MODULE C3

FORM EQP 5111 MODULE C3
USE AND MANAGEMENT OF LANDFILL

This section provides information regarding use and management of the Landfill at the Dow Silicones Corporation (Dow Silicones) Midland Site as required by Part 111, Hazardous Waste Management, of Michigan's Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (Act 451); under Rules R299.9504, R299.9505, R299.9519, R299.9522 which incorporates 40 CFR 270.21 by reference. This description provides information on the landfill located at the Dow Silicones Facility.

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C3.A LANDFILL INFORMATION [MAC R 299.9504(8), 299.9505, 299.9619 – 299.9622; 40 CFR 270.21; Part 264, Subpart N]

The landfill is located in the 800 and 1000 Blocks of the facility (see facility layout map in Appendix A1-1 and Module A1, General Description). The landfill was constructed in the late 1940's to early 1950's and is therefore not subject to the requirements of 40 CFR 264.301(c) regarding design criteria for new landfills.

C3.A.1 List of Wastes [40 CFR 270.21(a)]

This landfill has been permitted for disposal of wastes exhibiting the characteristic of toxicity for lead (D008). Renewal of authorization to receive characteristic D008 wastes is not requested since Dow Silicones currently has no plans to dispose of any hazardous wastes in the landfill. If such disposal were to be resumed, the facility would first obtain approval from the Michigan Department of Environment, Great Lakes and Energy (EGLE). No wastes containing free liquids are disposed in the landfill and no lead contaminated (D008) hazardous wastes have been placed in the landfill since 1985.

Non-hazardous solid wastes not regulated as hazardous wastes under RCRA may be disposed in the landfill. Examples include: RCRA-empty containers; containers of non regulated gloves, rags, pieces of metal and glass and other debris; column packing; cleaned process equipment; asbestos; construction debris; solidified silicone sealants, rubber and gums; solidified polysiloxane gels; nonhazardous contaminated dirt; nonhazardous sandblast media and used office furniture.

C3.B Liner System Exemption Requests

C3.B.1 Exemption Based on Existing Portion [40 CFR 270.21(b)(1), 264.301(a)]

This landfill was constructed prior to January 29, 1992 and has had no horizontal expansions since that date. The landfill is therefore exempt from the requirements of 40 CFR 264.301(c) for use of a double synthetic liner and leak detection system.

C3.B.2 Exemption Based on Alternative Design [40 CFR 270.21(b), 264.301(d)]

Appendix C3-1, "Landfill Equivalency Program, provides an "Equivalency Program" developed in cooperation with the State of Michigan in 1982 to establish the safety and efficacy of the liner system in the existing landfill and its functional equivalency to liners meeting the requirements then in effect under the former Act 64, Rule 419(4) and 419(f).

C3.C Liner System [40 CFR 270.21(b)(1), 264.301(a) and (c), MAC R 299.9620]

The landfill has a liner that was designed, constructed, and installed to prevent any migration of hazardous wastes or hazardous waste constituents to surrounding soil, groundwater, or surface waters during the active life and closure period of the landfill. This section describes how the liner is constructed to achieve this.

C3.C.1 Liner System Description [40 CFR 270.21(b)(1), 264.301(a) & (b)]

Underlying the landfill is a natural clay strata with a minimum thickness of 25 feet. See Module B3, Hydrogeologic Report, and Appendix C3-1, “Landfill Equivalency Program”, for detailed information on the location, thickness, and permeability of this natural clay layer.

A “ground truth” boring sample (Sample C-6, see Module B3, Hydrogeologic Report), taken through 25 feet of depth at the approximate center of the landfill, showed the following profile of the landfill floor:

Thickness of Unit (ft.)	Type of Soil	Permeability (cm/sec)
15	Clay (CL)	3×10^{-8}
1	Sandy clay (SM)	4.1×10^{-5}
4	Clayey-silt (ML)	1.5×10^{-7}
5	Clay-silt (CL)	1.2×10^{-6}

Resistivity studies showed that the clay base is uniform, continuous, and homogeneous. The conclusion of the equivalency report was that the existing clay base provides protection to human health and the environment equivalent to the requirements in effect at the time under the former Act 64, Rule 419(4) and 419(f).

A clay curtain wall surrounding the landfill was constructed in 1980 according to Act 64 standards to prevent horizontal migration of hazardous wastes, hazardous constituents, and landfill leachate. The construction of the curtain wall is shown on the drawing (Y1-31900) included in Appendix C3-4. The clay used for the curtain wall had an average permeability of 1.6×10^{-8} cm/sec. and was compacted to an average of 94% of its maximum density, based on the modified Proctor test. The walls were installed in one-foot lifts with a minimum lateral thickness of six feet,and were keyed into the natural clay base to prevent contaminant migration through the joints. The construction quality assurance report and field test results are provided in Appendix C3-2.

At final closure of the landfill, a cover of natural clay will be installed and keyed to the curtain wall to complete the encapsulation of the landfill contents. See Module A11, Closure and Postclosure Plans, for details of cover construction and installation.

C3.C(2) Resistance of Liner System to Loads and Wastes [40 CFR 270.21(b)(1), 264.301(a)(1)(i)]

In 1982, as part of the Landfill Equivalency Program, soil boring analysis was performed to determine the extent of contaminant migration through the landfill base after 30 years of unregulated operation. At that time, contamination was found to have penetrated only six inches into the underlying clay liner, indicating excellent resistance by the clay to chemical attack and permeation.

Resistance to hydraulic pressures from groundwater and runoff is provided by the leachate collection system within the landfill and the interceptor sewer on the outside of the curtain wall. Both systems serve to remove water which could otherwise exert pressures on the landfill base and curtain wall and are constructed of materials capable of withstanding the pressures and chemicals encountered in this application (see information in Appendix C3-3).

The collected liquids are drained to the wastewater sewer for treatment at Dow Chemical. Drawings of the landfill leachate collection system, the interceptor sewer system, and the connections to the wastewater sewer system are provided in Appendices C3-5 through C3-8.

C3.C(3) Liner System Coverage [40 CFR 270.21(b)(1), 264.301(a)(1)(iii)]

The natural clay base underlies the entire landfill area, which is also surrounded entirely by the clay curtain wall. No surrounding earth is likely to be in contact with waste or leachate.

C3.D Leachate Collection and Removal System [40 CFR 264.301(a)(2), MAC R 299.9619(4)]

See Appendix C3-4 (Drawing Y1-23606), for information on the design and construction of the leachate collection system. The leachate collection system is inspected weekly and after every major storm to ensure leachate flow is unobstructed, and maintenance is performed as necessary to remove obstructions.

C3.E Control of Run-on and Runoff

Systems for control of run-on and runoff are discussed in Appendix C3-5, “Run-on and Runoff Capture Systems, Capacity Evaluation”.

C3.F Landfill Operations

Construction of Lifts

The landfill is currently permitted for a total disposal volume of 453 acre-feet of wastes. The active cells are located in the 1000 Block portion of the facility; see Appendix C3-4 (Drawing Y1-116550). The landfill was developed in phases, with placement of wastes taking place only to the active cells to reduce exposure of wastes, erosion, and accumulation of precipitation. Wastes are added to the active cell in 10-foot deep lifts over a 6-inch layer of sand to provide drainage for leachate. Once a lift is completed, if it will be exposed for longer than three months before construction of the next lift, it is covered with a one foot layer of compacted earth.

Placement of Wastes

Materials to be placed in the landfill are transported to the landfill by Dow Silicones employees or by contractors under the direction of Dow Silicones employees. All materials to be placed in the landfill are required to first be approved by designated facility personnel and to have this approval noted on a waste materials approval tag. All materials placed in the landfill are recorded in the landfill log, which is maintained in the waste tracking computer database, and this information is kept as part of the facility operating record.

Laboratory testing is conducted if a material cannot be adequately characterized as to its acceptability for disposal in the landfill based on information provided by the plant department or operations that generated the waste. The laboratory tests may include chemical analysis, Toxicity Characteristic Leachate Procedure (TCLP), the paint filter test for free liquids, or other such testing or analysis as necessary to evaluate acceptability of the waste for land disposal.

Daily Cover

As each lift is filled, soil is mixed with the wastes in order to form a physically stable mixture. If the disposed waste is susceptible to wind dispersal it is covered daily with a minimum of six inches of soil or other approved cover material that is nontoxic, non-putrescible, and provides sufficient stability to prevent blowing of landfilled material. Treated, solidified polysiloxane gels will not be used for daily cover unless approved by the State of Michigan. Containerized wastes and other inert materials placed in the landfill are covered so that no more than 1,000 square feet of top surface remains exposed at any time. Materials used for cover may be soils from on-site construction projects and may consist of topsoil, sand, gravel, or similar porous materials to allow precipitation to permeate to the leachate collection system; clay is not used for daily cover.

Inspection

The facility hazardous waste landfill is inspected daily for the following items:

- Active cells: Minimum of 6 inches daily cover maintained.
- Active cells: Maximum of 1,000 square feet of exposed waste at any time
- Sidewalls: No gaps, no material leaking from cells.

The results of these inspections are recorded on inspection log sheets, examples of which are provided in Module A5 (Inspection Schedules) of this application.

C3.G Surveying and Recordkeeping [40 CFR 264.309]

Dow Silicones maintains a record of wastes placed in the landfill and their location with respect to permanently surveyed benchmarks. An annual survey of the landfill is performed for the purpose of determining the amount of available disposal volume remaining. The results of this survey are submitted to EGLE in a written report.

C3.H Special Requirements for Ignitable or Reactive Wastes [40 CFR 264.312]

Ignitable or reactive wastes are not disposed in the landfill.

C3.I Special Requirements for Incompatible Wastes [40 CFR 624.313]

Incompatible wastes are not disposed in the landfill.

C3.J Special Requirements for Bulk and Containerized Liquids [40 CFR 264.314]

Bulk or containerized wastes containing free liquids are not disposed in the landfill. To determine whether a waste contains free liquids, U.S. EPA Method 9095, the "Paint Filter Test", as described in "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods" (SW-846) is used.

If a waste containing free liquid, other than a lab pack, is to be disposed in the landfill it is first either decanted or otherwise drained of all free-standing liquid, or all free liquid has been absorbed or solidified using a sorbent or solidifying agent which is not biodegradable. These activities are generally carried out by the production building or other Dow Silicones location that generates the waste. Decanting and the addition of adsorbents or solidification agents may also be carried out at the 800 Block facility, at either the 804 Building truck wash slab or in the 809 container storage building. Since only non-RCRA regulated materials are landfilled, the hazards associated with these operations are minimal and will not cause release of hazardous constituents to the environment.

C3.K Special Requirements for Containers [40 CFR 264.315

Except for lab packs and very small containers such as ampoules, containers to be placed in the landfill are either crushed, shredded, or similarly reduced in volume to the maximum practical extent, or they must be at least 90% full.

C3.L Special Requirements for Lab Packs [40 CFR 264.316]

Small containers with free liquids may be placed in the landfill if they meet all of the following conditions:

1. They do not contain hazardous wastes.
2. They are overpacked within a metal open-head container not larger than 100 gallon capacity and meeting all applicable requirements of U.S. DOT packaging specifications.
3. The inner containers are tightly closed and also meet U.S. DOT requirements for inner packagings for the type of material contained.
4. The inner containers are packed in absorbent material which is not biodegradable, which is of sufficient quantity to absorb all free liquids in all the inner containers, and which will not react with the wastes.
5. All the wastes in all the inner containers in one overpack are chemically compatible with each other.

Dow Corning Corporation
Midland Plant Landfill
Equivalency Program

GENERAL DESCRIPTION

Midland, Michigan

February 1982

Dow Corning Corporation
Midland Plant Landfill
Equivalency Program

An Equivalency Program for the Midland Plant Landfill facility has been jointly developed by Dow Corning and the DNR, Resource Recovery Division, Geology Section. The purpose of this program is to establish that the existing facility as designed and constructed under approval of Act 641, P.A. of 1978 provides equivalent protection of the environment and human health as specified in Act 64, P.A. of 1979 in the following rules:

Rule 419 section (4)

(4) "The department may grant an exemption from subrules (1) and (2) of this rule if the applicant can demonstrate that equivalent protection of the environment and human health is provided without an early failure detection system."

and Rule 416 section (f)

(f) "Alternative liner designs and installations providing equivalent environmental and human health protection may be approved by the department. The applicant shall prove equivalency.

The Equivalency Program is based on demonstrating that after approximately 30 years of non-regulated landfilling, vertical migration of contamination has not occurred. The program designed to demonstrate this fact has two parts: (1) soil core sampling and analysis, and (2) resistivity analysis. A description of each analysis follows.

Soil Core Sampling and Analysis

To demonstrate that the existing insitu clay base of this facility is redirecting leachate flow horizontally, a core sampling test was developed.

It is hypothesized that the clay stratum under this facility exhibits characteristics that prevent leachate from continuing downward into possible ground water sources. Furthermore, if after 30 years of non-regulated operation, contamination doesn't exist below the clay surface, the upgraded facility will reduce this likelihood substantially.

To prove this hypothesis the following items were considered.

(1) The existing site has been operating for 30 years. The effects of this long term operation will provide a good prediction of leachate behavior on the clay and on its migration.

(2) Clay contours can be developed from the soil boring and horizontal leachate flow patterns mapped.

(3) Higher concentrations of contaminants will accumulate along leachate flow patterns.

(4) The depth of contamination into the clay surface will indicate the ability of this material to change the flow direction of leachate from vertical to horizontal.

(5) If a pitched sand seam exists under the facility, contamination will be evident at depths far below the clay interface. This geologic formation would have a very low probability as evidenced by the soil boring profiles.

To identify leachate contamination, core samples were taken along the flow pathways at various clay depths. The samples were analyzed for specific contaminates. A remote boring was done and core sample taken to act as a control and can be used for comparisons.

The results of the analysis of the core samples could show three potential contamination patterns which correlate to potential flow pathways. These contamination patterns are:

(1) If contamination depth at the clay surface is shallow, leachate during the past 30 years has not penetrated the clay formation and is being redirected horizontally along the surface of the clay.

(2) If contamination depths at the clay surface are great, then leachate during the past 30 years is penetrating the clay formation and is continuing downward. The clay formation does <u>not</u> have the ability to redirect flow.

(3) If contamination depth is not at the clay surface but rather at a depth far below this interface in a gravel or sand seam, then the clay formation is interrupted by a pitched permeable strata that is channelling leachate downward. This type of geology has a low probability of existing in this area and is not evidenced by existing soil borings.

Resistivity Analysis

To demonstrate that sand or gravel seams do not exist within the clay strata under this facility, electrical resistivity tests were developed.

It is hypothesized that the clay strata under this site is homogeneous and consistant. To determine if this hypothesis is correct without boring numerous holes into the strata or completely destroying the natural condition (both methods unfavorable), a non-destructive test was used.

In selecting this non-destructive test method the following items were considered.

(1) Electrical resistivities of existing soils can vary with moisture, contamination, temperature, procedure, etc.

(2) Use of this procedure in the existing landfill area would not provide appropriate data.

(3) Soil borings or "down the hole" truth must be used in interpreting the field data.

(4) The analysis of electrical resistivity tests can be completed by matching a field curve against a family of standard curves or by using a computer to generate a curve for given soil parameters.

The non-destructive test selected for this analysis used a Bison instrument and the Wenner configuration. In the test area (1000 Block of the Facility), a grid was established (see sketch) defining resistivity stations. At each station an apparent resistivity curve was generated.

To interprete the field curves a computer program was used to generate an apparent resistivity curve for a model soil profile which can be developed from ground truth (soil borings) or hypothetical constructed. The computer generated apparent resistivity curves are matched to the field curves. When the field curve is duplicated, a soil profile can be identified. This procedure was completed for representative stations and the results are supportive of the belief that the clay stratum is consistent and homogeneous.

Summary of Test Results

The soil core sampling and analysis results show that contamination penetrated the clay stratum to a depth of six (6) inches or less. The soil boring logs, the analysis results and procedures, profile sketches and location plots are included in this report.

The resistivity analysis results show that the clay stratum under this facility is continuous and homogeneous. The field data, procedures and a summary of the findings are included in this report.

Conclusions

The Dow Corning Midland Plant Landfill as defined, designed and constructed will provide equivalent protection of the environment and human health as specified in Act 64, P.A. of 1979. The equivalency is based on the following.

(1) This facility has been in operation for over 30 years and has established an environmentally acceptable performance record.

(2) The performance of the facility was verified by equivalency tests which demonstrate the capability of this facility to continue to protect the environment for the remainder of its life. The capability to provide environmental protection is based upon tests that used actual field data from this site.

(3) The facility will continue to operate for the purpose of disposing only Dow Corning Corporation by-products.

Dow Corning Corporation
Midland Plant Landfill
Equivalency Program

Test # 1 Soil Core Sampling And Analysis

Section 1 - Test Development

Section 2 - Test Procedures

Section 3 - Test Results

Soil Core Sampling And Analysis

Section 1 - Test Development

- Test Development Notes
- Clay Contour Sketch
- Soil Profile - Old Condition (1950-1980)
- Soil Profile - Existing Condition (1980-Present)

Soil Core Sampling And Analysis
Test Development Notes

1. The existing facility has been in operation for over 30 years. The projected life of the facility is for an additional 30 years.

2. An assessment of the performance of the facility over the past 30 years can be used to predict the expected performance for the remaining life of the upgraded facility.

3. By assessing leachate migration patterns and contamination levels at various depths near the facility, an evaluation of the site with respect to environmental protection can be made.

4. To verify that the underlying clay stratum is redirecting leachate flow from a vertical pattern to a horizontal pattern a clay contour map was made (attached). From the contours major flow channels can be identified. Along the major channels or pathways higher concentrations of contaminates will be deposited into the clay.

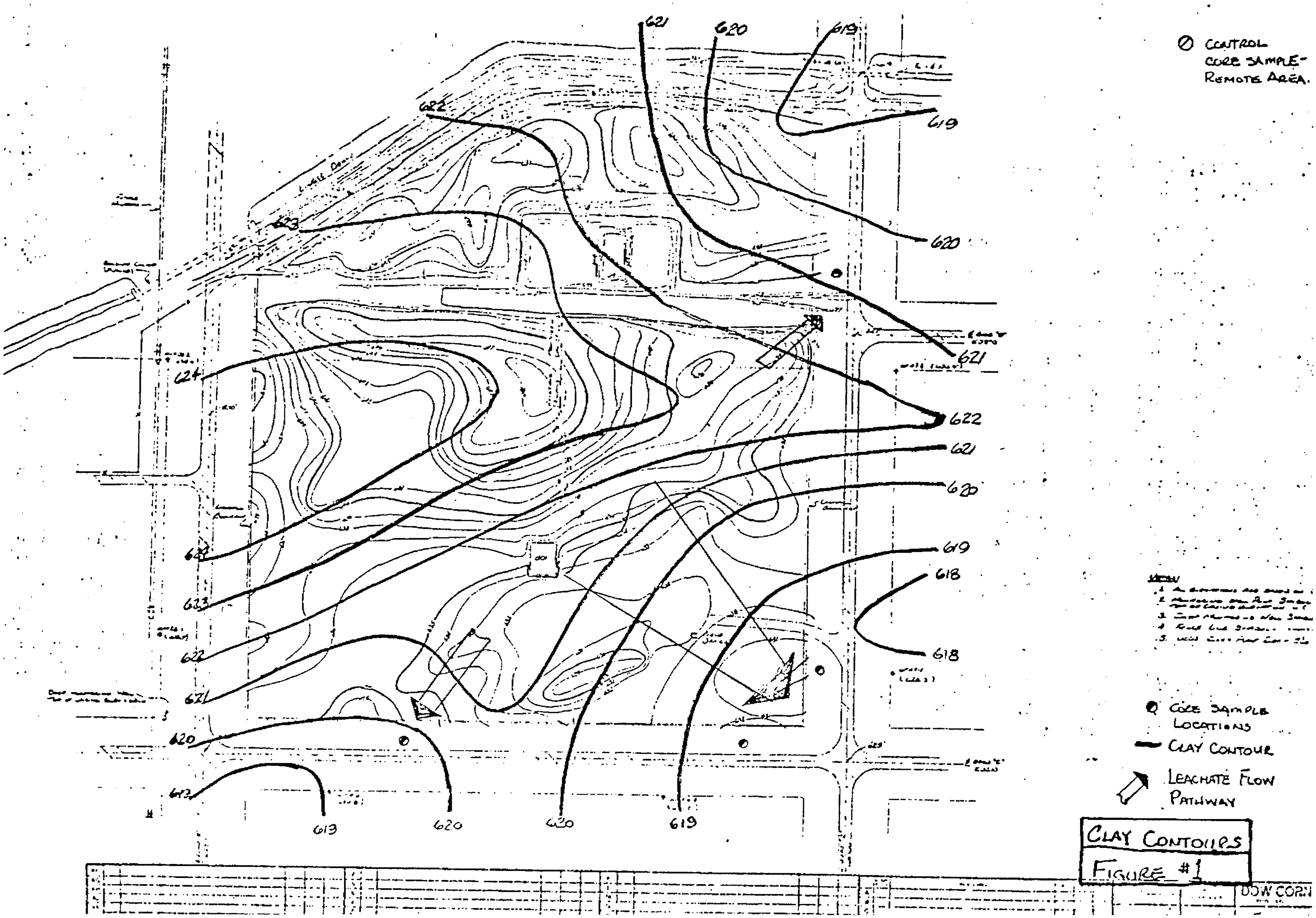
5. By taking core soil samples located along the flow pathways, contamination levels at various depths can be recorded. From this data an actual permeability of the clay soil can be calculated.

$$K_{(vertical)} = \frac{\text{Depth of contaminate penetration}}{\text{30 years}}$$

NOTE: (from the test results) $K_v = \frac{0.5ft}{30\ yrs.} = 1.61 \times 10^{-8}$ cm/sec

6. In addition to defining the clay characteristics exhibited at this site, these tests also show that the permeability of the natural clay is not increased by the leachate from this facility even after a 30 year exposure.

7. There are limitations of the soil core sampling test. The soil core samples cannot verify the consistency of the clay stratum under the site. Therefore a second non-destructing test was developed. The test designed to address this issue is a resistivity analysis which is defined later in this report.

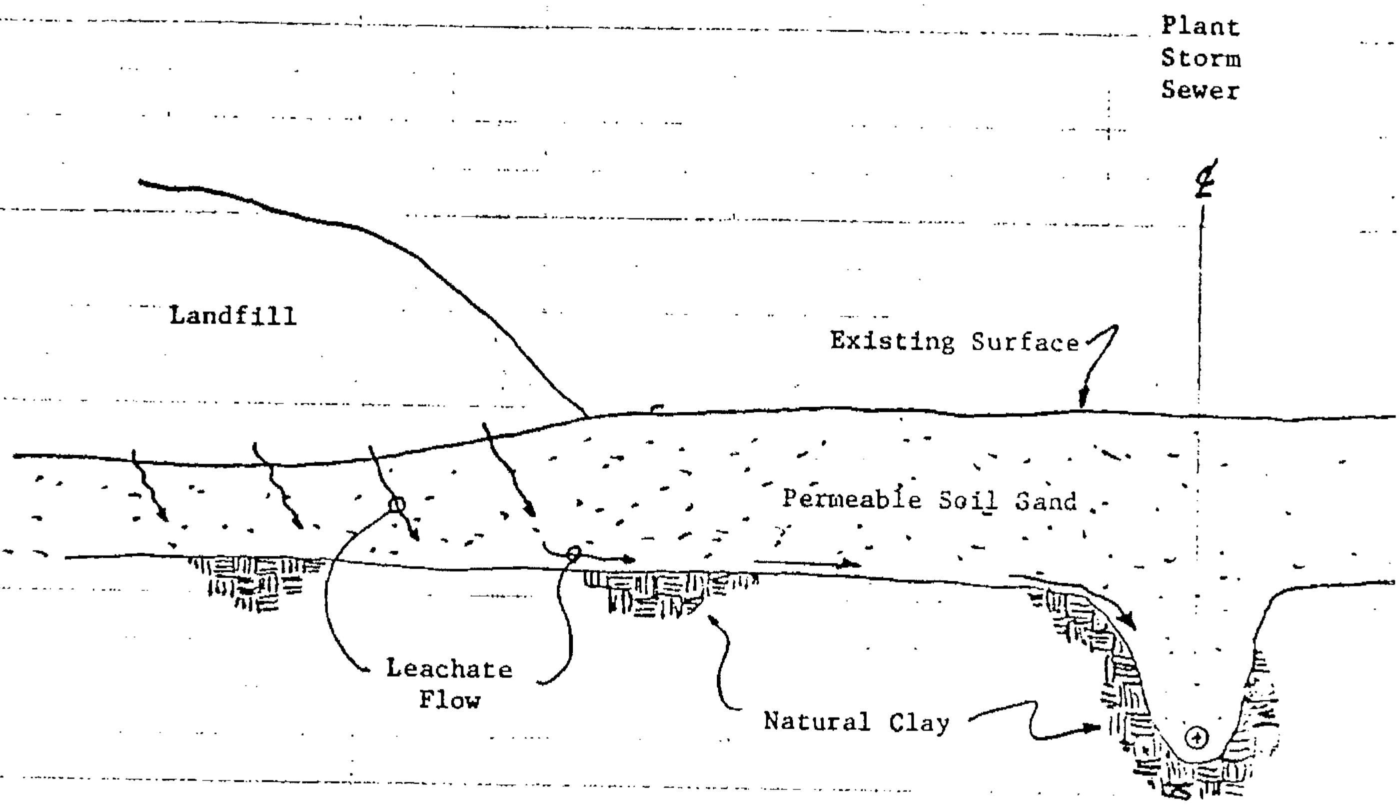


CLAY CONTOURS

FIGURE #1

DOW CORNING CORPORATION

MIDLAND PLANT LANDFILL

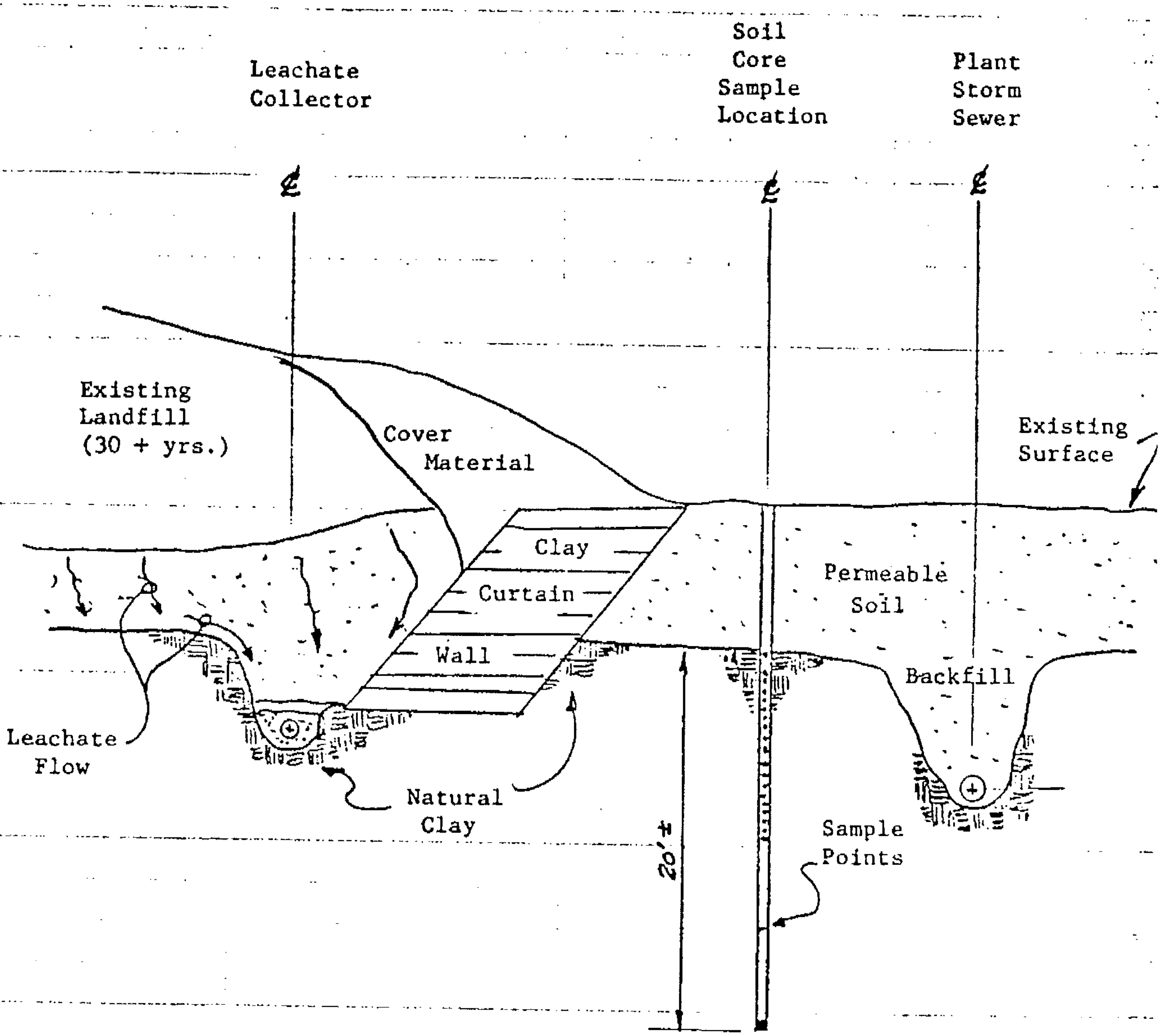


Soil Profile

Old Condition (1950 - 1980)

DOW CORNING CORPORATION

MIDLAND PLANT LANDFILL



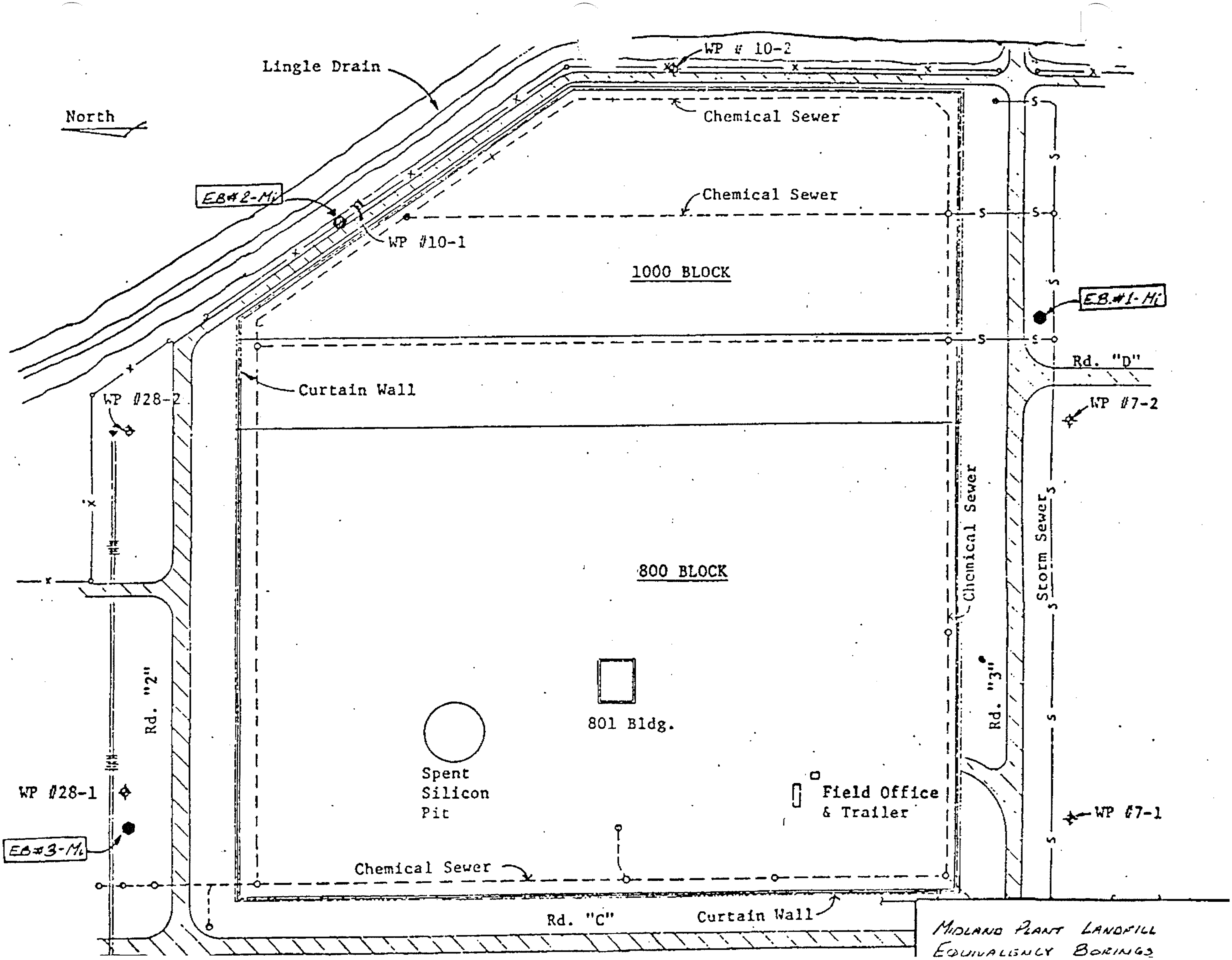
Soil Sampling Profile

Existing Condition (1980 - Present)

Soil Core Sampling And Analysis

Section 2 - Test Procedures

- Boring Location Plan
- Boring Logs
- Soil Analysis Methodology



MIDLAND PLANT LANDFILL
EQUIVALENCY BORINGS

LOG OF BORING NO. EB #1-M2

PROJECT: EQUIVALENCY BORING

SITE: East of Fence (outside) South Side of Rd. "3"

BORING STARTED: 11-4-81 **COMPLETED:** 11-4-81

PROJECT NO.: 81-127

SAMPLE TYPE: S. S. ___ AUGER ___ SHELBY ___

UNCONFINED COMPRESSIVE STRENGTH TONS/FT 2: 1, 2, 3, 4, 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %: 10, 20, 30, 40, 50

SURFACE ELEVATION

DEPTH IN FEET	DESCRIPTION OF MATERIAL	SAMPLE NO.	STD. PENETRATION "N" BLOWS PER FOOT	UNIT NAT. WT LB./FT 3
	Sand-brown, fine silty (SP)			
	Clay-brown, dense with some sand (CH)	A		
10		B		
	-gray, firm (CL)	C		
		D		
20				
		E		
		F		
30	End of Boring at 27½ ft.			

WATER LEVEL OBSERVATIONS

W.L.

W.L.

SAMTEST, INC.
DRILLING & TESTING SERVICES

LOG OF BORING NO. E.B.#2-Mi

PROJECT	SITE
EQUIVALENCY BORING	Near Lingle Drain

BORING STARTED 11-4-81 COMPLETED 11-4-81	PROJECT NO. 81-127	SAMPLE TYPE S. S. ___ AUGER ___ SHELBY ___

UNCONFINED COMPRESSIVE STRENGTH TONS/FT 2: 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %: 10 20 30 40 50

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION)	SAMPLE NO.	STD. PENETRATION "N" BLOWS PER FOOT	UNIT NAT. WT LB./FT 3
0	Sand-brown, fine silty (SP)			
10	Clay-dense gray (CL)	A		
		B		
		C		
	-sandy gray	D		
	-brownish gray	E		
20		F		
	-brownish gray, silty (CH)	G		
30		H		
	End of Boring at 33½ ft.			
40				

WATER LEVEL OBSERVATIONS

W.L.

W.L.

SAMTEST, INC.
DRILLING & TESTING SERVICES

LOG OF BORING NO. E3#3-Mi

PROJECT	SITE
EQUIVALENCY BORING	North of Rd. "2"

BORING	PROJECT NO.	SAMPLE TYPE
STARTED 11-6-81 COMPLETED 11-6-81	81-127	S. S. ___ AUGER ___ SHELBY ___

DEPTH IN FEET	LEGEND	SAMPLES	DESCRIPTION OF MATERIAL (SURFACE ELEVATION)	SAMPLE NO.	STD. PENETRATION "N" BLOWS PER FOOT	UNIT NAT. WT LB./FT3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT 2 (1 2 3 4 5); PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)
			Sand-brown, fine, silty (SP)				
			Clay-dense brown	A			
			-brownish gray, sandy	B			
10			-gray brown-firm	C			
			-gray, becoming less dense	D			
			-silty gray with 1" stones	E			
20							
			Silt-brownish gray, very soft	F			
			-greenish gray, silty				
				G			
30			End of Boring at 27 ft.				

WATER LEVEL OBSERVATIONS
W.L.
W.L.

SAMTEST, INC.
DRILLING & TESTING SERVICES

LOG OF BORING NO. SB #4-Mi

PROJECT	SITE
EQUIVALENCY BORING	West Side of Rd. "C"

BORING	PROJECT NO.	SAMPLE TYPE
STARTED 11-5-81 COMPLETED 11-5-81	81-127	S. S. ____ AUGER ____ SHELBY ____

UNCONFINED COMPRESSIVE STRENGTH TONS/FT 2: 1, 2, 3, 4, 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %: 10, 20, 30, 40, 50

DEPTH IN FEET	LEGEND	SAMPLES	DESCRIPTION OF MATERIAL (SURFACE ELEVATION —)	SAMPLE NO.	STD. PENETRATION "N" BLOWS PER FOOT	UNIT NAT. WT LB./FT3
			Sand-brown, fine, silty (SP)			
10		X	Clay-dense brown	A		
		X		B		
		X	-brown to light gray	C		
		X		D		
		X	-soft brown	E		
20						
		X	-grayish brown with pebbles	F		
30		X	-dk. gray with stones & pebbles	G		
			End of Boring at 30 ft.			

WATER LEVEL OBSERVATIONS

W.L.

W.L.

SAMTEST, INC.
DRILLING & TESTING SERVICES

LOG OF BORING NO. REFERENCE BORING - CONTROL

PROJECT	SITE
EQUIVALENCY BORING	WALDO & SALZBURG RDS.

BORING	PROJECT NO.	SAMPLE TYPE
STARTED 8-31-81 COMPLETED 8-31-81	81-127	S. S. ___ AUGER ___ SHELBY ___

DEPTH IN FEET	LEGEND	SAMPLES	DESCRIPTION OF MATERIAL (SURFACE ELEVATION)	SAMPLE NO.	STD. PENETRATION "N" BLOWS PER FOOT	UNIT NAT. WT LB./FT3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT2 (1 2 3 4 5); PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)
			Clay-stiff, moist, brown silty-oxidized variegated				
5			-stiff moist, silty brown with oxidized streaks	A	14		
			-stiff moist silty blue clay				
10				B	16		
15				C	10		
20				D	8		
25			End of Boring at 26 ft.	E	12		

WATER LEVEL OBSERVATIONS

W.L.

W.L.

SAMTEST, INC.
DRILLING & TESTING SERVICES

SOIL ANALYSIS METHODOLOGY

HAZARDOUS WASTE LANDFILL

EQUIVALENCY ISSUE

February, 1982

The soil samples were analyzed for volatile organic priority pollutants by Mead CompuChem, Research Triangle Park, N.C. The analytical procedures uses for the priority pollutants are based on those promulgated by EPA. The analytical methods used by CompuChem have been included with this report.

The soil samples were dispersed in distilled deionized water and placed on a wrist action shaker for 4 hours. The soil dispersions were centrifuged and the clear supernatant was analyzed for chloride and copper. The chloride was determined by CTM* 0018 using silver nitrate as the titrant with a potentiometric end point. The copper was determined by atomic absorption (CTM 0616) with a carbon furnace.

* CTM refers to Dow Corning Corporate Test Method

ANALYTICAL METHODS, DEFINITIONS AND EXPLANATIONS

The CompuChem report contains not only the concentrations of the priority pollutant compounds identified but also additional supportive information which is useful in the review of this data. A complete report includes the following (if ordered):

Priority Pollutant Data
- GC/MS (VOA, B/N/P, Acid)
- Pesticides (Method 608)
- Inorganics

Other Analytical Data (EP Toxicity, etc.)
Conventional Permit Data

The GC/MS priority pollutant data is presented in summary form (concentration of each identified compound) along with the detection limits specified by EPA. In addition, a reconstructed total ion chromatogram (RIC) for each fraction and for the relevant instrument calibration (standards) runs are included.

Also included in the report are the spectra for all organic (except for certain pesticides) priority pollutant compounds identified above EPA specified detection limits, as well as a laboratory chronicle of completion dates.

To assist in the interpretation and utilization of this data, a Glossary of frequently used terms, a Compound Cross-Reference List and a typical Spectral Match Diagram with explanatory notation are also included.

If the Twenty Peak option has been ordered, the report also includes spectral match diagrams for as many as twenty (20) additional non-priority pollutant compounds with peaks greater than half the intensity of the internal standard (d_{10}-anthracene).

If the Quality Control option has been ordered, the report also includes BFB and DFTPP tuning data for the GC/MS instruments, a summary of surrogate spike recovery data and the following:

Matrix Spike Data
Duplicate Data
Method Blank Data

Also included with the method blank is an RIC for each fraction plus spectra and spectral match diagrams for any compounds identified with concentrations greater than EPA specified detection limits found in the blank.

If the Chain-of-Custody option has been ordered, this information is included in the section with the sample data.

ANALYTICAL METHODS

The analytical methods used by CompuChem for priority pollutant, RCRA and NPDES permit analyses are based on those promulgated by EPA. These methods have appeared in the Federal Register as noted below.

In summary, gas chromatography/mass spectrometry (GC/MS) is the analytical technique employed for the analysis of organic compounds while atomic absorption spectrophotometry (AAS) is used for the analysis of metals.

On occasion CompuChem also performs analyses for other parameters which are not on the priority pollutant list. In these cases also, EPA methods are used if available, and if not methods are developed and verified along guidelines suggested by EPA.

References for Methods

Volatile Organics	(Method 624)	Federal Register 12-3-79
Acid Extractables	(Method 625)	" " "
Base/Neutral/Pesticide Extractables	(Method 625)	" " "
Pesticides	(Method 608)	" " "
Inorganics	EPA:	Analysis of Water & Waste Water (1974, 1979)
RCRA	Federal Register 5-19-80	

GLOSSARY OF TERMS

ACID FRACTION

Those compounds which solvent extract from the sample when it is pH-adjusted acidic (pH<2).

BFB TUNING

Each GC/MS instrument dedicated to VOA analyses is certified according to protocol prior to each 8-hour shift by injecting BFB (bromofluorobenzene) and comparing relationships between ion abundances for certain key mass numbers. If the prescribed relative ion abundances are not present, the instrument is adjusted until the criteria are met. With the available QC option, these parameters are included in the report for the BFB analysis following the specific sample analyzed.

B/N/P FRACTION

Those compounds which solvent extract from the sample when it is pH-adjusted basic (pH>11). This includes the pesticides (P), bases (B) and since this step is performed first, the neutral (N) compounds.

DFTPP TUNING

Each GC/MS instrument dedicated to Base/Neutral or Acid analyses is certified according to protocol prior to each 8-hour shift by injecting DFTPP (decafluorotriphenylphosphine) and comparing the relationships between ion abundances for certain key mass numbers. If the prescribed relative ion abundances are not present, the instrument is adjusted until the criteria are met. With the available QC option, these parameters are included in the report for the DFTPP analysis following the specific sample analyzed.

INDISTINGUISHABLE ISOMERS

Compounds with essentially the same mass spectrum and which have the same elution time from the gas chromatograph. An example is anthracene and phenanthrene.

INTERNAL STANDARD

CompuChem uses the internal standard method of quantitation. The same amount of d_{10}-anthracene is added to both the calibration standard and the sample. All calculations are referenced to a signal produced by this compound. Then all results are automatically corrected for any change in instrument sensitivity.

MATRIX SPIKES

Actual priority pollutants which are added to a second aliquot of the sample to determine the effect, if any, of the sample matrix on the analytical procedure.

METHOD BLANK

A sample of organic-free laboratory water which undergoes exactly the same extraction procedure at the same time as the actual samples. This monitors for possible contamination from glassware, solvents, or the extraction procedure.

