OF TOTAL
Slag	6290	43.4
Construction and Refractory Debris, Sorbents, Misc.	4104	28.3
Broiler House Ashes	1437	9.9
Coolant Swarves	1375	9.5
Mill Scale	1121	7.7
WWTP Sludge	165	1.2
Totals	14,492	100.0

Prior to 1978, approximately 7-½% to 8-½% of the total solid wastes deposited were classified as hazardous under the Resource Conservation Recovery Act regulations. Wastes containing hazardous substances (chromium) that were landfilled by Crucible include: 1. waste caustic solids, 2. acid pickling sludges, and 3. electric arc furnace and argon-oxygen decarburization dusts. Since 1978, the waste caustic solids were shipped to an approved hazardous waste facility. Starting in early 1981, the waste acid sludges were treated at the wastewater treatment plant. The last day that air pollution dusts were transported to the landfill was March 3, 1982.

/jmp/wp



NOTE

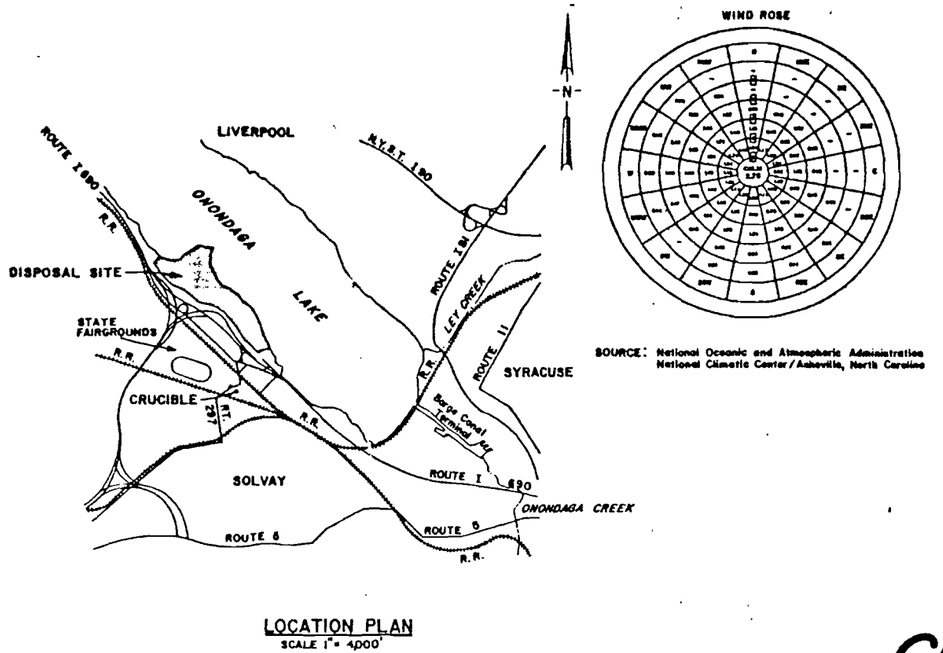
THESE PLANS ARE NOT TO SCALE
PLANS ARE APPROXIMATELY
ONE-HALF SIZE.
(1" = 400')

BOUNDARY SURVEY

PART OF
FARM LOT 27 | 15 ACRE PASTURE LOT 5
TOWN OF GEDDES
ONONDAGA CO., NEW YORK

APPENDIX A

Drawings



LOCATION PLAN
SCALE 1" = 4,000'

SOURCE: National Oceanic and Atmospheric Administration
National Climatic Center / Asheville, North Carolina

DRAWINGS TO ACCOMPANY CLOSURE PLAN
FOR

A SOLID WASTE MANAGEMENT FACILITY

CRUCIBLE SPECIALTY METALS DIVISION
A DIVISION OF
CRUCIBLE MATERIAL CORPORATION
GEDDES, NEW YORK

SHEET NO. 1 TITLE SHEET
SHEET NO. 2 EXISTING SITE PLAN
SHEET NO. 3 FINAL GRADING PLAN
SHEET NO. 4 CLOSURE SEQUENCING PLAN
SHEET NO. 5 SITE CROSS SECTIONS
SHEET NO. 6 SITE CROSS SECTIONS
SHEET NO. 7 SITE CROSS SECTIONS
SHEET NO. 8 CAP CONSTRUCTION DETAILS
SHEET NO. 9 MEMBRANE INSTALLATION PLAN
SHEET NO. 10 MEMBRANE INSTALLATION DETAILS
SHEET NO. 11 DRAINAGE COLLECTION PLAN

OCTOBER, 1985

DRAFT

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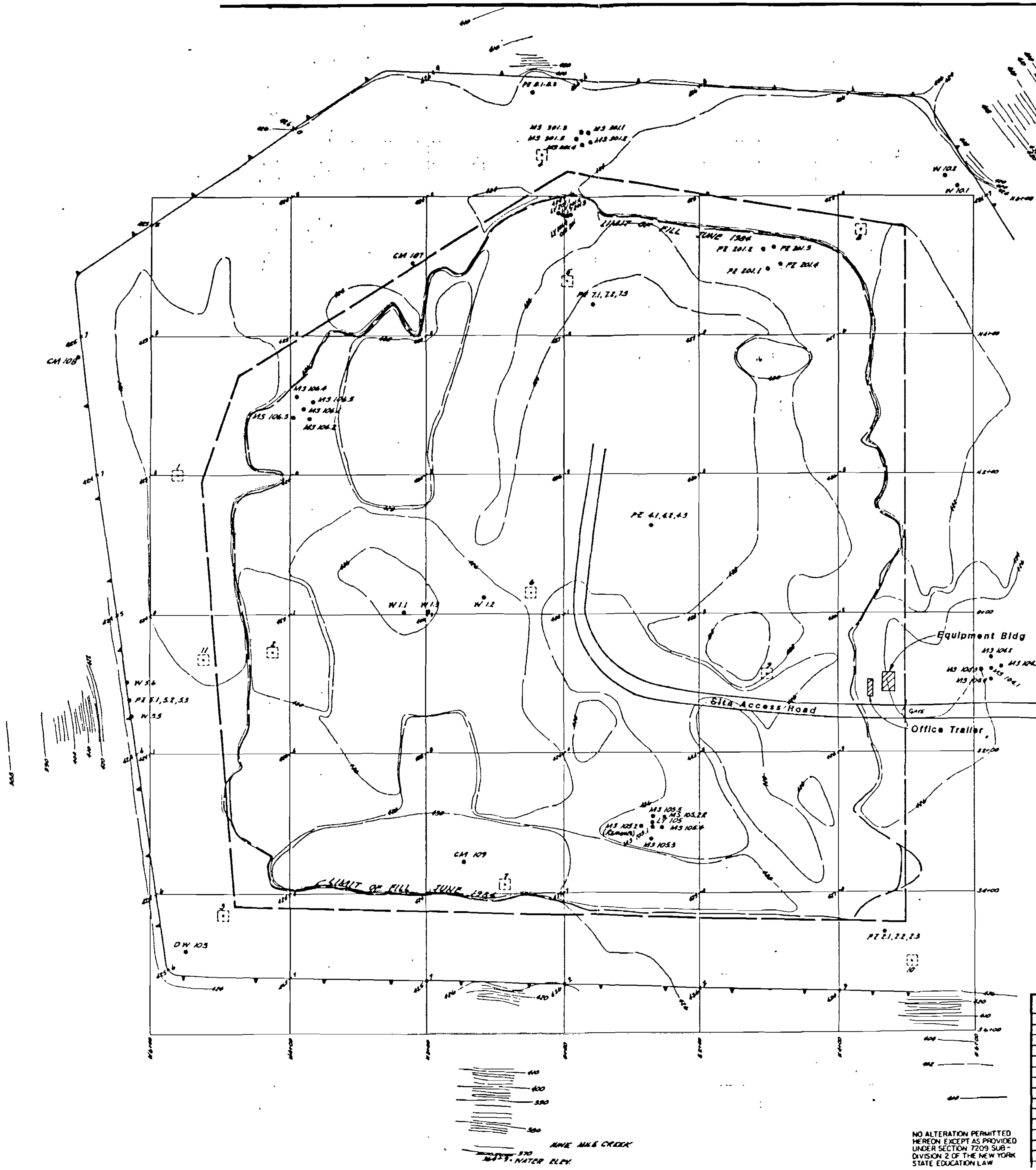
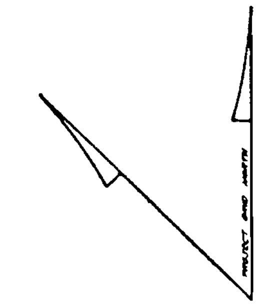
Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