PERCENT RECOVERY (SURROGATES AND MATRIX SPIKES)

The formula for determining percent recovery is:

$$\%\ \text{Recovery (Spike)} = \frac{\text{Conc. in Spike} - \text{Conc. in Sample}}{\text{Amount of Spike Added}} \times 100\%$$

$$\%\ \text{Recovery (Surrogate)} = \frac{\text{Amount found}}{\text{Amount added}} \times 100\%$$

PURITY VALUE (sometimes abbreviated PUR)

A mathematically devised index which indicates the "goodness of fit" between the spectrum in the sample and a compound in the library. The maximum value is 1000, and values greater than 800 indicate a high probability that the identification is correct. Values from 500 to 800 are only tentative and values less than 500 are not reliable. Also important is the relationship between purity values for the best, second and third matches; ideally the second and third purity scores are much lower than the first.

RIC - RECONSTRUCTED ION CHROMATOGRAM

A plot of the total ion current of the mass spectrometer during the analysis. The plot is analogous to a gas chromatogram where a peak indicates that a compound was detected at that time. The vertical axis is intensity and the horizontal axis is time (both minutes and mass spectral scan marks are labelled).

RPD - RELATIVE PERCENT DIFFERENCE

An average used to compare duplicate analyses:

$$RPD = \frac{2\ (C_1 - C_2)}{(C_1 + C_2)} \times 100\%$$

where C1 and C2 are the concentrations found in two separate aliquots of the same sample.

SATURATED ION

If a compound is present at a high enough concentration in the sample, the intensity of the major ions is generally so strong that the detector is overloaded by the signal. This is a result of the instrument having been adjusted for maximum sensitivity in order to reach lower detection limits.

SPECTRAL MATCH DIAGRAM

A display of the mass spectrum of the sample followed by the mass spectra of the three compounds in the library which are most similar to the sample (see Purity Value)

SURROGATES

A surrogate compound is chemically similar to one of the priority pollutants except that it is deuterated or fluorinated or in some other manner distinguishable by GC/MS from the other compounds in the sample.

TWENTY (20) PEAK SEARCH

An available option in which up to 20 non-priority peaks larger than half the internal standard peak are identified by searching the NBS spectral library. Only an estimate of concentration can be given which is:

Low	<50 ug/l
Medium	50-200 ug/l
High	>200 ug/l

VOA - VOLATILE ORGANICS ANALYSIS

Those highly volatile compounds detected by introducing the sample directly into the GC/MS through a purge and trap apparatus.

Soil Core Sampling And Analysis

Section 3 - Test Results

- Test Boring E.B. # 1 Mi
- Test Boring E.B. # 2 Mi
- Test Boring E.B. # 3 Mi
- Test Boring E.B. # 4 Mi
- Control Test Boring
- Test Detection Limits

TEST BORING EB #1 MI

SAMPLE	A	B	C	D	E	G	H
** SAMPLE DEPTH (Feet)	5½	7½	9½	11½	13½		
VOLATILE ORGANICS	Conc. (UG/KG	Conc. UG/KG	Conc. UG/KG	Conc. UG/KG	Conc. UG/KG		
1V. ACROLEIN							
2V. ACRYLONITRILE							
3V. BENZENE							
4V. BIS (CHLOROMETHYL) ETHER							
5V. BROMOFORM							
6V. CARBON TETRACHLORIDE							
7V. CHLOROBENZENE							
8V. CHLORODIBROMOMETHANE							
9V. CHLOROETHANE							
10V. 2-CHLOROETHYLVINYL ETHER							
11V. CHLOROFORM							
12V. DICHLOROBROMOMETHANE							
13V. DICHLORODIFLUOROMETHANE							
14V. 1,1-DICHLOROETHANE							
15V. 1,2-DICHLOROETHANE							
16V. 1,1-DICHLOROETHYLENE							
17V. 1,2-DICHLOROPROPANE							
18V. 1,3-DICHLOROPROPYLENE							
1[illegible] ETHYLBENZENE							
[illegible] METHYL BROMIDE							
[illegible]. METHYL CHLORIDE							
22V. METHYLENE CHLORIDE	44	50	45	49	44		
23V. 1,1,2,2-TETRACHLOROETHANE							
24V. TETRACHLOROETHYLENE							
25V. TOLUENE							
26V. 1,2-TRANS-DICHLOROETHYLENE							
27V. 1,1,1-TRICHLOROETHANE							
28V. 1,1,2-TRICHLOROETHANE							
29V TRICHLOROETHYLENE							
30V. TRICHLOROFLUOROMETHANE							
31V. VINYL CHLORIDE							
**SAMPLE DEPTH (Feet)	7½	9½	11½	13½	15½	22½	27½
CHLORIDE (ppm)	36	31	11	—	3	3	1
COPPER (ppb)	<10	<10	<10	—	<10	<10	<10

** Sample depths shown in the above table is the distance measured from grade level to the sample. Sand-clay interface for EB #1 MI was 5½ feet.

TEST BORING EB #2 MI

	SAMPLE	A	B	C	D	E	F	G
	** SAMPLE DEPTH (Feet)	9½	11½	13½	15½	17½		
	VOLATILE ORGANICS	Conc. UG/KG	Conc. UG/KG	Conc. UG/KG	Conc. UG/KG	Conc. UG/KG		
1V.	ACROLEIN							
2V.	ACRYLONITRILE							
3V.	BENZENE	89						
4V.	BIS (CHLOROMETHYL) ETHER							
5V.	BROMOFORM							
6V.	CARBON TETRACHLORIDE							
7V.	CHLOROBENZENE	16						
8V.	CHLORODIBROMOMETHANE							
9V.	CHLOROETHANE							
10V.	2-CHLOROETHYLVINYL ETHER							
11V.	CHLOROFORM							
12V.	DICHLOROBROMOMETHANE							
13V.	DICHLORODIFLUOROMETHANE							
14V.	1,1-DICHLOROETHANE							
15V.	1,2-DICHLOROETHANE							
16V.	1,1-DICHLOROETHYLENE							
17V.	1,2-DICHLOROPROPANE							
[illegible]V.	1,3-DICHLOROPROPYLENE							
	ETHYLBENZENE							
[illegible]	METHYL BROMIDE							
21V.	METHYL CHLORIDE							
22V.	METHYLENE CHLORIDE	120	35	83	19	81		
23V.	1,1,2,2-TETRACHLOROETHANE							
24V.	TETRACHLOROETHYLENE							
25V.	TOLUENE							
26V.	1,2-TRANS-DICHLOROETHYLENE							
27V.	1,1,1-TRICHLOROETHANE							
28V.	1,1,2-TRICHLOROETHANE							
29V	TRICHLOROETHYLENE							
30V.	TRICHLOROFLUOROMETHANE	11		12				
31V.	VINYL CHLORIDE							
	** SAMPLE DEPTH (Feet)	11½	13½	15½	17½	19½	21½	26½
	CHLORIDE (ppm)	153	65	–	20	8	2	3
	COPPER (ppb)	< 10	< 10	–	< 10	< 10	< 10	< 10

** Sample depths shown in the above table is the distance measured from grade level to the sample. Sand-clay interface for EB #2 MI was 9½ feet.

TEST BORING EB #3 MI

SAMPLE	A	B	C	D	E	F	G
** SAMPLE DEPTH (Feet)	5	7	9	11	13		
VOLATILE ORGANICS	Conc. UG/KG	Conc. UG/KG	Conc. UG/KG	Conc. UG/KG	Conc. UG/KG		
1V. ACROLEIN							
2V. ACRYLONITRILE							
3V. BENZENE							
4V. BIS (CHLOROMETHYL) ETHER							
5V. BROMOFORM							
6V. CARBON TETRACHLORIDE							
7V. CHLOROBENZENE							
8V. CHLORODIBROMOMETHANE							
9V. CHLOROETHANE							
10V. 2-CHLOROETHYLVINYL ETHER							
11V. CHLOROFORM							
12V. DICHLOROBROMOMETHANE							
13V. DICHLORODIFLUOROMETHANE							
14V. 1,1-DICHLOROETHANE							
15V. 1,2-DICHLOROETHANE							
16V. 1,1-DICHLOROETHYLENE							
17V. 1,2-DICHLOROPROPANE							
18'' 1,3-DICHLOROPROPYLENE							
[illegible] ETHYLBENZENE							
[illegible] METHYL BROMIDE							
21V. METHYL CHLORIDE							
22V. METHYLENE CHLORIDE	65	140	80	100	84		
23V. 1,1,2,2-TETRACHLOROETHANE							
24V. TETRACHLOROETHYLENE							
25V. TOLUENE		24					
26V. 1,2-TRANS-DICHLOROETHYLENE							
27V. 1,1,1-TRICHLOROETHANE							
28V. 1,1,2-TRICHLOROETHANE							
29V TRICHLOROETHYLENE							
30V. TRICHLOROFLUOROMETHANE							
31V. VINYL CHLORIDE							
** SAMPLE DEPTH (Feet)	7	9	11	13	15	22	27
CHLORIDE (ppm)	204	103	54	40	61	81	—
COPPER (ppb)	<10	<10	<10	<10	<10	<10	—

** Sample depths shown in the above table is the distance measured from grade level to the sample. Sand-clay interface for EB #3 MI was 5 feet.

TEST BORING EB #4 MI

SAMPLE		A	B	C	D	E	F	G
	** SAMPLE DEPTH (Feet)	8	10	12	14	16		
	VOLATILE ORGANICS	Conc. UG/KG	Conc. UG/KG	Conc. UG/KG	Conc. UG/KG	Conc. UG/KG		
1V.	ACROLEIN							
2V.	ACRYLONITRILE							
3V.	BENZENE	44						
4V.	BIS (CHLOROMETHYL) ETHER							
5V.	BROMOFORM							
6V.	CARBON TETRACHLORIDE							
7V.	CHLOROBENZENE	16						
8V.	CHLORODIBROMOMETHANE							
9V.	CHLOROETHANE							
10V.	2-CHLOROETHYLVINYL ETHER							
11V.	CHLOROFORM							
12V.	DICHLOROBROMOMETHANE							
13V.	DICHLORODIFLUOROMETHANE							
14V.	1,1-DICHLOROETHANE							
15V.	1,2-DICHLOROETHANE							
16V.	1,1-DICHLOROETHYLENE							
17V.	1,2-DICHLOROPROPANE							
18V.	1,3-DICHLOROPROPYLENE							
	ETHYLBENZENE							
	METHYL BROMIDE							
21V.	METHYL CHLORIDE							
22V.	METHYLENE CHLORIDE	120	170	78	120	65		
23V.	1,1,2,2-TETRACHLOROETHANE							
24V.	TETRACHLOROETHYLENE							
25V.	TOLUENE							
26V.	1,2-TRANS-DICHLOROETHYLENE							
27V.	1,1,1-TRICHLOROETHANE							
28V.	1,1,2-TRICHLOROETHANE							
29V	TRICHLOROETHYLENE							
30V.	TRICHLOROFLUOROMETHANE							
31V.	VINYL CHLORIDE							
	** SAMPLE DEPTH (Feet)	10	12	14	16	18	25	30
	CHLORIDE (ppm)	336	—	29	6	3	3	—
	COPPER (ppb)	<10	—	<10	<10	<10	<10	—

** Sample depths shown in the above table is the distance measured from grade level to the sample. Sand-clay interface for EB #4 MI was 8 feet.

EXHIBIT II - COMPOUND LIST

SAMPLE IDENTIFIER: 5124 59 6'-0" / 5124-59-10'-0" (CONTROL)
COMPUCHEM SAMPLE NUMBER: 8321

SAMPLE LOCATION: 5300 BLOCK, NEAR WALDO ROAD

	VOLATILE ORGANICS	6'-0" CONCENTRATION (UG/KG)	10'-0" CONCENTRATION (UG/KG)	DETECTION LIMIT (UG/KG)	SCAN NUMBER
1V.	ACROLEIN	BDL	BDL	100	
2V.	ACRYLONITRILE	BDL	BDL	100	
3V.	BENZENE	BDL	BDL	10	
4V.	BIS (CHLOROMETHYL) ETHER	BDL	BDL	10	
5V.	BROMOFORM	BDL	BDL	10	
6V.	CARBON TETRACHLORIDE	BDL	BDL	10	
7V.	CHLOROBENZENE	BDL	BDL	10	
8V.	CHLORODIBROMOMETHANE	BDL	BDL	10	
9V.	CHLOROETHANE	BDL	BDL	10	
10V.	2-CHLOROETHYLVINYL ETHER	BDL	BDL	10	
11V.	CHLOROFORM	BDL	BDL	10	
12V.	DICHLOROBROMOMETHANE	BDL	BDL	10	
13V.	DICHLORODIFLUOROMETHANE	BDL	BDL	10	
14V.	1,1-DICHLOROETHANE	BDL	BDL	10	
15V.	1,2-DICHLOROETHANE	BDL	BDL	10	
16V.	1,1-DICHLOROETHYLENE	BDL	BDL	10	
17V.	1,2-DICHLOROPROPANE	BDL	BDL	10	
18V.	1,3-DICHLOROPROPYLENE	BDL	BDL	10	
19V.	ETHYLBENZENE	BDL	BDL	10	
20V.	METHYL BROMIDE	BDL	BDL	10	
21V.	METHYL CHLORIDE	BDL	BDL	10	
22V.	METHYLENE CHLORIDE	65	84	10	199
23V.	1,1,2,2-TETRACHLOROETHANE	BDL	BDL	10	
24V.	TETRACHLOROETHYLENE	BDL	BDL	10	
25V.	TOLUENE	10	BDL	10	696
26V.	1,2-TRANS-DICHLOROETHYLENE	BDL	BDL	10	
27V.	1,1,1-TRICHLOROETHANE	BDL	BDL	10	
28V.	1,1,2-TRICHLOROETHANE	BDL	BDL	10	
29V	TRICHLOROETHYLENE	BDL	BDL	10	
30V.	TRICHLOROFLUOROMETHANE	BDL	10	10	252
31V.	VINYL CHLORIDE	BDL	BDL	10	

UG/KG = ppb

BDL=BELOW DETECTION LIMIT

NOTE:

All sample results including the control indicate the presence of methylene chloride. An investigation of this situation suggests that the detected methylene chloride is from using this material as a cleaning agent by the analytical laboratory (CompuChem). This laboratory has informed Dow Corning that they have experienced cross-contamination problems with methylene chloride on previous occasions and is attempting to correct it. A check of company records revealed that methylene chloride is purchsed only in pint bottles and is used in plant laboratories. All spent chemicals from laboratories are routinely incinerated thus effectively eliminating this source as the origin of the contamination.

	VOLATILE ORGANICS	DETECTION LIMIT (UG/KG)
1Y.	ACROLEIN	100
2Y.	ACRYLONITRILE	100
3Y.	BENZENE	10
4Y.	BIS (CHLOROMETHYL) ETHER	10
5Y.	BROMOFORM	10
6Y.	CARBON TETRACHLORIDE	10
7Y.	CHLOROBENZENE	10
8Y.	CHLORODIBROMOMETHANE	10
9Y.	CHLOROETHANE	10
Y.	2-CHLOROETHYLVINYL ETHER	10
11Y.	CHLOROFORM	10
12Y.	DICHLOROBROMOMETHANE	10
13Y.	DICHLORODIFLUOROMETHANE	10
14Y.	1,1-DICHLOROETHANE	10
15Y.	1,2-DICHLOROETHANE	10
16Y.	1,1-DICHLOROETHYLENE	10
17Y.	1,2-DICHLOROPROPANE	10
18Y.	1,3-DICHLOROPROPYLENE	10
19Y.	ETHYLBENZENE	10
20Y.	METHYL BROMIDE	10
21Y.	METHYL CHLORIDE	10
22Y.	METHYLENE CHLORIDE	10
23Y.	1,1,2,2-TETRACHLOROETHANE	10
24Y.	TETRACHLOROETHYLENE	10
25Y.	TOLUENE	10
26Y.	1,2-TRANS-DICHLOROETHYLENE	10
27Y.	1,1,1-TRICHLOROETHANE	10
28Y.	1,1,2-TRICHLOROETHANE	10
29Y	TRICHLOROETHYLENE	10
30Y.	TRICHLOROFLUOROMETHANE	10
31Y.	VINYL CHLORIDE	10

UG/KG = ppb

Dow Corning Corporation
Midland Plant Landfill
Equivalency Program

Test # 2 Resistivity Analysis

Section 1 - Summary of Test

Section 2 - Apparent Resistivity Curves - Field Data

Section 3 - Field Data Interpretion

Resistivity Analysis

Section 1 – Summary of Tests

- Procedures
- Interpretation of Resistivity Curves
- Results and Discussion

SAMTEST Inc.

P.O. BOX 1444 MIDLAND, MI 4
(517) 496-3610

February 23, 1982

Dow Corning Corporation
Building #205
Midland, MI 48640

Attn: G. Hamblin - Project Engineer

Re: Resistivity Survey-Midland Plant Landfill-1000 Block Addition-Midland Plant-Dow Corning Corporation

Gentlemen:

The resistivity survey for the above referenced facility has been completed. This work was authorized by your office as of December 8, 1981.

This report summarizes the field data and the follow-up analysis of the resistivity curves at representative stations based on two/three layer models and ground truth where that is known with some degree of certainty.

Please call if there are any questions or if we might be of additional service

Respectfully Submitted,

William A. Crozier, Ph.D.
SAMTEST, Inc.

WAC/ss

Enclosures

Introduction

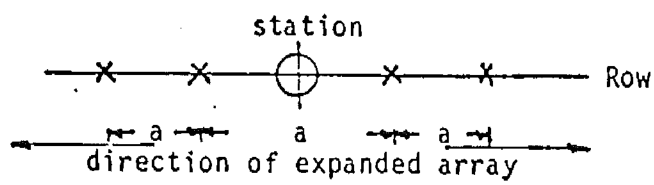
The resistivity survey for the Dow Corning Landfill, Proposed Expansion, Midland Plant is completed. Apparent resistivity values were measured at three (3) rows of stations as outlined by Mr. James Janiczek, Resource Recovery Division, Michigan Department of Natural Resources in his letter of 11-17-81 and designated rows B, C & D. Stations were set up every sixty feet (60 ft.) by Dow Corning personnel and the survey run about each station along the row line using a Wenner electrode configuration. The field data is summarized on the Table later in this report and reported in graphical form on log-log paper marked according to row and station.

At the time of this survey, (12-14-81 thru' 12-22-81), the site was excavated to near the clay bottom stratum but covered in most locations by from several inches to ten, (10), inches of medium fine sand. Although the proposed first cell had been previously excavated to the planned bottom elevation, it was filled with water and not accessible for this survey. The exterior clay barrier wall had also been constructed and represented the limit of this investigation.

The purpose of this investigation is to demonstrate from a vertical electrical sounding survey that the clay stratum which constitutes the lower barrier of the landfill does not contain any interbedded sand lens within the upper five feet (5 ft.), that would jeopardize the integrity of the landfill site for waste containment.

Field Testing Procedure

Field data for this survey were collected using a Bison Model 2350 Resistivity Meter and the Wenner electrode configuration. Each station along a given row was designated as the center of the electrode array and the first potential electrodes spaced at one and one half feet, (1 1/2 ft.) on either side of the station center. ("a" spacing of three feet) The spacing was increased by three feet for successing readings to a maximum of forty-eight feet, (48 ft.). This is represented graphically below as viewed from above the site:



Electrode length and the soil profile for the upper one to one and one half foot, (1 1/2 ft.), indicates good contact with the upper clay surface at all stations for the survey. Some variation in the surface clay quality was noted during the shallow surface soil profile evaluation and appears in the soil log presented on the appropriate row/station resistivity curve

This resistivity meter system uses heavy duty plug connection to the meter for the electrode wire with wire reel connections at each electrode stake to minimize spurious readings.

Interpretation of Resistivity Curves

The apparent resistivity data appear later in this report in tabular form and are plotted on log-log paper for uniformity and convenience in interpretation. Since concern is directed to the upper five to ten feet (5-10 ft.), of the soil profile as reflected in the electrode spacings, examination of the soil layer model is restricted primarily to the left hand side of the curve where a generalized two layer model appears to apply. The soil properties and layer thickness value are taken from the generalized log-log curves presented by Van Nostrand and Cook [1]. Several curves were evaluated using a three layer curve matching technique presented by Wetzel and McMurry [2]. These soil parameters are then used in conjunction with a computer program developed by Zohdy [3]. to construct apparent resistivity values for different Wenner electrode spacings. The generalized approach to the calculation of the apparent resistivity appears on Table #2.

This evaluation is performed for several typical stations along each of the B and C rows.

In conjunction with the above interpretation, the purpose of the survey and known ground truth from nearby perimeter borings, a multilayer model is constructed to try and clarify the sensitivity of the resistivity technique to detect an interbedded sand lens. This model and the results are superimposed on Row/Station C-8 figure #3.

No attempt was made to quantitatively interpret apparent resistivity curves for Row D-stations where a somewhat complex multilayer structure occurs.

Results and Discussions

Rows B and C, with all stations excluding the beginning and end stations for each row, cover the major protion of the proposed landfill barrier layer. Almost all of the resistivity curves can be represented by a two layer model where the value of resistivity in the upper clay layer p_1 is less then the resistivity, p_2, for the generalized lower layers ($p_1 < p_2$). A typical ratio for this is about $p_1:p_2::1:2$. This lower generalized resistivity is considerably less than the resistivity measured off site for the site excavated sands, ($p=1100\Omega ft.$), and is in line with what might be expected for the drier sandy clay till layer known to underly the site at about twenty-five feet, (25 ft.), (site el.$\sim$75'). Certainly, this p_2 value could represent a combination of an underlying clayey silt layer with the clay till basement

It is recognized that, as the apparent resistivity curve becomes flatter, approaches an asymptote, it is easier to reconstruct the curve from a soil model with variables having a rather wide variation in value. Generally, the solution then becomes less unique for deeper strata but still gives valuable information regarding shallow depths.

The multi-layer model was developed around a typical C row station (C-8) in order to generate the type of apparent resistivity curve that could be expected for a sand lens in the upper five feet, (5 ft.) of clay. The results of this model are presented on Figure #3, where a sand layer of one foot, (1 ft.), thickness appears at several locations within the clay layer. Generally, such a layer can be easily detected on this resistivity curve. However, when reduced to a six inch, (6 in.), or a 0.5 ft. layer occuring near the bottom of the clay barrier layer it could easily be undetected and represented by a new two layer model with the sand lens resistivity part of the combined lower layer resistivity.

Apparent resistivity curves observed for the D row stations are generally described as "H" type curves which can generally be described by a three layer model. Here the relative values for the resistivities is $p_1 > p_2 < p_3$. The clay dyke sand topsoil cover and adjacent road bed continually vary along this row. However, any lower lying sand layers, if present, are thin enough to be suppressed by the compacted clay wall resistivity.

Summary

Generally, based on the uniformity of the curves representing row B & C, interior to the proposed landfill addition there are no interbedded sand lenses thick enough to be detected by this method in the upper clay layer. Also, compared with ground truth for the perimeter of the site and the uniformity of the shallow depth portion of the resistivity curves, the clay stratum for the bottom of the site appears to provide adequate barrier under Act 64 requirements.

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1. Van Nostrand, R. G., and K. L. Cook, 1966, Interpretation of resistivity data: Professional Paper 499, United States Geological Survey, 310 pages.

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3. Zohdy, A. A. R., and Bisdorf, R. J., 1975, Computer programs for the forward calculation and automatic inversion of Wenner sounding curves: available only from U.S. Department of Commerce National Technical Information Services, Springfield, Virginia 22161 as PB-247 265.

TABLE #1

"B" ROW STATIONS - APPARENT RESISTIVITIES (OHM-FT)

Reading	"A" Space	AB/2	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14
			Stations													
1	3	2.25	17.7	25.1	43.2	30.9	46.2	46.8	60.9	60.9	56.4	93.6	72.6	110.1	102.0	90.0
2	6	4.5	21.9	30.7	47.5	38.6	60.0	56.3	74.4	79.2	55.6	102.0	88.8	115.8	115.2	107.4
3	9	6.75	36.4	38.5	53.6	48.8	69.6	72.9	84.9	90.0	70.8	115.2	100.4	122.4	126.9	119.7
4	12	9	36.3	42.1	63.6	57.0	80.0	87.5	95.4	101.2	85.3	124.8	118.1	126.0	128.4	132.0
5	15	11.25	24.9	49.4	71.2	62.2	89.9	101.7	106.4	107.5	91.2	131.2	129.4	133.9	139.5	145.6
6	18	13.5	38.2	57.2	75.1	68.4	94.9	103.7	112.3	110.9	91.3	140.0	135.2	136.6	144.7	150.5
7	21	15.75	47.3	49.3	79.4	75.6	102.9	106.5	118.0	106.3	106.4	142.4	138.4	145.7	147.4	154.1
8	24	18	76.8	49.0	83.3	76.6	108.5	111.4	125.3	116.9	112.6	145.9	141.6	150.5	152.2	155.8
9	27	20.25	89.1	57.8	88.3	66.2	109.9	114.2	127.7	126.9	116.1	148.2	145.8	140.9	156.6	148.2
10	30	22.5	84.6	54.9	88.2	71.7	111.9	118.2	132.9	129.0	120.6	150.6	150.0	156.0	159.6	148.5
11	33	24.75	91.7	53.8	91.1	93.1	115.2	123.8	133.0	136.6	123.1	151.5	152.1	156.8	165.0	151.8
12	36	27	93.9	56.5	105.5	97.6	117.4	130.7	134.3	142.2	125.6	151.6	153.4	160.9	166.3	155.9
13	39	29.25	99.0	58.5	109.6	94.8	117.8	128.7	136.5	147.4	132.2	158.3	155.6	165.0	166.1	162.2
14	42	31.5	76.9	54.2	108.8	107.1	120.1	130.2	139.0	152.5	135.3	163.0	158.3	166.7	168.8	168.0
15	45	33.75	107.1	-	110.7	105.3	126.4	131.0	142.2	154.8	137.7	164.2	159.8	169.7	173.3	175.5
16	48	36	109.4	69.6	112.3	107.5	130.1	133.4	144.9	156.5	139.2	168.0	161.8	171.8	173.8	180.0

Underline Apparent Resistivities: Field Noted Change in Instrument Operation (I Variation)

"C" ROW STATIONS - APPARENT RESISTIVITIES (OHM-FT)

Reading	"A" Space	$\overline{AB}/2$	C-1	C-2	C-3	C-4	C-5	(East-West) C-6↲	C-6	C-7	C-8	C-9	C-10	C-11	C-12
1	3	2.25	-	-	58.8	67.5	98.4	97.8	94.5	96	99.9	93	105.0	-	94.8
2	6	4.5	-	-	54.2	75.6	114.0	110.4	105.0	114.6	112.8	106.2	112.8	114.0	106.8
3	9	6.75	-	-	69.4	91.8	129.6	122.4	124.2	126.9	125.1	118.8	121.5	128.7	120.6
4	12	9	78.0	62.5	80.0	103.2	136.8	140.4	129.6	135.6	134.4	126.0	133.2	141.6	136.8
5	15	11.25	73.5	74.1	91.2	114.9	140.7	143.4	138.3	140.4	137.7	136.2	140.5	148.5	146.1
6	18	13.5	78.1	79.9	101.9	119.3	142.8	149.8	149.2	142.9	147.6	143.5	148.0	157.1	152.1
7	21	15.75	81.3	83.6	106.5	121.6	142.8	151.6	152.0	147.4	152.0	147.8	155.2	164.0	157.9
8	24	18	87.4	90.7	110.2	124.8	126.0	153.1	151.4	151.7	157.9	154.6	158.6	168.7	162.7
9	27	20.25	97.2	95.0	116.1	128.0	145.0	158.2	151.7	155.0	160.1	159.8	163.9	175.0	171.2
10	30	22.5	98.4	99.0	115.5	132.3	147.9	157.2	156.0	159.9	164.1	162.3	168.3	178.5	174.3
11	33	24.75	101.9	104.6	120.4	135.6	148.2	161.4	155.4	160.7	166.7	166.6	169.6	180.5	181.2
12	36	27	106.6	81.7	120.3	138.6	150.8	162.0	156.2	162.4	167.4	166.3	172.4	182.9	190.4
13	39	29.25	110.4	108.8	125.2	120.1	155.2	166.1	159.1	163.8	171.2	168.4	176.7	186.0	198.9
14	42	31.5	115.9	108.8	124.3	140.7	154.1	169.3	159.6	165.1	173.9	171.4	179.8	187.7	205.4
15	45	33.75	117.9	115.2	125.1	142.6	154.4	153.4	160.2	166.5	175.5	172.4	180.9	189.4	212.4
16	48	36	120.9	117.1	130.1	143.0	155.5	156.5	160.3	168.0	176.2	173.3	181.4	191.0	210.2

"D" ROW STATIONS - APPARENT RESISTIVITY (OHM-FT)

			Stations							
Reading	"A" Space	$\overline{AB}/2$	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8
1	3	2.25	102.0	201.3	169.8	147.3	165.6	172.8	160.0	111.0
2	6	4.5	108.0	131.4	107.4	120.0	114.0	120.0	103.2	109.8
3	9	6.75	107.1	108.9	108.0	99.9	50.6	100.8	123.3	98.1
4	12	9	100.7	103.8	103.1	77.4	111.3	101.4	105.1	97.4
5	15	11.25	102.4	102.3	108.75	68.25	46.2	111.9	110.4	94.05
6	18	13.5	97.0	104.4	113.8	110.52	123.5	118.1	120.1	96.5
7	21	15.75	102.3	112.1	115.9	116.97	128.5	125.6	126.8	103.3
8	24	18	109.4	117.8	117.4	37.92	137.0	135.8	134.2	124.3
9	27	20.25	115.3	123.1	129.6	125.01	140.9	142.3	143.1	132.6
10	30	22.5	116.7	129.9	132.6	124.2	147.9	153.6	151.5	141.9
11	33	24.75	124.1	138.6	142.9	136.6	125.4	163.0	148.8	155.8
12	36	27	130.7	140.0	150.8	54.0	164.9	163.4	162.4	165.6
13	39	29.25	134.9	146.6	155.2	145.0	168.5	162.2	170.0	175.5
14	42	31.5	139.9	150.0	135.2	149.9	170.5	170.5	175.1	186.1
15	45	33.75	144.0	156.1	159.8	148.0	181.4	172.4	167.0	193.5
16	48	36	148.8	162.2	162.2	156	190.1	179.0	182.4	194.4

TABLE 2

Theoretical Wenner Vertical Electric Soundings

By: A.R. Zohdy and David L. Campbell
U.S. Geological Survey

This method computes theoretical vertical electrical sounding curves for the Wenner electrode arrays. The earth structure is assumed to be a horizontally layered medium comprised of 6 layers or less. The input data consist of layer resistivities, depths (or thicknesses), and an initial electrode spacing value (a=AB/3 for Wenner). The output is the coordinate values for the theoretical sounding curve computed at the rate of 3 points per logarithmic cycle.

TECHNIQUE: The convolution method is used with Ghosh's filters to compute sounding curves (Ghosh, 1971: Zohdy, 1973; Zohdy, 1974; Zohdy and Bisdorf, 1975). For each electrode spacing, the computations involve two steps. First, the kernel function B(x) is calculated from the layer thicknesses and resistivities at 9 (Schlumberger) or 10 (Wenner) abscissa values (x). These abscissa values which depend on the value of the particular electrode spacing are logarithmically equally spaced at the rate of 3 points per logarithmic cycle ($\Delta x = 10^{1/3}$). Each electrode spacing used is multiplied by Ghosh's shift factor 1.36 for the Wenner spacings. Second, B(x) is convolved with the appropriate Ghosh filter coefficients to compute the apparent resistivity at the given electrode spacing.

EQUATIONS:

1. Use Sunde's recursive formula to compute B(x) as follows:
   a. Initialize for bottom layer (half-space)

   $$B_n = 1$$

   b. Using the following recursive formula upward for all the layers for i = n to 2,

   $$R_i = B_i \, p_i$$

   $$K_i = (p_{i-1} - R_i) / (p_{i-1} + R_i)$$

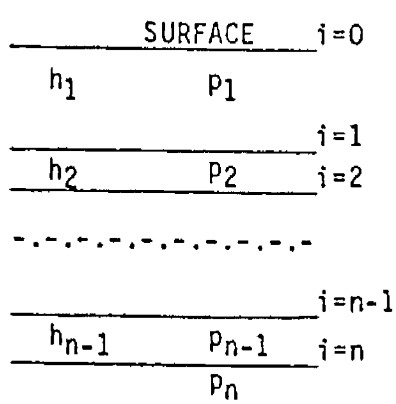
   $$M_i = -2h_{i-1}/f \cdot x \quad (f = \text{shift factor})$$

   $$Q_i = K_i \exp (M)$$

   $$B_{i-1} = (1-Q_i)/(1+ Q_i)$$

   we get

   $$B(x) = B_1 \cdot p_1$$



2. Convolve B(x) with Ghosh coefficients, G_j to compute

   $$\bar{p}_W(a) = \sum_{1}^{10} G_j \cdot B(x_j)$$

   where $\bar{p}_W(a)$ = Wenner apparent resistivity at a.

REFERENCES:

Anderson, W. L., 1979, Numerical integration of related Hankel transforms of orders 0 and 1 by adaptive digital filtering: Geophysics, v. 44, p. 1287-1305.

Ghosh, D. P., 1971, Inverse filter coefficients for the computation of apparent resistivity standard curves for a horizontally stratified earth: Geophysical Prospecting (Netherlands), v. 19, no. 4, p. 769-775.

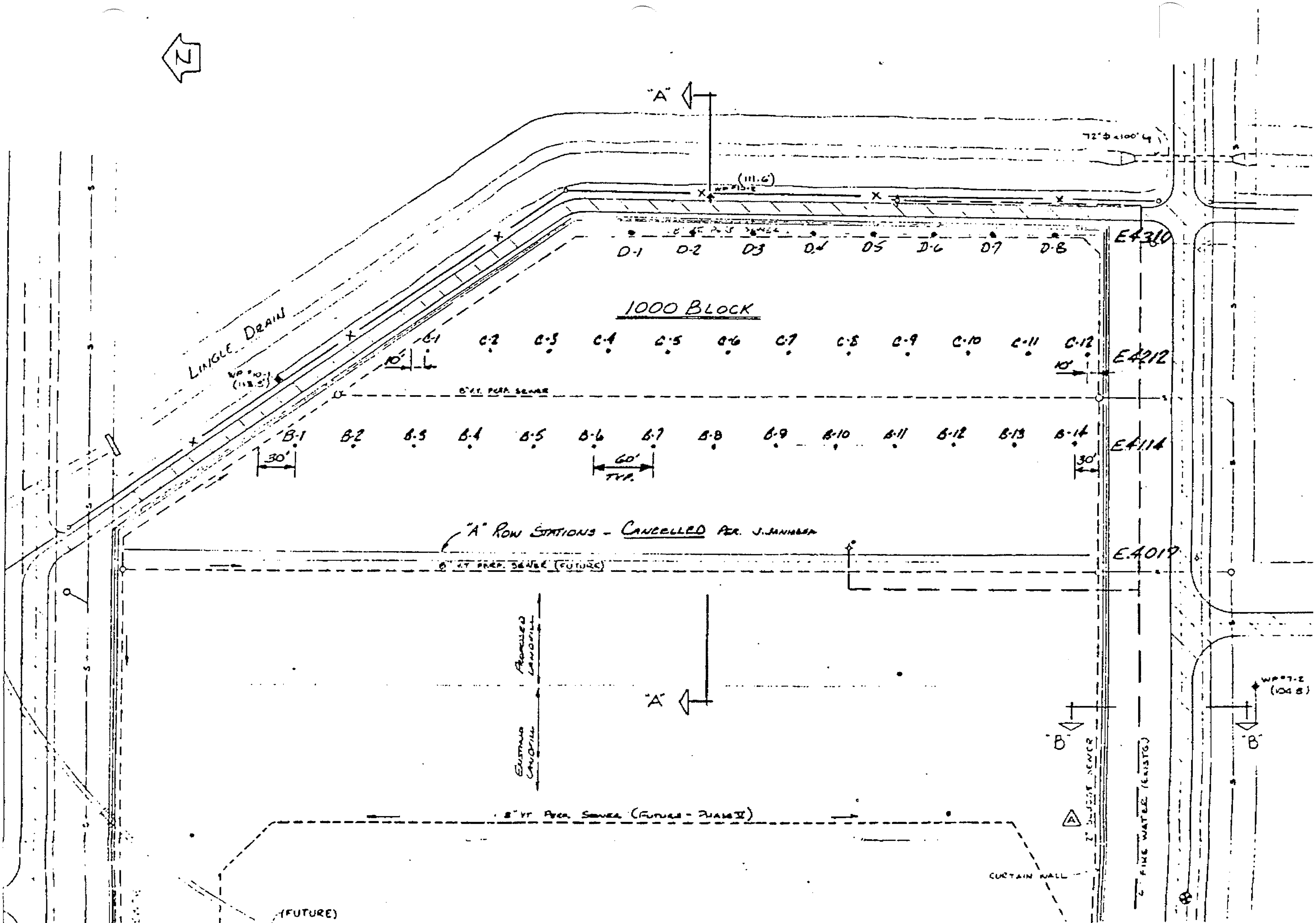
Zohdy, A. A. R., and Bisdorf, R. J., 1975, Computer programs for the forward calculation and automatic inversion of Wenner sounding curves: available only from U.S. Department of Commerce National Technical Information Services, Springfield, Virginia 22161 as PB-247 265.

Resistivity Analysis

Section 2 - Field Data

- Resistivity Stations Plan
- Apparent Resistivity Plots - Stations

FIGURE #1
Apparent Resistivity Curves
Stations B, C & D

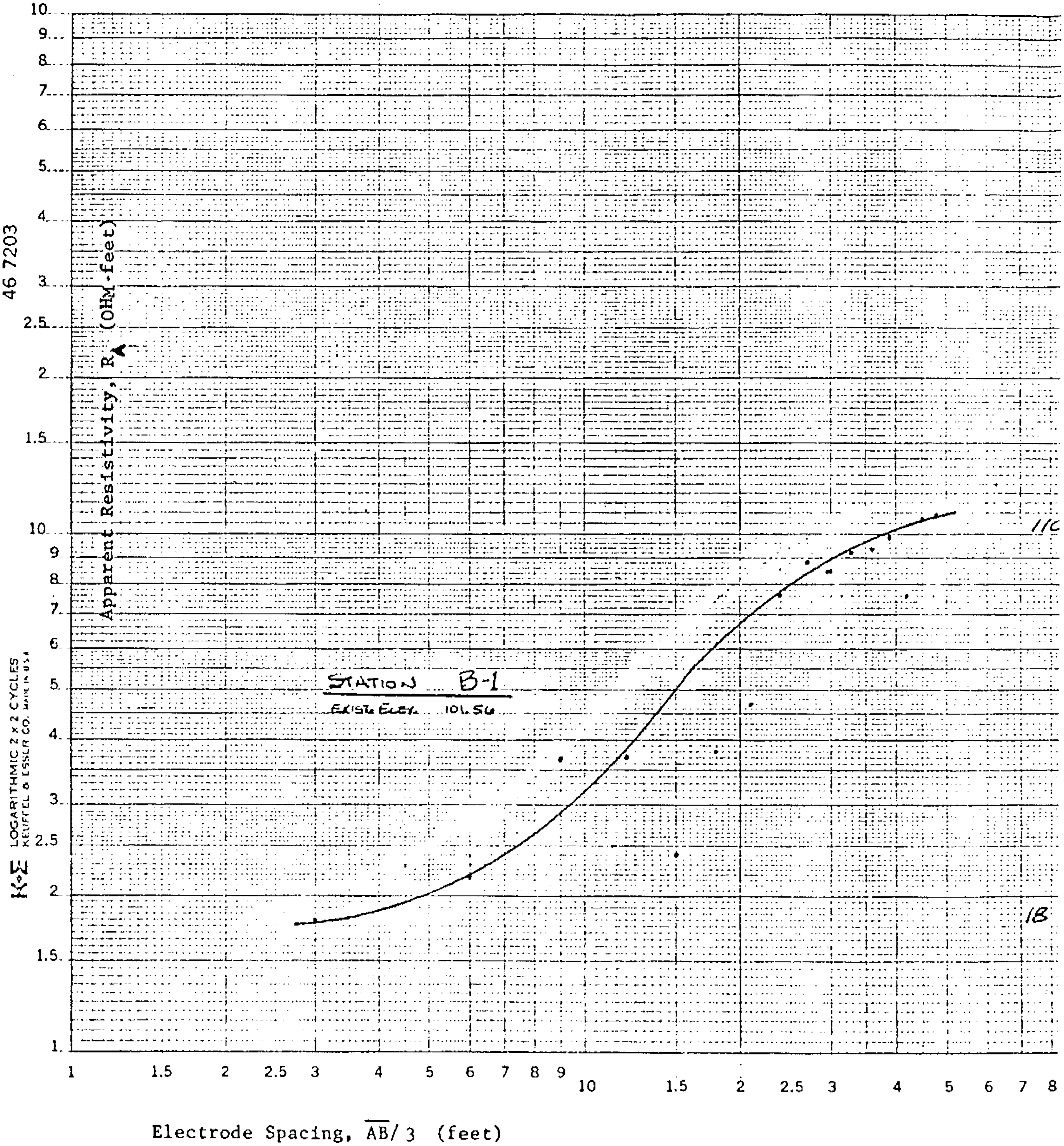


MIDLAND PLANT LANDFILL
RESISTIVITY TESTS LAYOUT

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT



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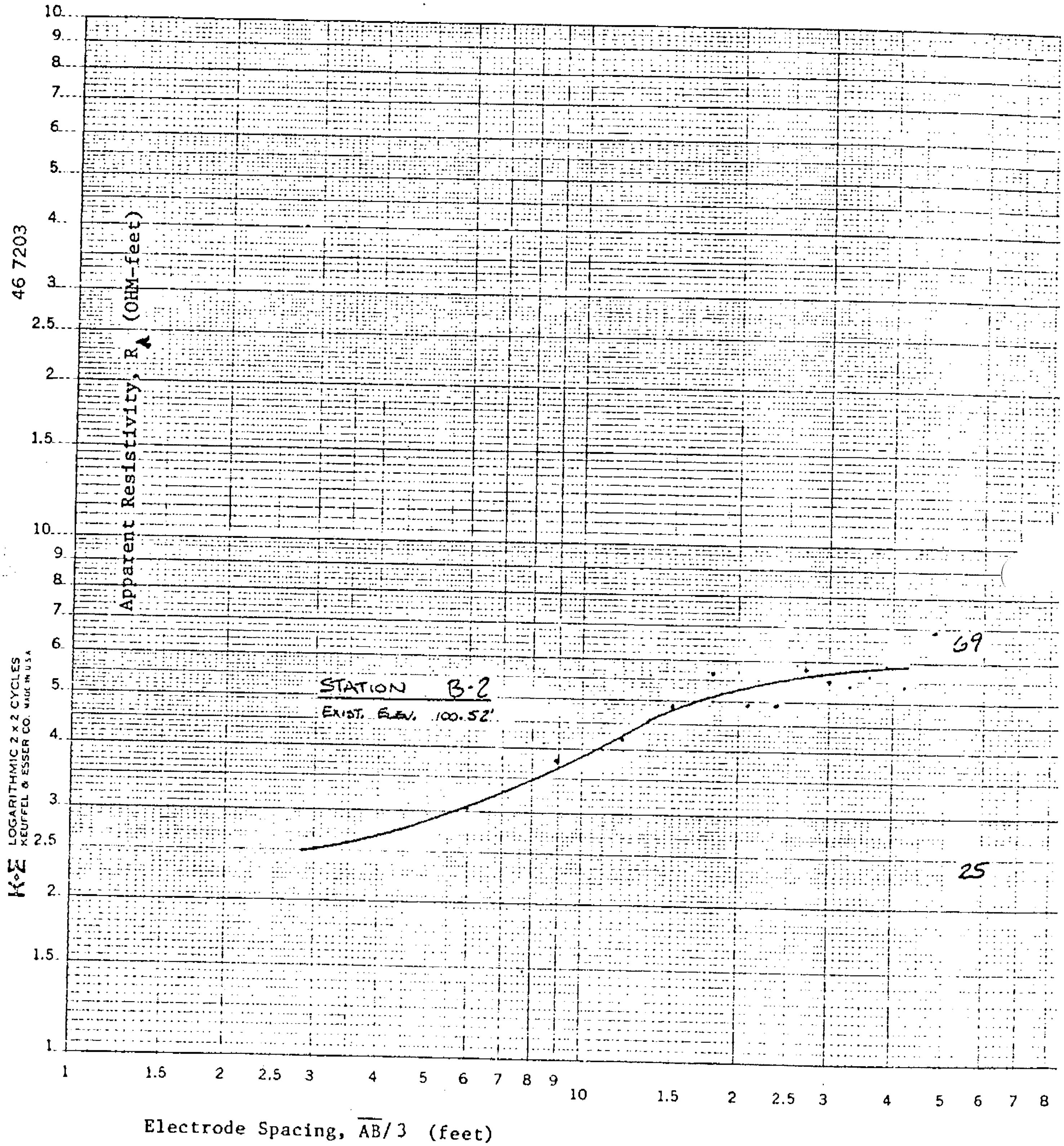

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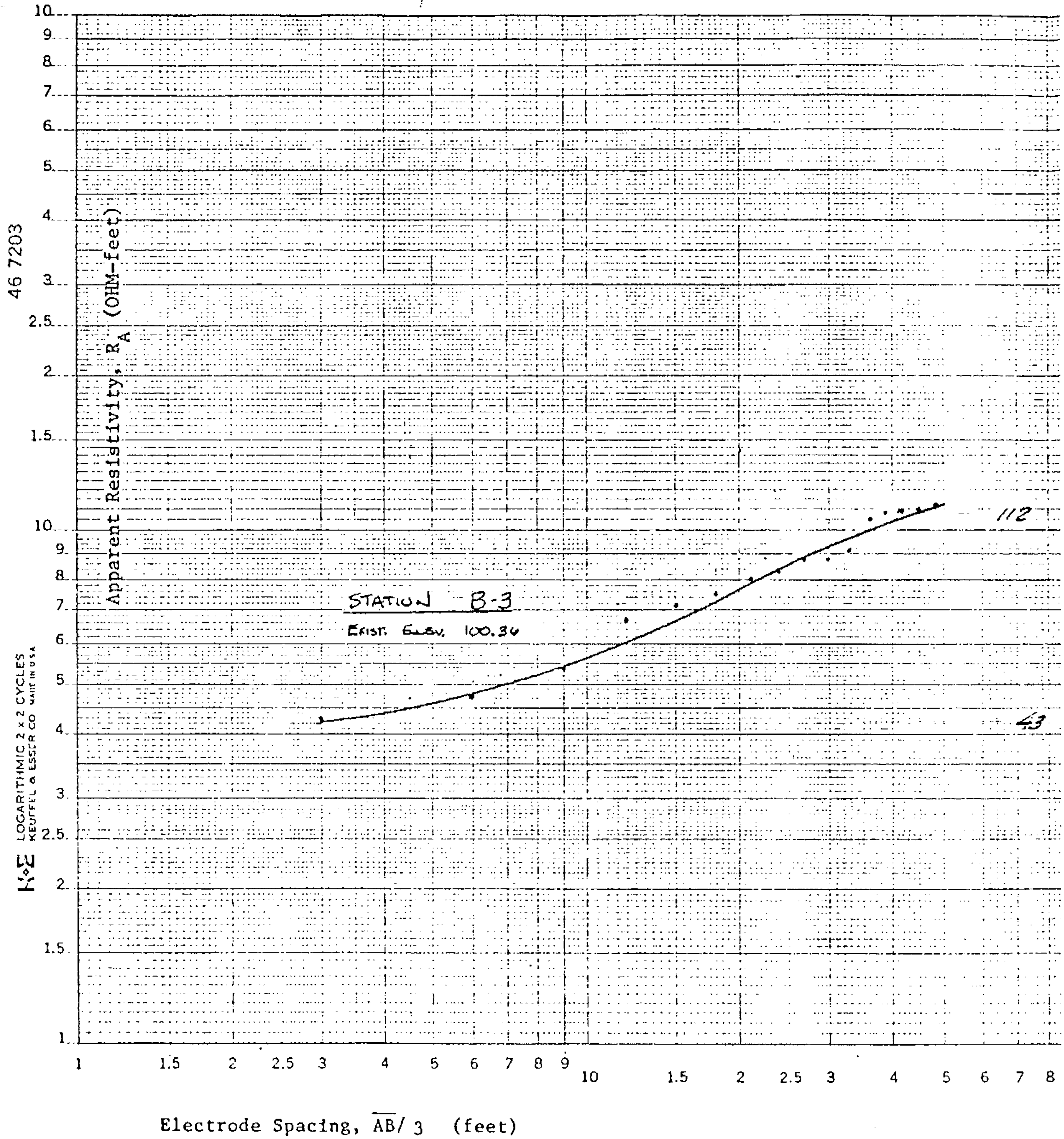

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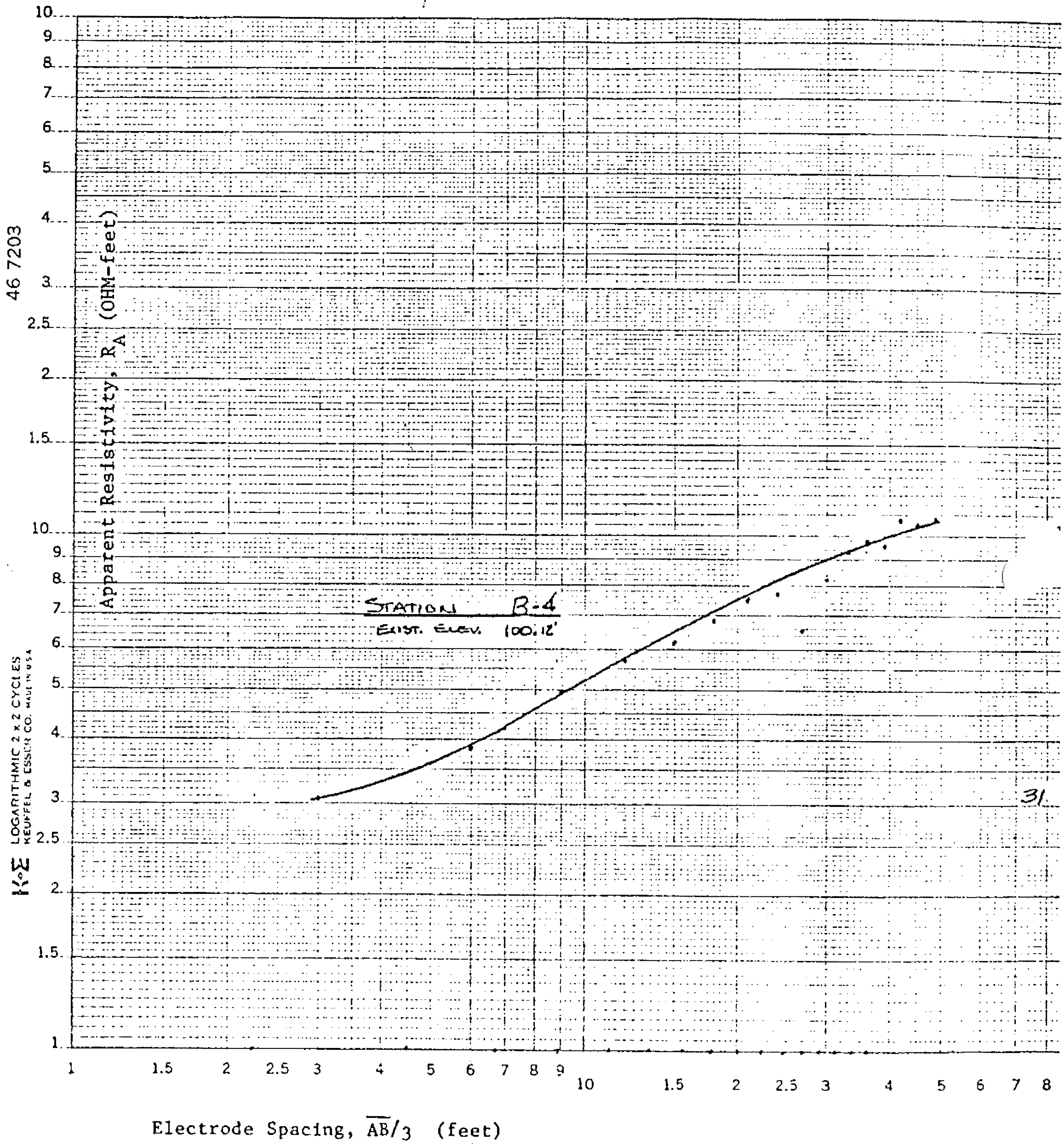

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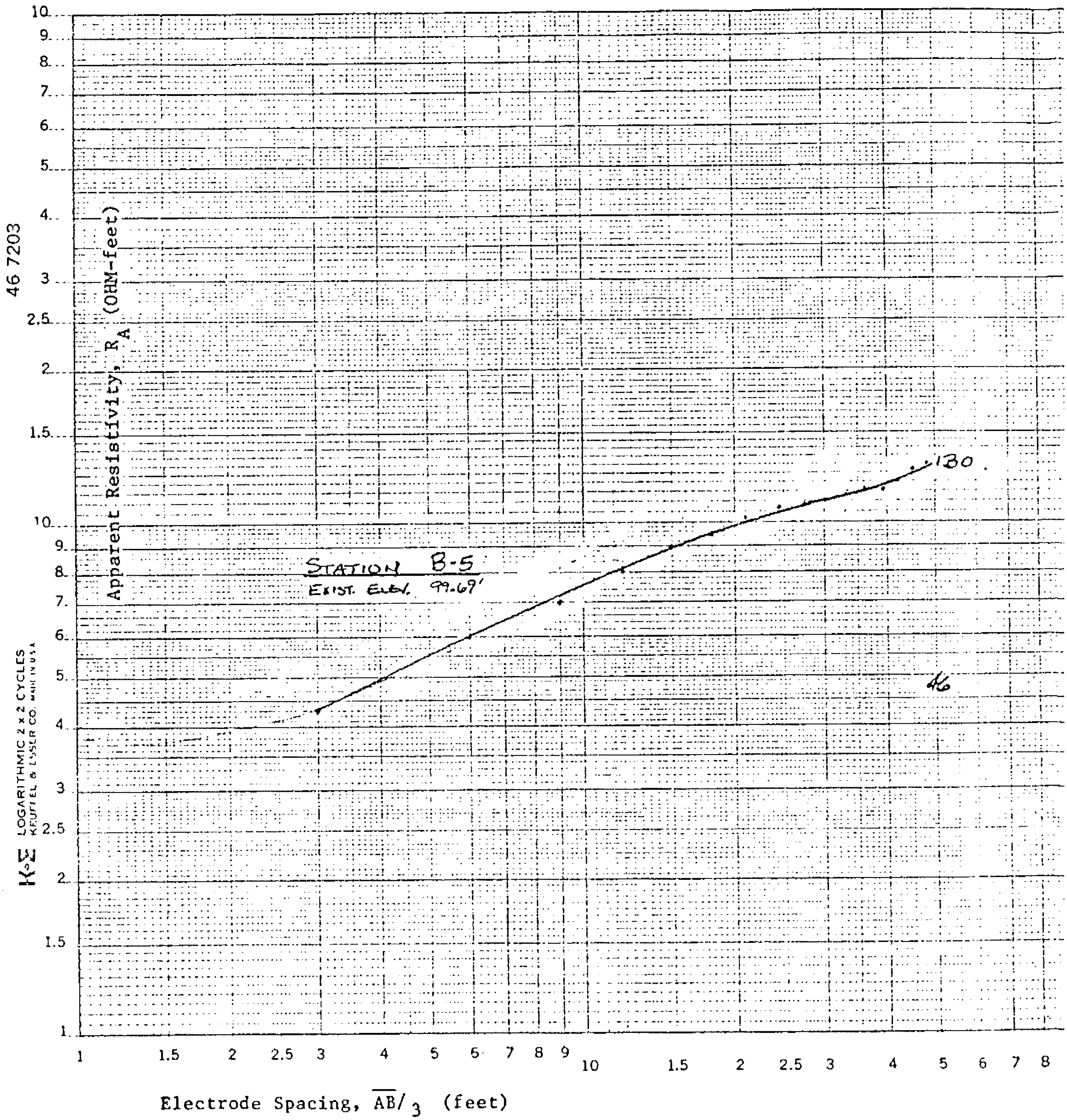

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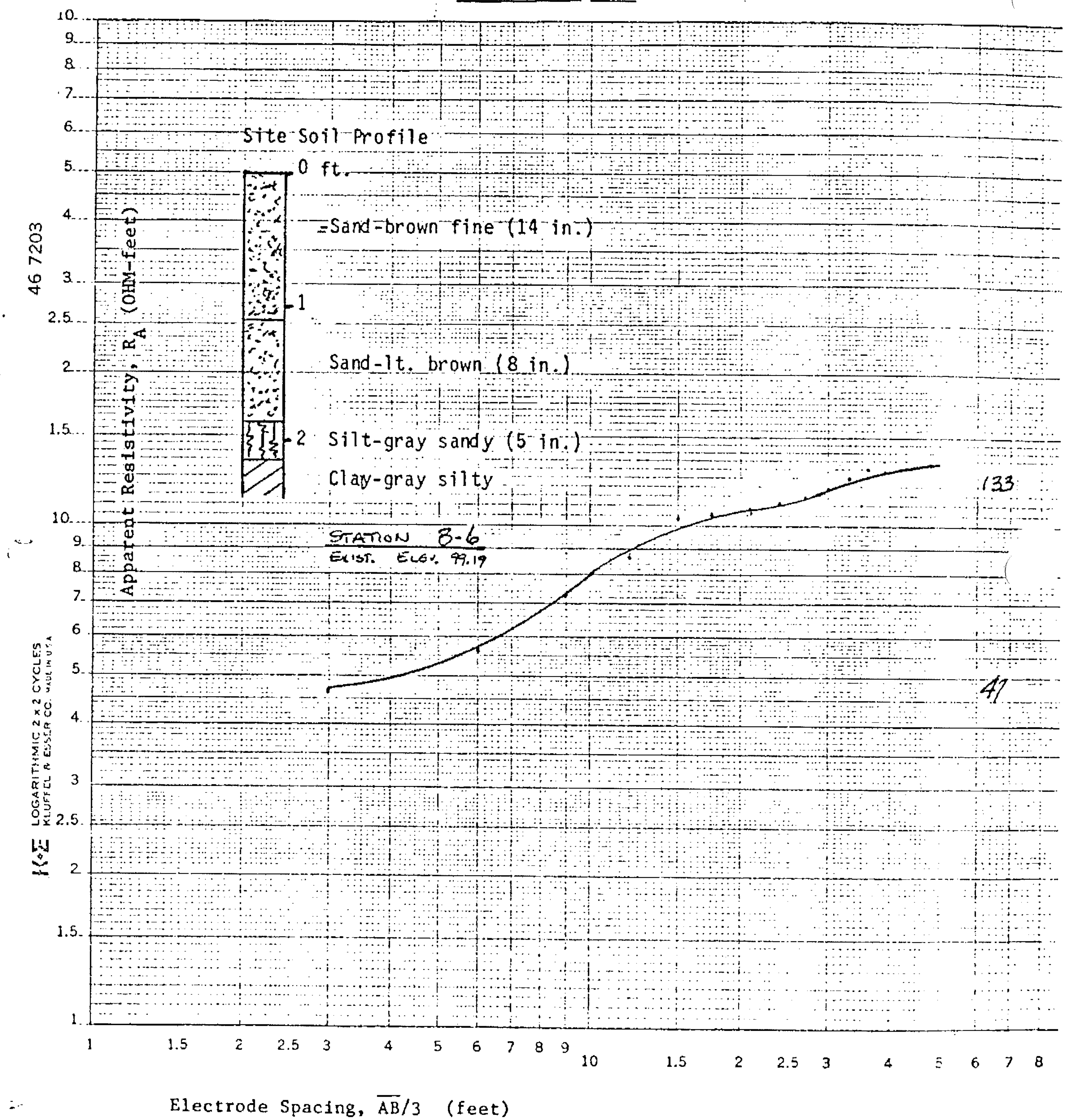

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EQUIVALENCY PROGRAM

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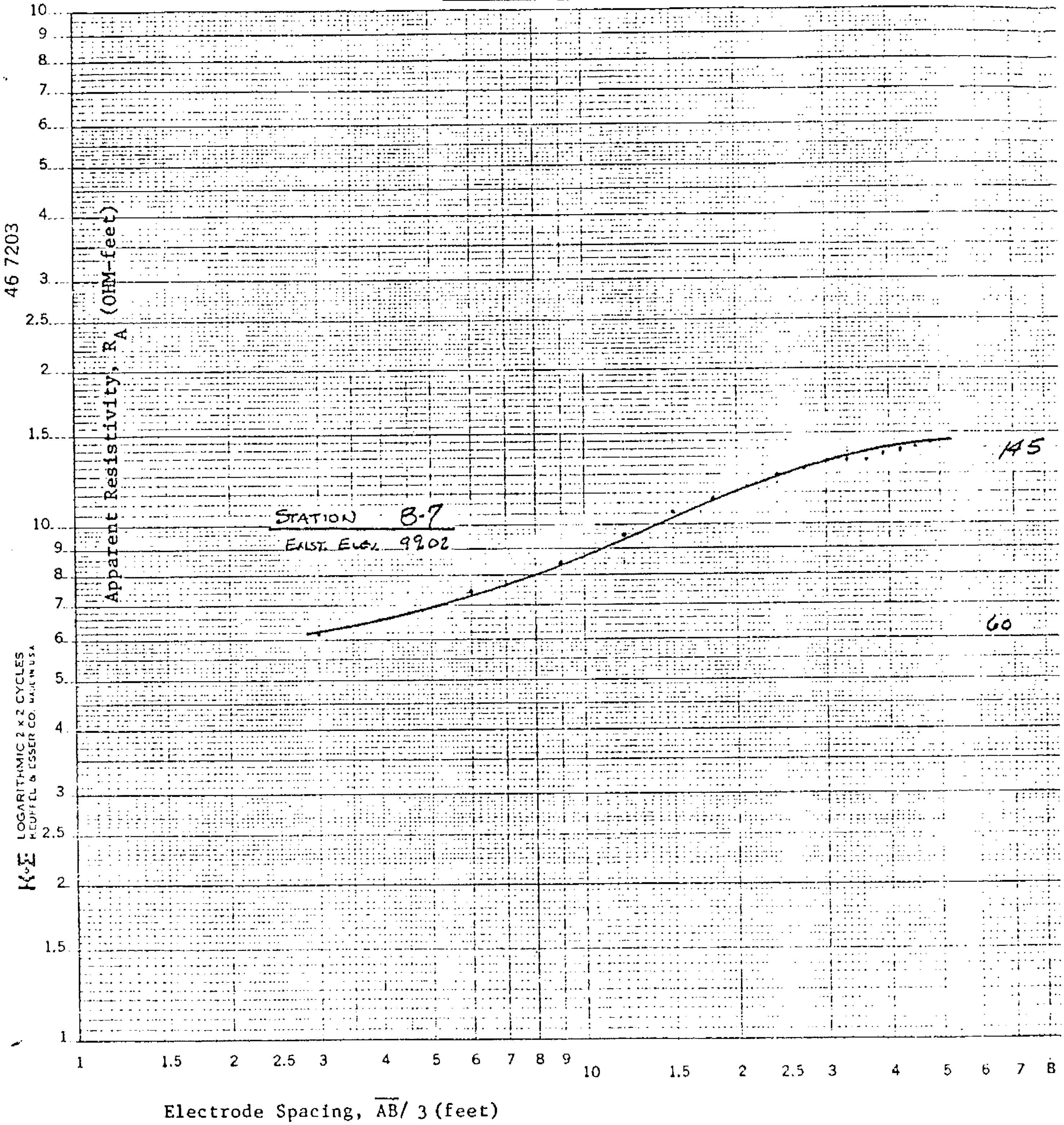

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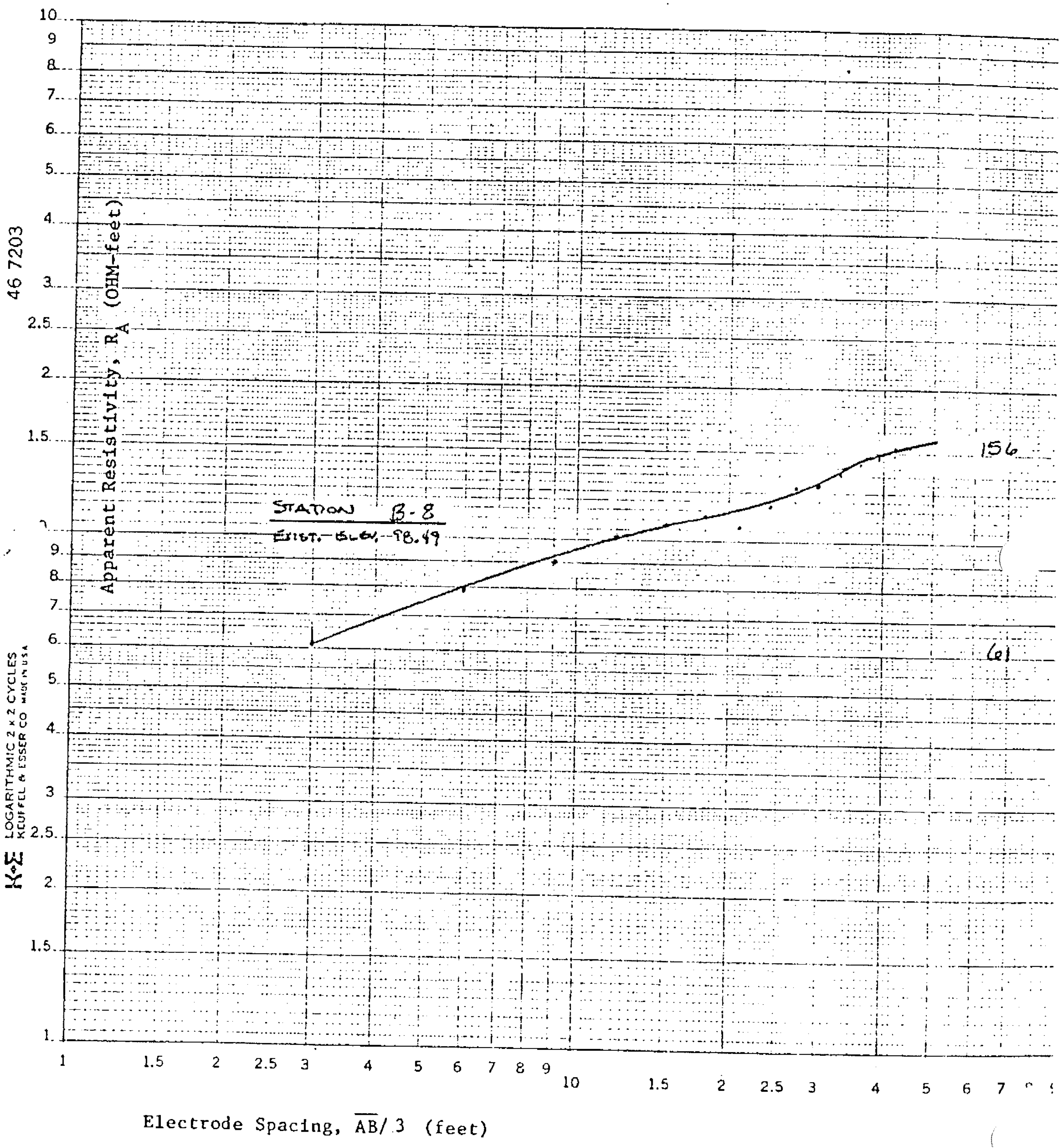
RESISTIVITY PLOT



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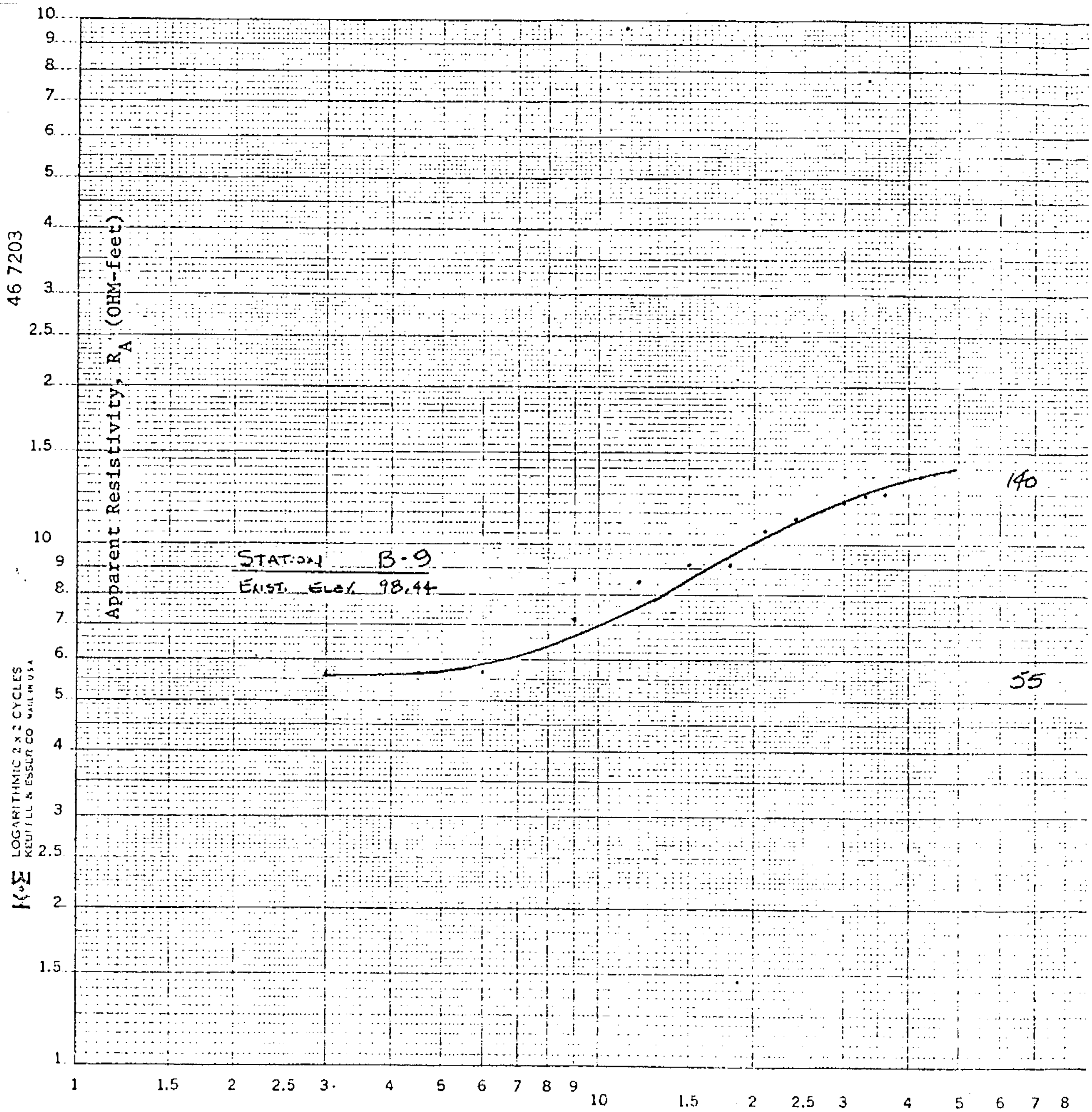
EQUIVALENCY PROGRAM

RESISTIVITY PLOT



Electrode Spacing, $\overline{AB}/3$ (feet)

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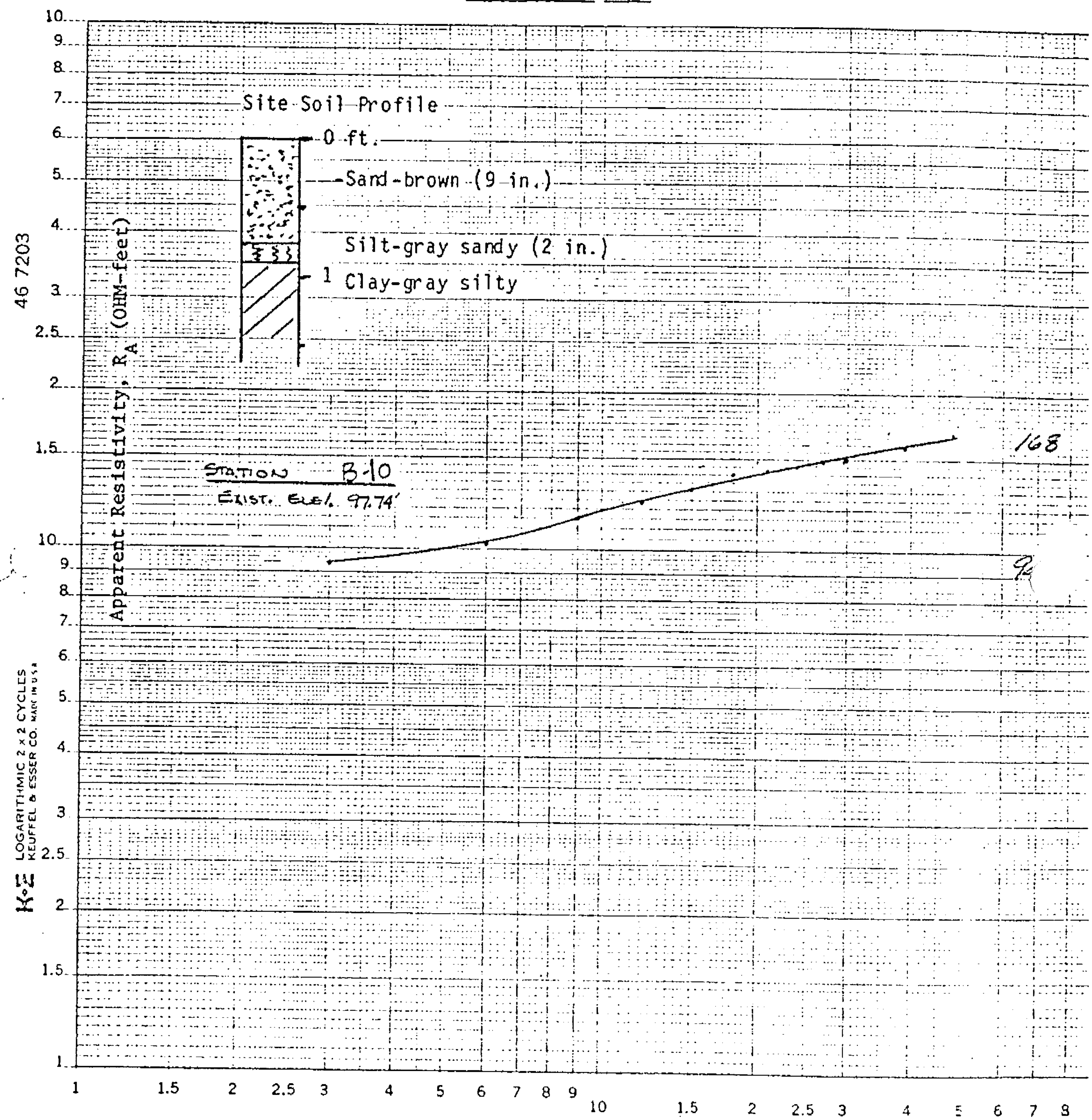
EQUIVALENCY PROGRAM

RESISTIVITY PLOT

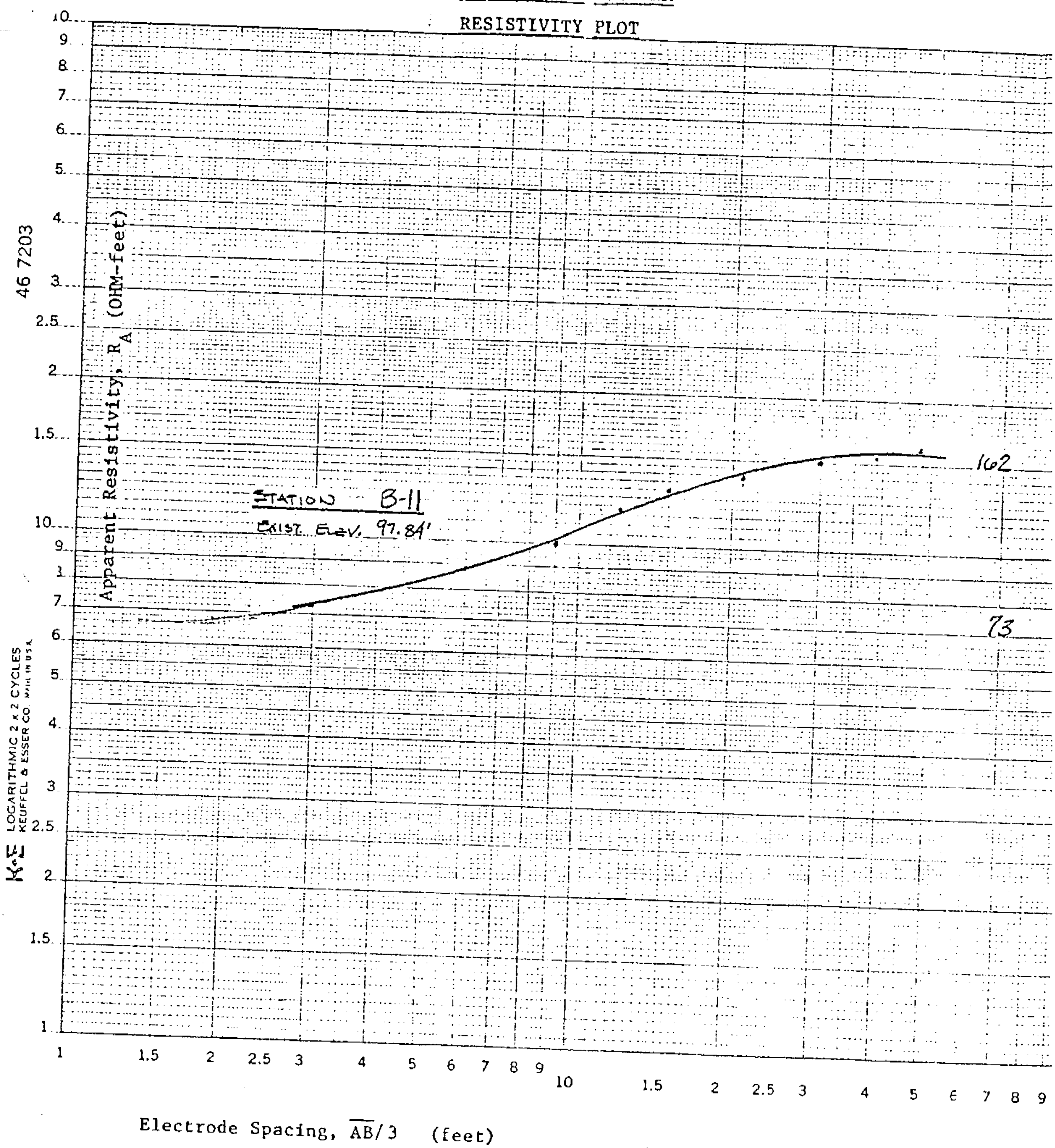


Electrode Spacing, $\overline{AB}/3$ (feet)

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT



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EQUIVALENCY PROGRAM

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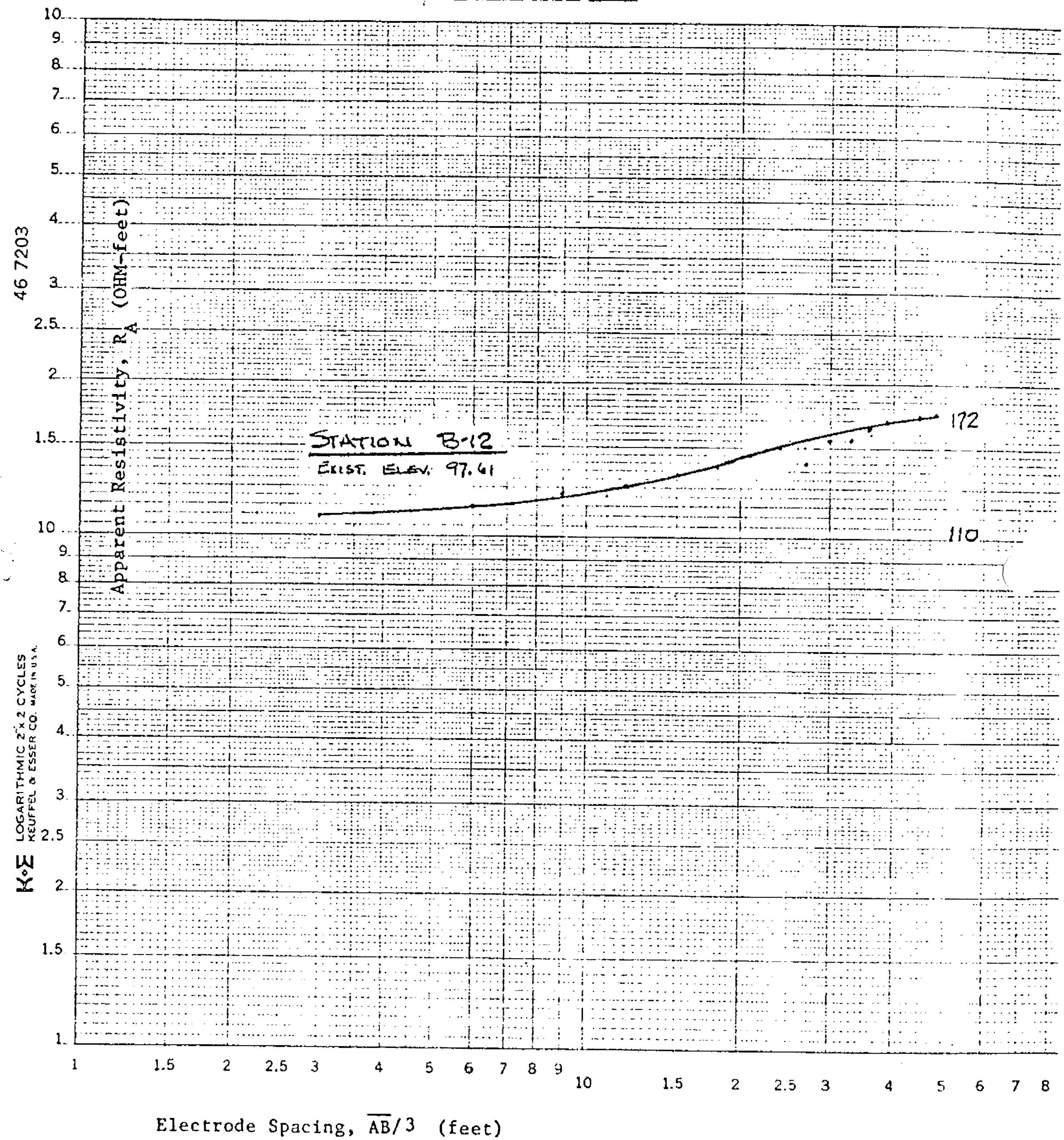

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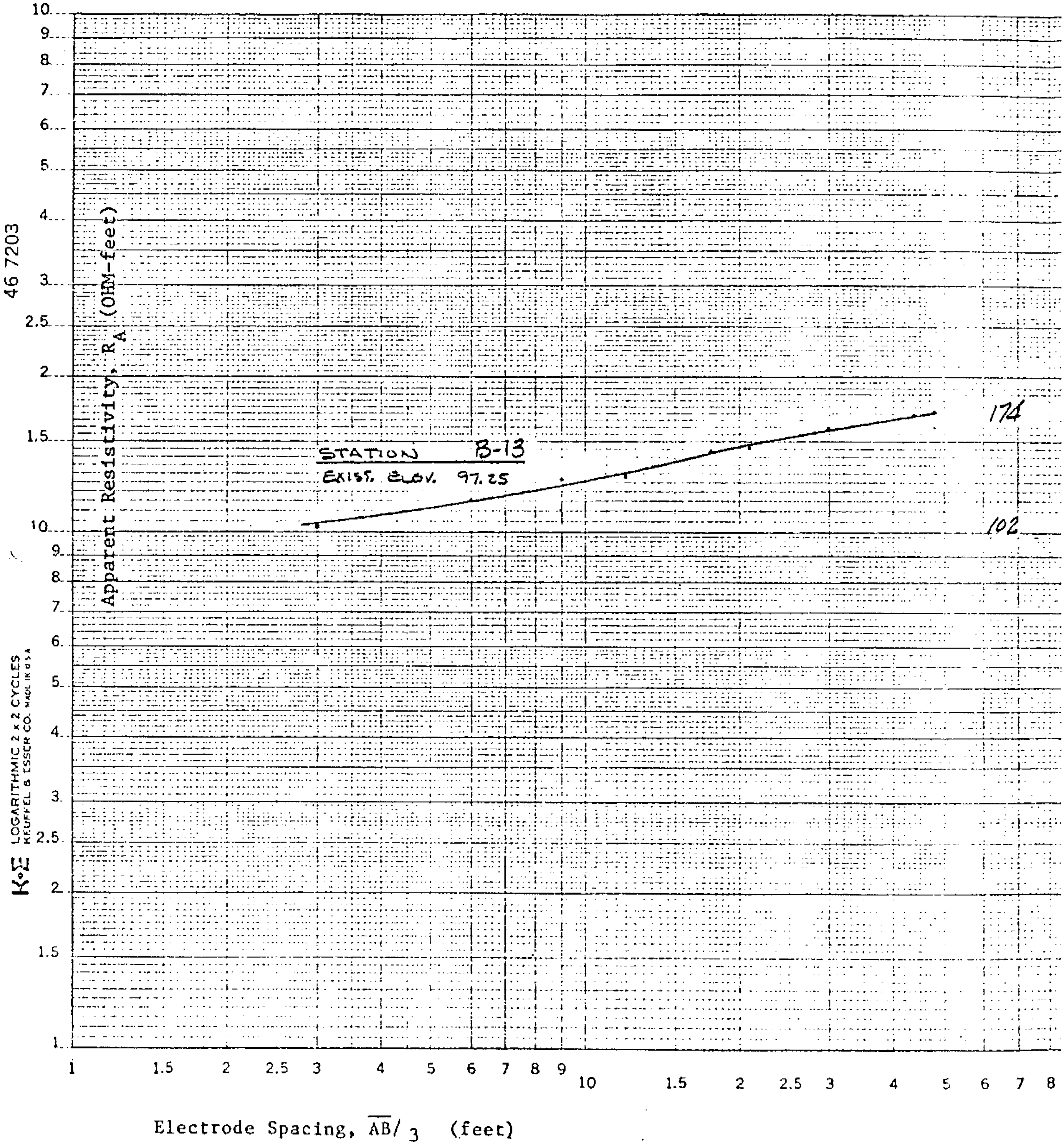