Frank J. Spina N.Y.S.R.E. Lic No. 37109

SHEET NO. 1





LEGEND

427+6	ACTUAL GROUND ELEVATION
430	EXISTING CONTOUR LINE
MS 106.4	GROUNDWATER MONITORING WELL
	TOP OF SOLVAY PROCESS WASTE DIKE
	EXISTING SETTLEMENT PLATE
	PERMIT LIMIT

NOTES

ALL ELEVATIONS REFERRED TO U.S.G.S. DATUM.
CONTOUR INTERVAL IS 2'.

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CONTRACT DOCUMENTS

0 100 200 300 FEET

R. W. KLIPPEL, P.E.
D. J. EVERETT, M.J. DROLO
R. J. GEARY, P.E.

NO ALTERATION PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUB-DIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

REVISIONS
REVISED 10/85

CRUCIBLE INC., SPECIALTY METALS DIVISION
GEDDES, NEW YORK

LANDFILL CLOSURE

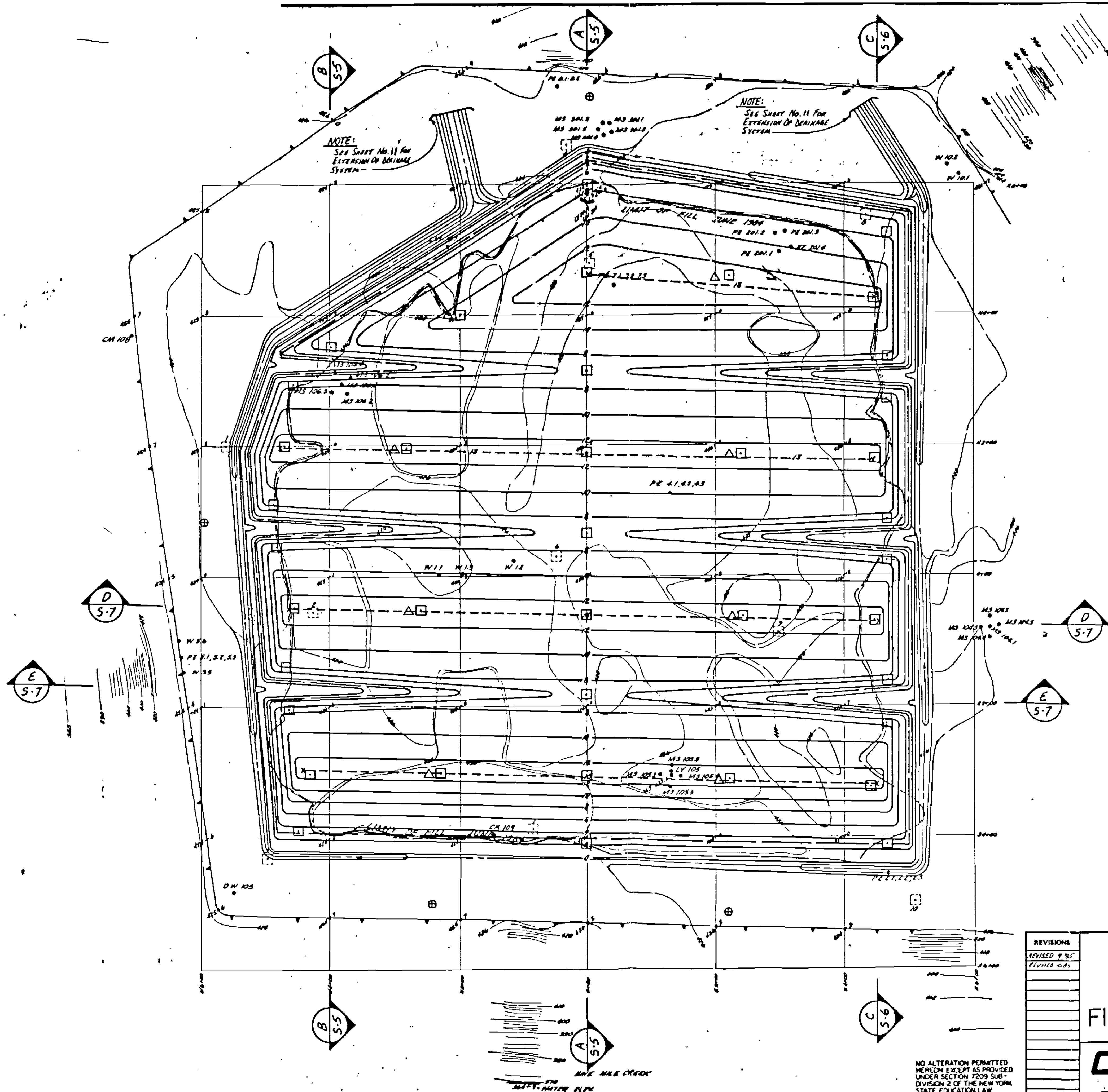
EXISTING SITE PLAN

University Of The State Of New York — Licensed Professional Engineer — No. 37199

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

DATE: JULY 27, 1984
SCALE: AS SHOWN
FILE NO. 434 062

SHEET NO. 2



LEGEND

- ACTUAL GROUND ELEVATION
- CONTOUR LINE
- DEPTH OF FILL
- GROUNDWATER MONITORING WELL
- TOP OF SOLVAY PROCESS WASTE DIKE
- EXISTING SETTLEMENT PLATE
- PROPOSED SETTLEMENT PLATE
- HORIZONTAL GRID POINT
- INCLINOMETER
- VANE SHEAR BORING

NOTES:

1. LANDFILL CONTOURS REFER TO DEPTH OF FILL + COVER DUE TO DIFFERENTIAL SETTLEMENT OF SOLVAY PROCESS WASTE.
2. EMBANKMENT SLOPES NOT TO EXCEED 1 (VERT.) ON 4 (HORIZ.).
3. MAXIMUM FILL HEIGHT INCLUDING FINAL COVER NOT TO EXCEED 13 FEET.