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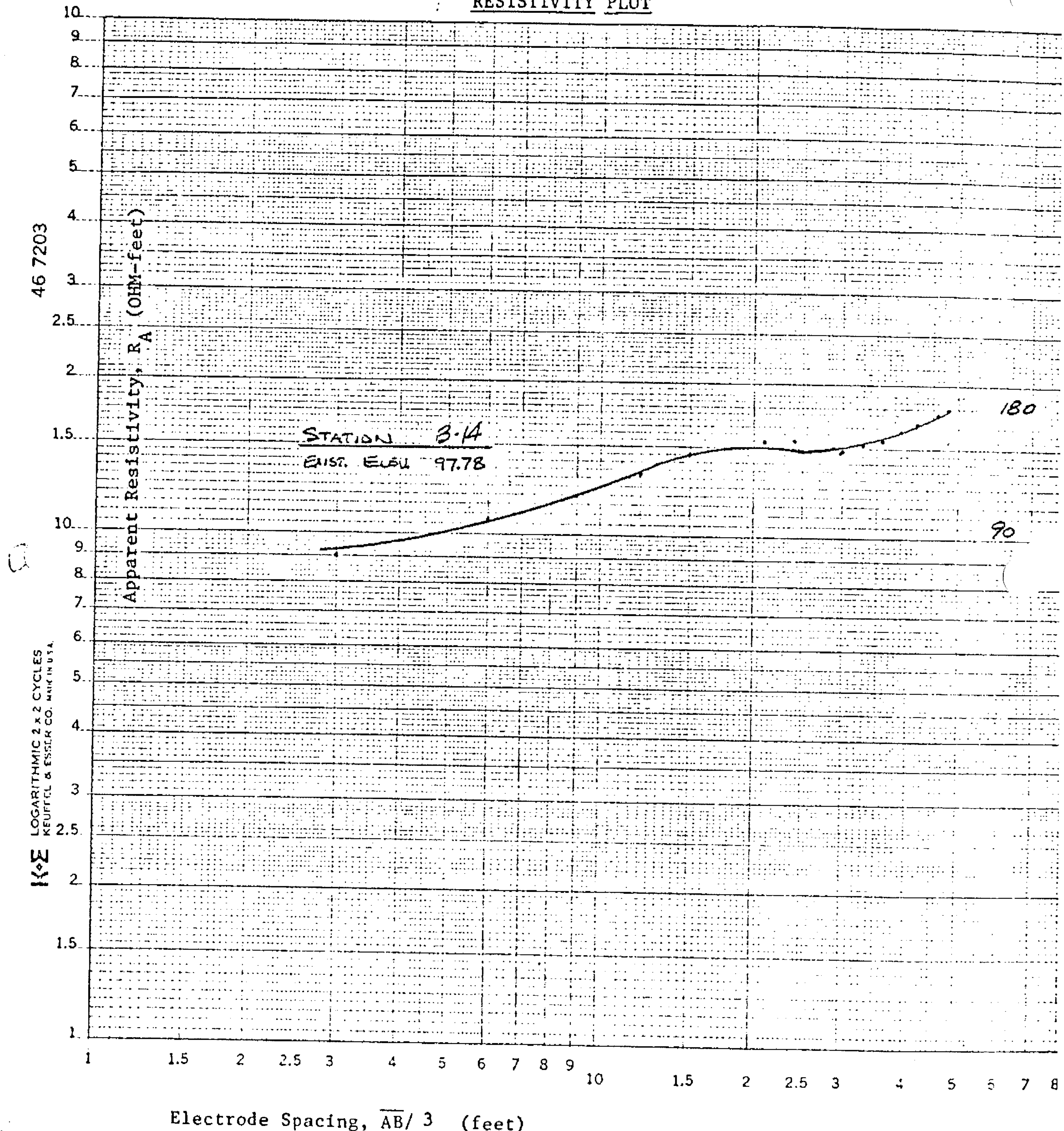

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EQUIVALENCY PROGRAM

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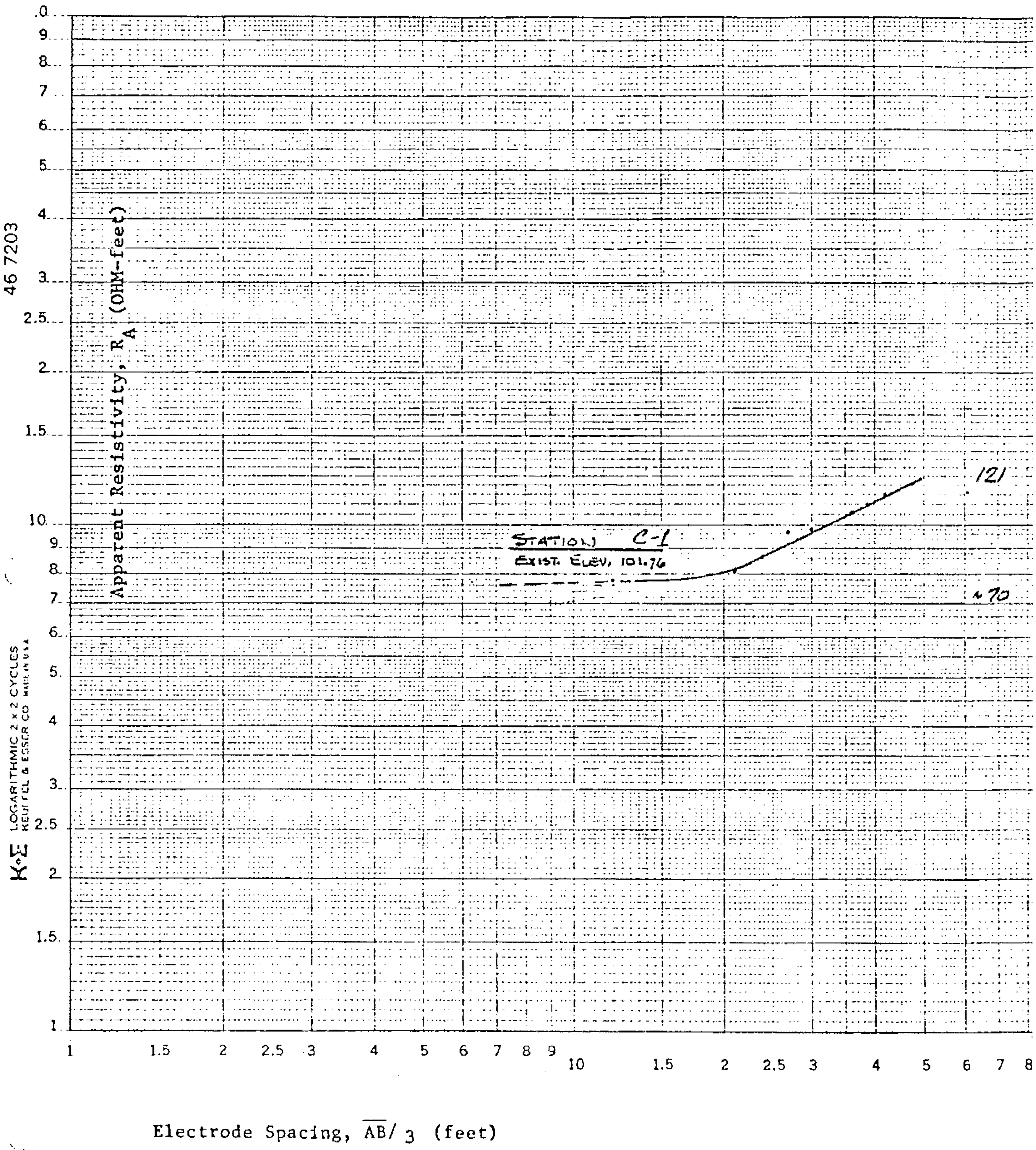

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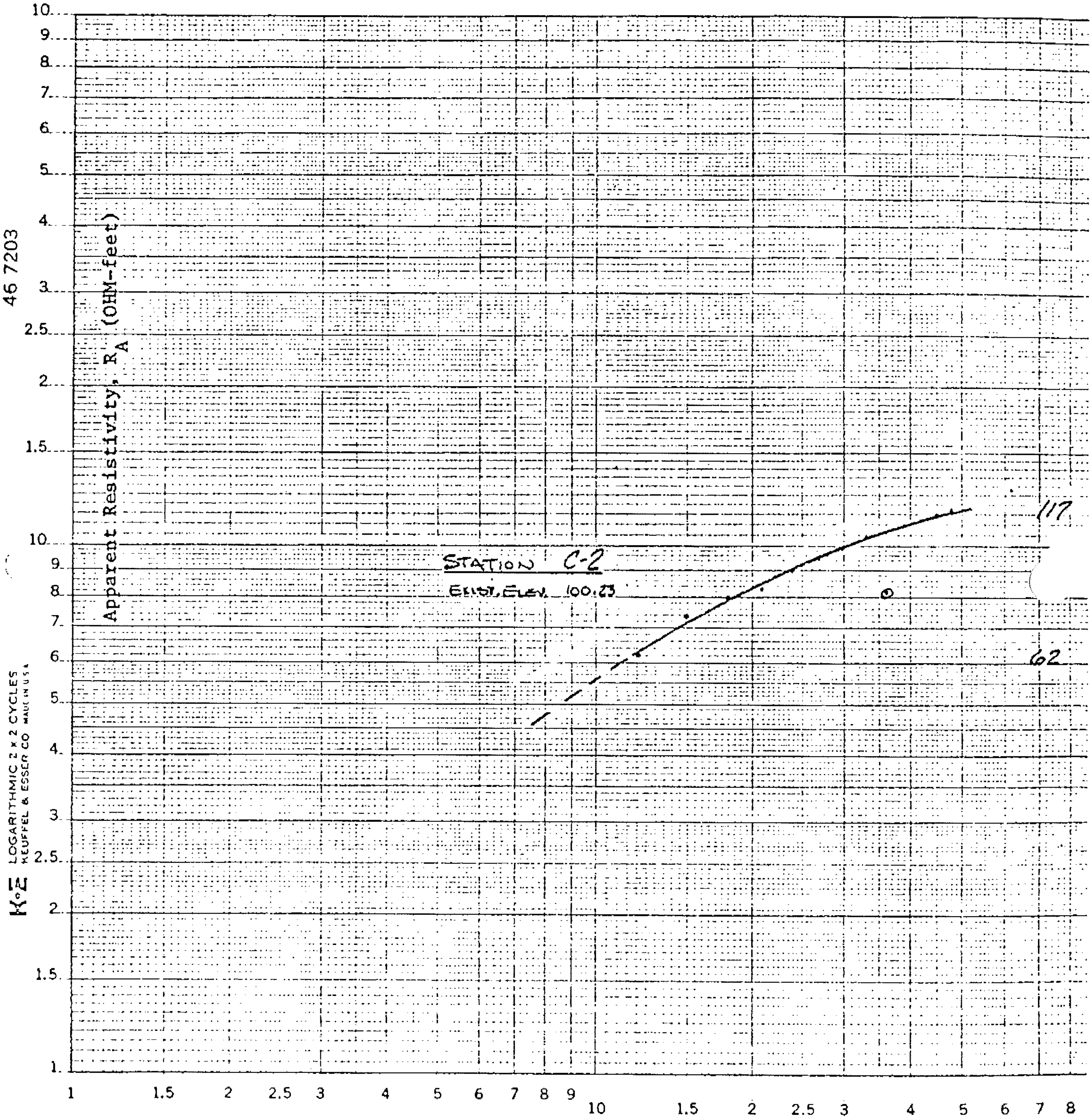
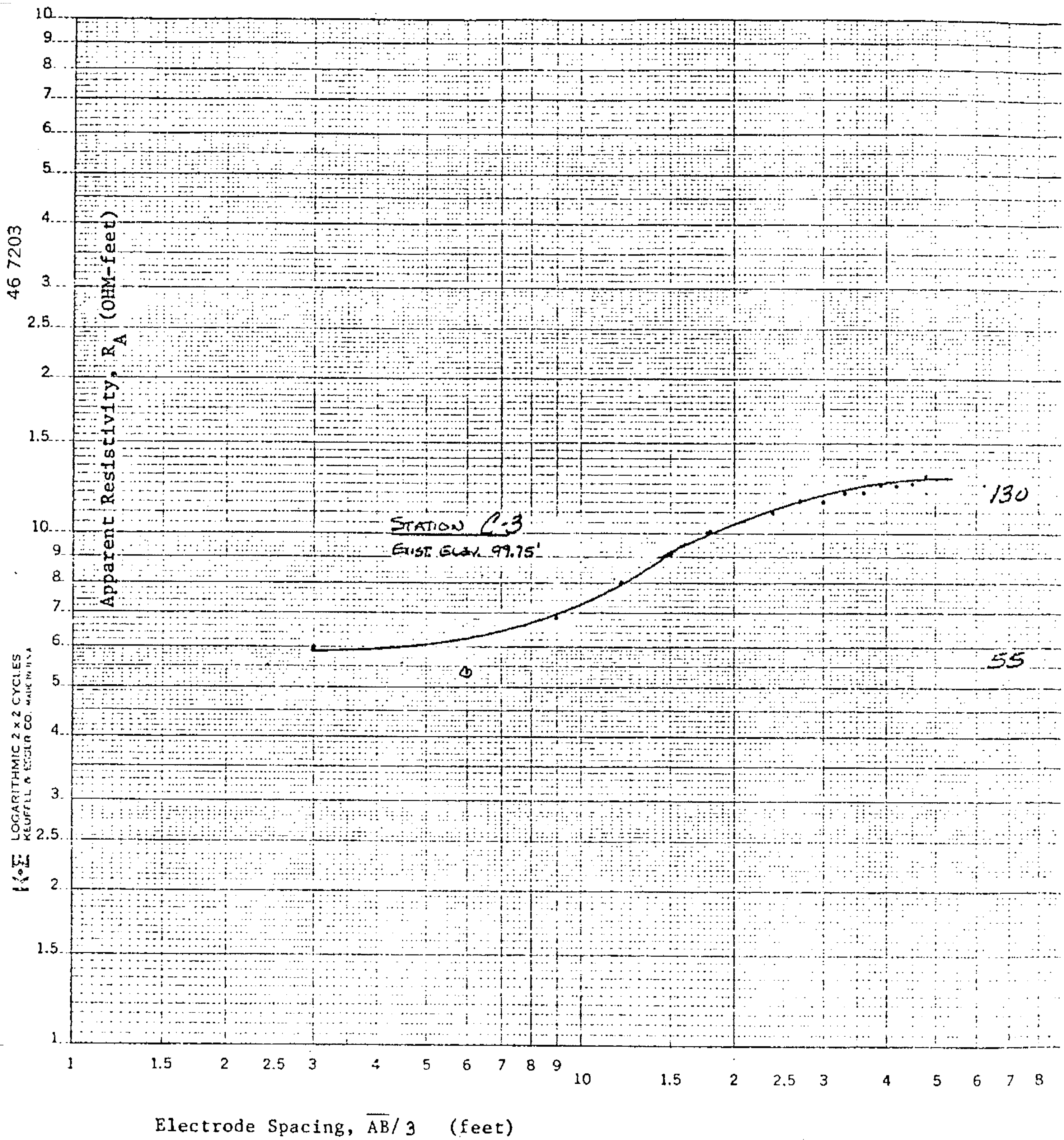


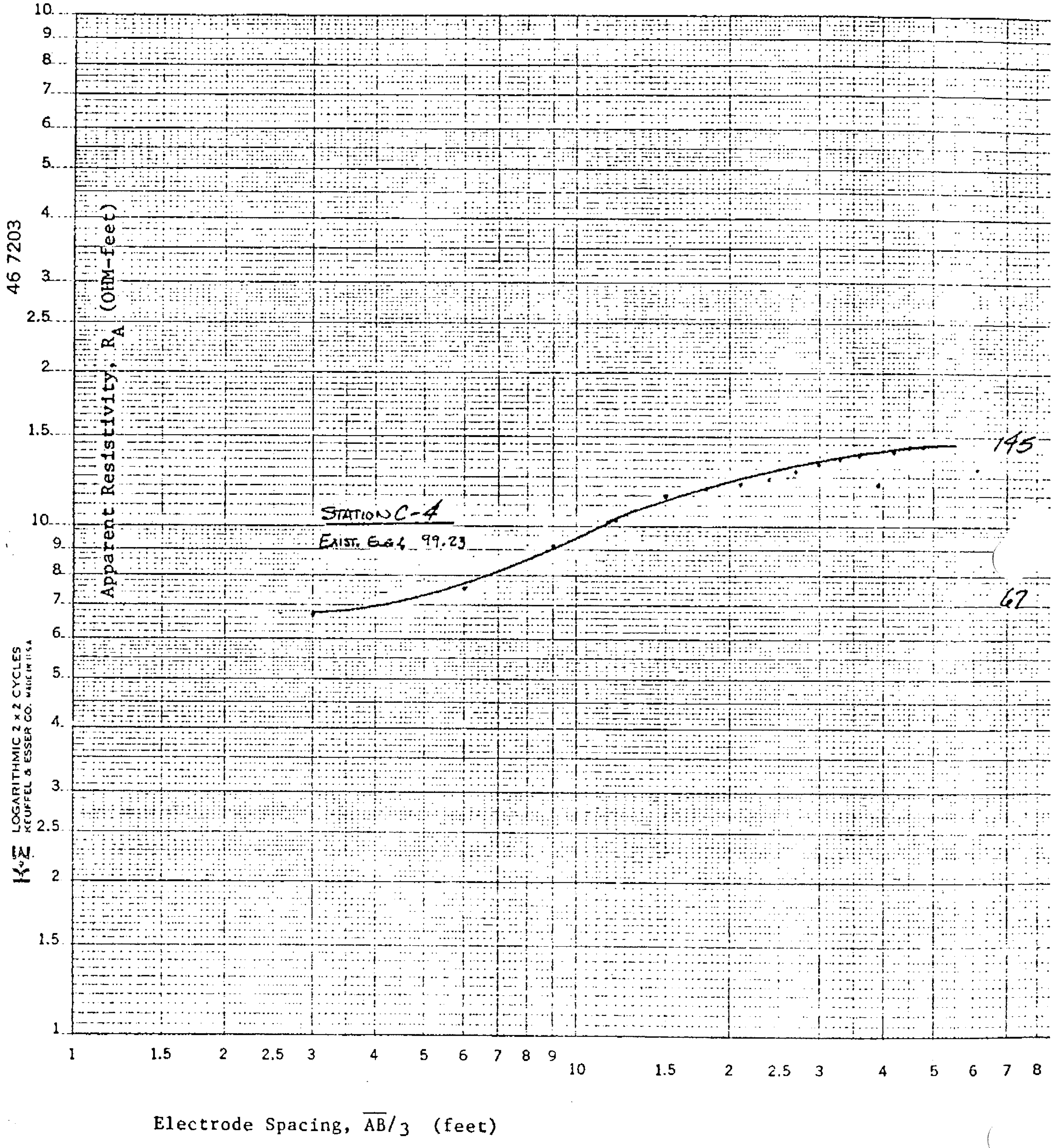
Electrode Spacing, $\overline{AB}/3$ (feet)

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT




46 7203
Apparent Resistivity, R_A (OHM-feet)
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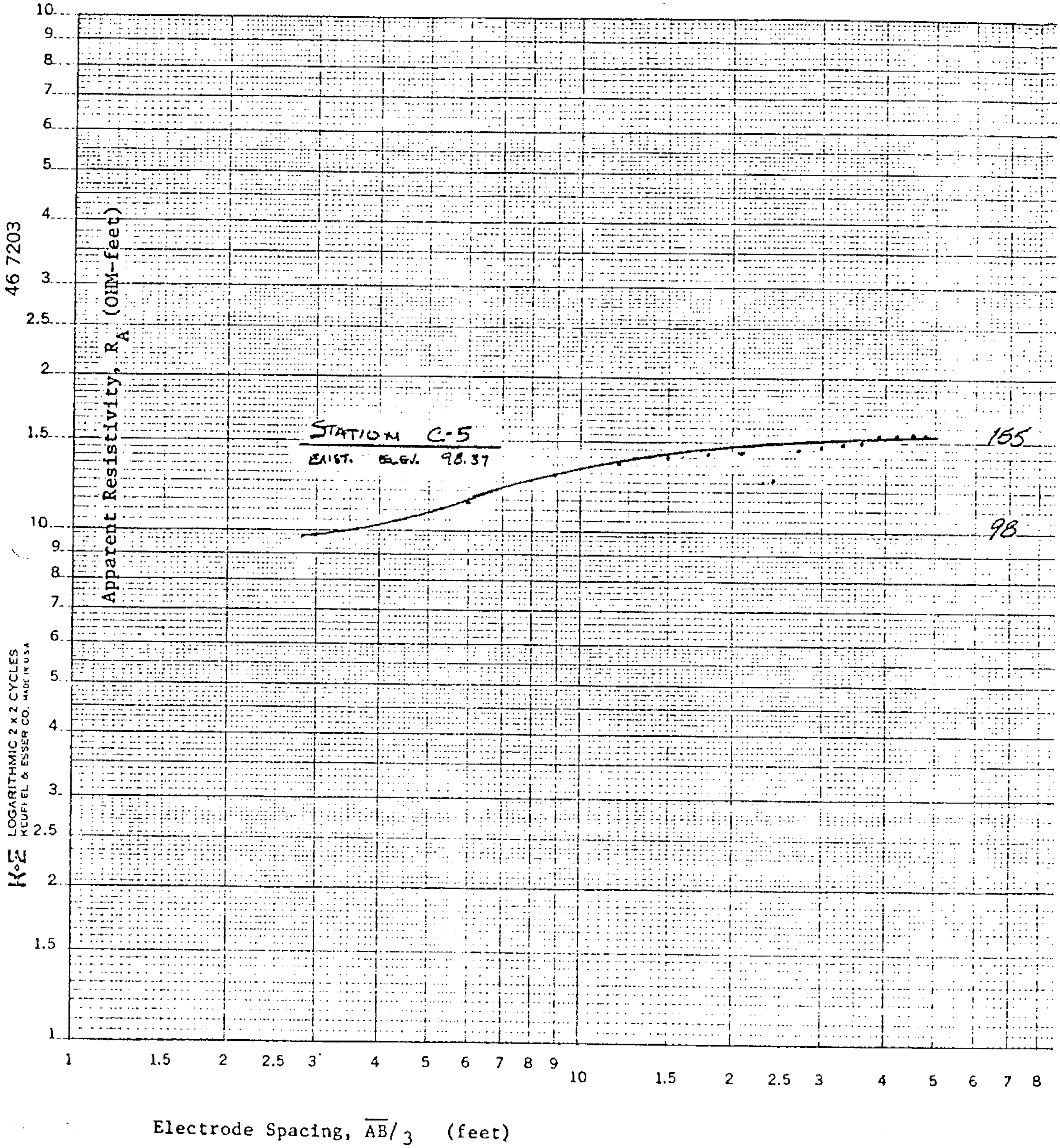
K+E LOGARITHMIC 2 x 2 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.
Electrode Spacing, $\overline{AB}/3$ (feet)

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

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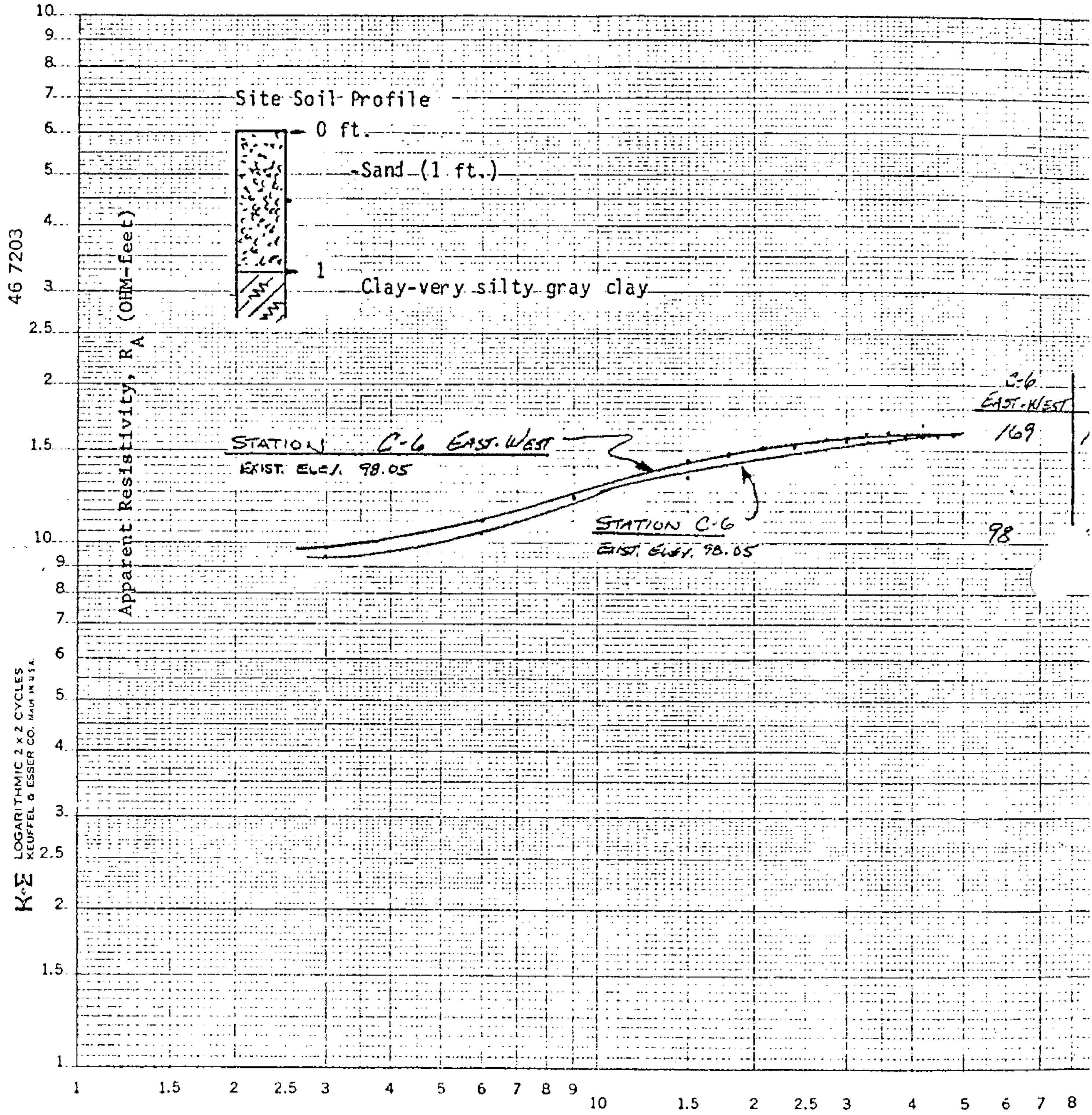
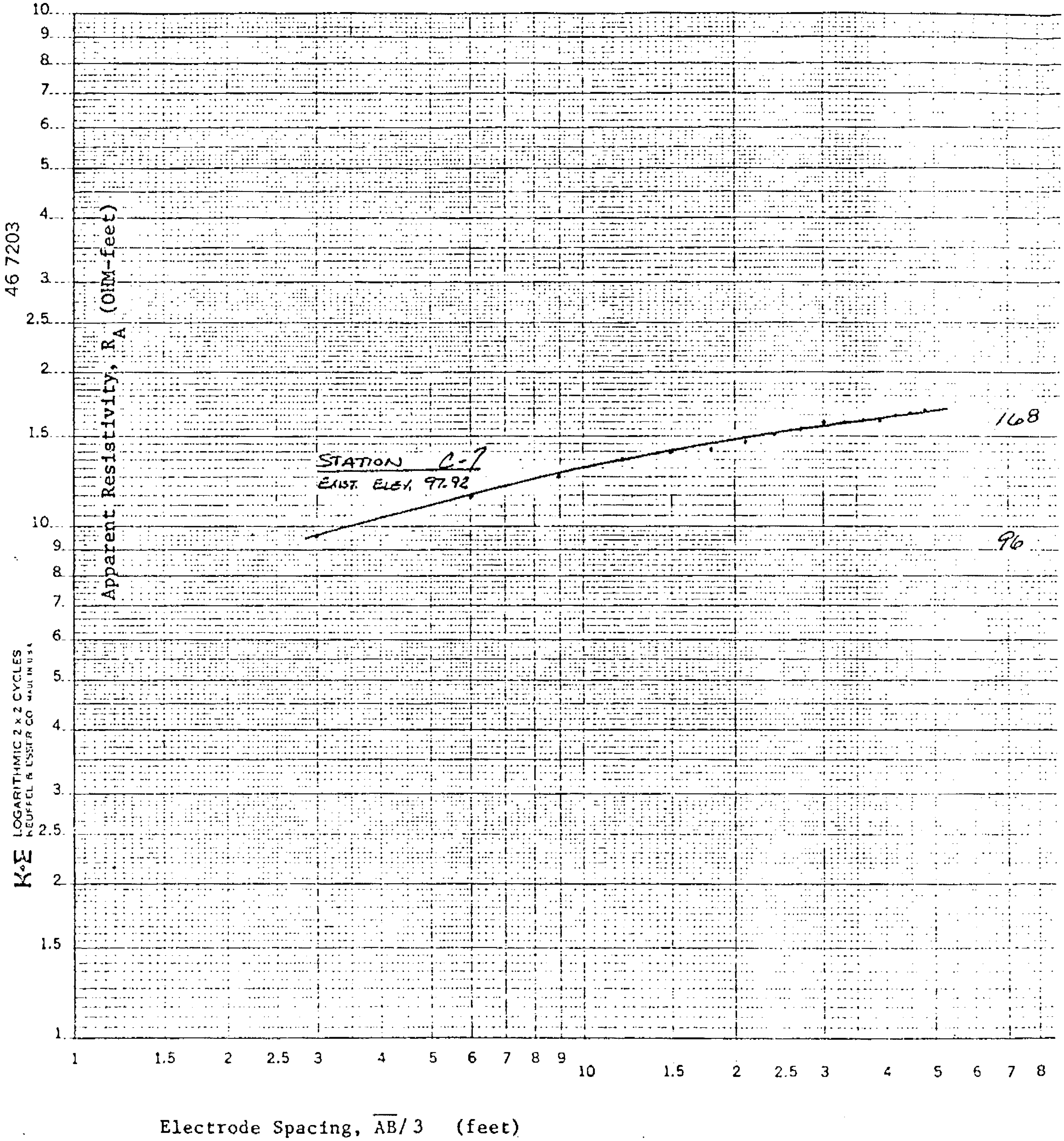


Electrode Spacing, $\overline{AB}/3$ (feet)

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

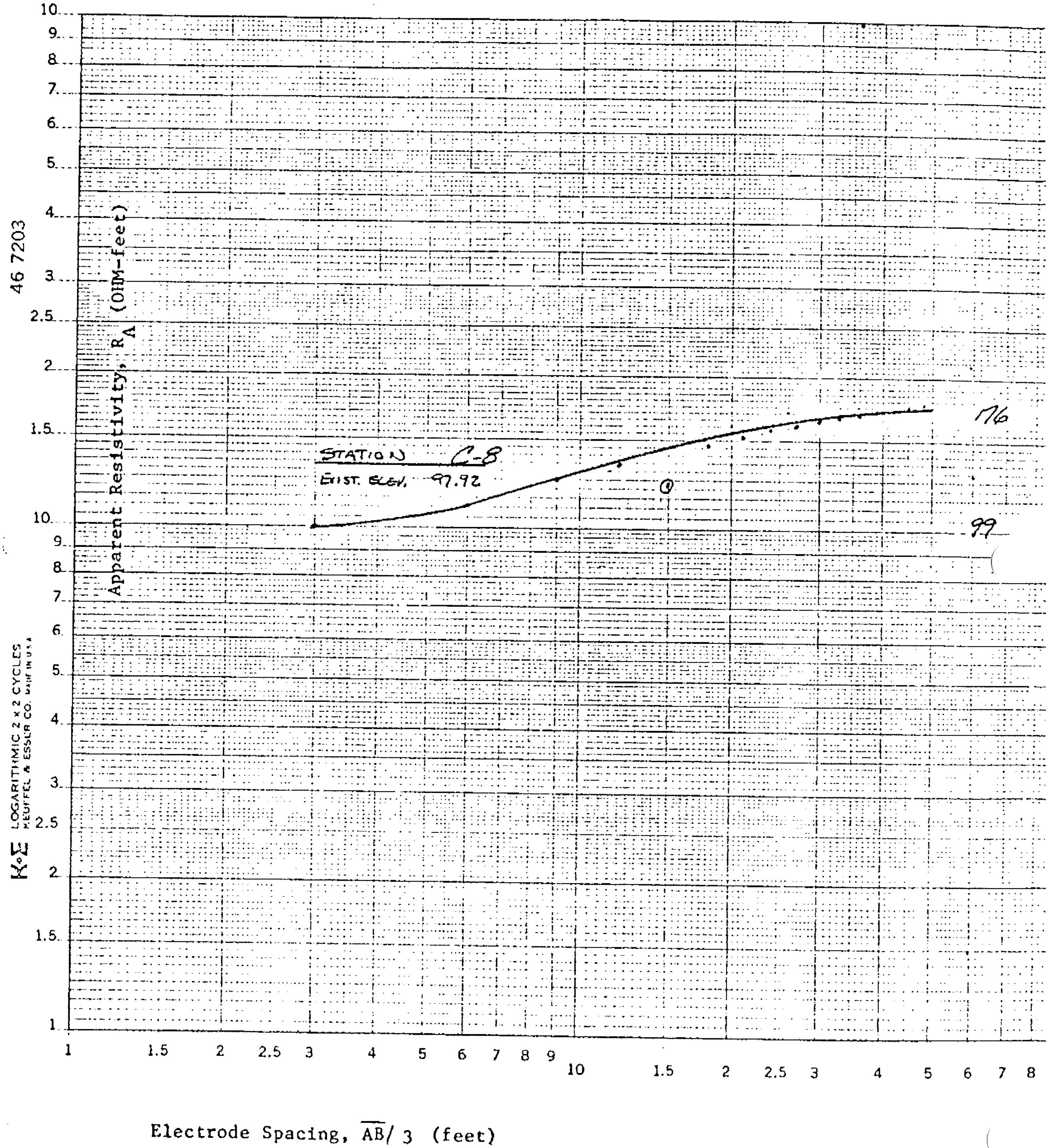
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

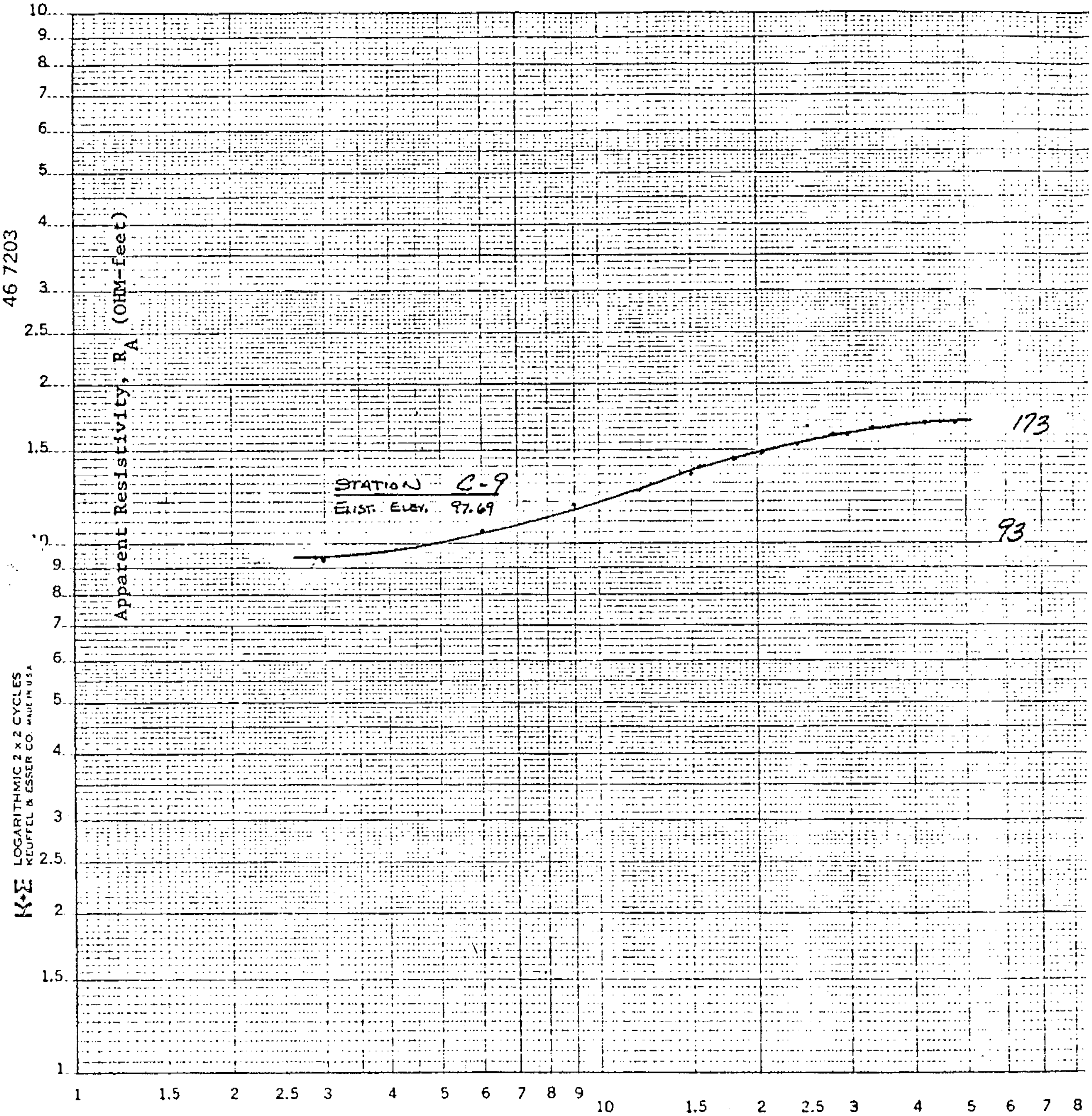
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT

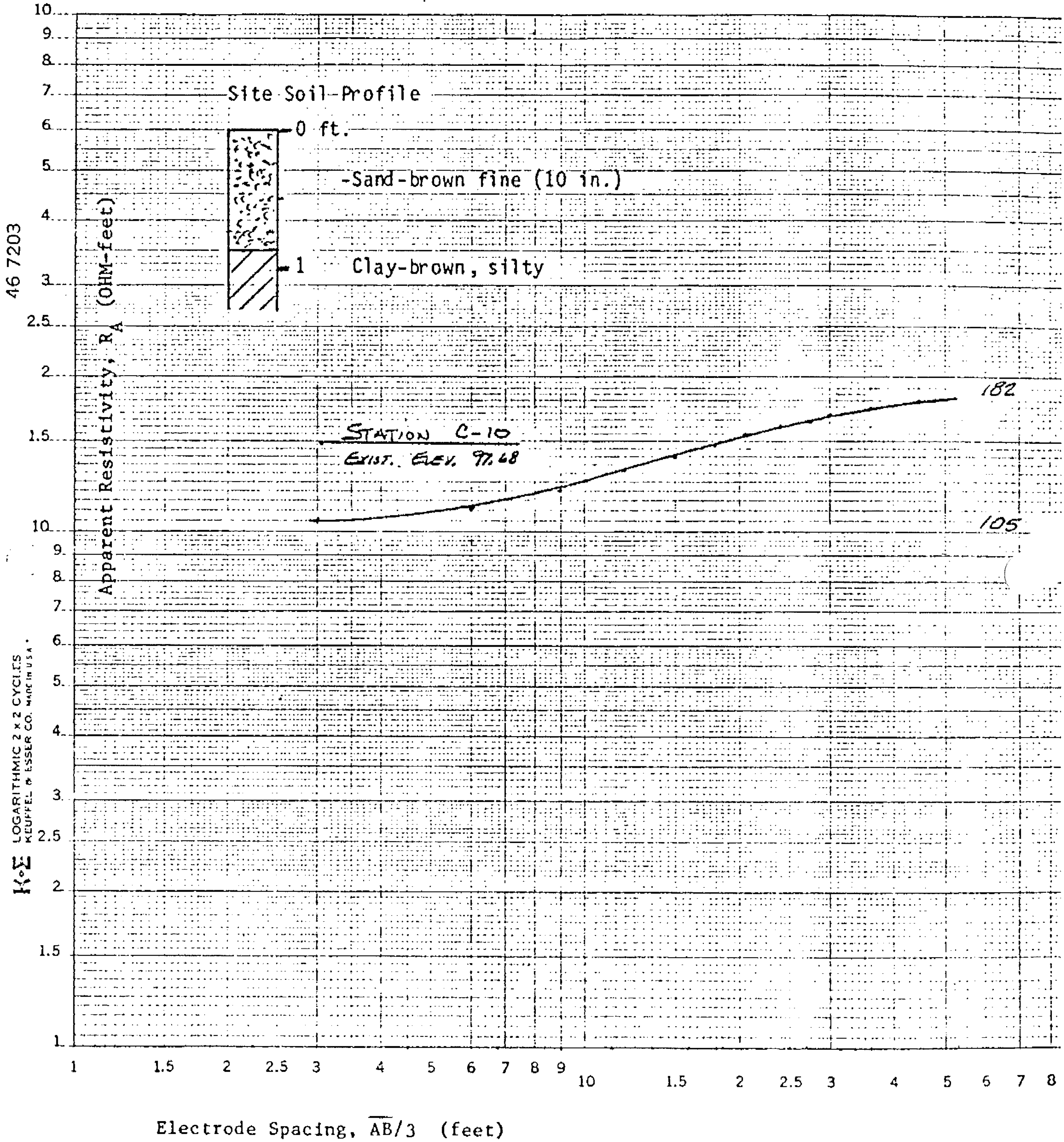


Electrode Spacing, $\overline{AB}/3$ (feet)

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

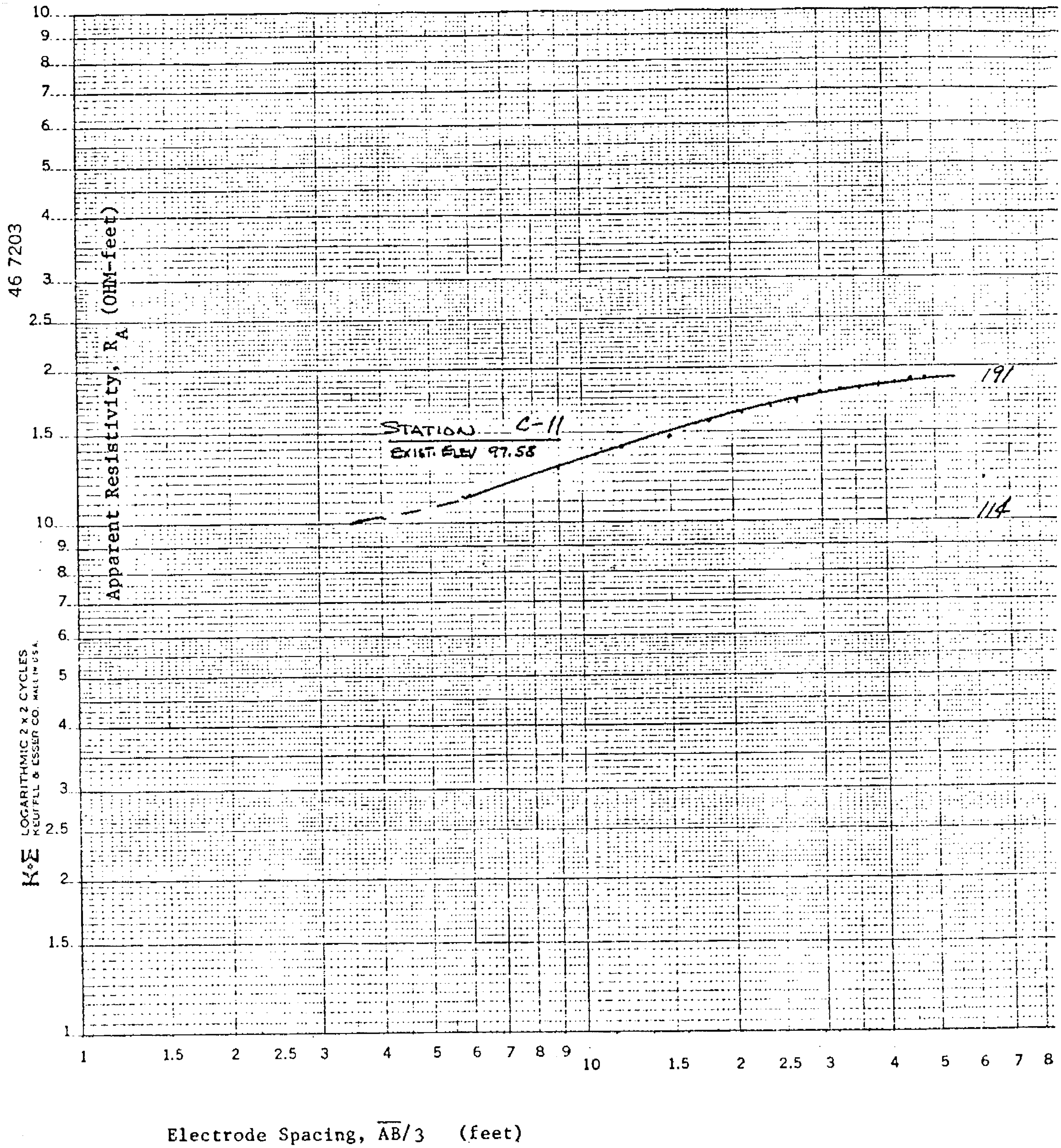
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

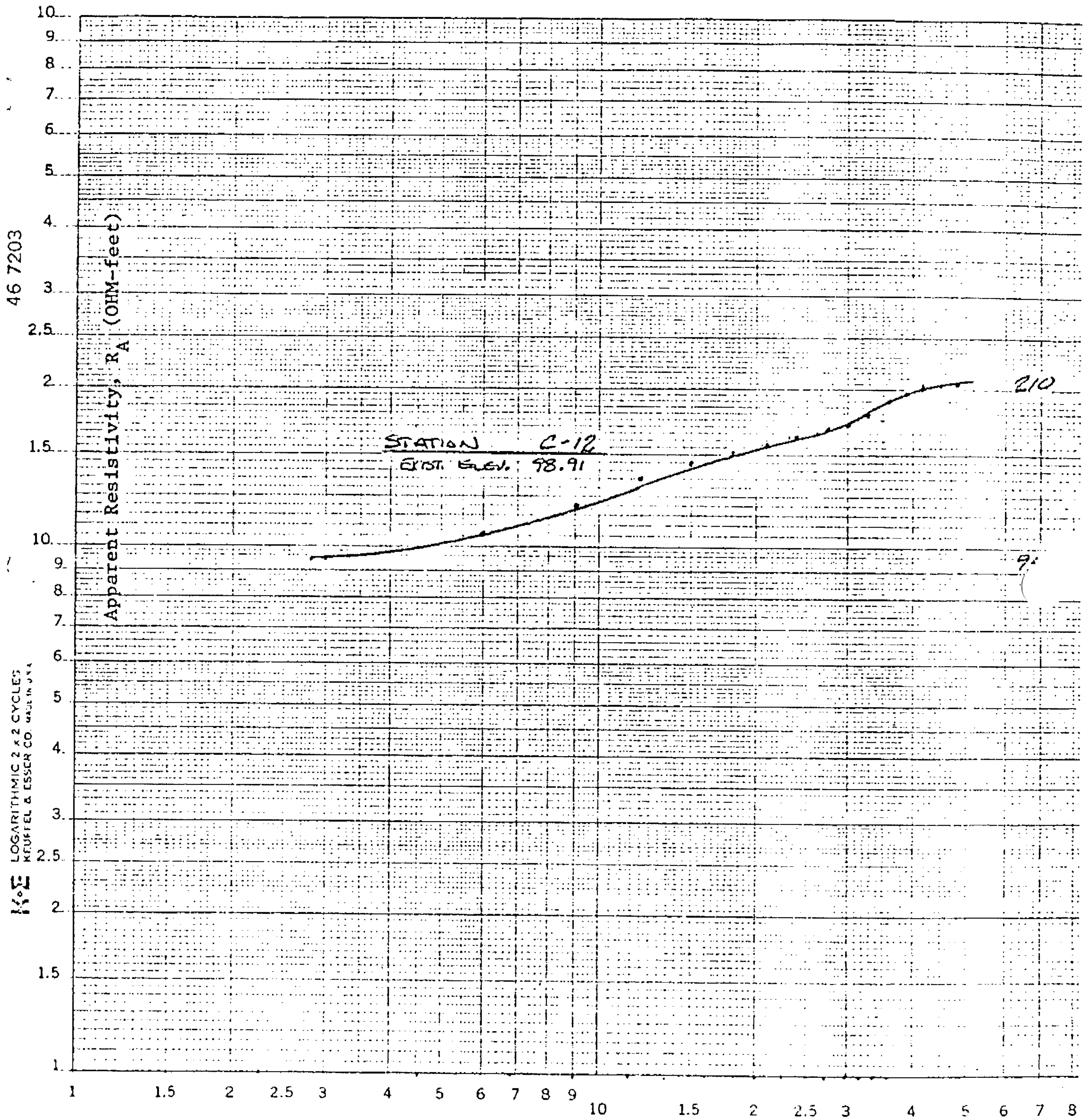
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT

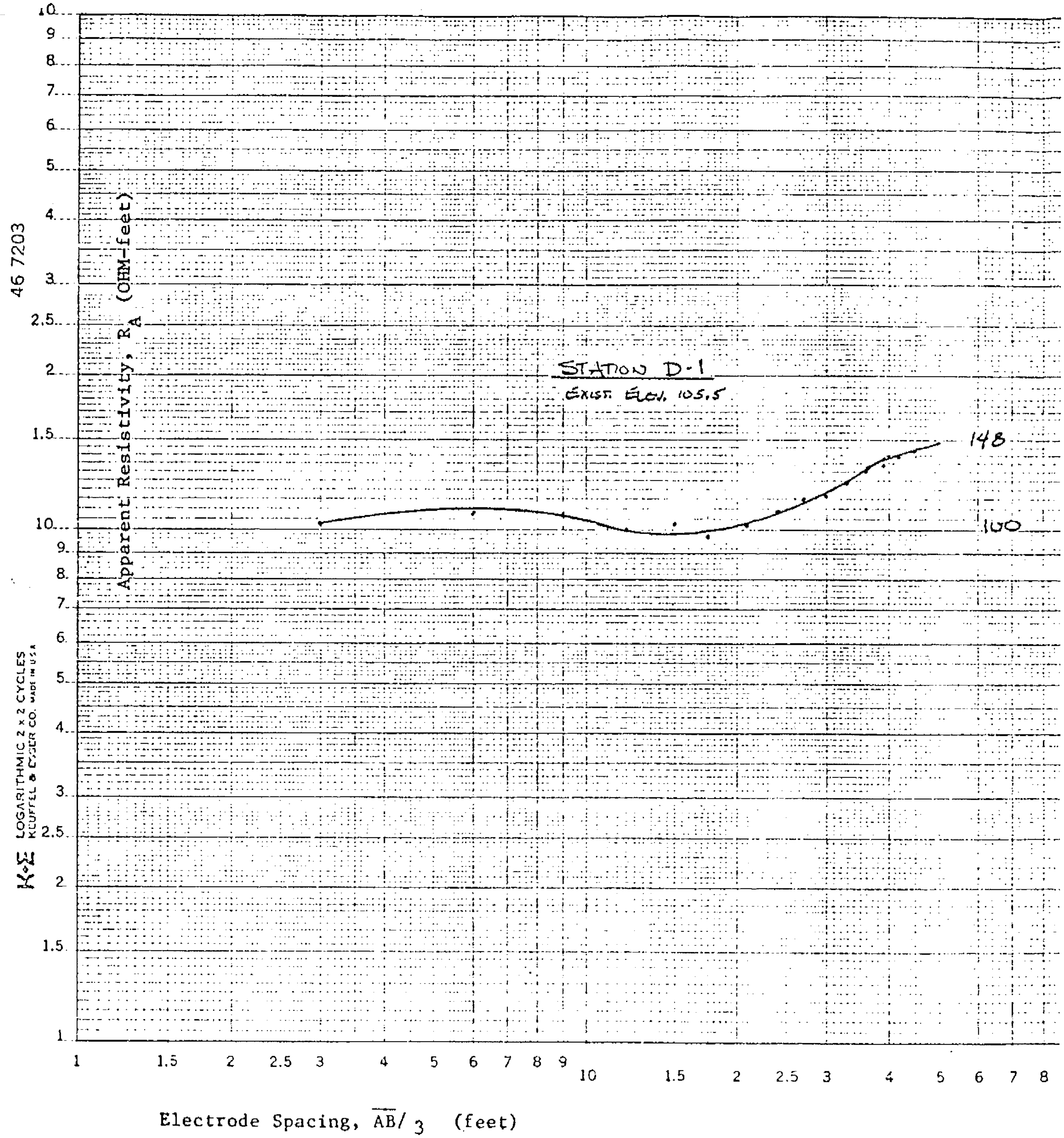


Electrode Spacing, $\overline{AB}/_3$ (feet)

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

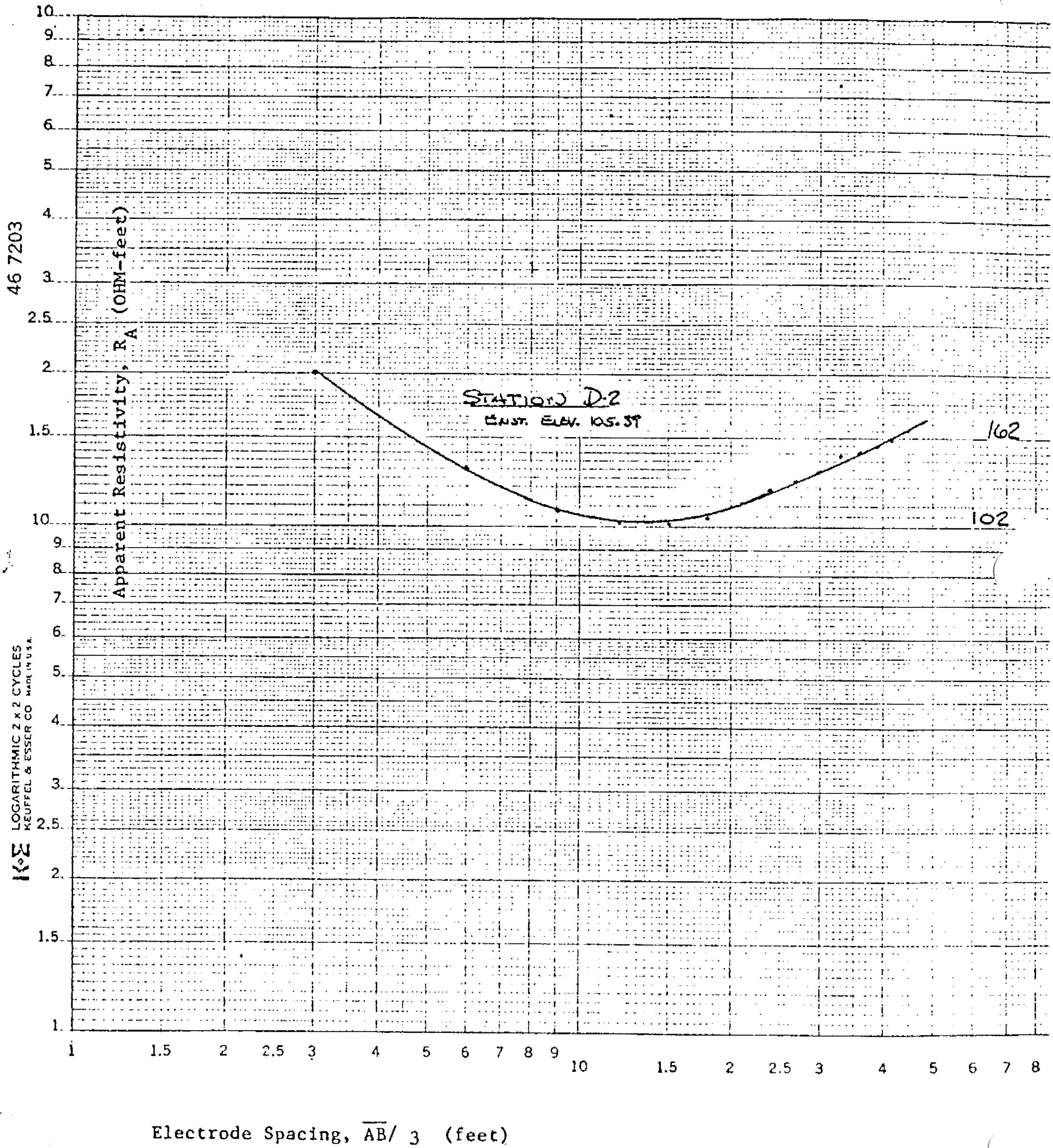
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

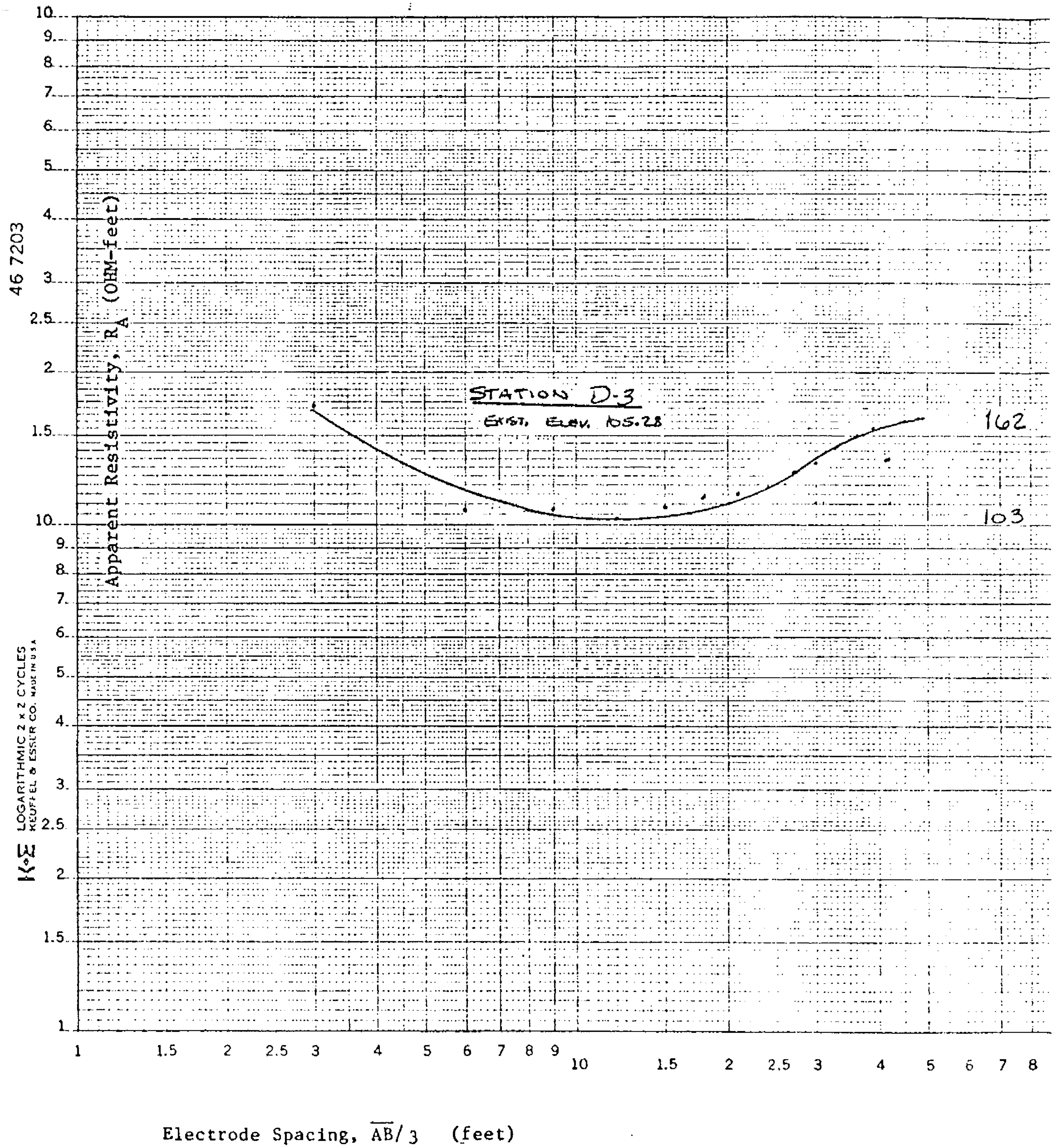
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

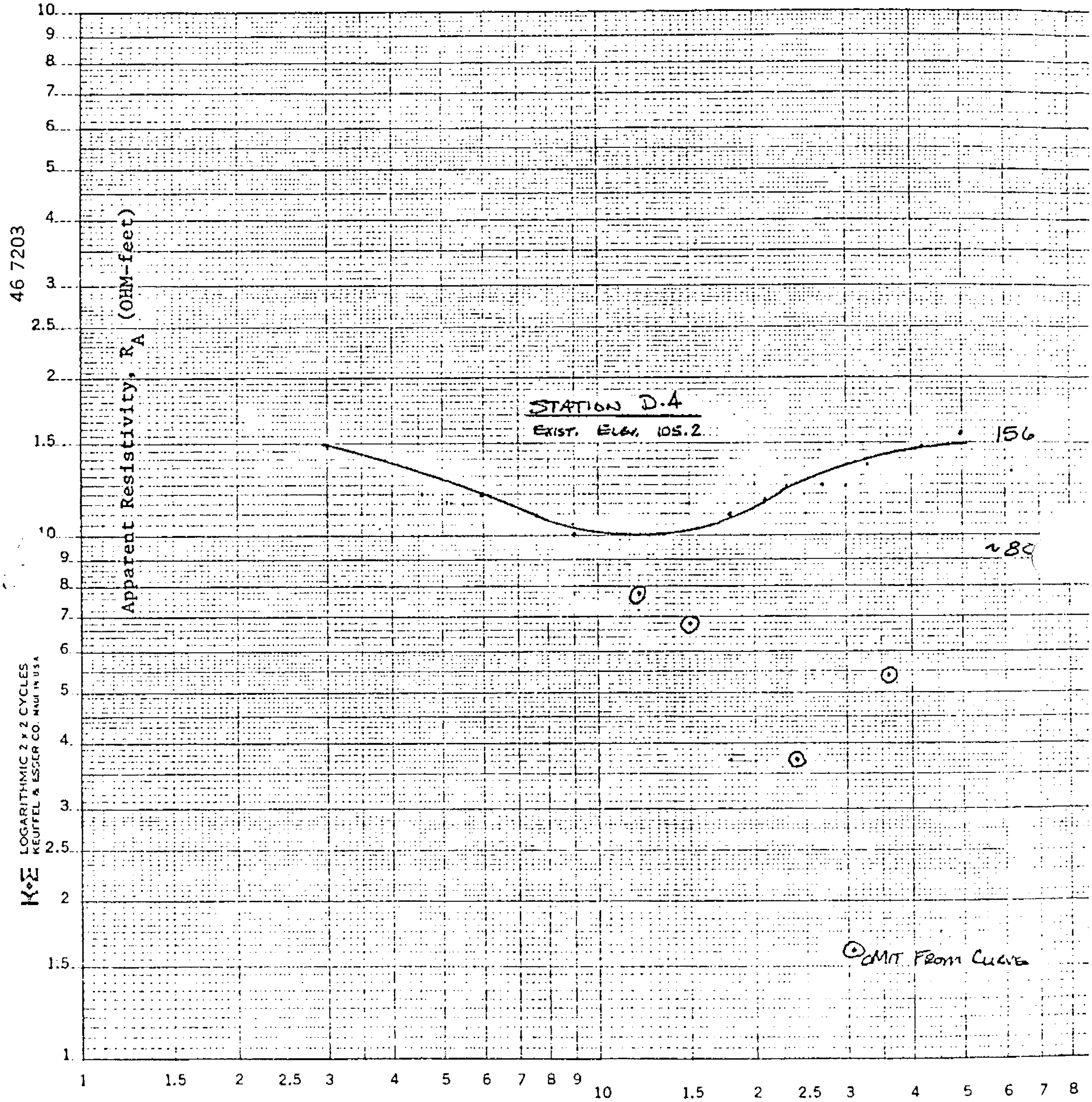
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT

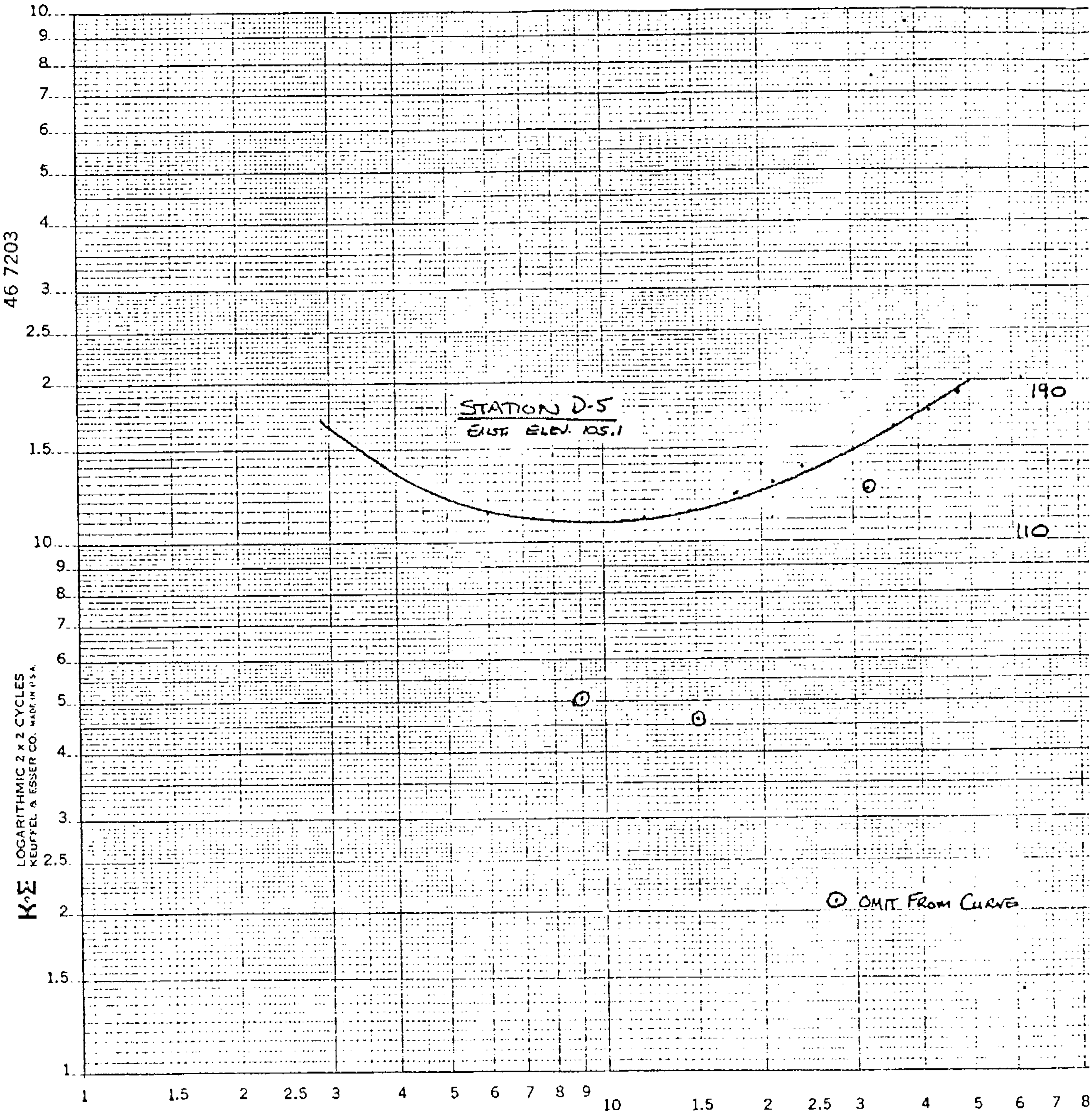


Electrode Spacing, $\overline{AB}/3$ (feet)

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT

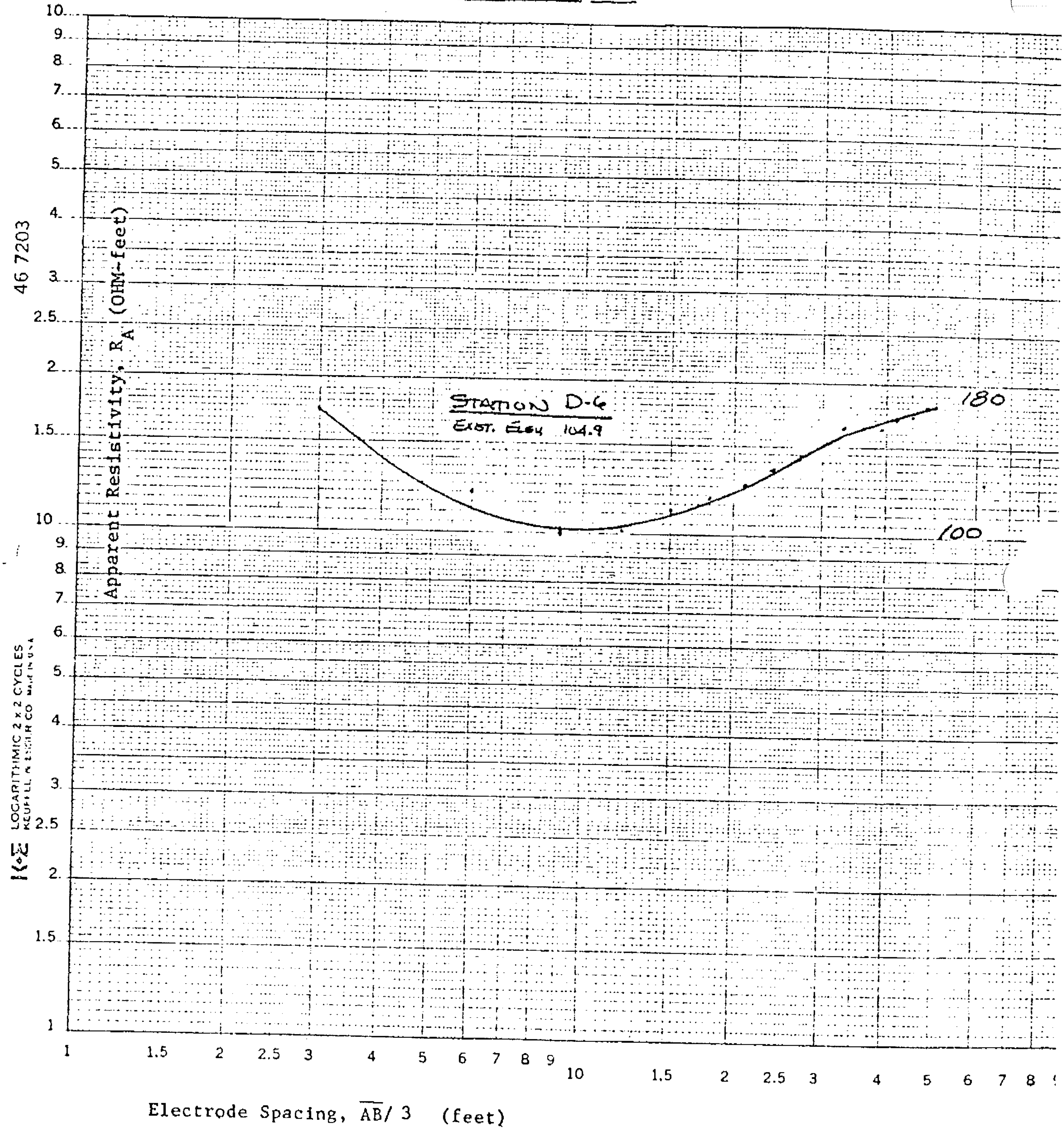


Electrode Spacing, $\overline{AB}/3$ (feet)

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

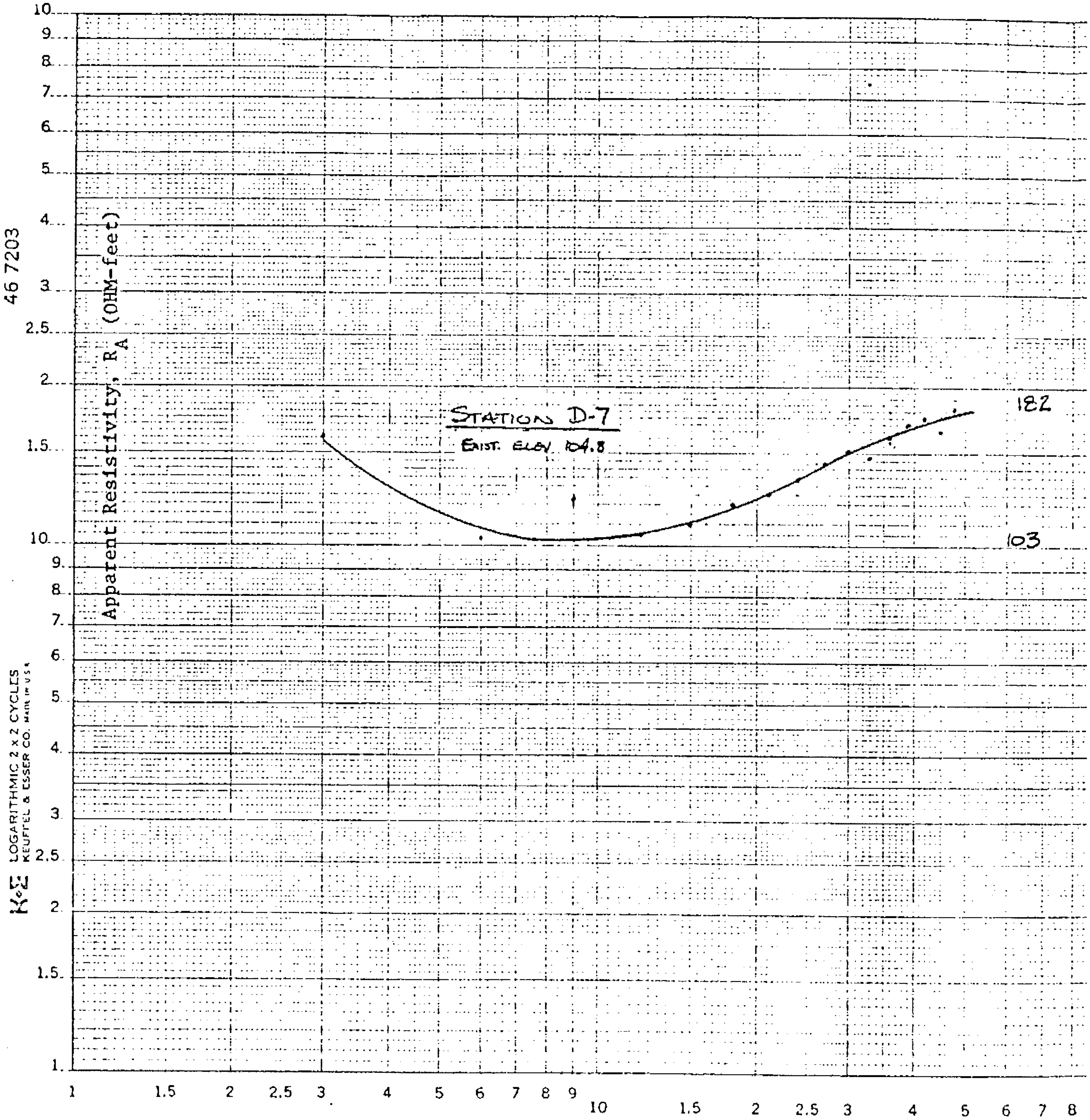
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT

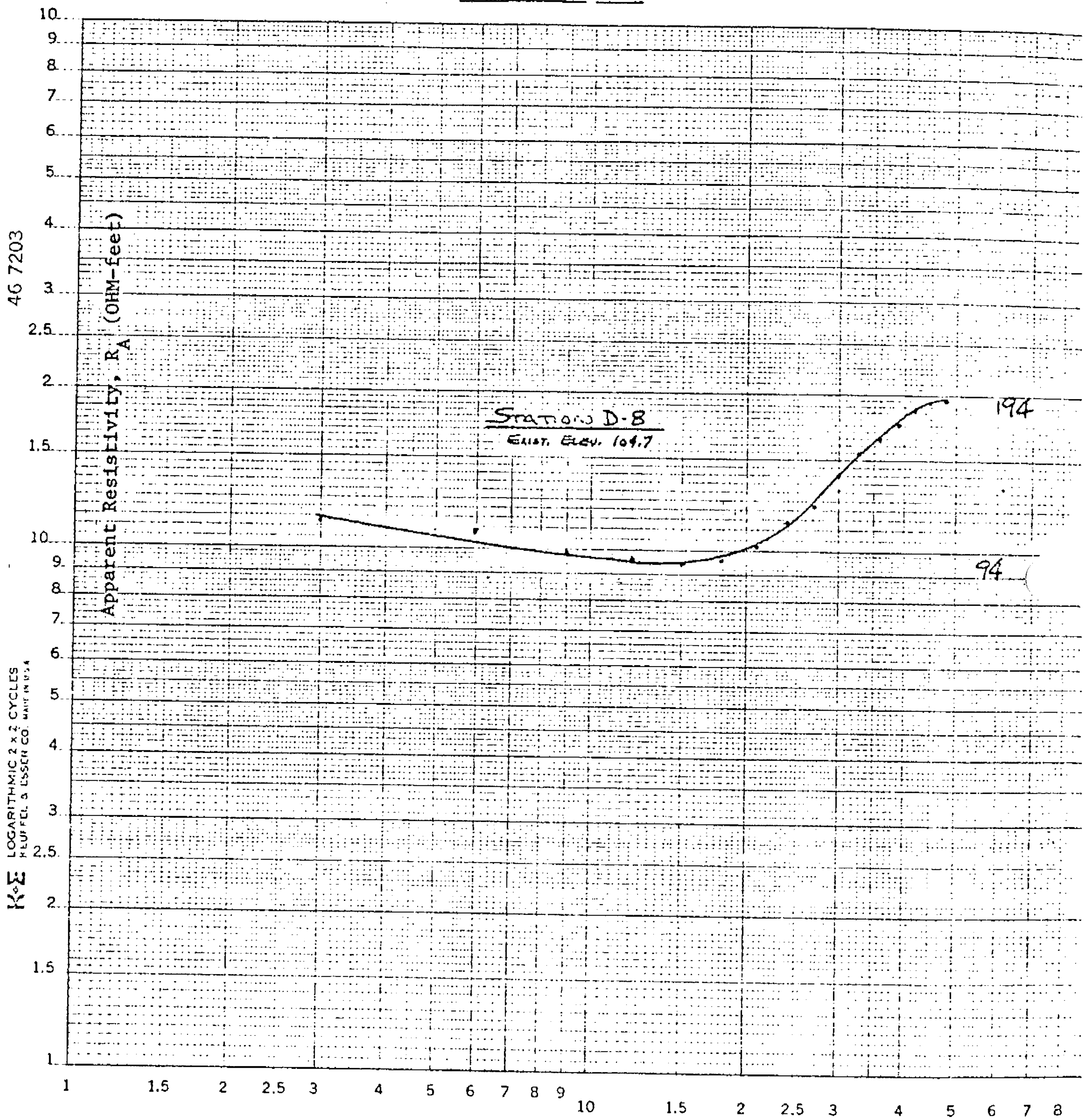


Electrode Spacing, $\overline{AB}/_3$ (feet)

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT



Electrode Spacing, $\overline{AB}/3$ (feet)

Resistivity Analysis

Section 3 - Field Data Interpretation

- Calculated Apparent Resistivity Curves Based On Two And Three Layer Soil Models

- Calculated Vertical Electrical Sounding Curves For Sand Layers In Upper Clay Stratum

FIGURE #2

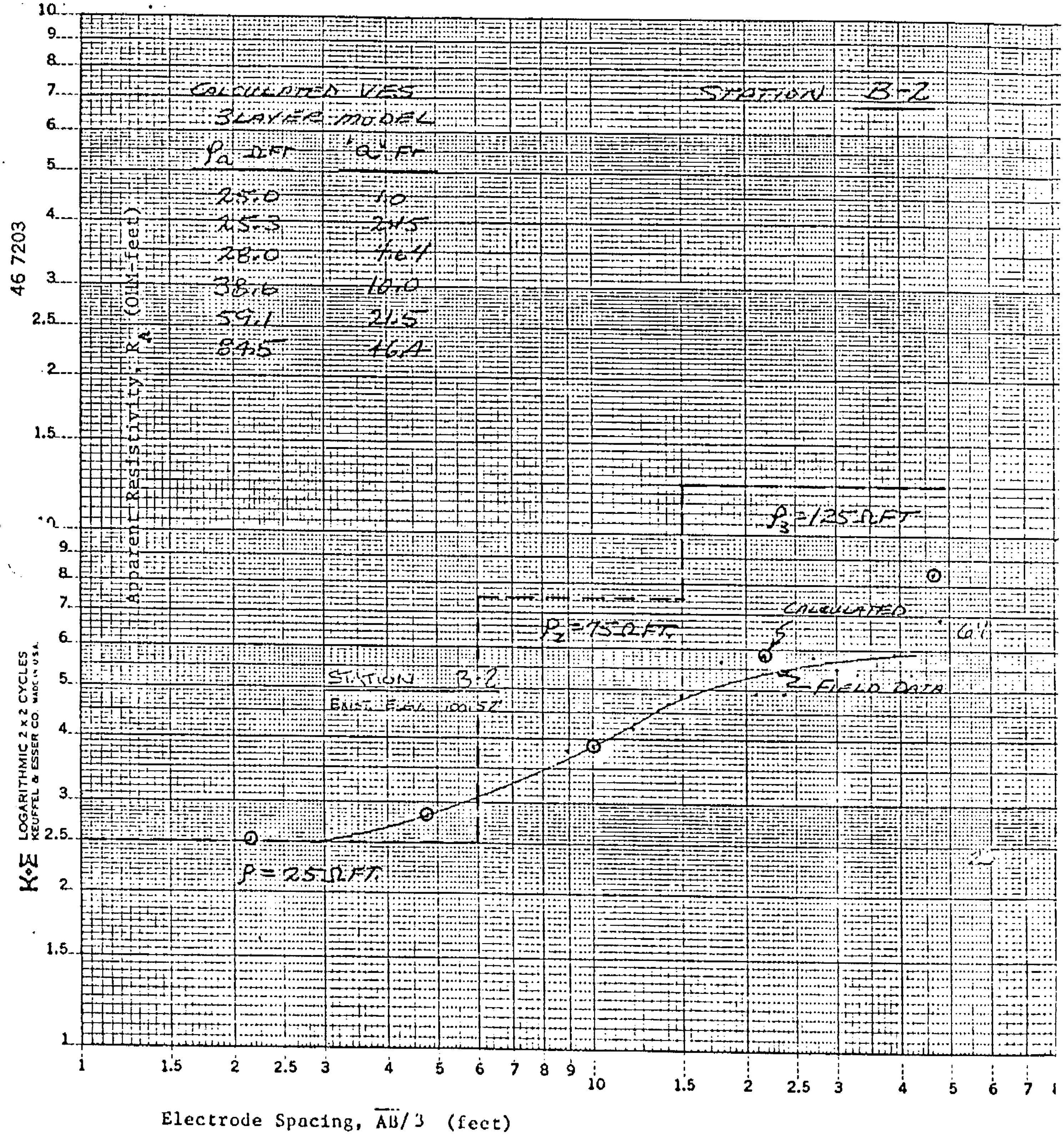
Vertical Electric Sounding Curves

Calculated Apparent Resistivity
Based on Two and Three Layer Soil Models

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

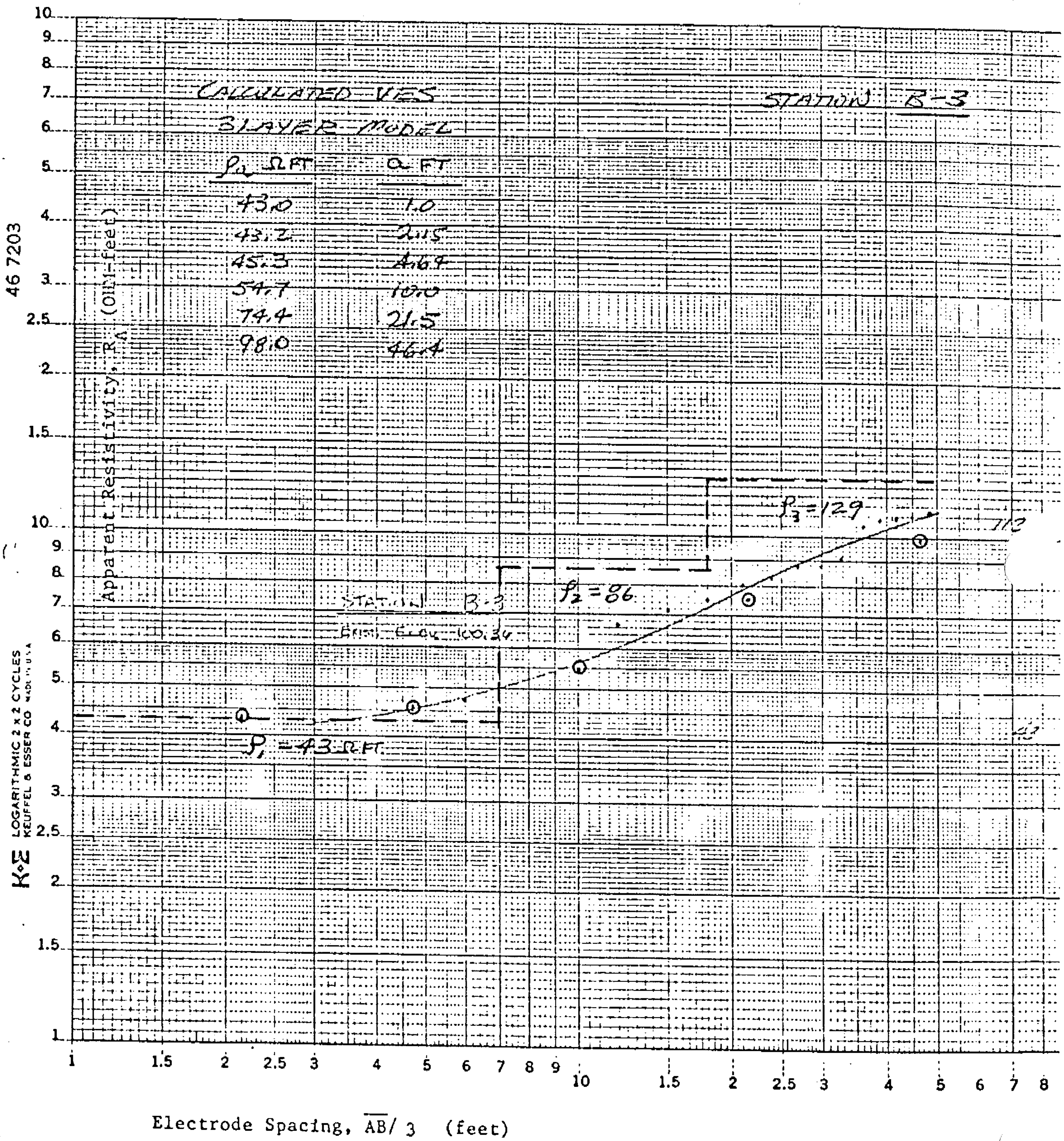
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