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0 100 200 300 FEET

REVISIONS
REVISED 9.85
REVISED 10.85

CRUCIBLE INC., SPECIALTY METALS DIVISION
GEDDES, NEW YORK

LANDFILL CLOSURE

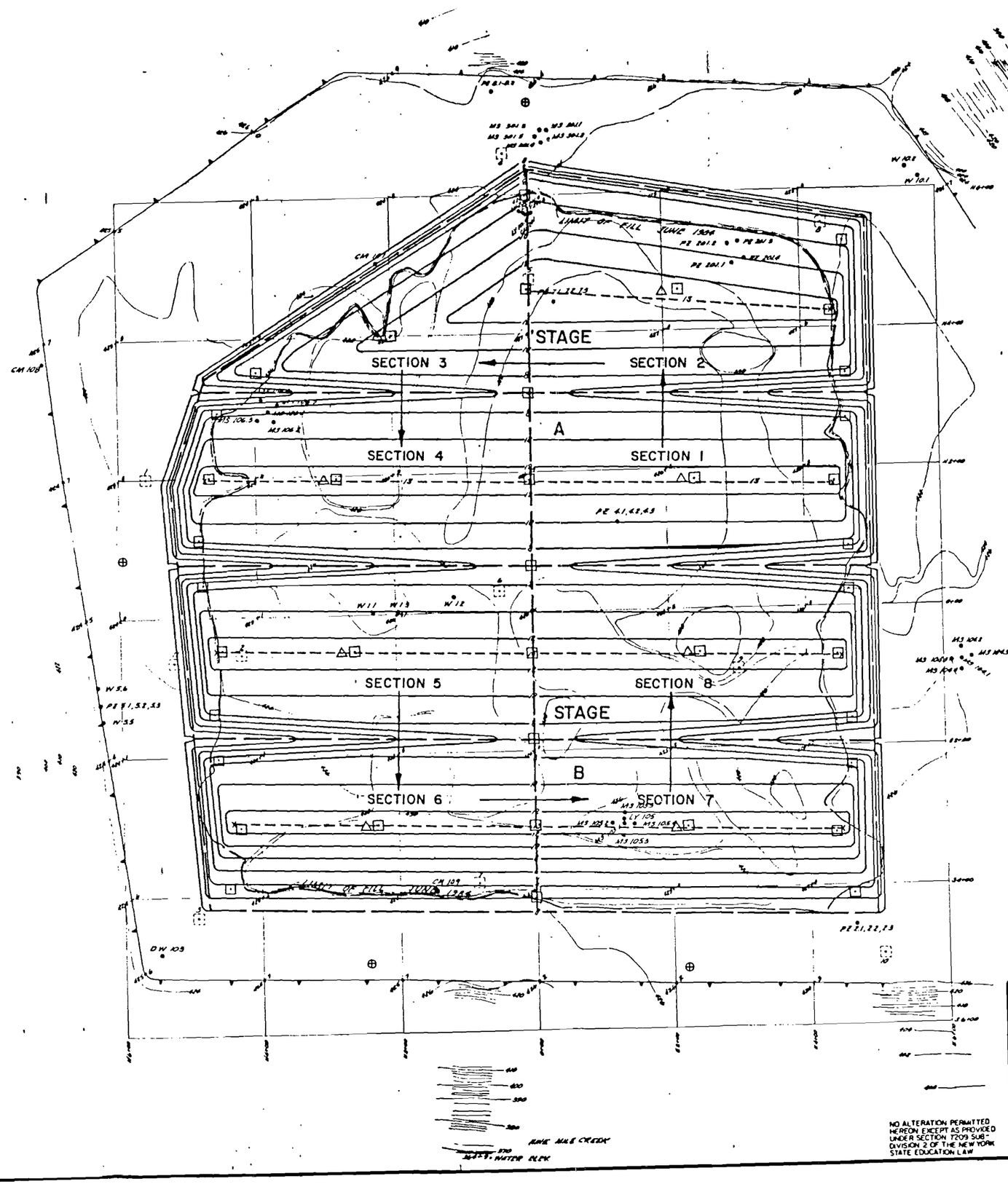
FINAL GRADING PLAN

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

DATE: SEPTEMBER 1985
SCALE: AS SHOWN
FILE NO. 434 062
SHEET NO. 3

NO ALTERATION PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUB-DIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

DESIGNED BY: R.W. KLIPPEL, P.E.
DRAWN BY: R.E. EVERETT, N.J. CAROLO
CHECKED BY: R.J. GEARY, P.E.



LEGEND

- ACTUAL GROUND ELEVATION
- CONTOUR LINE
- DEPTH OF FILL
- GROUNDWATER MONITORING WELL
- TOP OF SOLVAY PROCESS WASTE DIKE
- EXISTING SETTLEMENT PLATE
- PROPOSED SETTLEMENT PLATE
- HORIZONTAL GRID POINT
- INCLINOMETER
- VANE SHEAR BORING

CONSTRUCTION SEQUENCE

1. ROUGH GRADE STAGE A (SECTION 1 - 4).
2. INSTALL ENTIRE LOWER LEVEL RUN-OFF COLLECTION SYSTEM; CHANNELS, DIKE WALL CONSTRUCTION, ENERGY DISIPATERS AND EROSION CONTROLS.
3. INSTALL PERIMETER DRAINAGE SWALES AND EROSION CONTROLS FOR SECTIONS 1 - 4.
4. CAP STAGE B; BUFFER, MEMBRANE AND VEGETATIVE SUPPORT LAYER.
5. ROUGH GRADE STAGE B.
6. SEED STAGE A.
7. INSTALL PERIMETER DRAINAGE SWALES AND EROSION CONTROLS FOR SECTION 5 - 8.
8. CAP AND SEED STAGE B.
9. INITIATE MAINTENANCE INSPECTIONS.