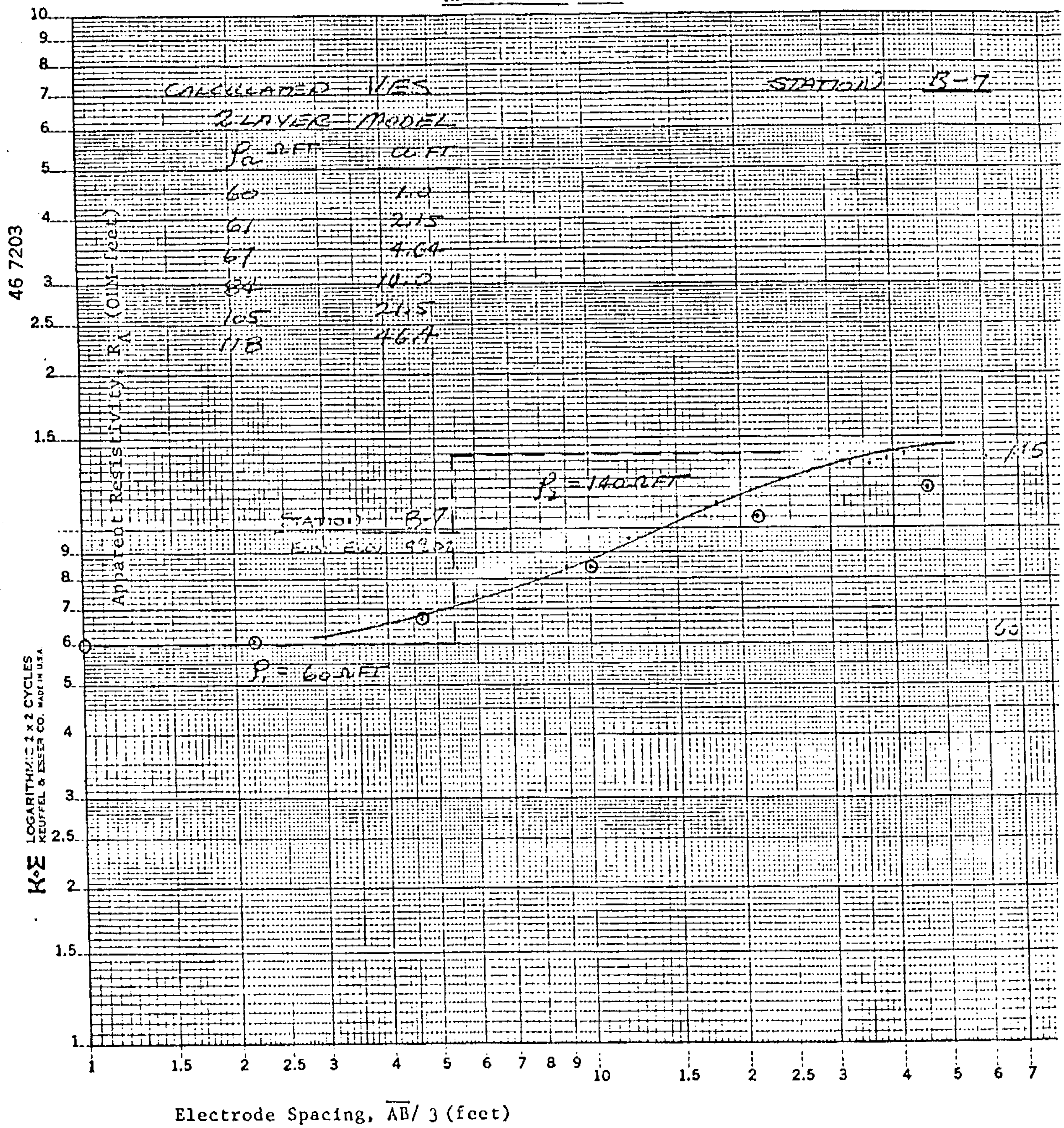
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

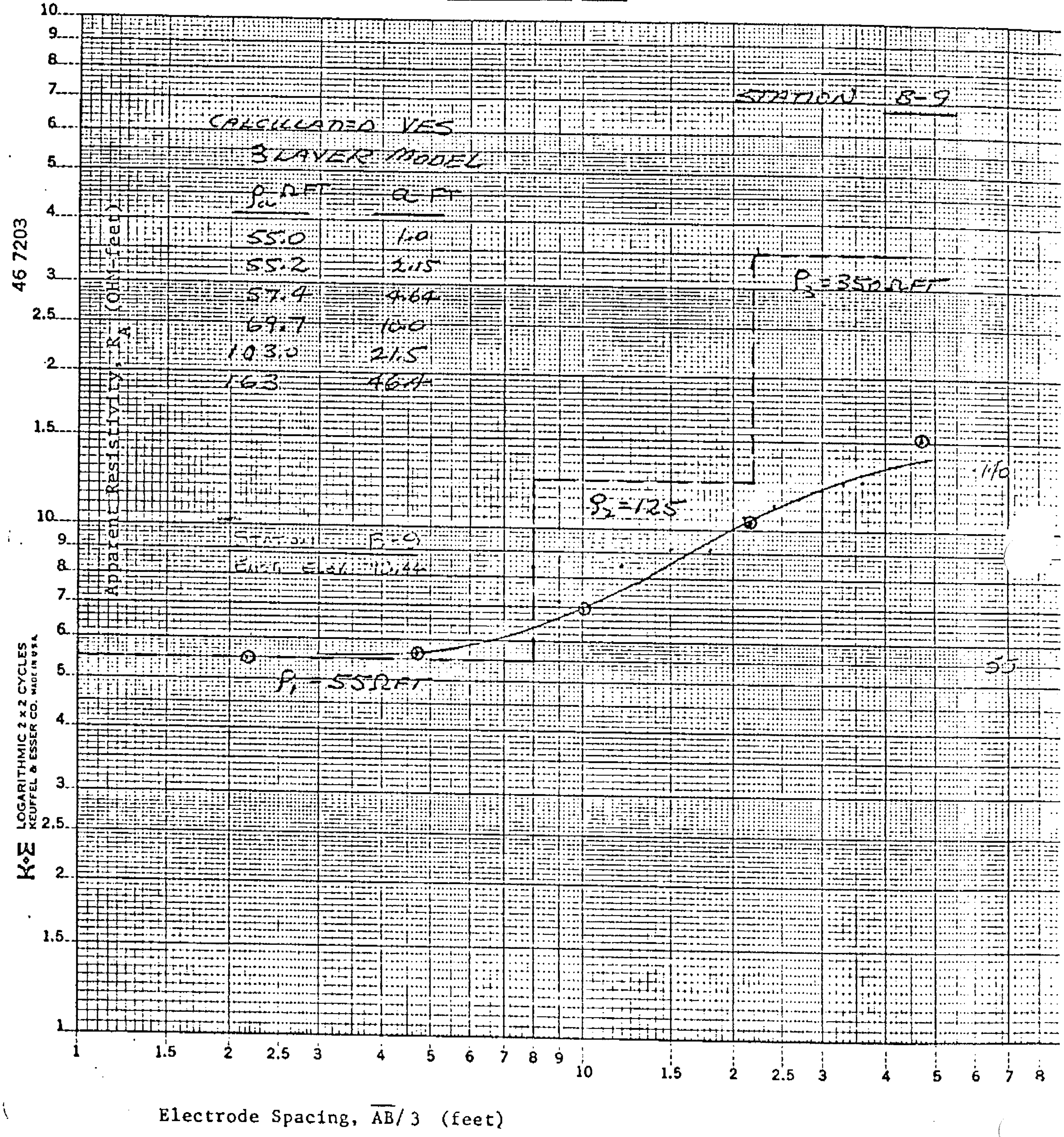
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

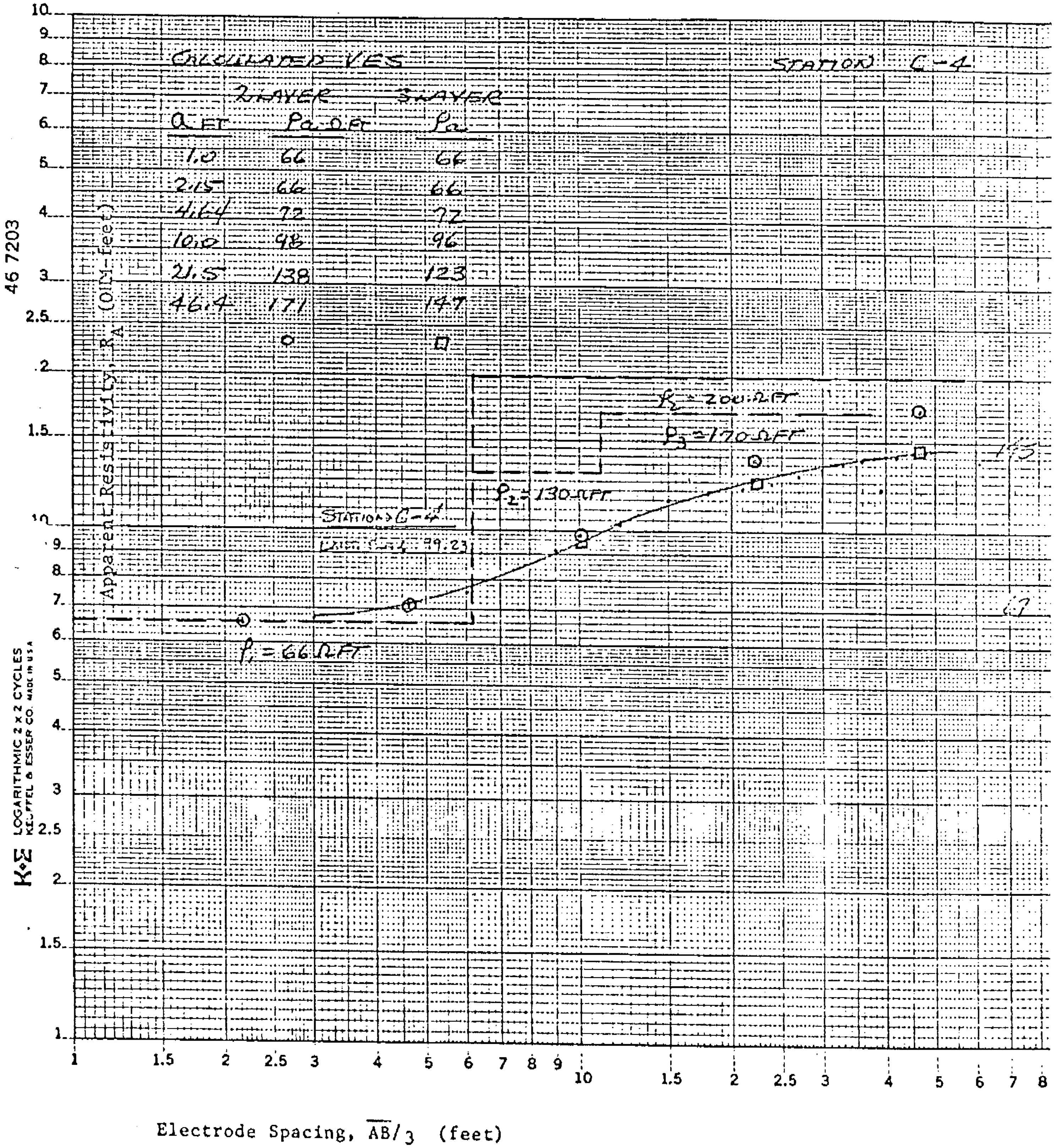
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

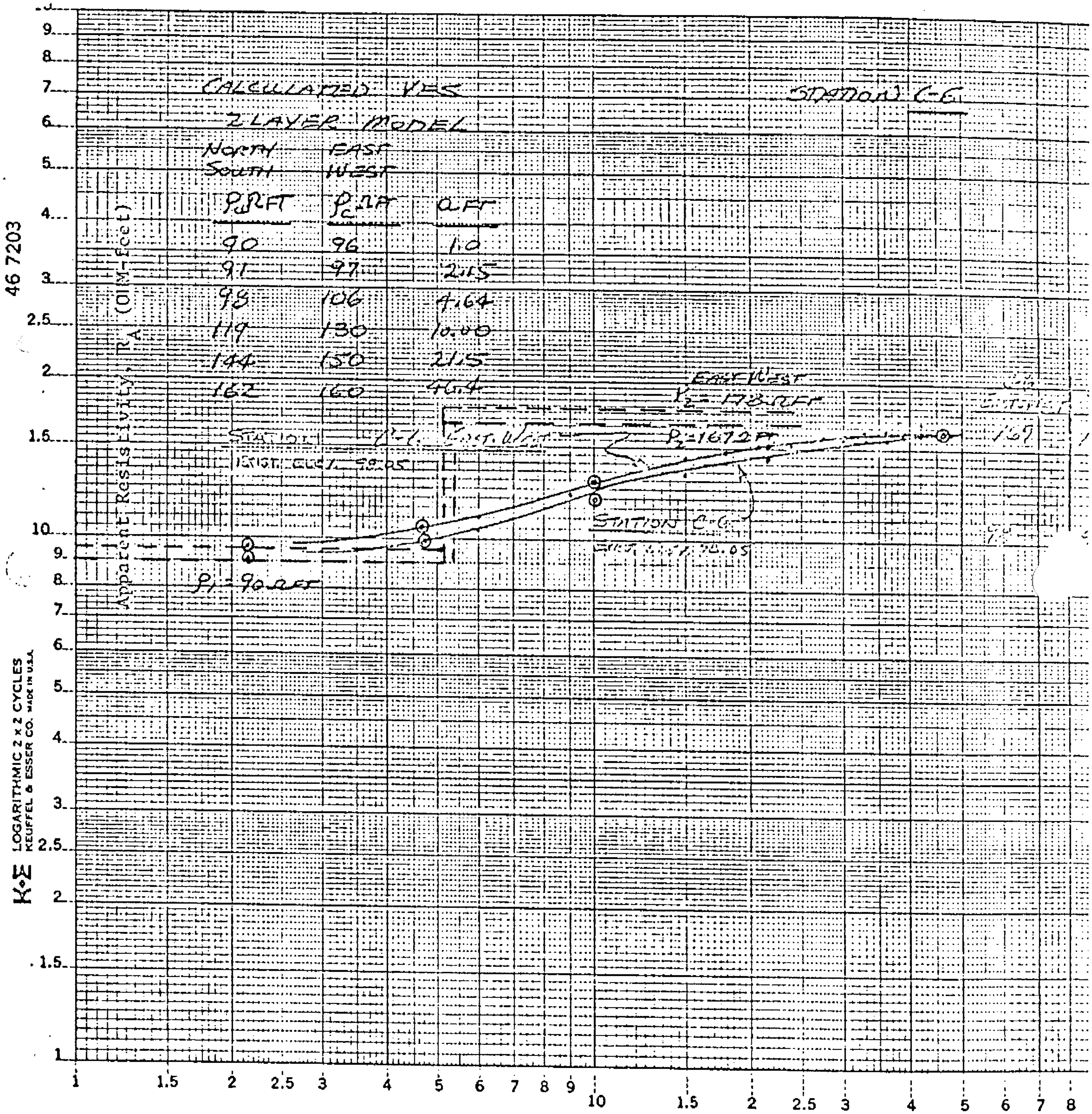
RESISTIVITY PLOT



MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT

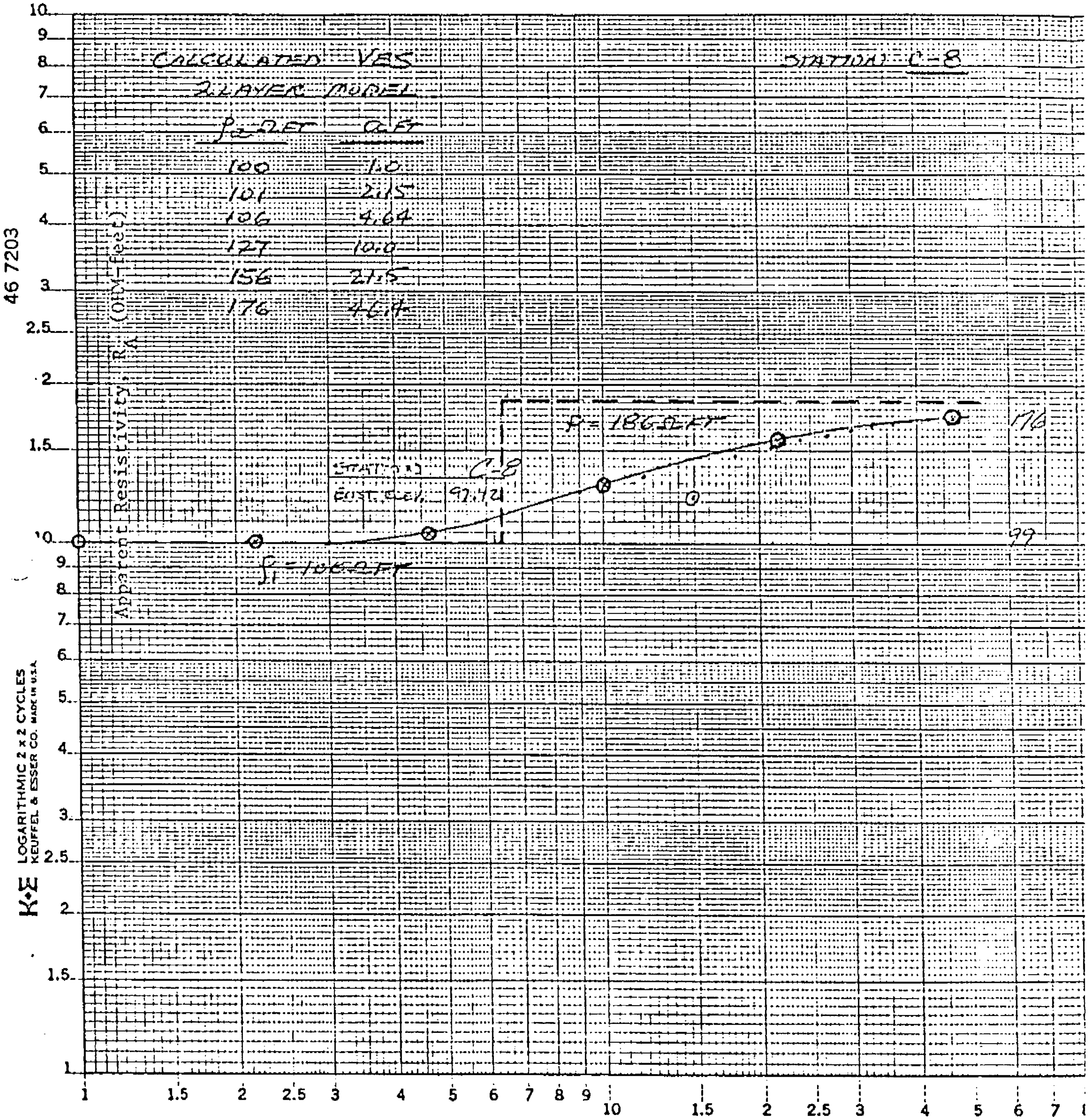


Electrode Spacing, $\overline{AB}/3$ (feet)

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT



Electrode Spacing, $\overline{AB}/3$ (feet)

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT

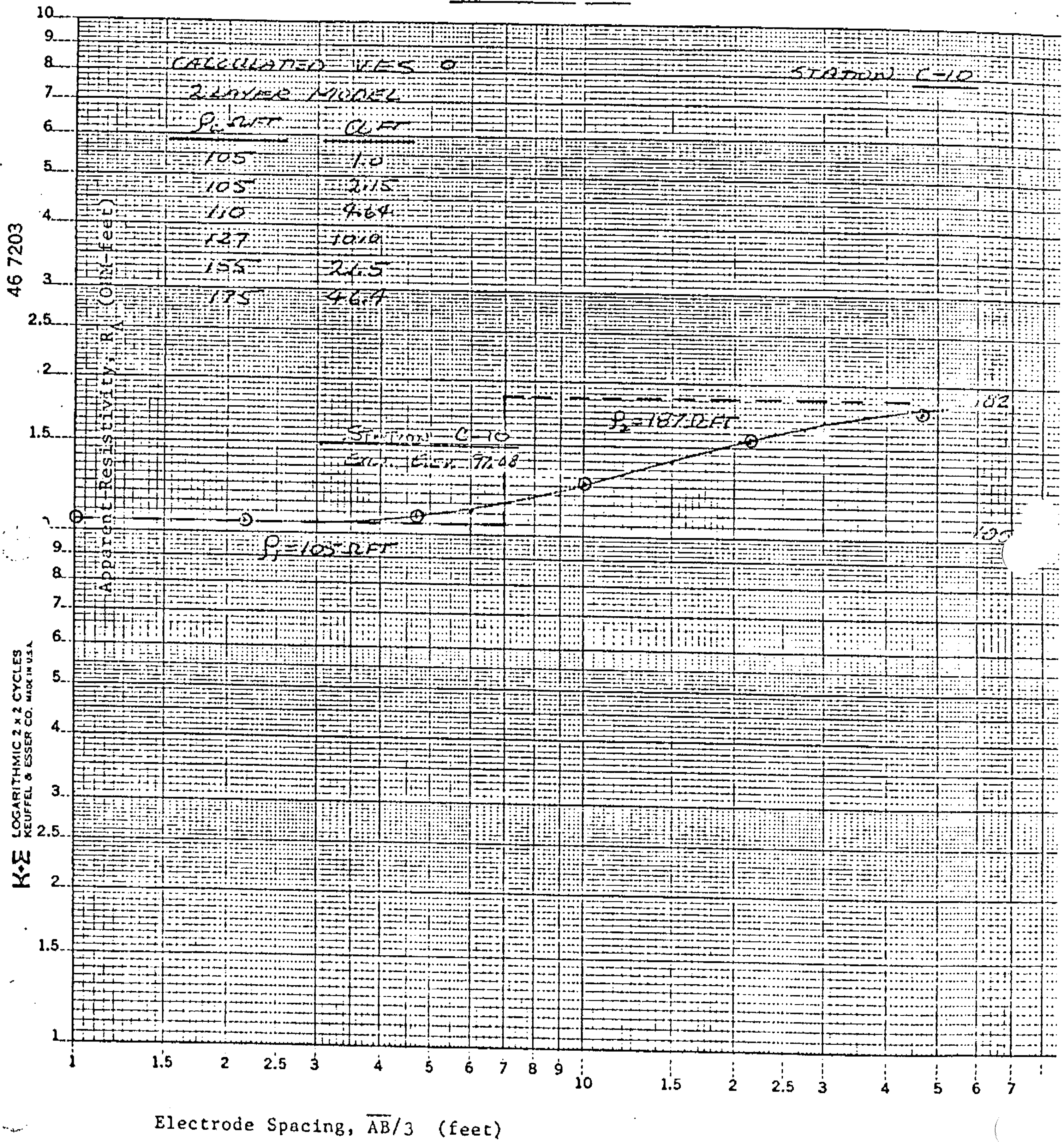


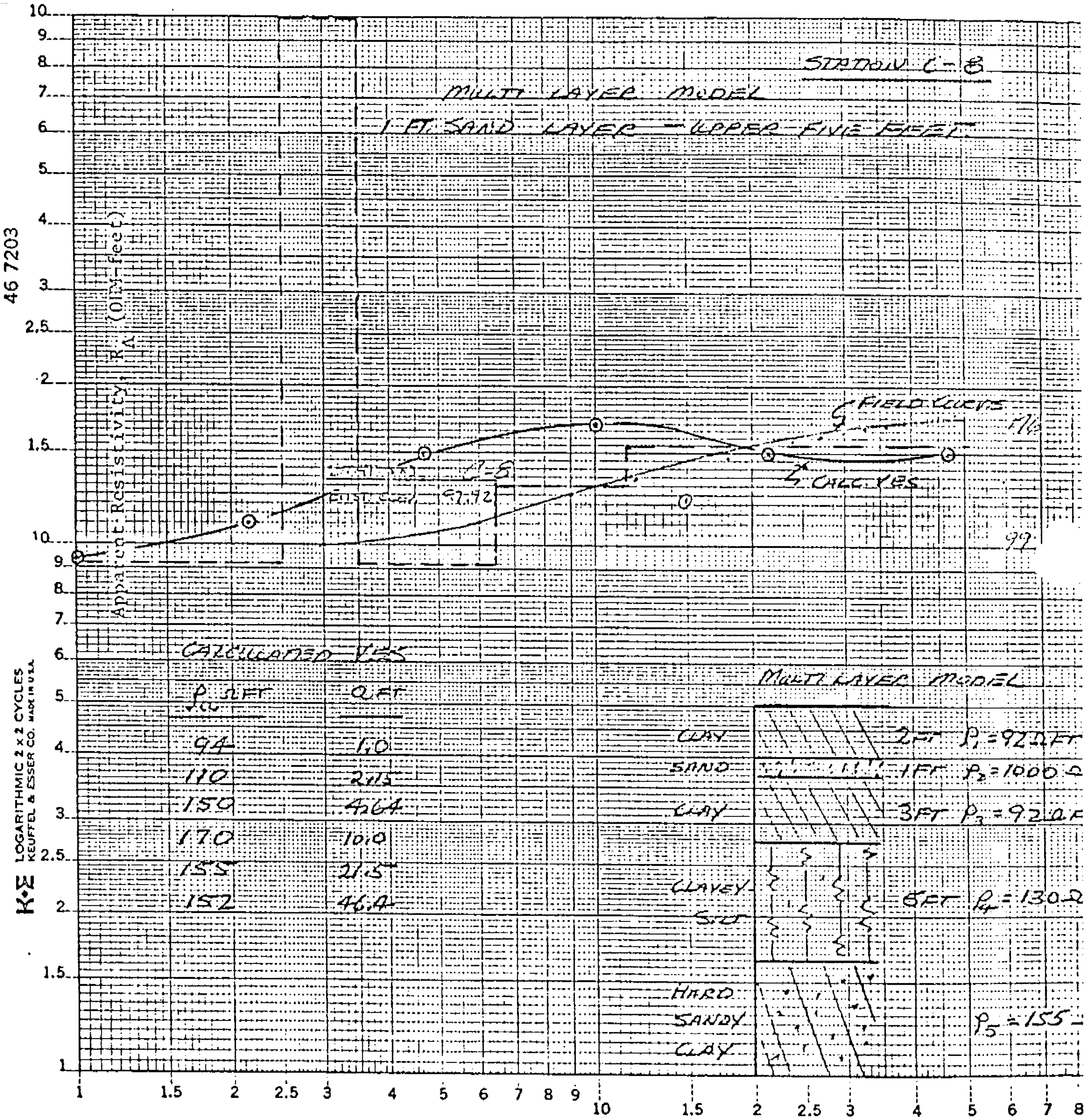
FIGURE #3

Calculated Vertical Electrical Sounding Curves For Sand Layers in Upper Clay Stratum

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT

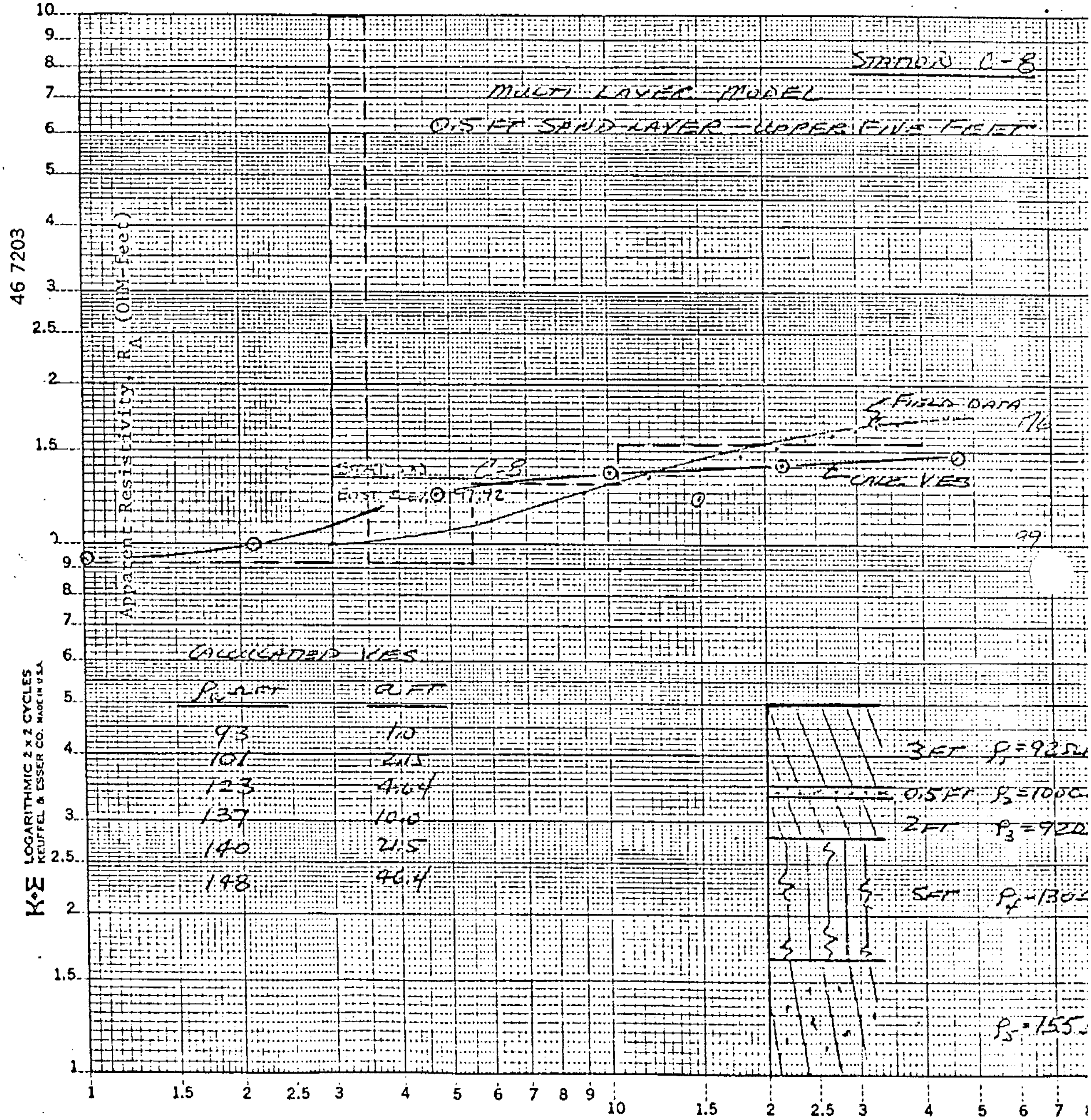


Electrode Spacing, $\overline{AB}/3$ (feet)

MIDLAND PLANT LANDFILL

EQUIVALENCY PROGRAM

RESISTIVITY PLOT



Electrode Spacing, $\overline{AB}/3$ (feet)

Summary Report
Quality Assurance Testing
Dow Corning Corporation
Midland Plant Landfill
(Hazardous Waste Type I Landfill)

Report To

Dow Corning Corporation
Bldg #205
Midland, MI 48640

By

SAMTEST, Inc.
Midland, MI 48640

February 6, 1981

Project #80-352

SAMTEST Inc.

P.O. BOX 1444 MIDLAND, MI 48
(517) 496-3610

February 6, 1981

Dow Corning Corporation
Bldg #205
Midland, MI 48640

File #80-352

Attn: J. Hamblin, Project Engineer

Re: Quality Assurance Testing - Dow Corning Corporation, Midland Plant Landfill (Hazardous Waste Type I-Landfill)

Gentlemen:

Please find enclosed the complete quality assurance report covering the construction of the perimeter clay barrier wall, the interior wall and bottom of Cell A for the facility. The report summarizes the initial clay quality certificates, existing sub-grade quality, in place compactions, periodic clay fill quality and wall width observations.

Field reports were supplied as on-going construction performance documents but are included in the supplement for reference. These results are summarized in Tables #3, 4, and 5 of this report.

Please call if there are any questions or if we can be of additional service.

Yours truly,

William A. Crozier, Ph.D.
SAMTEST, Inc.

WAC/ss

Introduction

The quality assurance program for the construction phase of the existing Dow Corning, Midland Plant Landfill (Hazardous Waste Type I Landfill) is completed. The plan, which primarily covers the construction of the exterior containment wall, included inspection and quality assurance testing of the various phases of construction. This included testing the borrow pit clay for compliance with specifications, inspection of the existing subgrade, observation of the construction procedures with subsequent verification of compaction and permeability of the as-placed impervious soil.

The test data is summarized in the appendix of the report and the actual daily field reports are included as a supplement along with the location diagram.

The purpose of this quality assurance program is to guarantee that the site as constructed provides sufficient barrier to insure no effect on the surrounding environment from any of the materials in the disposal site.

Testing Program

A. Barrier Wall Subgrade

The exposed subgrade representing the bottom and keyway for the barrier wall was visually inspected for continuous and uniform clay soil with absence of any interbedded sand seams. In addition to the visual inspection program, the in-place subgrade soil density was determined at approximately seventy-five lineal foot intervals along the wall key to confirm the soil quality based on a complete classification. At several locations along each side the sampling depth was extended to about one foot below the keyway invert elevation and undisturbed soil samples returned to the laboratory for permeability tests. A constant head procedure was used in measuring the soil permeability coefficient.

Soil classification tests were performed based on standard procedures as published by American Society for Testing and Materials (A.S.T.M.) and listed at the conclusion of this section on Table #1.

Table #2, lists the specifications that apply to this phase of the project.

B. Barrier Wall

One of our technicians, periodically and at random, visited the site each day during construction of the actual walls to observe the construction procedure, determine in-place compactions and sample the clay for conformance with initial specifications. In addition, at four random times (ie location and elevation) during the construction of each wall, as placed, compacted samples were taken for determination of the permeability coefficient.

Actual wall construction proceeded with the placing of loose clay lifts approximately six inches thick, subsequently compacted with a vibratory sheepsfoot compactor impressing twenty-nine tons of total force. The compacted width of the wall exceeded slightly the roller width which is seven feet. Sand was charged against the exterior of the wall for protection, support and construction convenience as the wall elevation increased.

C. General Testing Procedures

The general test procedures as outlined in A.S.T.M. are listed below where they apply to the clay classification. The in-place compaction values are compared with the maximum dry density value as generated using the A.S.T.M. D-1557 Method A (T-180 Modified Proctor). Actual compactions were performed using the rubber balloon procedure due to the high reliability of this method. Moistures were all determined by drying at 105°C in a forced air oven to avoid the error introduced by drying on a stove, a common in-field procedure.

Periodically, clay samples were returned to the lab where single T-180 Modified Proctor points were determined near optimum to verify the continued use of the proper maximum density value for compaction. These results appear on Figure #1..

Results and Discussion

The results summarized at the end of this report for compaction, classification and permeability indicate compliance with the project specifications and reasonably uniform construction quality.

Clay Compaction:-

Compaction results, as noted in the previous section, were compared against the Modified Proctor maximum dry density (ASTM D1557). This was verified periodically for any changes in borrow pit material by compacting a single point and plotting it on the curve. Care was taken not to use over optimum material since this part of the curve, for all cohesive materials having the same specific gravity value, will have approximately the same curve. The single point Proctor determinations suggest a some what lower reference value but the initially determined value was retained for all compactions. This guarantees conservative compaction tests.

As an additional check on the validity of the compaction results the percent saturation was determined for each determination. The saturation, expressed as a percentage, cannot exceed 100% and be correct. These values appear on Table #3. Some slightly higher value reflects the variation in the specific gravity for the clay particles that is used for the calculation.

In-Place Clay Permeability Coefficients:- Table #4

All of the permeability coefficients, corrected to 20°C, are less than the specified 1×10^{-7}cm/sec. A correlation exists, in theory, between the void ratio, a measure of the pore voids, and the permeability. However, these determinations were made on field compacted samples, where some channeling and non-uniform sample compaction and/or composition can be expected.

Error Evaluation For Permeability Coefficients:-

The formula used for constant head determination of the permeability coefficient is listed on Table #6. The variables are defined on the same table along with the expected variation in the measured values based on the experimental procedure. For a nominal determination of 3.4×10^{-8}cm/sec. the expected variation is $\pm$ 0.64×10^{-8}cm/sec.

More significant to the results is the effect of channeling along the walls of the cell. This can increase the value of the coefficient by one to two powers of ten. In this case the cell is partially disassembled and the sample is remolded against the sides of the cell and the test re-run.

Most experimentally measured variables affect only the coefficient but not the exponent.

Summary

Generally, the results of the tests performed at the site, the field observations and the follow-up tests performed in the laboratory indicate compliance with the initial construction specifications. The compaction tests show most of the tests comply with an arbitrary compaction requirement of ninety to ninety-five percent (90-95%) the average compaction figure is 94% with the standard deviation 4.4%. This is considered above average for a project of this type.

A review of the clay quality results indicate the borrow material used for the project complies with the specification requirements of CL classification as noted in Table #2.

Figure #1 shows the dry density versus moisture relationship for the clay used in the barrier walls. In addition, appearing on the same diagram are the single point values determined throughout the project supporting the uniformity of the soil and justifying the maximum dry density values used in calculating compaction.

Permeability values exhibit an average value of $1.6x10^{-8}$ (standard deviation $1.3x10^{-8}$) all of which are less than the $1x10^{-7}$cm/sec. value required in this specification.

Visual observations and using a comparative and reference mensuration technique indicate the barrier wall to be in excess of the six foot thickness design which is twenty percent greater than that required by Act No. 641. The thickness is actually closer to eight foot (8 ft.).

Based on the tests and to the extent we were involved in the field observations it is our opinion that the proposed landfill site has been constructed to date in compliance with the specifications as outlined in Act No. 641 and that the environment will not be affected by its operation.

Dow Corning, Midland Plant
Landfill (Hazardous Waste
Type I Landfill) #80-352

TABLE OF CONTENTS

TABLE #1

Summary of Test Procedures

Test Procedures:-

1. Soil Classification:

   ASTM D422-63 Particle-Size Analysis of Soils
   ASTM D423-66 Liquid Limits of Soils
   ASTM D424-59 Plastic Limits of Soils

2. Soil in Place Density:

   ASTM D2167-66 Density of Soil in Place By The Balloon Method

3. Moisture Density Relation for Cohesive Soils-

   ASTM D-1557 Method A Moisture-Density Relations of Soil Using 10 lb. Rammer and 28 in. Drop (4 in. mold soil passing #4 sieve)

4. Permeability of Fine Grained Soils - Constant Head Procedure.

TABLE #2

General Construction Specification

1. Clay Quality - 30% min 0.002mm Clay
   Liquid Limits 25 min.
   Plasticity Index 7 min.

2. In place compacted density 90-95%*
   * compared with maximum dry density as determined using the D 1557 - Method A

3. Permeability Coefficient - as placed
   $1x10^{-7}$cm/sec or less

4. Wall Dimensions - 5 ft. thick min.
   6 ft. thick (as designed)

FIGURE #1

SAMTEST, INC.
DRILLING & TESTING SERVICES

P.O. Box 1444
Midland, Mich. 48640
1-517-496-3610

JOB NO 80-352

DATE 5-22-80

MOISTURE-DENSITY RELATIONSHIP
(PROCTOR)

CLIENT Dow Corning Corp.

PROJECT Waste Disposal Site

LOCATION Midland Plant

TEST X T180 MODIFIED (ASTM-D1557 ________ T99 STANDARD (ASTM-D698

________ MICHIGAN CONE

RESULTS MAXIMUM DRY DENSITY 134.2 LB/FT^3

OPTIMUM MOISTURE 8.7 %

MATERIAL Clay, brown, silty CLASSIFICATION CL

SOURCE Midland City Sanitary Landfill - Ashman St.