DRAFT

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0 100 200 300 FEET

REVISIONS
REVISED 10/85

CRUCIBLE INC., SPECIALTY METALS DIVISION
GEDDES, NEW YORK

LANDFILL CLOSURE

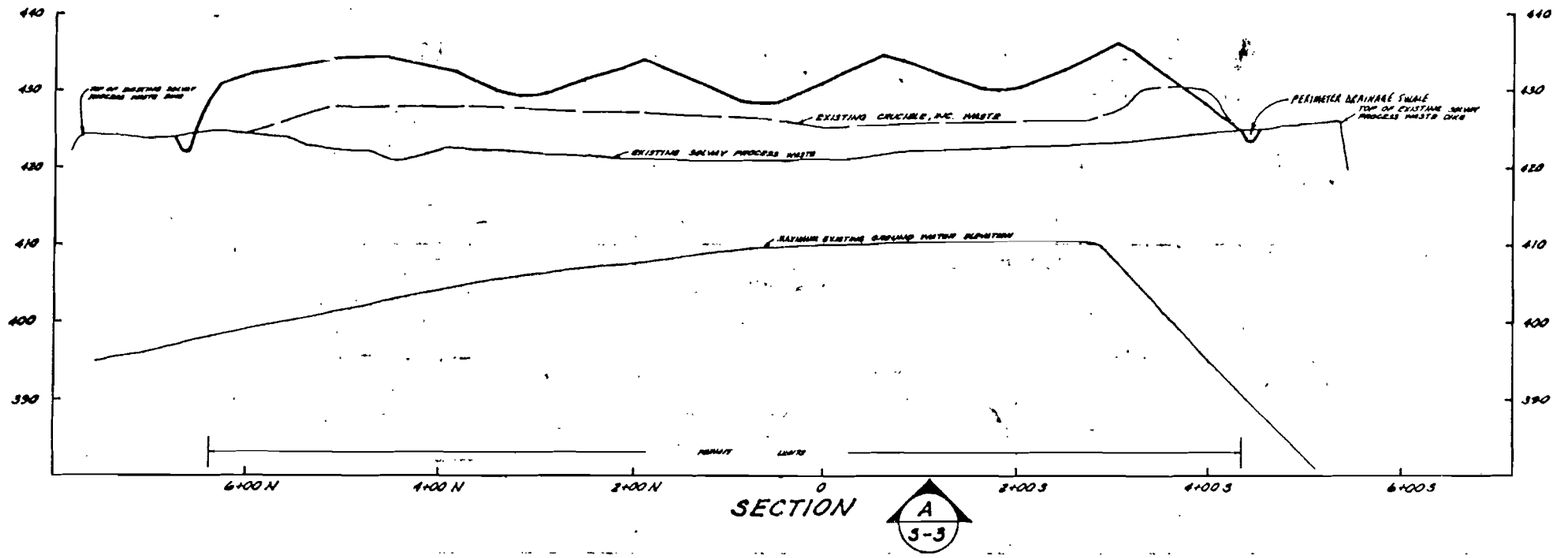
CLOSURE SEQUENCING

Cosecrines & Spine
CONSULTING ENGINEERS
Liverpool, New York 13088

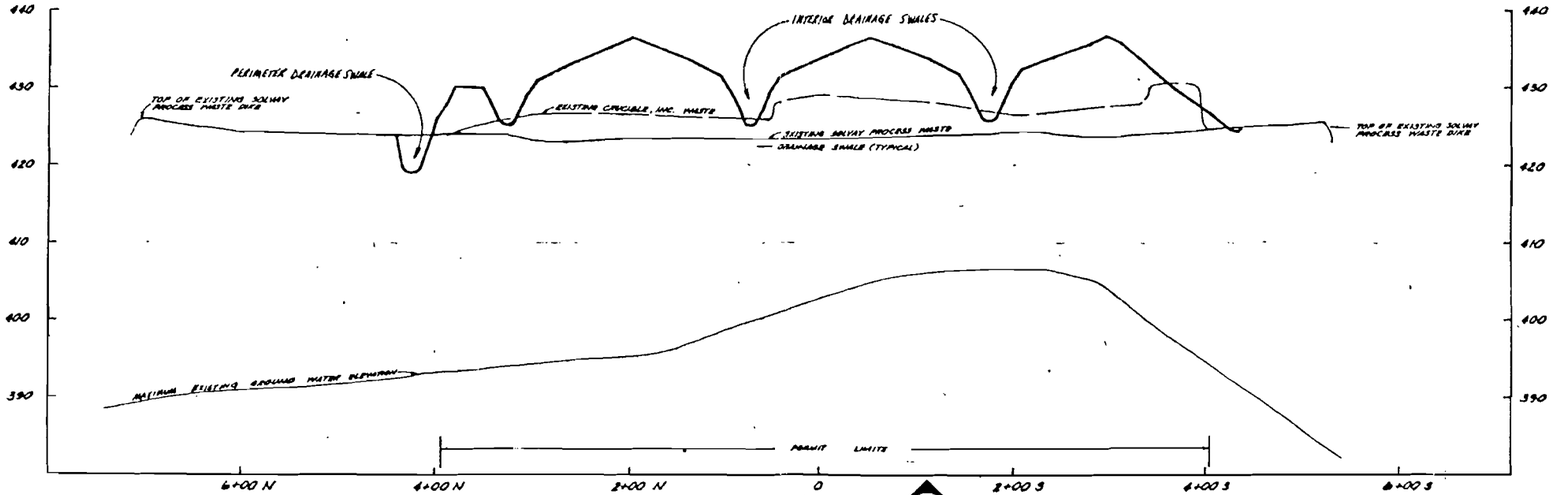
DATE: SEPTEMBER 1985
SCALE: AS SHOWN
FILE NO. 434.062

SHEET NO. 4

DRAWN BY: P.W. KUPPEL, P.E.
NAME BY: D.J. EVERETT, N.S. DAVID
CHECKED BY: R.J. GEARY, P.E.



SECTION A 3-3



SECTION B 3-3

DRAFT

NOT PART OF CONTRACT DOCUMENTS

HORZ. 0 100 200 300 FEET

VERT. 0 10 20 30 FEET

REVISIONS
REVISED 9/13

CRUCIBLE INC., SPECIALTY METALS DIVISION
GEDDES, NEW YORK

LANDFILL CLOSURE

SITE CROSS SECTIONS

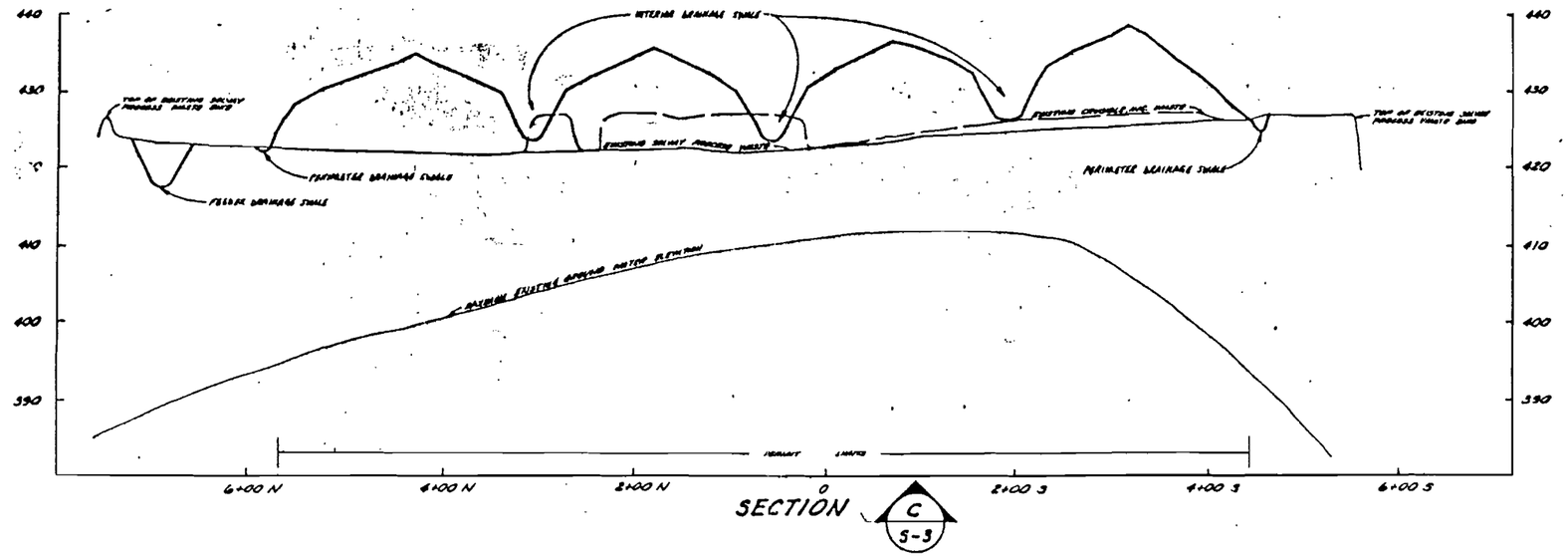
University Of The State Of New York — Joseph Ehrs — No. 37197 — Licensed Professional Engineer