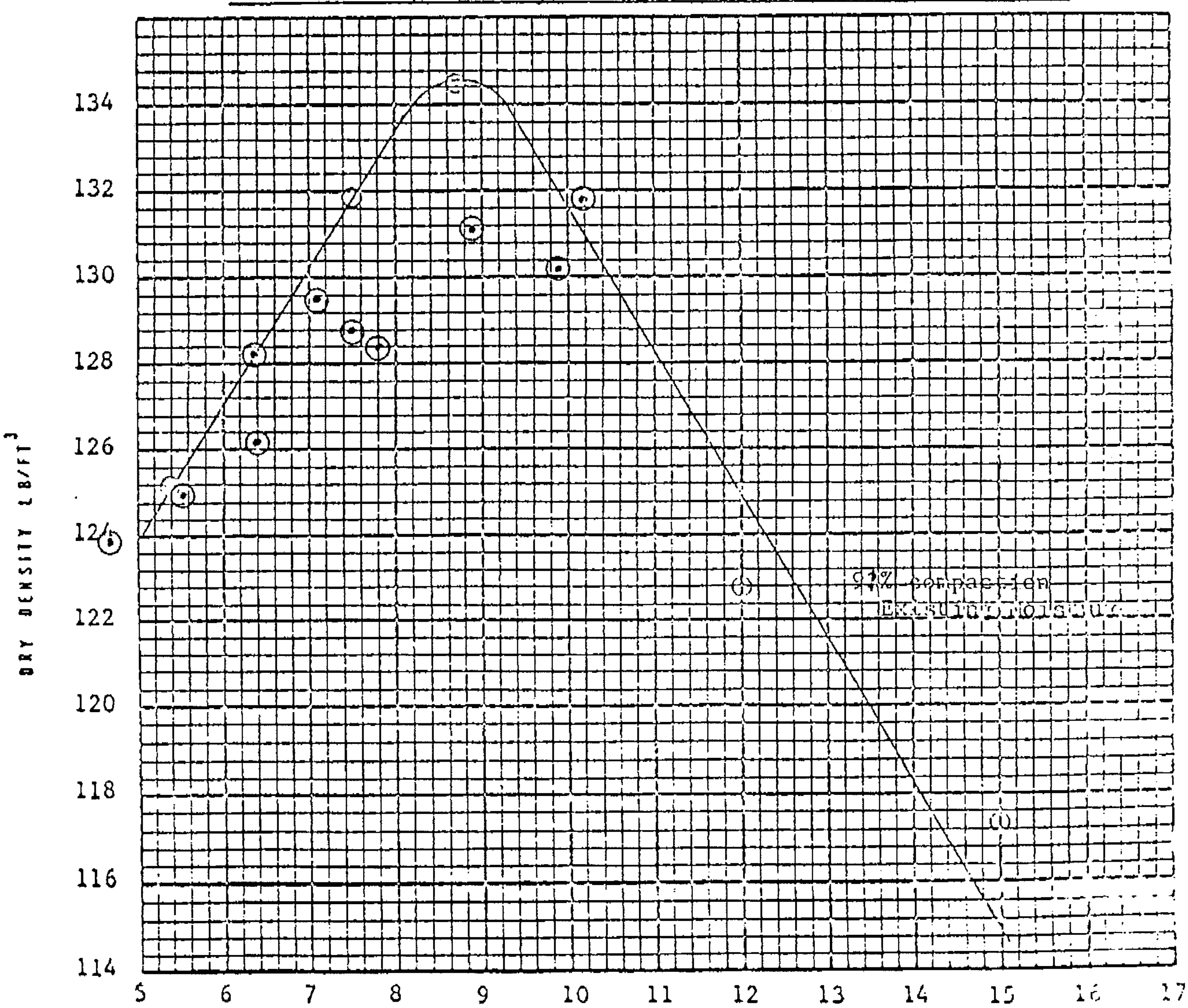
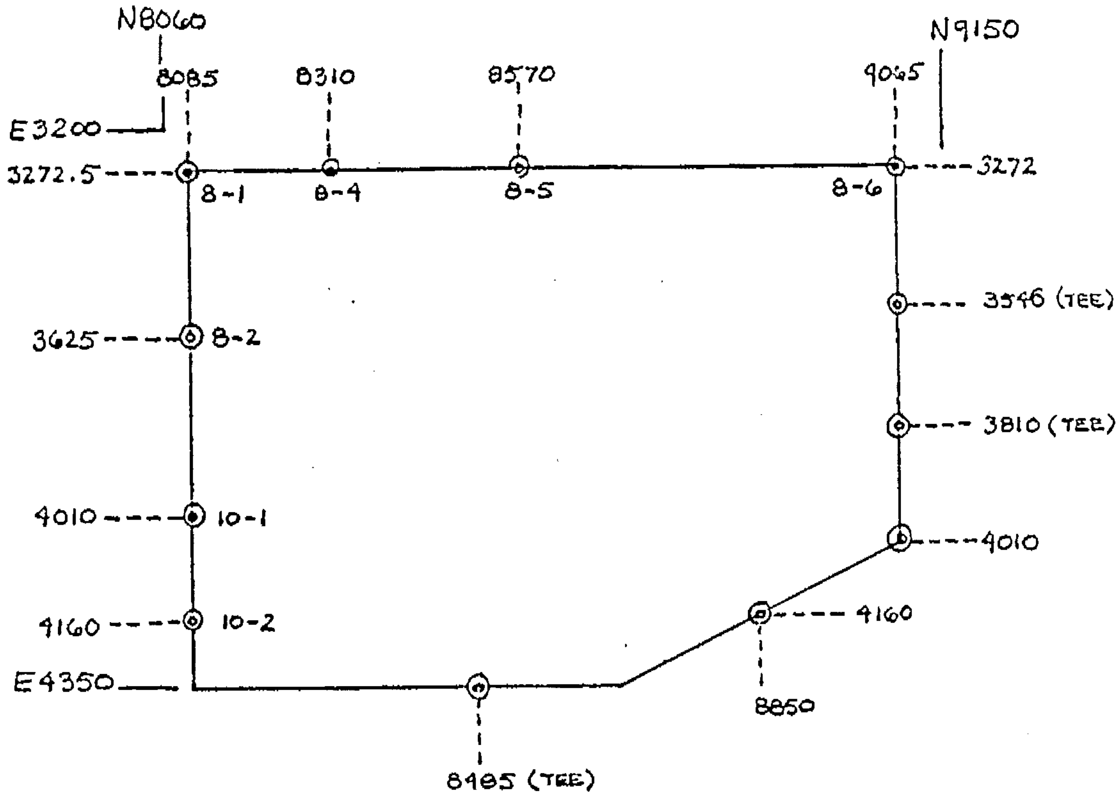


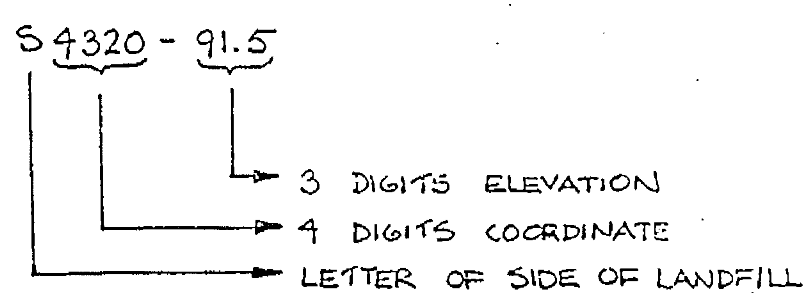
FIGURE #2 (A)

Dow Corning, Midland Plant
Landfill (Hazardous Waste
Type I Landfill)#80-352

SOIL TEST NUMBERING SYSTEM



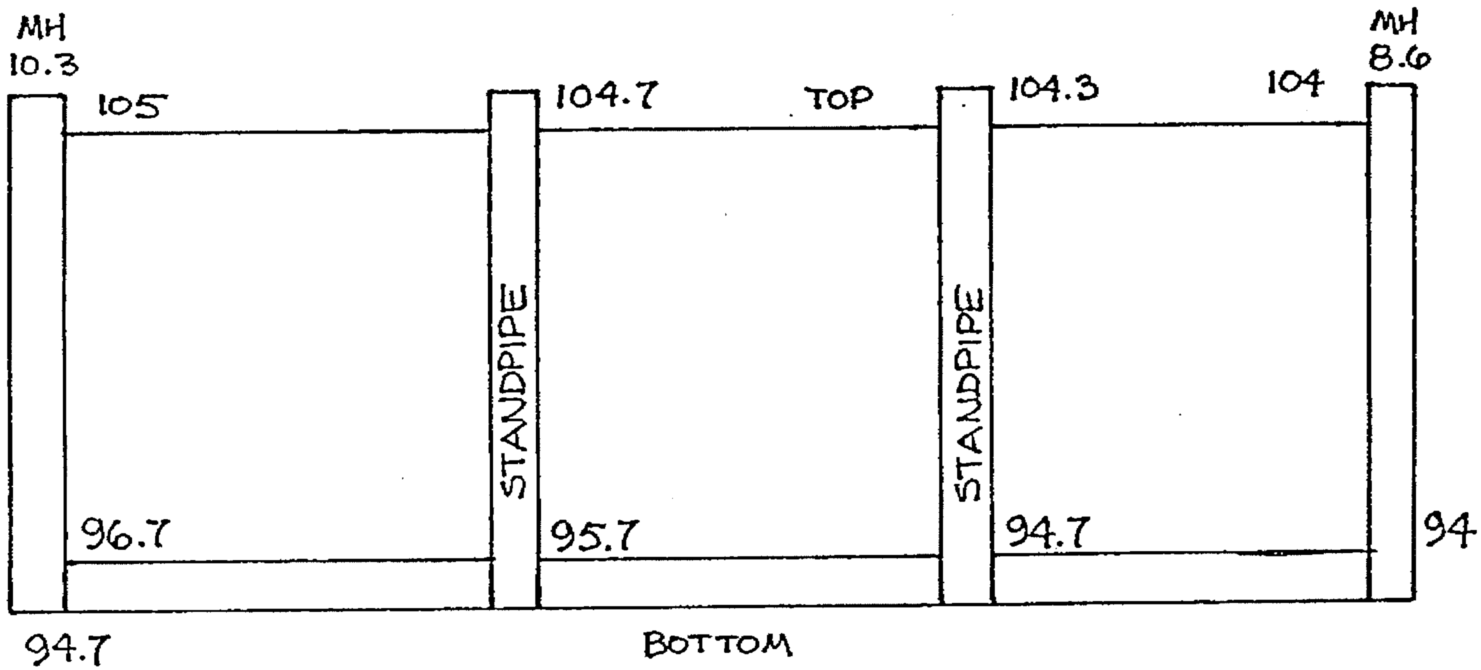
TEST NUMBER SYSTEM



SAMTEST, INC.- DIVERSIFIED TESTING SERVICES - P.O. BOX 1444 - MIDLAND, MICH.- 517-496-3610

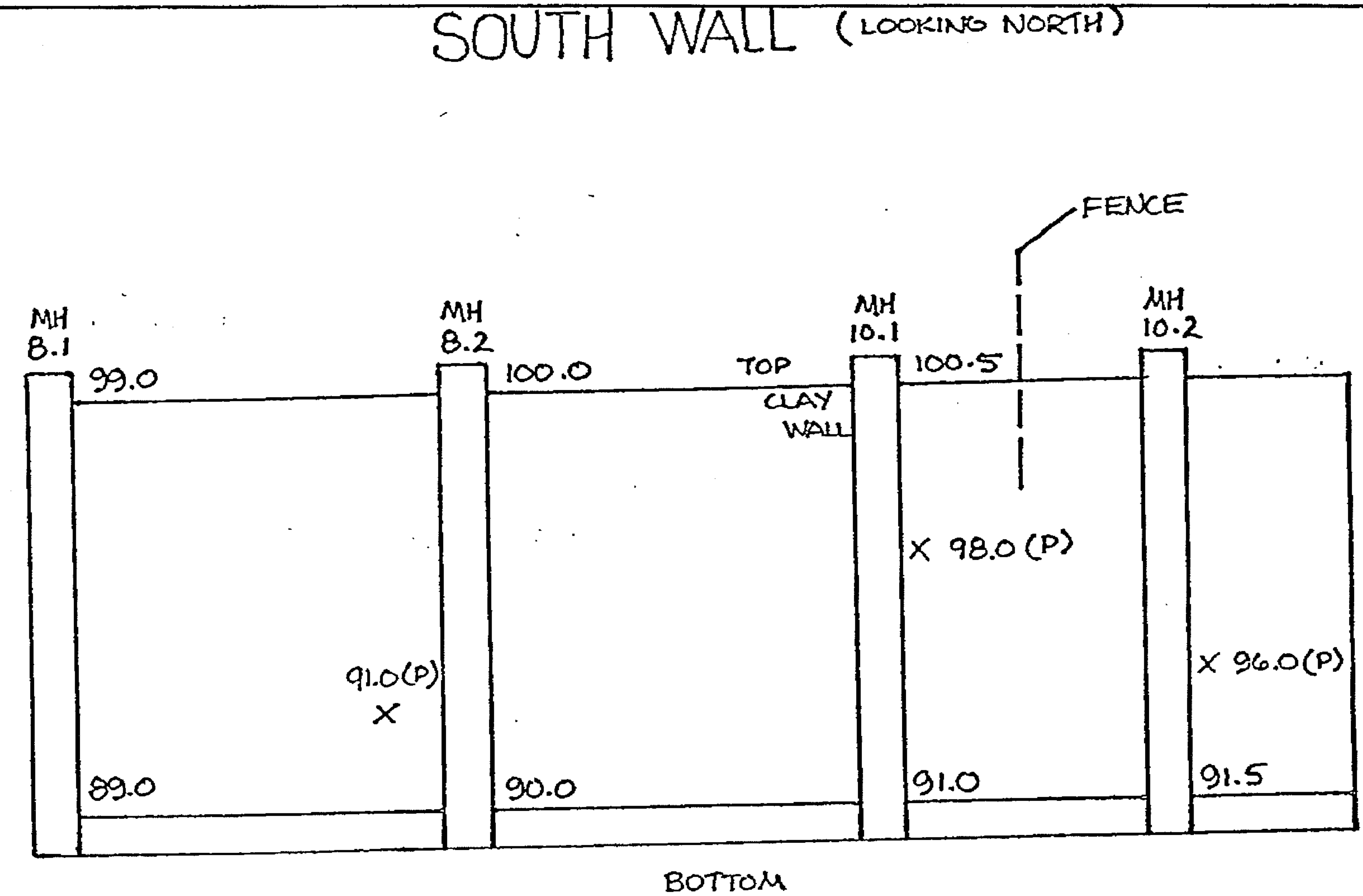
FIGURE #2 (B)

NORTH WALL (LOOKING SOUTH)



DOW CORNING WASTE DISPOSA
DOW CORNING CORPORATION
PROJECT # 80-352

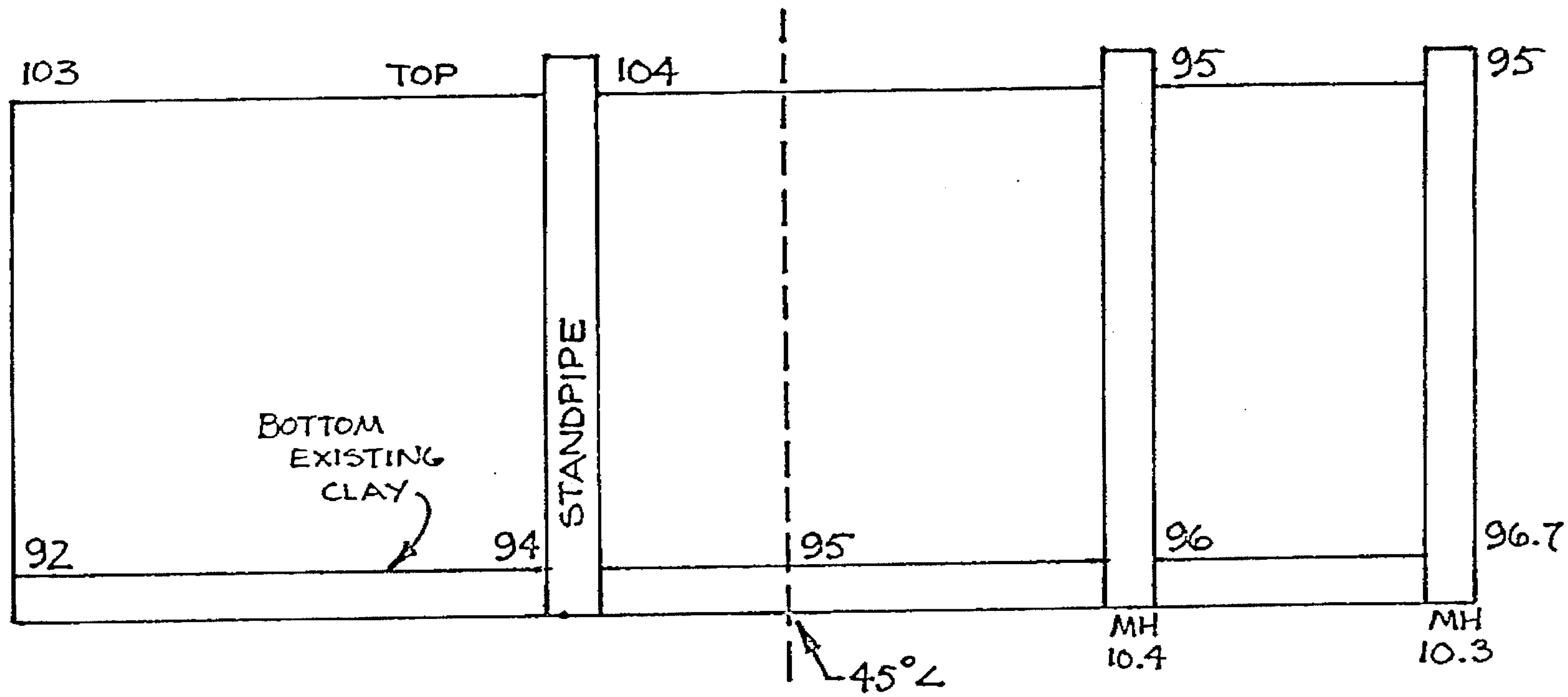
FIGURE #2 (C)



DOW CORNING WASTE DISPO
DOW CORNING CORPORATIO
PROJECT # 80 - 35

FIGURE #2 (D)

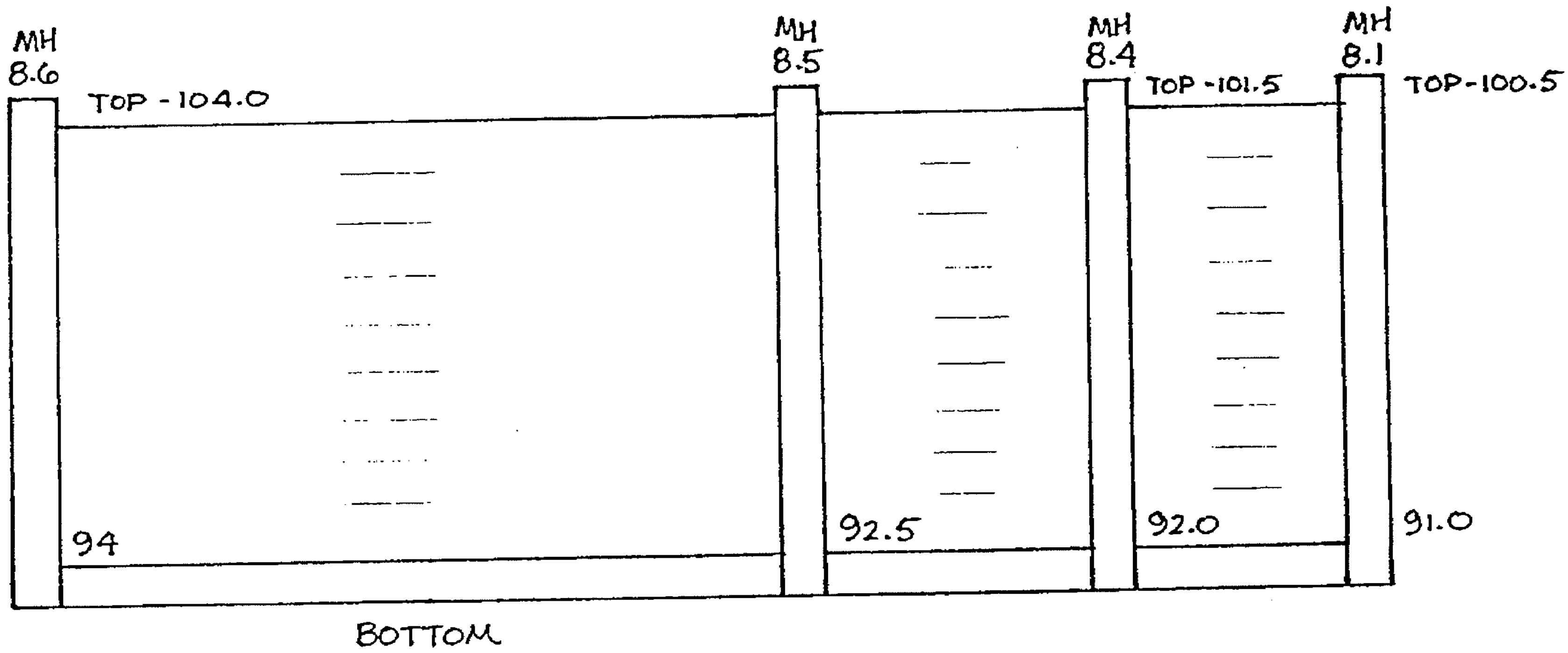
EAST WALL (LOOKING WEST)



DOW CORNING WASTE DISPOSA
DOW CORNING CORPORATION
PROJECT # 80-352

FIGURE #2 (E)

WEST WALL (LOOKING EAST)



DOW CORNING WASTE DISPOSAL
DOW CORNING CORPORATION

PROJECT # 80-352

Dow Corning, Midland Plant
Landfill (Hazardous Waste
Type I Landfill) #80-352

TABLE # 3

Summary of Field Test Reports

Sample#	Elev.	% Moisture	% Compaction	% Saturation
N-4010	99'	8.6	99	97
N-3950*	98'	12.3	95	97
N-3845	96' Exst.	23.7		-
N-3300	99'	10.2	96	84
N-3350*	101'	11.7	94	89
N-3430	99'	10.8	95	86
N-3460	94.3' "	23.6		-
N-3460	100'	11.0	96	91
N-3590*	101'	10.6	98	95
N-3845*	92.5'			-
N-3875	102'	11.1	96	92
N-3840	101'	10.3	97	89
N-3950	98'	10.8	80	-
N-3843	99'	12.2	86	-
N-3441	97'	11.9	95	94
N-3681	97'	12.3	96	100
N-3950	98' RT	12.3	95	
N-3843	99' RT	10.5	97	90
S-4220*	99.2'	11.6	96	96
S-4150*	93' Exst.	25.6		-
S-4010*	98'	12.6	93	92
S-4010	99'	9.6	100	94
S-3625*	90' Exst.			-
S-3625	93'	11.5	93	82
S-3625*	91'			-
S-3725	94'	12.8	90	83
S-3272.5	91'	12.2	97	103
S-3375	93'	12.8	93	94
S-3475	93'	12.6	86	-
S-3475	93' RT	11.6	96	96

RT-Represents Retest
(Exst. indicates existing elevation)

TABLE #3 (con't)

Sample#	Elev.	% Moisture	% Compaction	% Saturation
S-3285*	98'	10.9	96	90
S-4300	91.5' Exst.	15.3		-
S-4025	96'	15.4	88	93
S-4225	96'	12.2	93	89
S-4200	98'	13.0	95	102
S-4064	98'	12.6	93	92
S-4070	98'	11.0	99	99
S-3725	92' Exst.	4.1	98	94
S-3590	91'	11.5	97	99
S-3735	97'	10.7	99	100
S-3785	97'	11.1	98	100
S-3565	97'	12.8	83 Top of Wall after rain	65
S-3950	91' Exst.	17.9		
S-3410	98'	19.8	82 " "	
S-3300	97.5'	13.0	88	80
E-8284*	102'	11.7	96	97
E-8395*	100'	10.1	96	83
E-8880*	96' Exst.	21.5		-
E-8965*	98'	9.5	98	85
E-8710	97'	9.2	95	73
E-8610	96'	12.1	96	100
E-8370	96'	13.3	95	100
E-8470*	94' Exst.	27.2		-
E-8628	103'	11.8	91	80
E-4064*	104'	11.0	94	84
E-8895	101'	9.6	93	70
E-8712	101'	9.3	88	56
E-8904	101' RT	11.8	97	100
E-8793	101' RT	12.9	96	103
E-8485	101'	10.6	96	88
E-8380	103'	11.3	92	79

TABLE # 3(con't)

Sample#	Elev.	% Moisture	% Compaction	% Saturation
E-8560	104'	10.4	100	102
E-8748	105'	10.9	93	80
E-4350	103'	13.8	85	75
E-4500	103.5'	12.3	96	101
E-4350	103'	11.0	93	80
W-8610*	92.5' Exst.	24.9		-
W-8390	100'	10.5	96	87
W-8965*	94' Exst.	22.0		-
W-8705	97'	11.0	97	95
W-8225*	92'			-
W-8990	98'	13.1	94	100
W-3845*	92'			-
W-9035*	97'	10.7	95	85
W-3483*	97'			-
W-9045*	94'	12.0	91	81
W-3460*	94.3'	23.6		-
W-8470	97'	10.7	98	96
W-8225	97'	10.1	92	71
W-8470	94'	14.7	93	100
W-8345	96'	12.2	95	97
W-8610	96'	16.3	83	83
W-8395	95'	11.6	95	92
W-8670	95'	12.1	96	100
W-8470	94'	12.4	94	94
W-9045	94'	12.0	91	81
		Ave(69 tests)	94%	(St. dev.=4.4%)

BASE CELL-A

N.W. Corner*	90'	15.5
E. Center *	90'	12.9
S. Center *	90'	14.2

* Indicates permeability was done.

TABLE # 4

Summary of Clay Permeabilities

Test Location	Elev.	Ratio Void (e)	Perm. k cm/sec	Soil	Gs sp.g.
N-3950	98	0.2805	$1.1x10^{-8}$	Fill	2.754
N-3350	101	0.3617	$4.9x10^{-9}$	Fill	
N-3590	101	0.3068	$7.1x10^{-9}$	Fill	
N-3845	92.5	0.5897	$1.5x10^{-8}$	Existing	
S-4220	99	0.3342	$1.2x10^{-8}$	Fill	
S-4150	93	0.6540	$2.7x10^{-8}$	Existing	
S-4010	98	0.3770	$1.8x10^{-8}$	Fill	
S-3625	90	0.5081	$1.0x10^{-8}$	Existing	
S-3625	91		$5.5x10^{-8}$	Fill	
S-4150	96		$8.1x10^{-9}$	Fill	
S-3285	98	0.3291	$2.3x10^{-8}$	Fill	
E-8284	102	0.3342	$1.4x10^{-8}$	Fill	
E-8395	100	0.3342	$8.3x10^{-9}$	Fill	
E-8880	96	0.6898	$2.9x10^{-8}$	Fill	
E-8965	98	0.3068	$4.0x10^{-9}$	Fill	
E-8470	94	0.6701	$1.9x10^{-8}$	Existing	
E-4064	104	0.3671	$4.3x10^{-9}$	Fill	
W-8610	92.5	0.6508	$1.5x10^{-8}$	Existing	
W-9035	97	0.3564	$3.2x10^{-9}$	Fill	
W-8225	92		$1.1x10^{-8}$	Existing	
W-3483	97		$1.1x10^{-8}$	Fill	
W-8965	94	0.5971	$3.4x10^{-8}$	Existing	
W-9045	94	0.4074	$4.1x10^{-9}$	Fill	
W-3845	92		$1.5x10^{-8}$	Existing	
W-3460			$4.4x10^{-8}$	Existing	
		Average =	$1.6x10^{-8}$		
CELL A Existing					
N.W. Corner	90	0.4006	$2.0x10^{-8}$	Existing	
E. Center	90	0.4638	$5.1x10^{-9}$	"	
S. Center	90	0.3848	$4.4x10^{-8}$		

TABLE #5

Summary of Clay Classifications

Sample #	Elev.	Classification	LL	PI	% Clay
N-3350	101'	CL-brn., sandy $\overline{w}$ silt	24.6	10.3	29.8%
N-3590	101'	CL-brn., silty clay	41.8	17.2	30.7%
N-3845 *	96'	CL-clay, brn., silty-some sand	43.3	18.1	66.5%
N-3460 *	94.3'	CL-clay, brown, silty trace sand	41.0	18.4	68.0%
S-3285	98'	CL-brn., silty clay	26.4	13.3	33.0%
S-3475	93'	CL-brn., silty, sandy-clay	25.8	12.9	30.0%
S-3725	94'	CL- " " " "	25.0	10.6	32.0%
S-4150 *	93'	CL-brn., silty, clay $\overline{w}$ trace sand	24.9	24.0	73.0%
S-4300	91.5'	CL-ML, clay, sandy, brn-silty	19.4	6.7	32.0%
E-8470 *	94'	CH-clay, brn., silty trace sand	43.6	18.9	66.0%
E-8965	98'	CL-clay, brown silty	23.7	10.6	30.3%
E-4064	104'	CL-clay, brown silty	24.8	9.0	
W-8225 *	92'	CL-brn., clay	24.8	11.2	29.6%
W-8610 *	92.5'	CL-clay, brn., silty	24.9	11.6	71.0%
W-8965 *	94'	CL-brn. clay	46.2	20.0	66.4%
W-9035	97'	CL-clay brown silty	23.6	10.1	30.8%

TABLE #6

Error Calculations For Permeability Coefficient

Variable Measurement with Error

Variable	Nominal	Variation Minimum	Maximum
L col. length	6.35 ± 1.59mm	6.191	6.509
Q vol. cm^3	0.21ml ± 0.01	0.20	0.22
A area	$9.580cm^2$ ± 0.437	9.143	10.017
Time of flow (sec)	3600sec ± 120sec	3480	3720
T temp	21°C ± 1.0°C	0.952	1.000
h head cm water	1134cm	1120cm	1148cm

Permeability Coefficient Calculation:-

$$k = \frac{QL}{t\ h\ A}$$

Nominal	Max. Variations Min.	Max.
3.4×10^{-8}	2.75×10^{-8}	4.02×10^{-8}

Dow Corning Corporation
Midland Plant Landfill
(Hazardous Waste Type I Landfill)

#80-352

FIELD TEST REPORT FORMS

DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 6-9-80 JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corp. JOB NO.:
CONTRACTOR:

WEATHER Clear TEMP RANGE ° TO ° AREA WORKED

TYPE OF FILL: [ ] SAND [XX] CLAY [ ] LOAM [ ]

METHOD OF COMPACTION: [ ] VIBRATORY PLATE [ ] PNEUMATIC TAMP. [ ] SHEEPSFOOT [ ] RUBBER TIRED [ ] STEEL WHEEL [ ] VIB. STEEL WHEEL [ ] VIB. PNEUMATIC [XX] Vib. Sheepsfoo

TYPE OF SUBGRADE: [ ] SAND [XX] CLAY [ ] LOAM [ ]

CONDITION OF GRADE: [XX] ROUGH [ ] SMOOTH [ ] WET [ ] DRY [ ] FROZEN [ ] LOOSE [ ] HARD [ ] RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 0 FT

MAX. DENSITY OF MATERIAL [XX] MOD. AASHO T 180 [ ] STD. AASHO T-99

METHOD OF TEST [ ] SANDCONE [XX] BALLOON [ ]

134.2 #/ CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE NO. OF TESTS TO DATE

LOCATION AND RESULTS OF TESTS

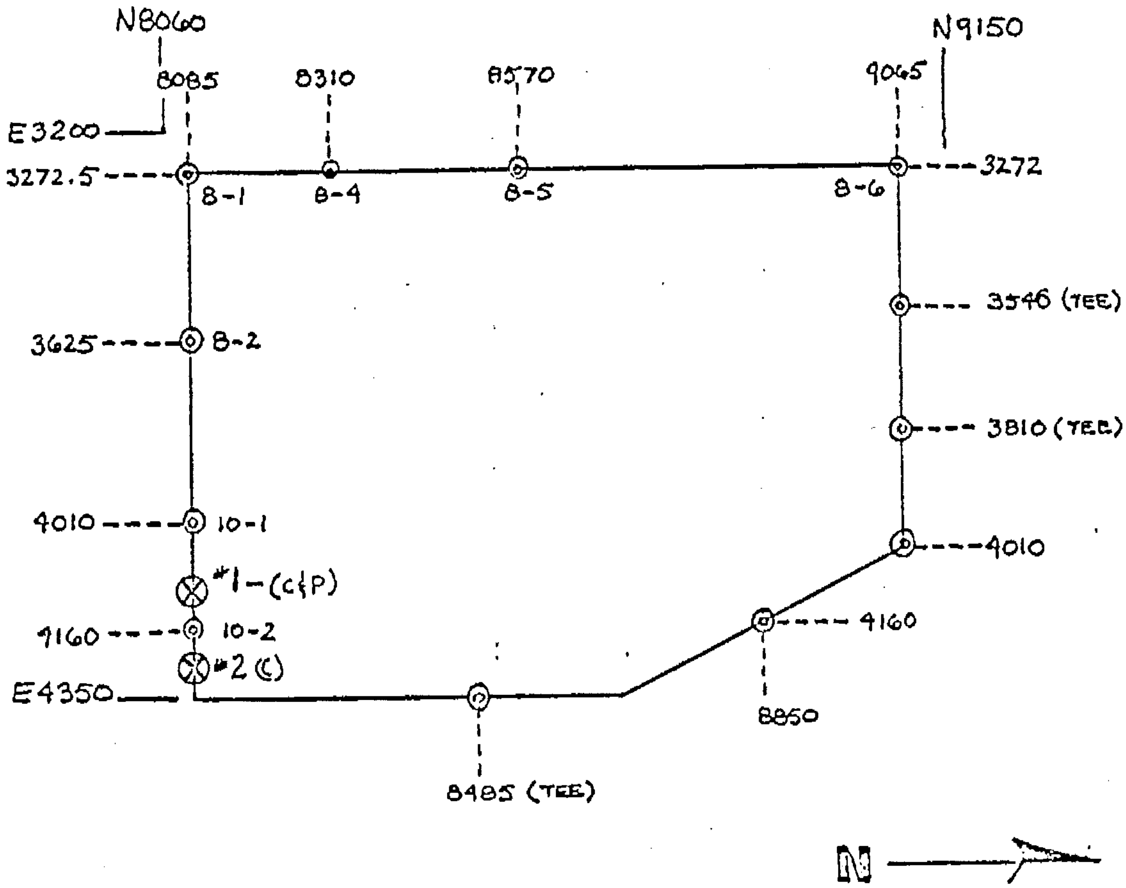
TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCENT COMPACTI
	S-4150 - Existing Soil	93.0		
#2	S-4300 - Existing Soil	91.5	15.3	
	Permeability:			
	S-4150 - 2.7x10^{-8}cm/sec.			

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

SEE ATTACHED DIAGRAM

SIGNED William Olrozer

SOIL TEST NUMBERING SYSTEM



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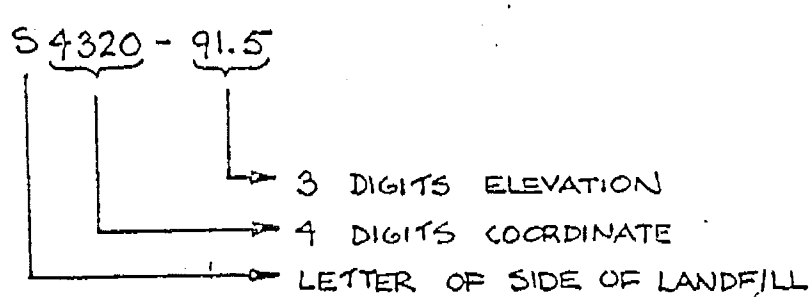


DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 6-16-80 (AM) JOB NO.: 80-352
PROJECT: Waste Disposal
CLIENT: Dow Corning JOB NO.:
CONTRACTOR:

WEATHER Clear TEMP RANGE ° TO ° AREA WORKED South Wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM. ☐ ____

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☐ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☒ Vib. Sheepsfoot

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM. ☐ ____

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 4 F

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOO ☐ ____

134.2 #/ CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

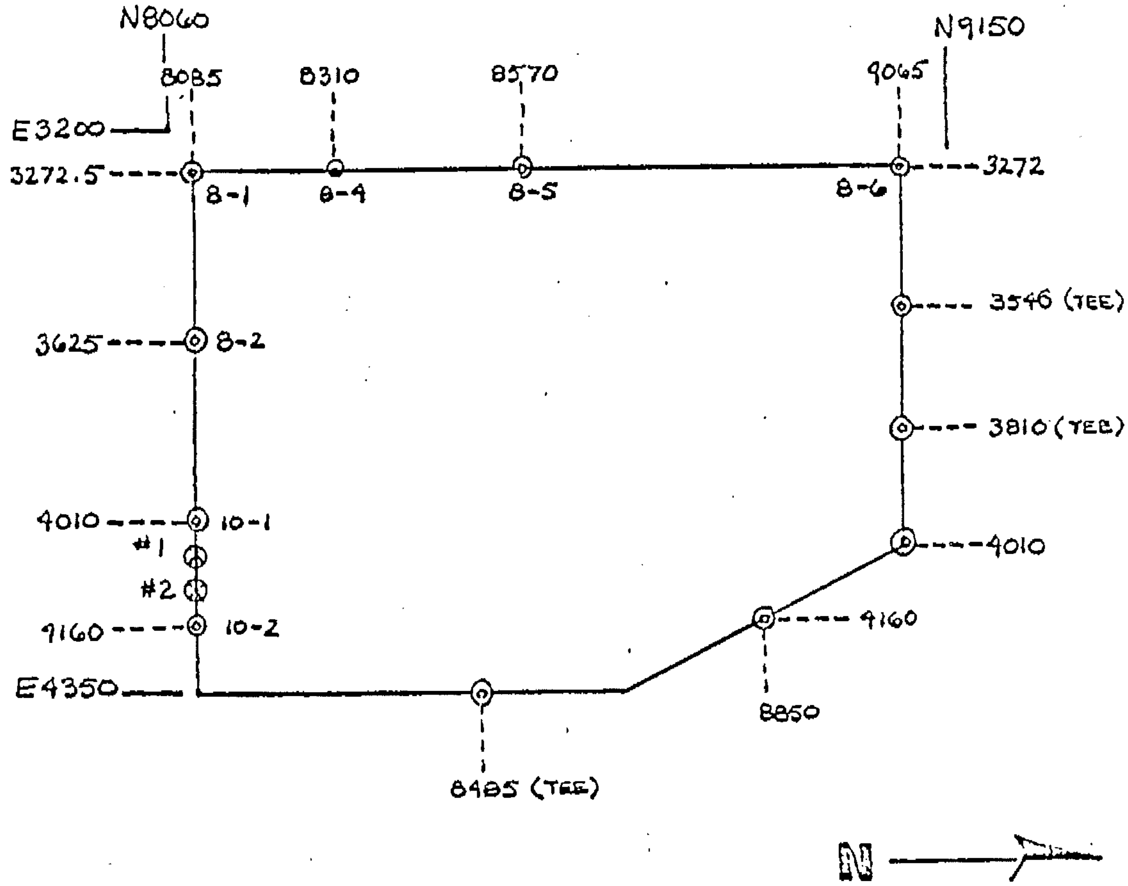
TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCE COMPAC
	S-4025	96.0	15.4	88
2	S-4225	96.0	12.2	

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

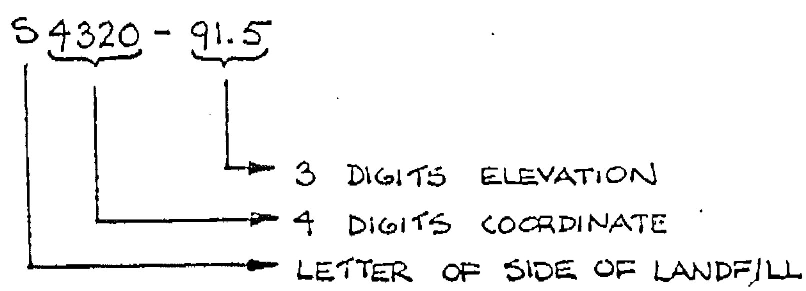
SEE ATTACHED DIAGRAM

SIGNED William Olszewski

SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DAILY SOILS REPORT

DATE: 6-16-80 (PM) JOB NO: 80-352
PROJECT: Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER Clear TEMP RANGE ° TO ° AREA WORKED South Wall

TYPE OF FILL: [ ] SAND [X] CLAY [ ] LOAM [ ] ____

METHOD OF COMPACTION: [ ] VIBRATORY PLATE [ ] PNEUMATIC TAMP. [ ] SHEEPSFOOT [ ] RUBBER TIRED [ ] STEEL WHEEL [ ] VIB. STEEL WHEEL [ ] VIB. PNEUMATIC [XX] Vib. Sheepsfoot

TYPE OF SUBGRADE: [ ] SAND [X] CLAY [ ] LOAM [ ] ____

CONDITION OF GRADE: [XX] ROUGH [ ] SMOOTH [ ] WET [ ] DRY [ ] FROZEN [ ] LOOSE [ ] HARD [ ] RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 6 FT

MAX. DENSITY OF MATERIAL [X] MOD. AASHO T 180 [ ] STD. AASHO T-99

METHOD OF TEST [ ] SANDCONE [XX] BALLOON [ ] ____

134.2 #/ CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

COMPACTED FILL

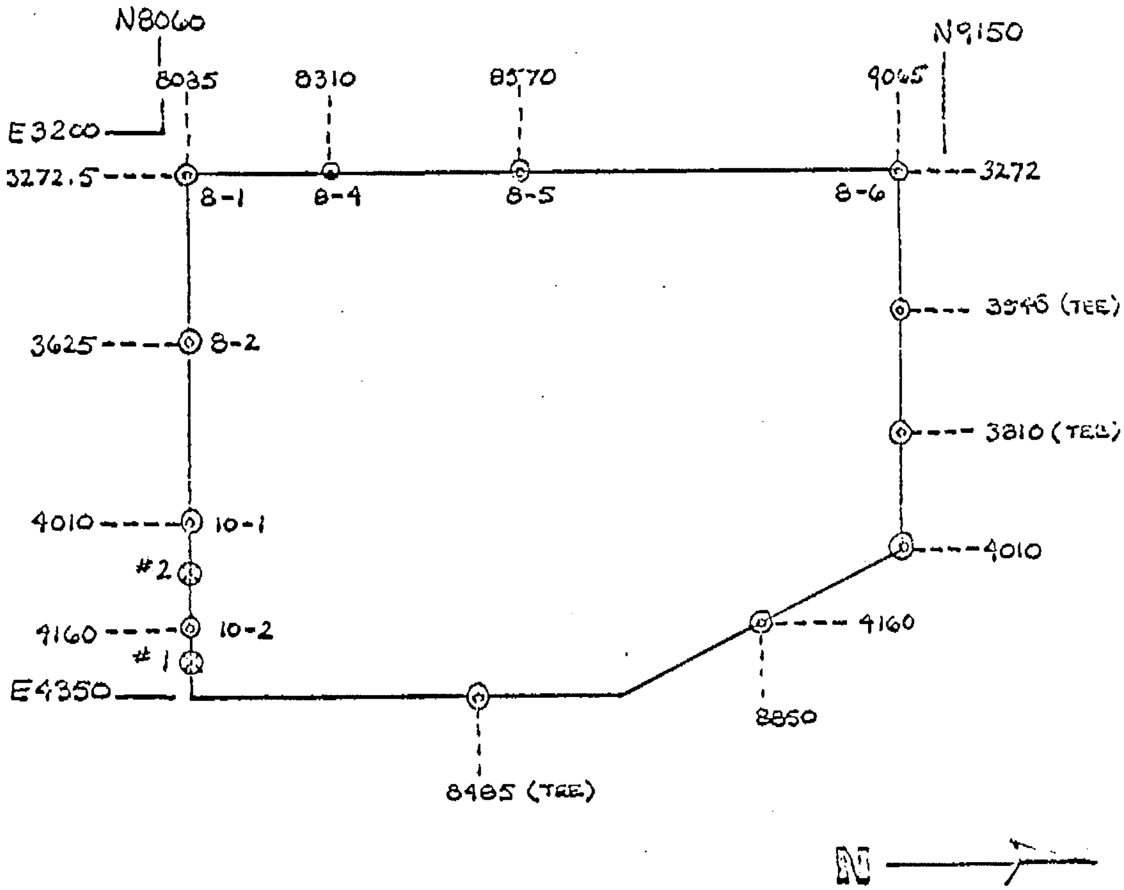
TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCENT COMPACTIO
	S-4200	98.0	13.0	95
2	S-4064	98.0	12.6	

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

SEE ATTACHED DIAGRAM

SIGNED William [signature]

SOIL TEST NUMBERING SYSTEM



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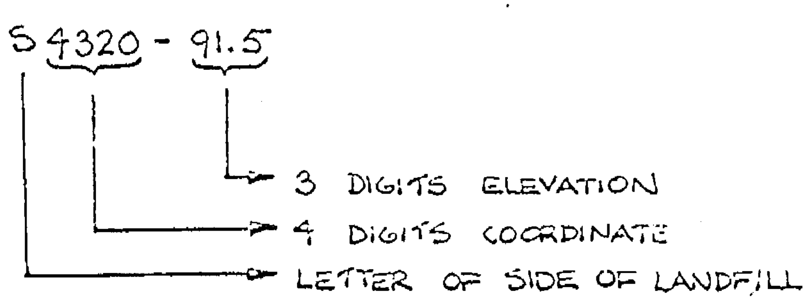


SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DAILY SOILS REPORT

DATE: 6-17-80 (AM) JOB NO.: 80-352
PROJECT: Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER Clear TEMP RANGE 70 ° TO 80 ° AREA WORKED South Wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☐ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☐ Vib. Sheepsfoot

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 6 FT

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOON ☐ ____

134.2 #/ CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

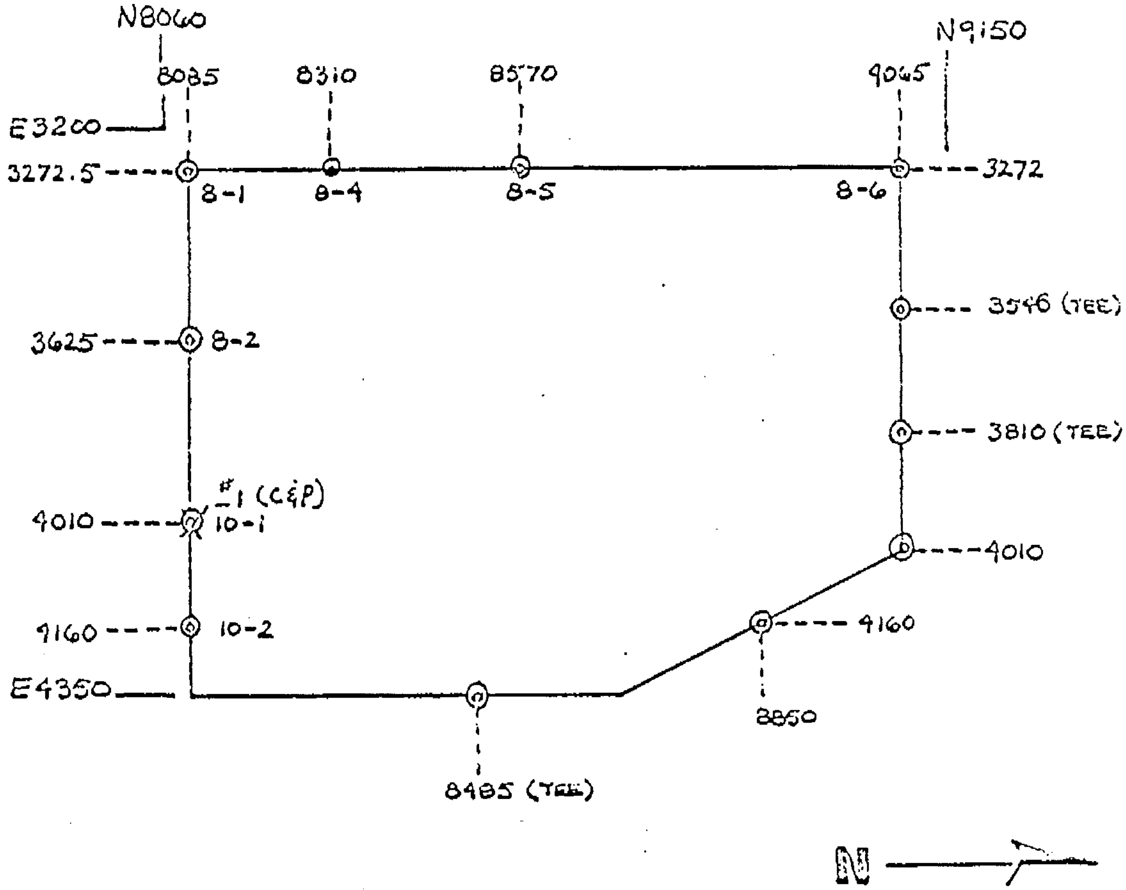
TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCENT COMPACTION
	S-4010	98.0	12.6	93
	Permeability:			
	S-4010 - 1.8×10^{-8} cm/sec.			