Calocerinos & Spina — CONSULTING ENGINEERS — Liverpool, New York 13088

DATE: JULY 27, 1984
SCALE: AS SHOWN
FILE NO. 434.062

SHEET NO. 5

DESIGNED BY R.W. KLUPPEL, P.E.
DRAWN BY D.J. EVERETT
CHECKED BY R.J. SCARY, P.E.



DRAFT

NOT PART OF CONTRACT DOCUMENTS

0 100 200 300 FEET
HORZ.

0 10 20 30 FEET
VERT.

REVISIONS
DATES

CRUCIBLE INC., SPECIALTY METALS DIVISION
GEDDES, NEW YORK

LANDFILL CLOSURE

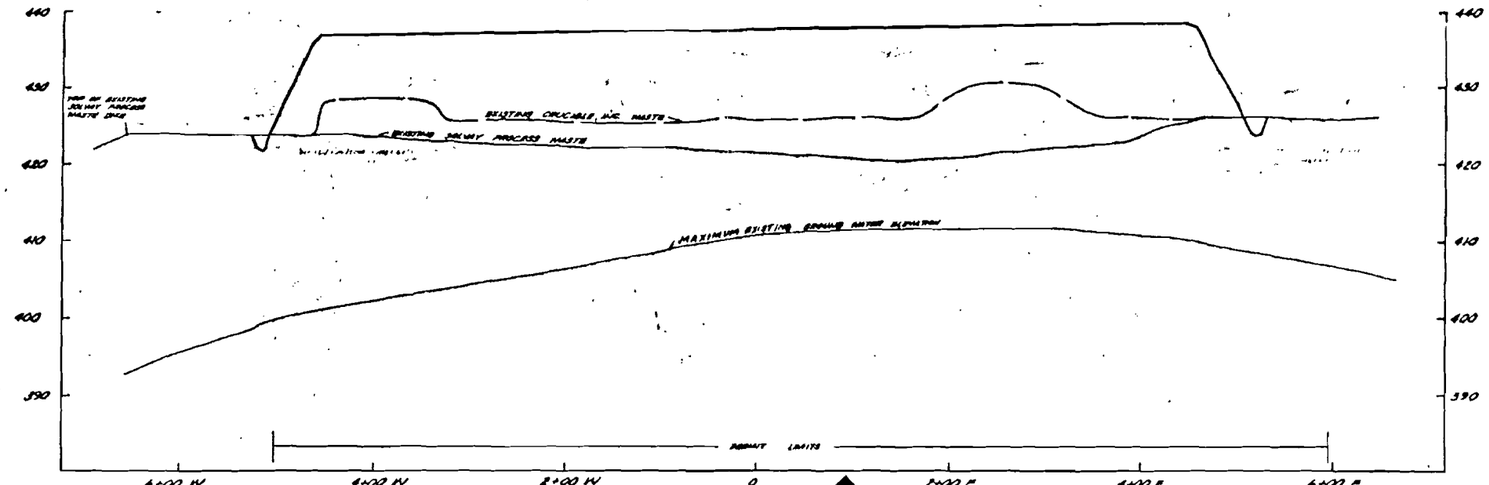
SITE CROSS SECTIONS

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

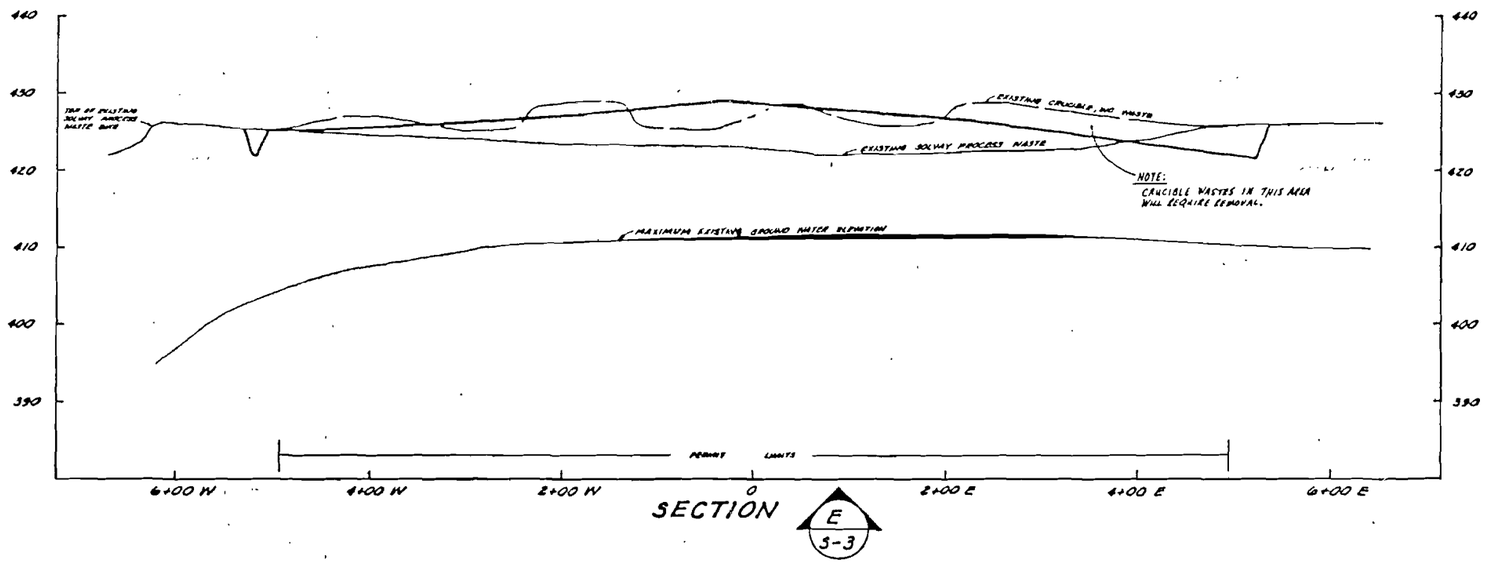
DATE: JULY 27, 1984
SCALE: AS SHOWN
FILE NO. 434 062

SHEET NO. 6

IN CHARGE OF R. W. KLIPPEL, P.E.
DRAWN BY D. J. EVERETT
CHECKED BY R. J. GRABY, P.E.



SECTION D 5-3



SECTION E 5-3

DRAFT

NOT PART OF CONTRACT DOCUMENTS

HORZ. 0 100 200 300 FEET

VERT. 0 10 20 30 FEET

REVISIONS
REVISED NOTES

CRUCIBLE INC., SPECIALTY METALS DIVISION
GEDDES, NEW YORK

LANDFILL CLOSURE

SITE CROSS SECTIONS

University of the State of New York — Registered Professional Engineer — No. 31139

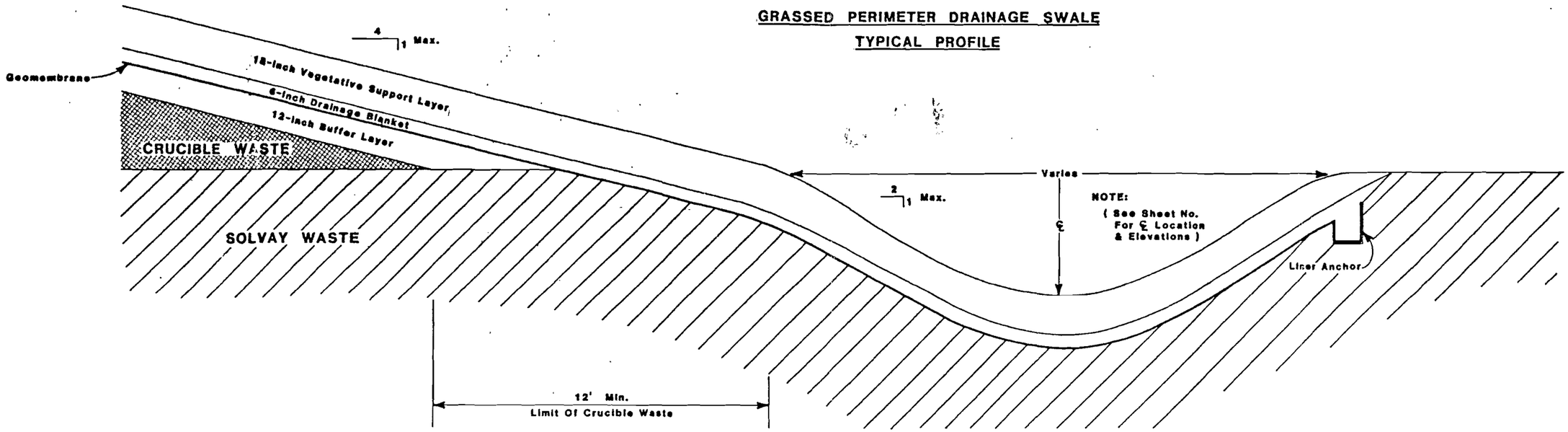
Ciaccarino & Spina Consulting Engineers, Liverpool, New York 13088

DATE: JULY 27, 1984
SCALE: AS SHOWN

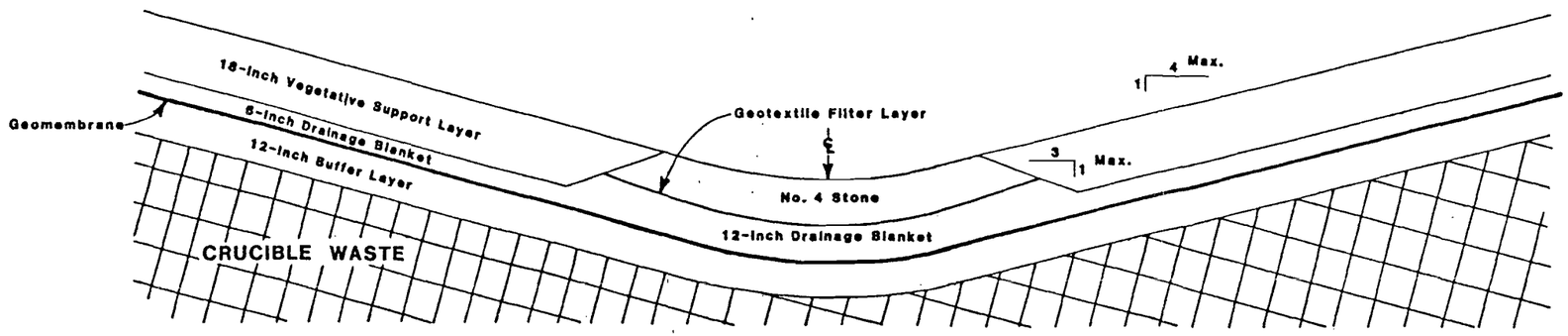
SHEET NO. 7

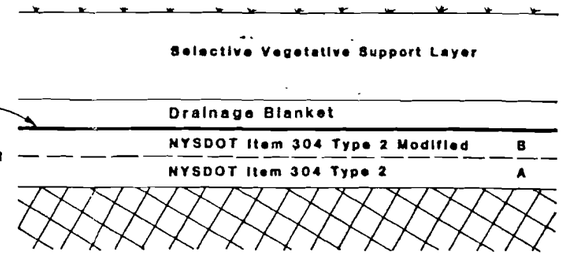
Designed on R. W. KLIPPEL, P.E.
Drawn on D. J. EVERETT
Checked on R. J. GEARY, P.E.

GRASSED PERIMETER DRAINAGE SWALE
TYPICAL PROFILE



INTERIOR DRAINAGE SWALE
TYPICAL PROFILE





TYPICAL CAP DETAIL

NOT PART OF
CONTRACT DOCUMENTS

REVISIONS	CRUCIBLE INC., SPECIALTY METALS DIVISION GEDDES, NEW YORK	DRAFT
REVISED NOTES	CAP CONSTRUCTION DETAILS	
	Calocerinos & Spina CONSULTING ENGINEERS SYRACUSE • ATLANTA • BUFFALO • PITTSBURGH	DATE: OCTOBER, 1985 SCALE: NONE FILE NO. 434.062
		SHEET NO. 8

IN CHARGE OF:
MADE BY:
CHECKED BY:

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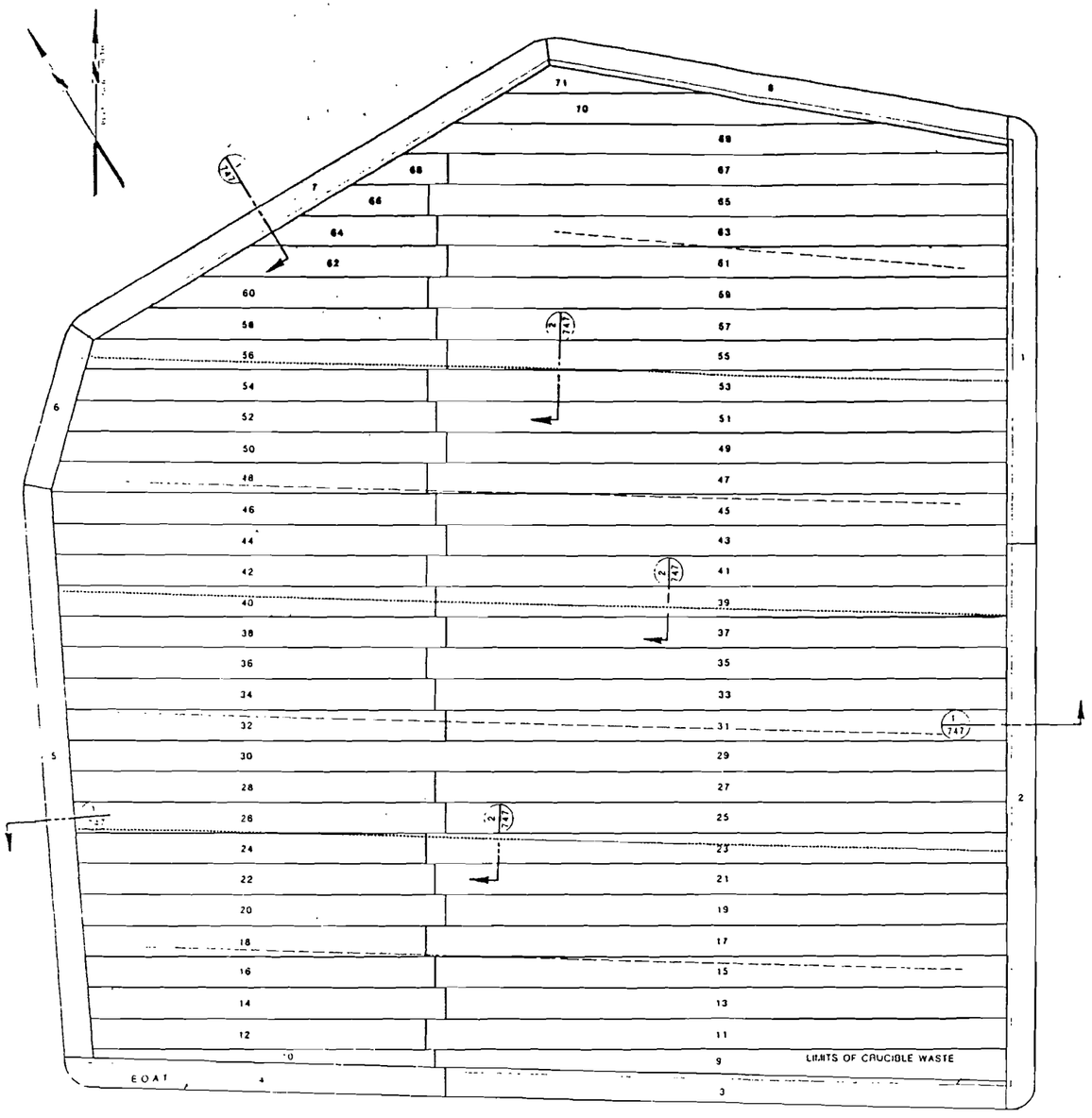

PLAN VIEW

NOTE THIS PLAN IS SCALED FROM CLIENT DRAWING

NOTES:

1- ALL EARTHWORK BY OTHERS.
2- ALL PIPEWORK BY OTHERS.
3- ALL CONCRETE WORK BY OTHERS. ALL CONCRETE CORNERS SHALL BE RADIUSED A MINIMUM OF 1" TYPICAL FOR ALL CORNERS IN CONTACT WITH LINER SURFACES. ALL CONCRETE SHALL HAVE STEEL TROWEL SMOOTHED FINISH.
4- EXCAVATION AND BACKFILL OF ANCHOR TRENCH BY OTHERS
5- ALL LINER FIELD SEAMS TO BE LOCATED AT THE DISCRETION OF SLT SITE MANAGER.
6- LINER EXPANSION/CONTRACTION COMPENSATION SHALL BE INSTALLED PER FIELD REQUIREMENTS.
7- GAS VENTING BY SLT, IF REQUIRED.
8- AREA TO BE LINED: APPROX. 25.3 ACRES 60 MIL
FINAL AREA TO BE DETERMINED PER FIELD MEASUREMENTS.

LEGEND

- WELDED SEAMS
- SCHLEGEL® SHEET
42 - PANEL NO. (TYP.)
T.O.B. - TOP OF BERM
T.O.S. - TOE OF SLOPE
E.O.A.T. - EDGE OF ANCHOR TRENCH
- DETAIL OR SECTION NO. DRAWING NO.
- ℄ OF INTERIOR DRAINAGE SWALE
- HIGH EL. POINT

SCHLEGEL LINING TECHNOLOGY, INC.

CRUCIBLE INC.
SPECIALTY METALS DIVISION
LANDFILL CLOSURE
GEDDES NEW YORK
LINER LAYOUT

DRAWN	CHKD	APPD	US/1486
JAN	NAN	JBA	
NOTED 10-10-85		1746	0.0

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REVISIONS

CRUCIBLE INC., SPECIALTY METALS DIVISION
GEDDES, NEW YORK

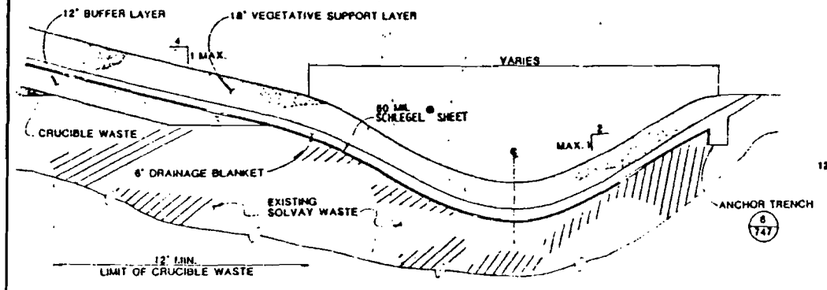
MEMBRANE INSTALLATION

PLAN

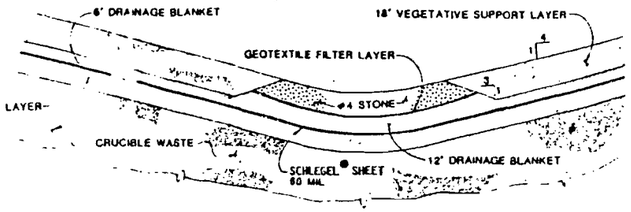
DRAFT

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

DATE: October 1985	SHEET NO. 9
SCALE:	
FILE NO. 434.062	



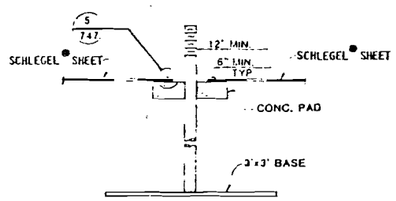
SECTION 1
TYPICAL GRASSED PERIMETER DRAINAGE SWALE
N.T.S.



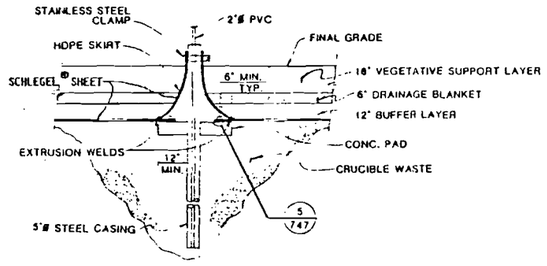
SECTION 2
TYPICAL INTERIOR DRAINAGE SWALE
N.T.S.

LAP WELD SHEET JOINT (TYP.)
N.T.S.

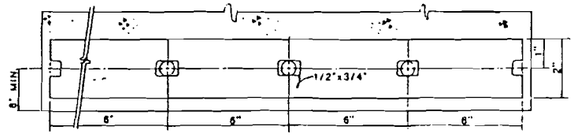
FILLET WELD SHEET JOINT (TYP.)
N.T.S.

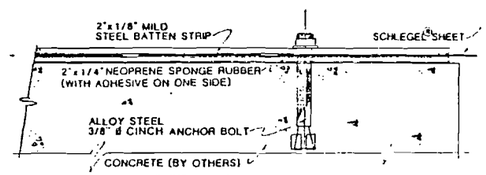


DETAIL 3
SETTLEMENT PLATE DETAIL
N.T.S.

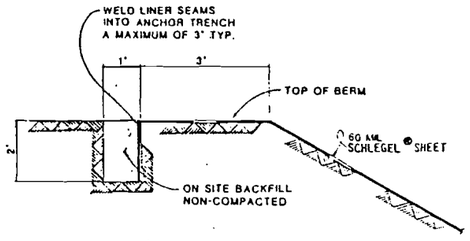


DETAIL 4
MONITORING WELL DETAIL
N.T.S.





DETAIL 5
BATTEN STRIP AND ANCHOR BOLT DETAIL
N.T.S.



DETAIL 6
ANCHOR TRENCH
TYPICAL DETAIL
N.T.S.

LEGEND

- WELDED SEAMS
- SCHLEGEL® SHEET
- 42 - SHEET NO. (TYP.)
- T.O.B. - TOP OF BERM
- T.O.S. - TOE OF SLOPE
- E.O.A.T. - EDGE OF ANCHOR TRENCH
- DETAIL OR SECTION NO. DRAWING NO.

SCHLEGEL LINING TECHNOLOGY INC.

CRUCIBLE INC
SPECIALTY METALS DIVISION
LANDFILL CLOSURE
GEDDES NEW YORK
SECTIONS AND DETAILS
DRAWN NOTED 10-10-85 1747 0.0

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REVISIONS

CRUCIBLE INC., SPECIALTY METALS DIVISION
GEDDES, NEW YORK

MEMBRANE INSTALLATION DETAILS

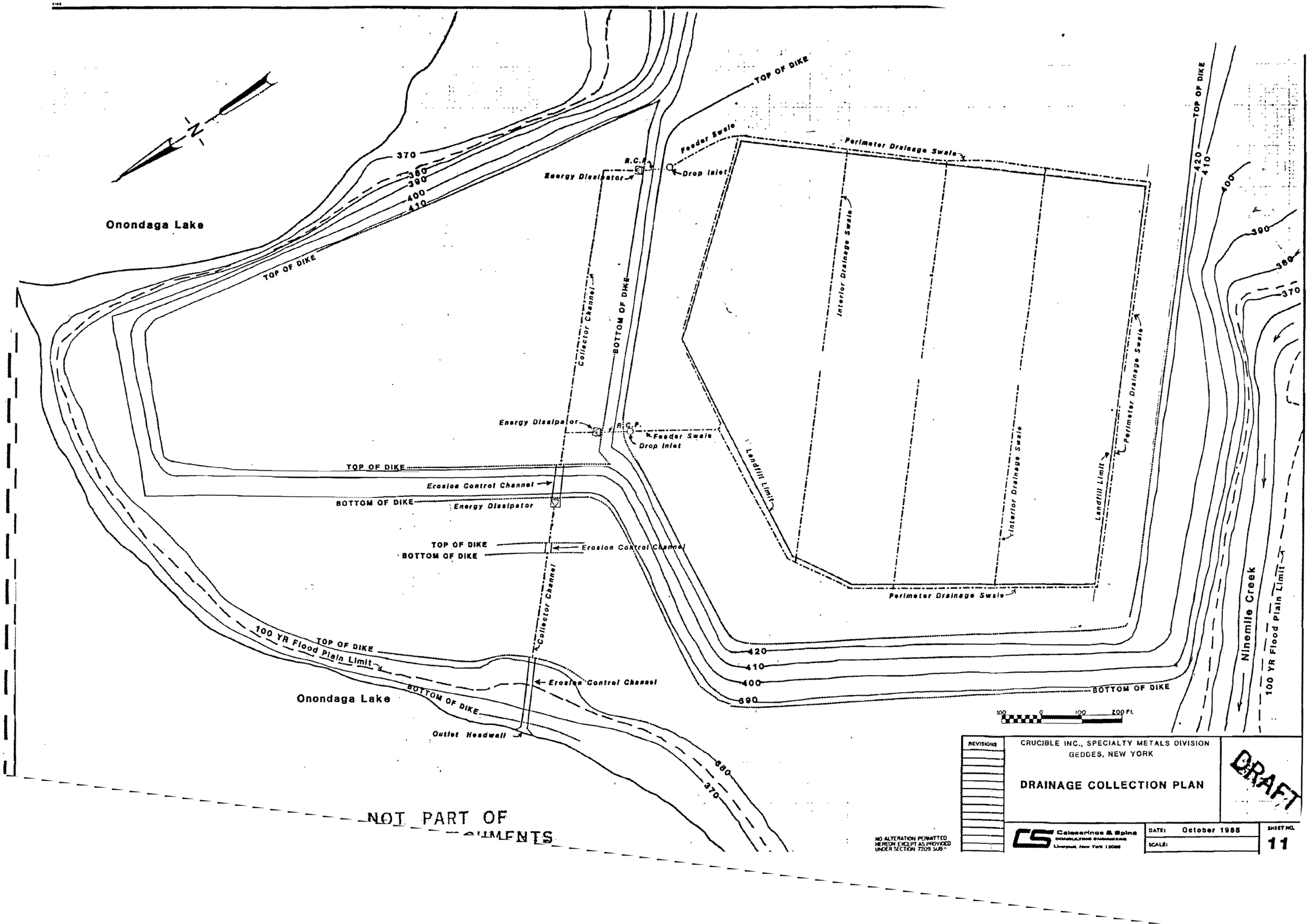
DRAFT

Calocerinos & Spina CONSULTING ENGINEERS
SYRACUSE • ATLANTA • BUFFALO • RUTHERFORD

DATE: October 1985
SCALE:
FILE NO. 434.062

SHEET NO. 10

IN CHARGE OF:
MADE BY:



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REVISIONS

CRUCIBLE INC., SPECIALTY METALS DIVISION
GEDDES, NEW YORK

DRAINAGE COLLECTION PLAN

DRAFT

Calocerinos & Spina
CONSULTING ENGINEERS
Liverpool, New York 13088

DATE: October 1988

SCALE:

SHEET NO. 11