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

See Attached Diagram

SIGNED William [signature]

SOIL TEST NUMBERING SYSTEM



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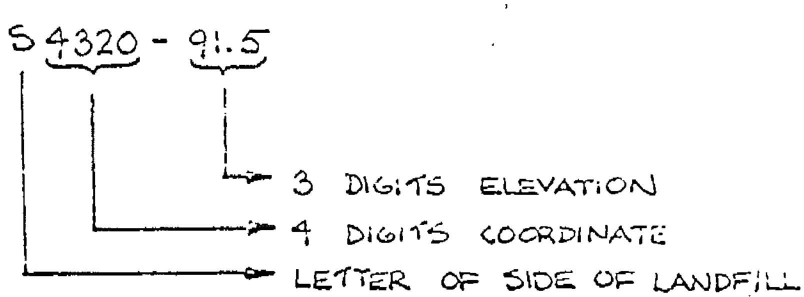


DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 6-17-80 (PM) JOB NO.: 80-352
PROJECT: Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER Clear TEMP RANGE 70 ° TO 80 ° AREA WORKED S. Wall

TYPE OF FILL: [ ] SAND [X] CLAY [ ] LOAM [ ] ______

METHOD OF COMPACTION: [ ] VIBRATORY PLATE [ ] PNEUMATIC TAMP. [ ] SHEEPSFOOT [ ] RUBBER TIRED [ ] STEEL WHEEL [ ] VIB. STEEL WHEEL [ ] VIB. PNEUMATIC [ ] Vib. Sheepsfoot

TYPE OF SUBGRADE: [ ] SAND [X] CLAY [ ] LOAM [ ] ______

CONDITION OF GRADE: [X] ROUGH [ ] SMOOTH [ ] WET [ ] DRY [ ] FROZEN [ ] LOOSE [ ] HARD [ ] RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT. PLACED TO DATE 2-8 FT.

MAX. DENSITY OF MATERIAL [X] MOD. AASHO T 180 [ ] STD. AASHO T-99

METHOD OF TEST [ ] SANDCONE [X] BALLOON [ ] ______

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ______ NO. OF TESTS TO DATE ______

LOCATION AND RESULTS OF TESTS

TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCENT COMPACTI[ON]
	S-4220	99.2	11.6	96
2	S-4070	98.5	11.0	(
3	S-3725	92.0	4.1	98
4	S-3590	91.0	11.5	97

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

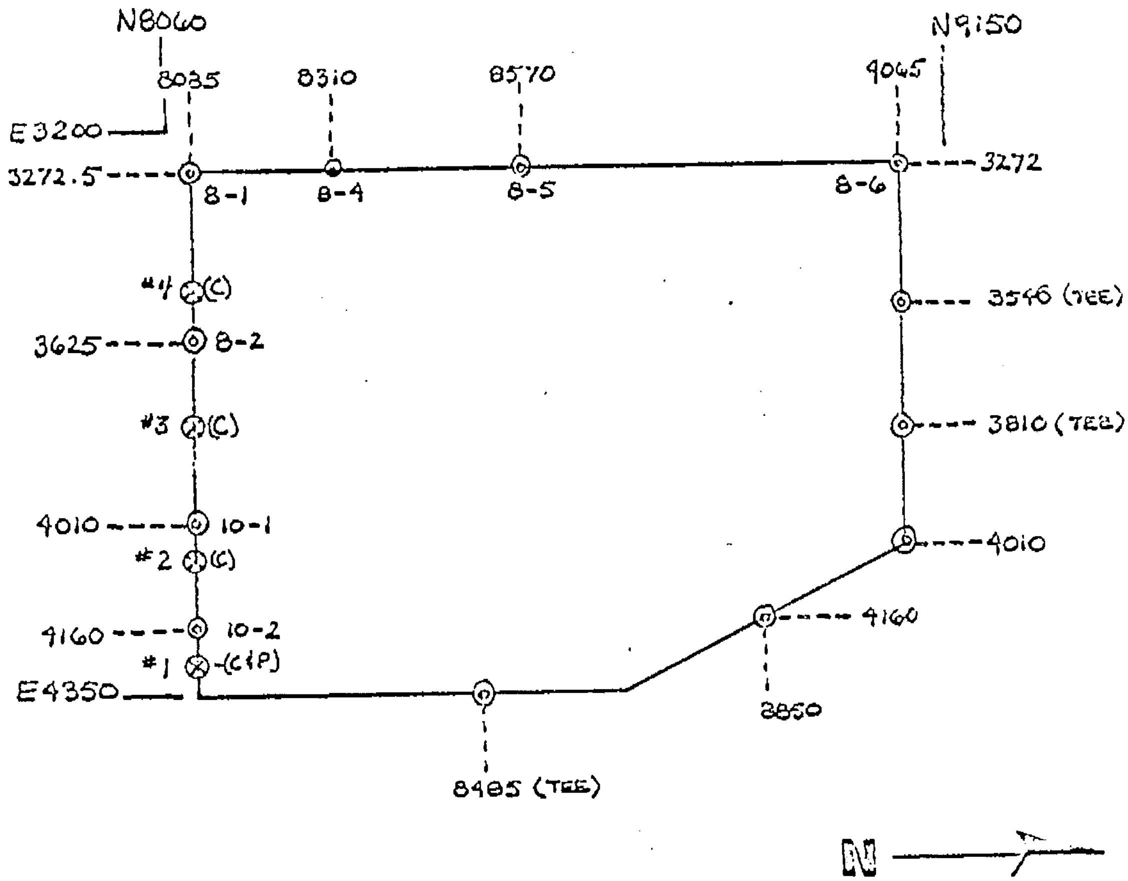
Permeability:

S-4220 - $1.2x10^{-8}$cm/sec.

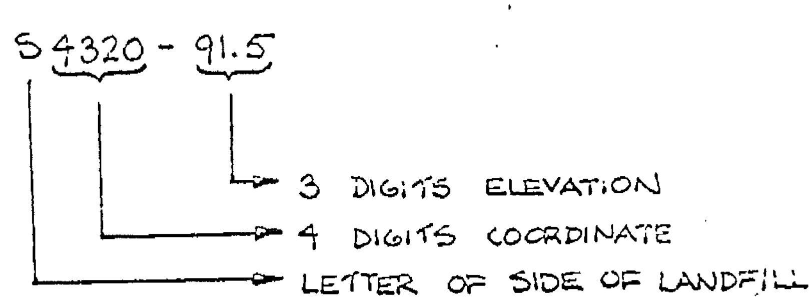
See Attached Diagram

SIGNED William [signature]

SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DAILY SOILS REPORT

DATE: 6-18-80 (PM) JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER Clear TEMP RANGE 70 ° TO 80 ° AREA WORKED

TYPE OF FILL: [ ] SAND [X] CLAY [ ] LOAM. [ ] ____

TYPE OF SUBGRADE: [ ] SAND [X] CLAY [ ] LOAM. [ ] ____

METHOD OF COMPACTION: [ ] VIBRATORY PLATE [ ] PNEUMATIC TAMP. [ ] SHEEPSFOOT [ ] RUBBER TIRED [ ] STEEL WHEEL [ ] VIB. STEEL WHEEL [ ] VIB. PNEUMATIC [X] VIB. Sheepsfoot

CONDITION OF GRADE: [X] ROUGH [ ] SMOOTH [ ] WET [ ] DRY [ ] FROZEN [ ] LOOSE [ ] HARD [ ] RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 2-4 FT

MAX. DENSITY OF MATERIAL [X] MOD. AASHO T 180 [ ] STD. AASHO T-99

METHOD OF TEST [ ] SANDCONE [X] BALLOON [ ] ____

134.2 #/CU. FT OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

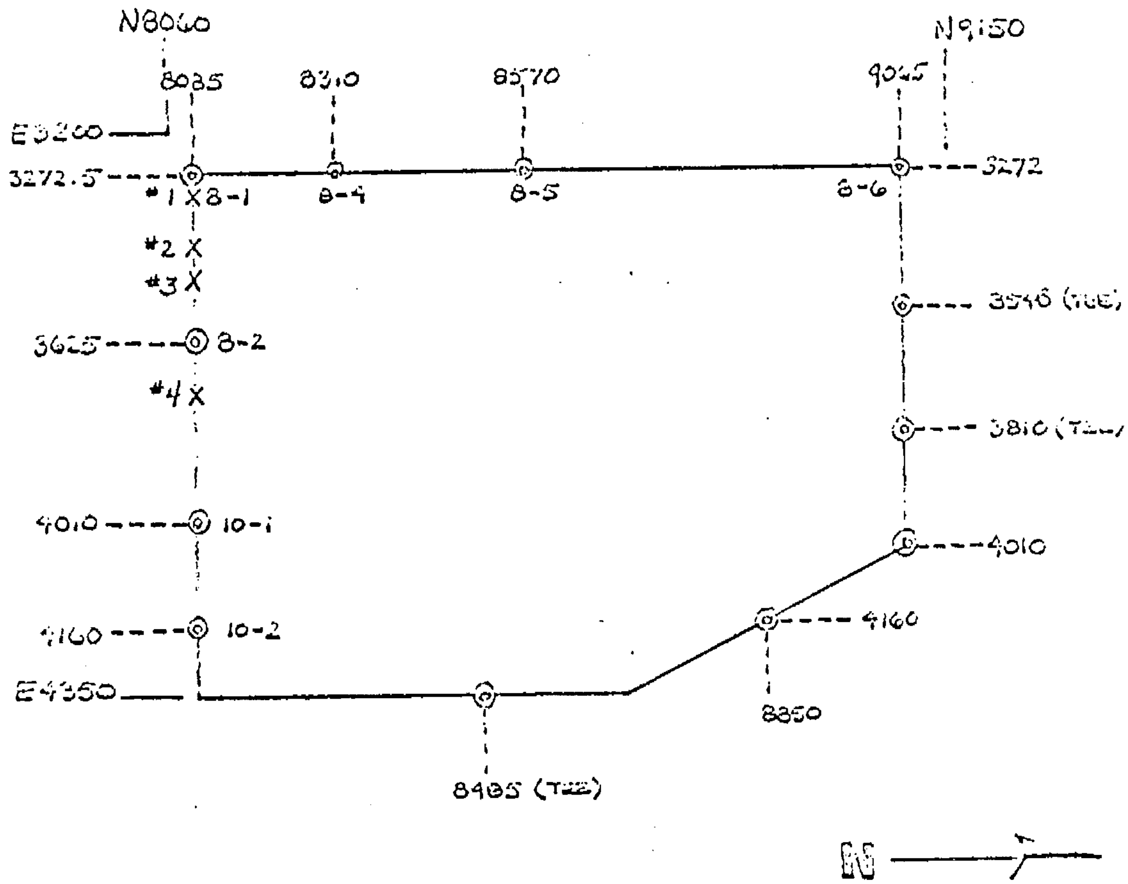
TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCENT COMPACTION
	S-3272.5 - 91.0	91.0	12.2	97
2	S-3375.0 - 93.0	93.0	12.8	[illegible]
3	S-3475.0 - 93.0	93.0	12.6	86
4	S-3725.0 - 94.0	94.0	12.8	90

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

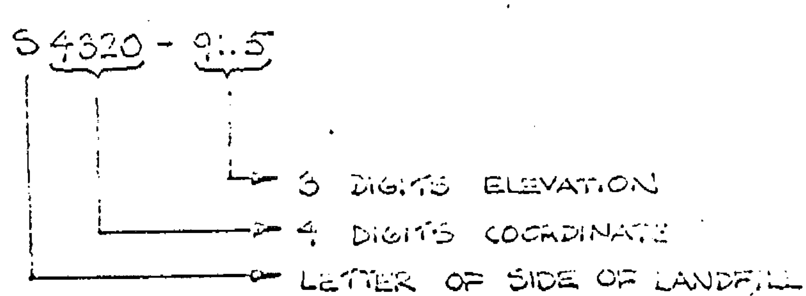
SEE ATTACHED DIAGRAM

SIGNED William [signature]

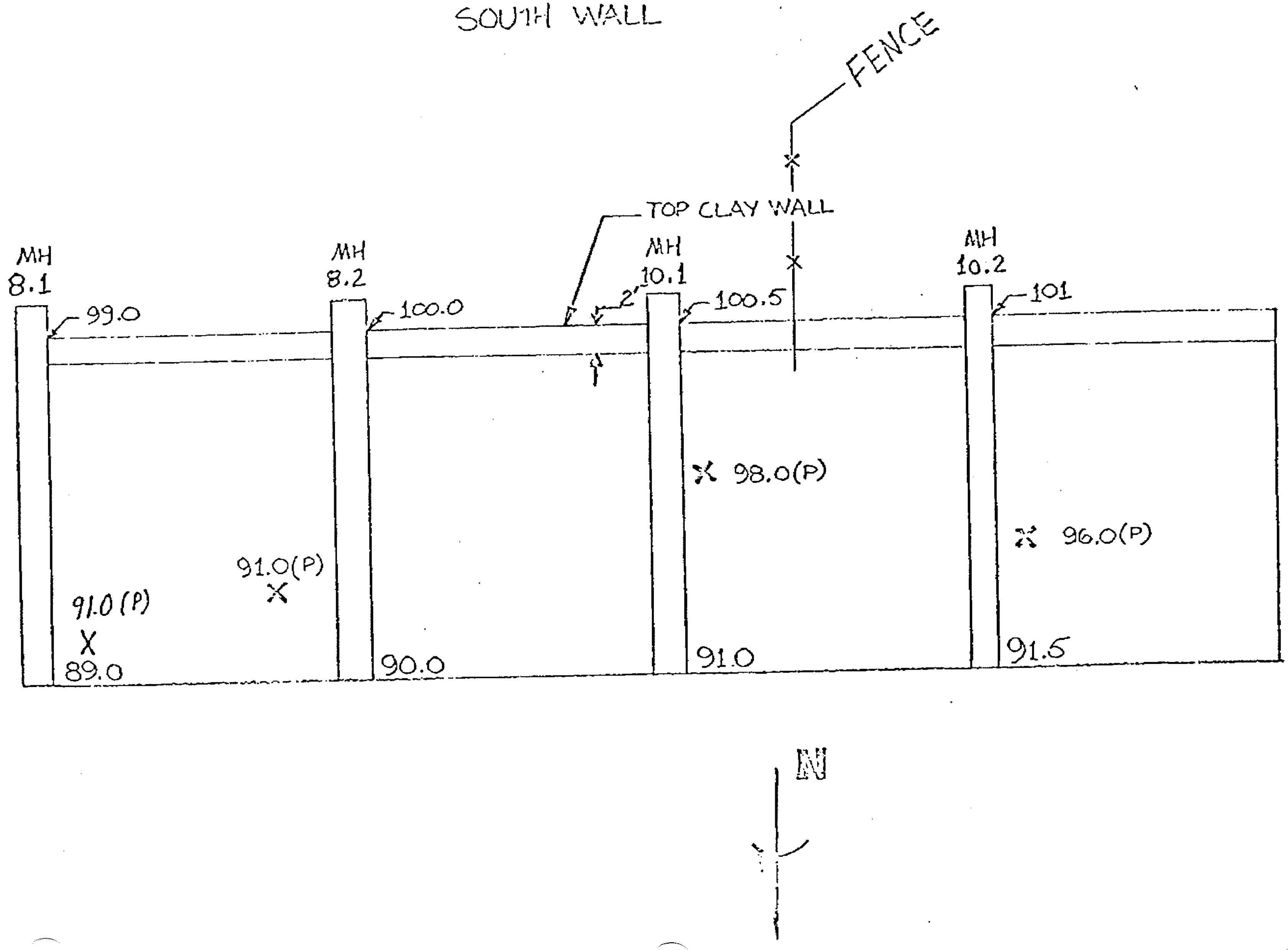
SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



SOUTH WALL


FENCE
TOP CLAY WALL
MH 8.1
99.0
MH 8.2
100.0
2'
MH 10.1
100.5
MH 10.2
101
98.0(P)
96.0(P)
91.0(P)
91.0 (P)
89.0
90.0
91.0
91.5
N

DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 6-19-80 (AM) JOB NO: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.: ____
CONTRACTOR: ____

WEATHER Cloudy TEMP RANGE 60 ° TO 70 ° AREA WORKED ____

TYPE OF FILL ☐ SAND ☐ CLAY ☐ LOAM. ☐ ____

METHOD OF COMPACTION ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☐ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☐ ____

TYPE OF SUBGRADE ☐ SAND ☐ CLAY ☐ LOAM. ☐ ____

CONDITION OF GRADE ☐ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT. PLACED TO DATE 3-4 FT

MAX. DENSITY OF MATERIAL ☐ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☐ BALLOON ☐ ____

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

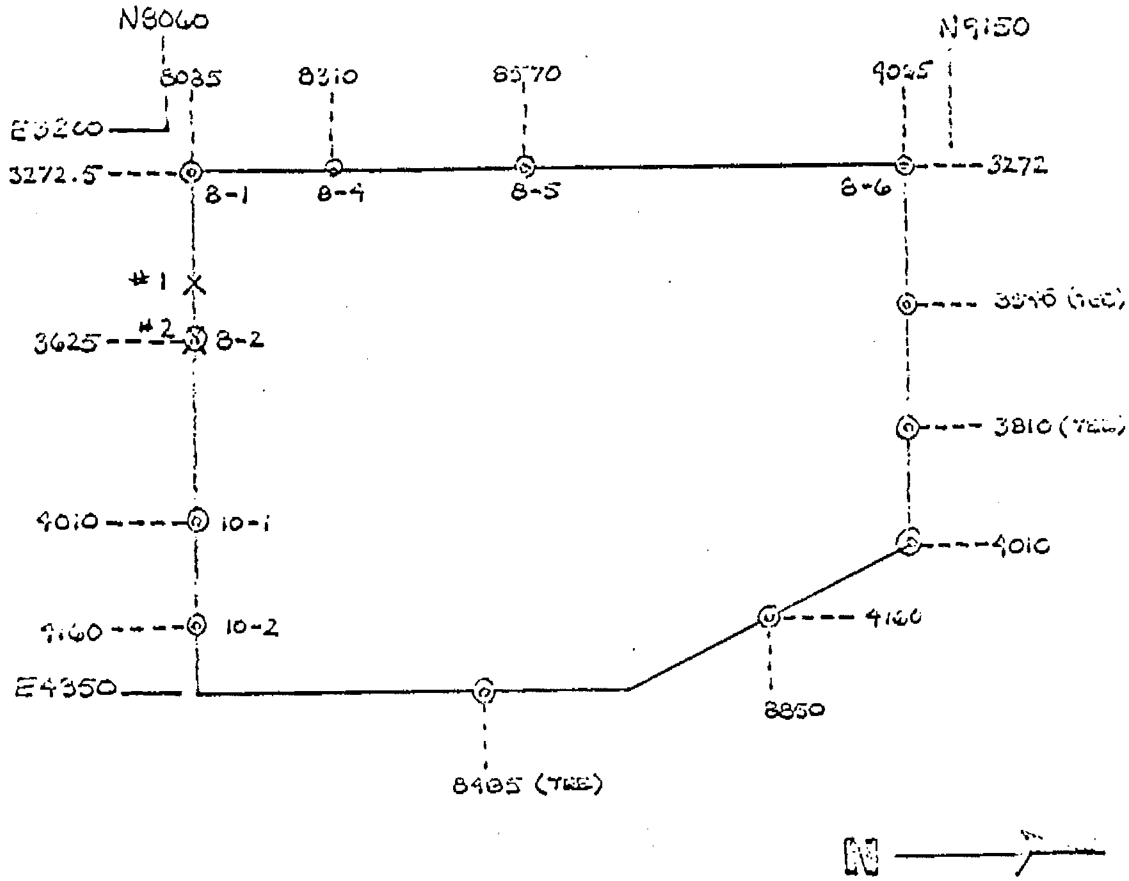
TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCENT COMPACTI
	S-3475 93.0 (Retest of 6-18-80)	93.0	11.6	
2	S-3625 93.0	93.0	11.5	95

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

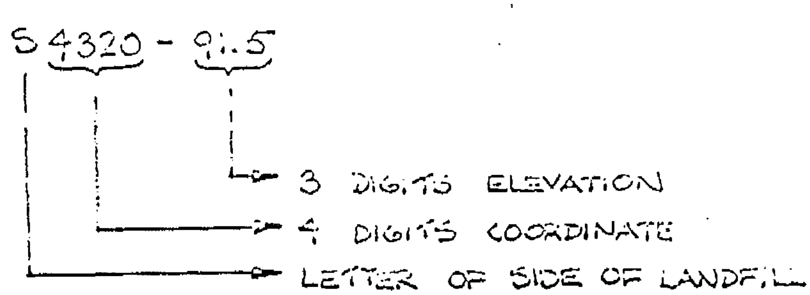
SEE ATTACHED DIAGRAM

SIGNED William [signature]

SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 6-23-80(p.m.) JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER Clear TEMP RANGE 70 ° TO 80 ° AREA WORKED

TYPE OF FILL: [ ] SAND [X] CLAY [ ] LOAM. [ ] ____

METHOD OF COMPACTION: [ ] VIBRATORY PLATE [ ] PNEUMATIC TAMP. [ ] SHEEPSFOOT [ ] RUBBER TIRED [ ] STEEL WHEEL [ ] VIB. STEEL WHEEL [ ] VIB. PNEUMATIC [X] Vib. Sheepsfoot

TYPE OF SUBGRADE: [ ] SAND [X] CLAY [ ] LOAM. [ ] ____

CONDITION OF GRADE: [X] ROUGH [ ] SMOOTH [ ] WET [ ] DRY [ ] FROZEN [ ] LOOSE [ ] HARD [ ] RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 7-9 FT.

MAX. DENSITY OF MATERIAL [XX] MOD. AASHO T 180 [ ] STD. AASHO T-99

METHOD OF TEST [ ] SANDCONE [X] BALLOON [ ] ____

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

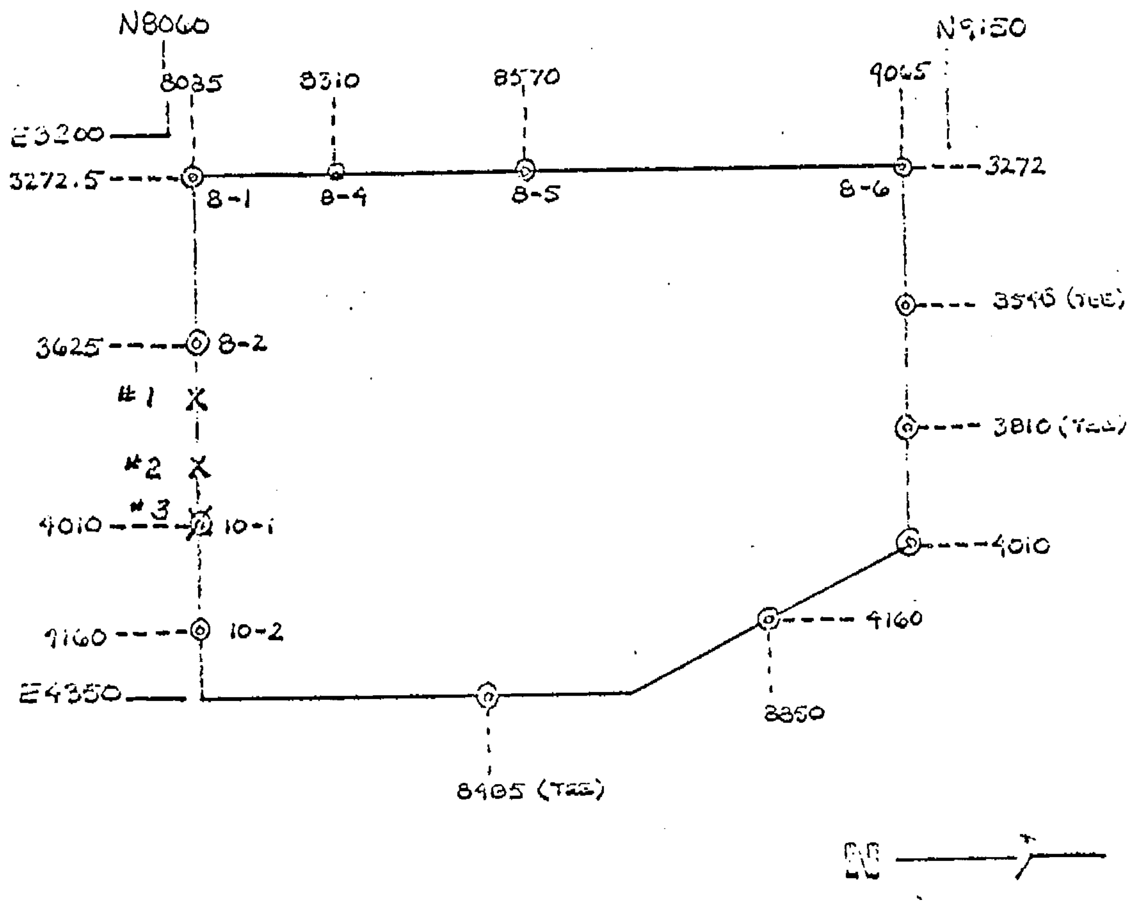
TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCENT COMPACTI[ON]
	S-3735 - 97.0	97.0	10.7	
2	S-3785 - 97.0	97.0	11.1	98
3	S-4010 - 99.0	99.0	9.6	100

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

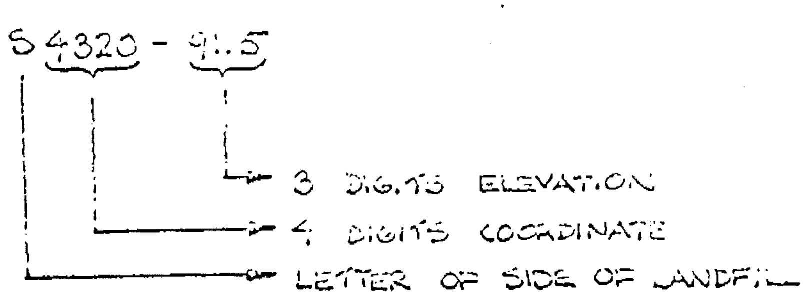
SEE ATTACHED DIAGRAM

SIGNED William [illegible]

SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 6-24-80 JOB NO: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER Clear TEMP RANGE 70 ° TO 80 ° AREA WORKED South Wall

TYPE OF FILL: [ ] SAND [X] CLAY [ ] LOAM [ ] ____

METHOD OF COMPACTION: [ ] VIBRATORY PLATE [ ] PNEUMATIC TAMP [ ] SHEEPSFOOT [ ] RUBBER TIRED [ ] STEEL WHEEL [ ] VIB. STEEL WHEEL [ ] VIB. PNEUMATIC [X] Vib. Sheepsfoot

TYPE OF SUBGRADE: [ ] SAND [X] CLAY [ ] LOAM [ ] ____

CONDITION OF GRADE: [X] ROUGH [ ] SMOOTH [ ] WET [ ] DRY [ ] FROZEN [ ] LOOSE [ ] HARD [ ] RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 7-8 FT

MAX. DENSITY OF MATERIAL [XX] MOD. AASHO T 180 [ ] STD. AASHO T-99

METHOD OF TEST [ ] SANDCONE [X] BALLOON [ ] ____

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

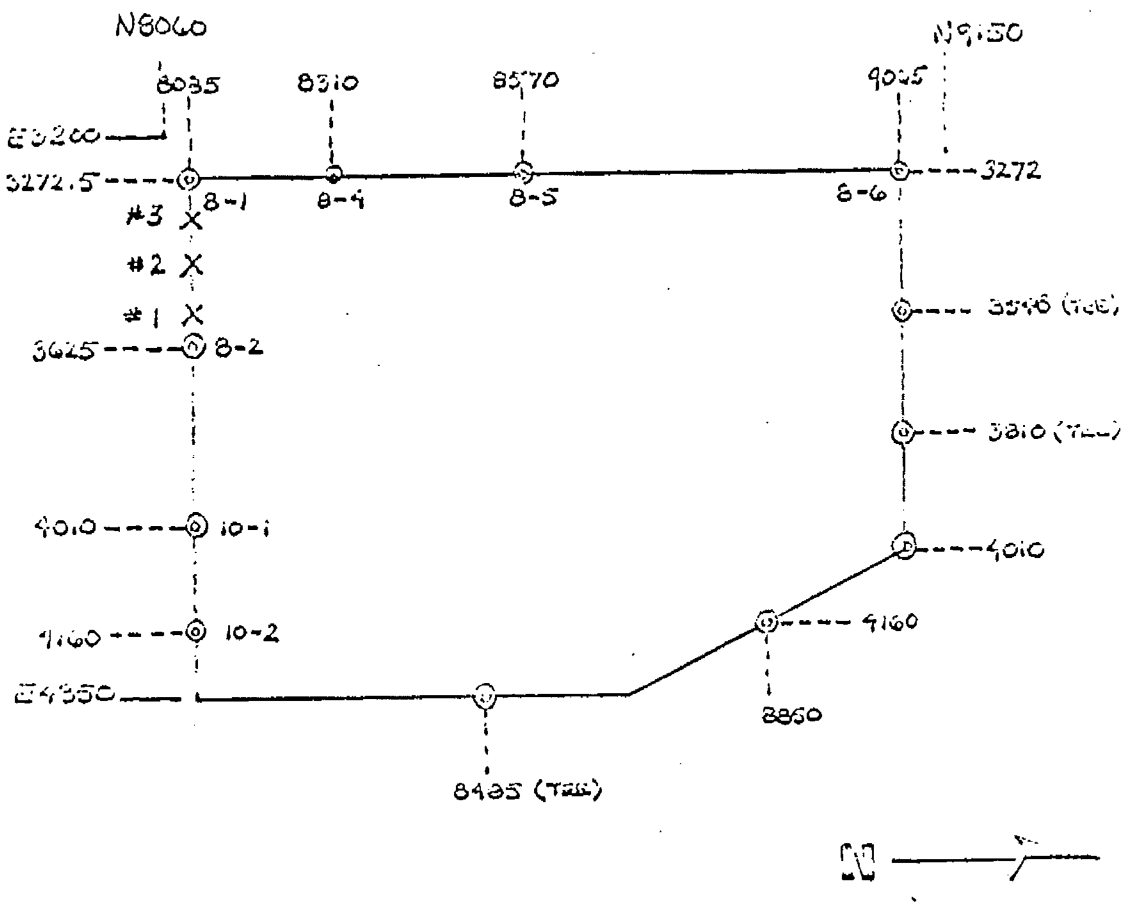
TEST NO.	LOCATION	ELEVATION	PERCENT MOISTURE	PERCENT COMPACTION
	S-3565 - 97.0	97.0	12.8	[illegible]
2	S-3410 - 98.0	98.0	19.8	82
3	S-3300 - 97.5	97.5	13.0	88

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

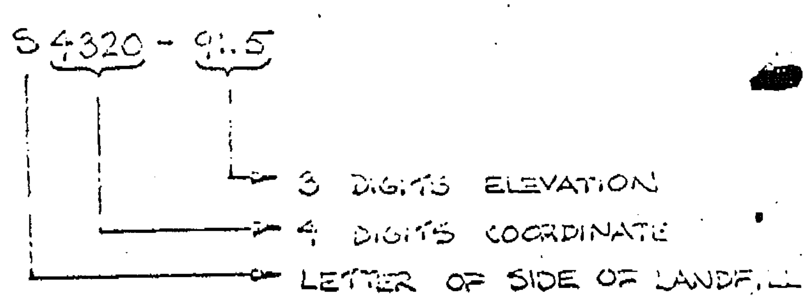
SEE ATTACHED DIAGRAM

SIGNED [signature]

SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 6-26-80 JOB NO: 80-352
PROJECT: Dow Corning waste disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER Cloudy TEMP RANGE 70° TO 80° AREA WORKED South Wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☐ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☒ Vib. Sheepsfoot

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 8-9 FT

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☐ BALLOON ☐ ____

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

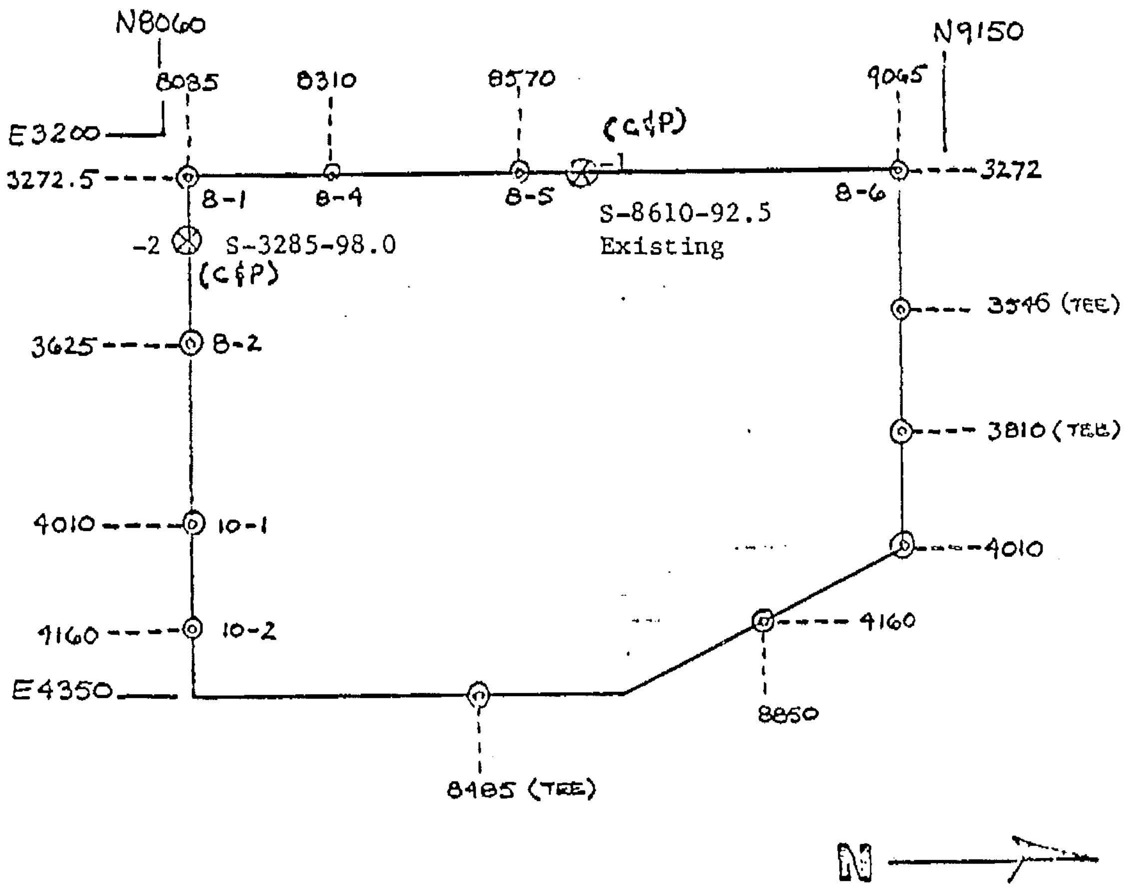
TEST NO.	LOCATION	ELEVATION	PERCENT MOISTURE	PERCENT COMPACTION
1	W - 8610 (Existing Grade material)	92.5	24.9	
2	S - 3285 (Compacted Fill)	98.0	10.9	96
	Permeabilities:			
	W-8610 - 1.5x10^{-8}cm/sec.			
	S-3285 - 2.3x10^{-8}cm/sec.			

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

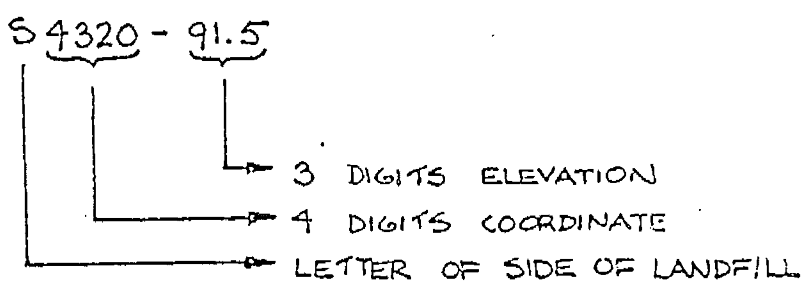
SEE ATTACHED DIAGRAM

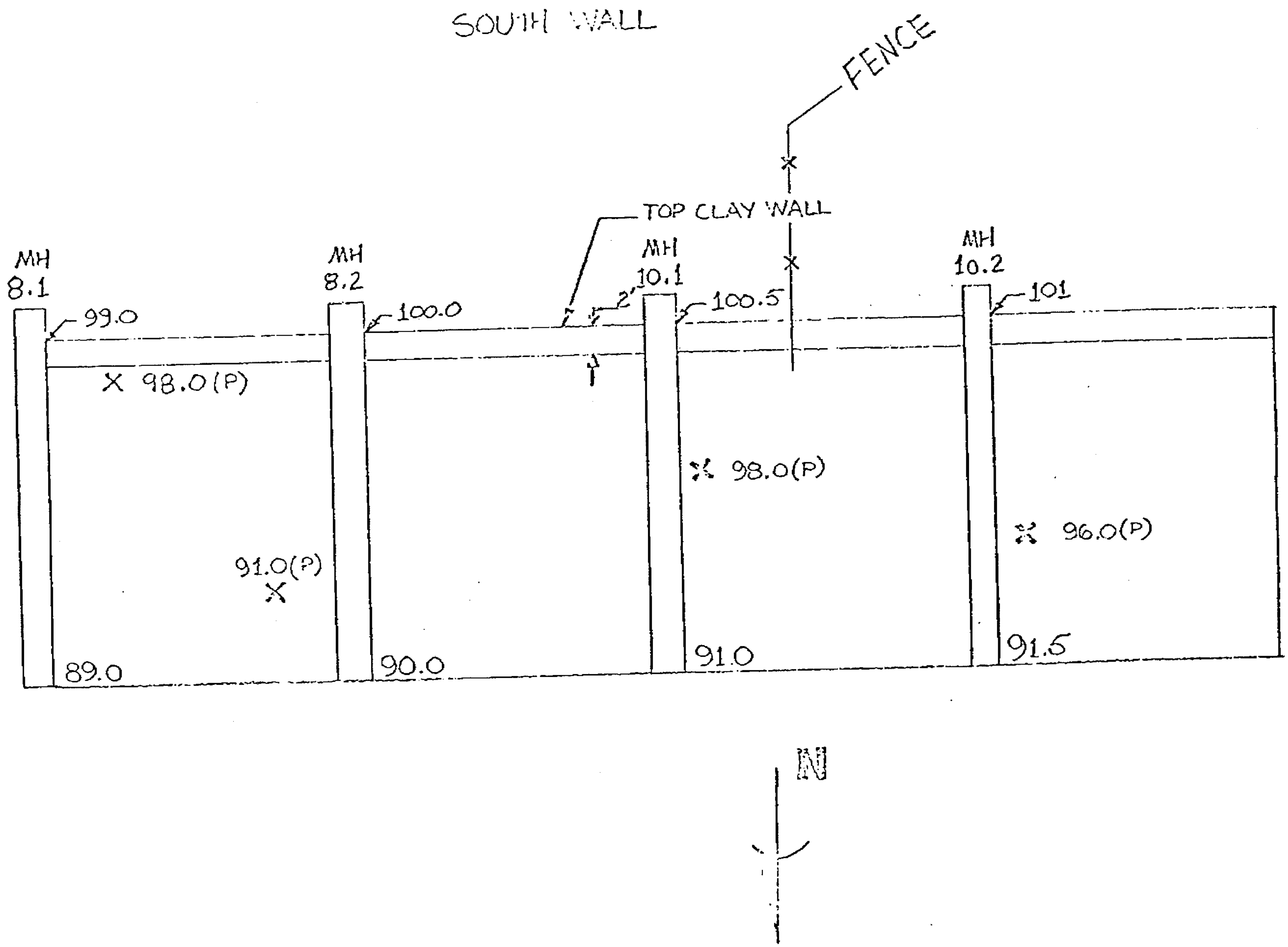
SIGNED [signature]

SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM




SOUTH WALL
FENCE
TOP CLAY WALL
MH 8.1
MH 8.2
MH 10.1
MH 10.2
99.0
100.0
2'
100.5
101
X 98.0(P)
91.0(P)
98.0(P)
96.0(P)
89.0
90.0
91.0
91.5
N

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DAILY SOILS REPORT

DATE: 6-30-80 JOB NO: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER Clear TEMP RANGE ° TO ° AREA WORKED

TYPE OF FILL: [ ] SAND [X] CLAY [ ] LOAM [ ] ____

METHOD OF COMPACTION: [ ] VIBRATORY PLATE [ ] PNEUMATIC TAMP. [ ] SHEEPSFOOT [ ] RUBBER TIRED [ ] STEEL WHEEL [ ] VIB. STEEL WHEEL [ ] VIB. PNEUMATIC [X] Vib. Sheepsfoot

TYPE OF SUBGRADE: [ ] SAND [X] CLAY [ ] LOAM [ ] ____

CONDITION OF GRADE: [X] ROUGH [ ] SMOOTH [ ] WET [ ] DRY [ ] FROZEN [ ] LOOSE [ ] HARD [ ] RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT. PLACED TO DATE 2-4 FT

MAX. DENSITY OF MATERIAL [X] MOD. AASHO T 180 [ ] STD. AASHO T-99

METHOD OF TEST [ ] SANDCONE [X] BALLOON [ ] ____

134.2 #/ CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

WEST WALL

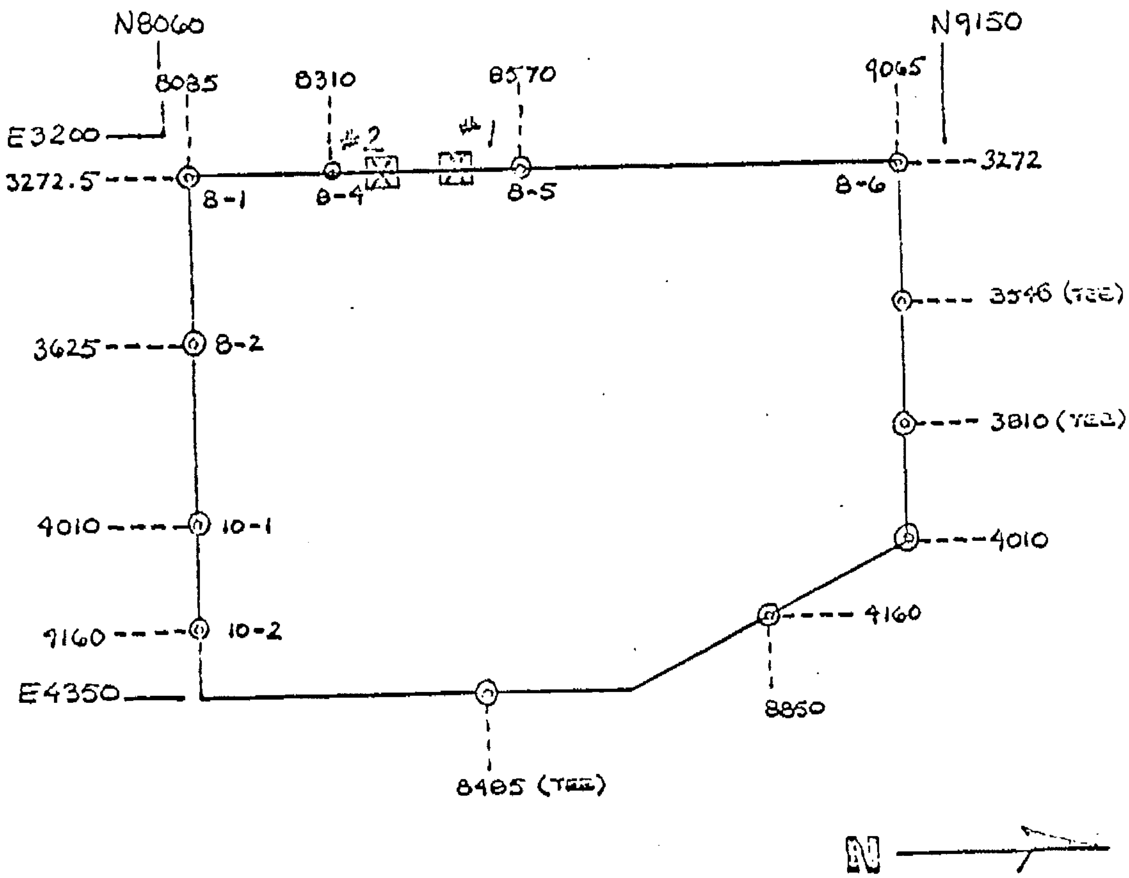
TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCENT COMPACT.
	W-8470 - 94.0	94.0	14.7	93
2	W-8345 - 96.0	96.0	12.2	

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

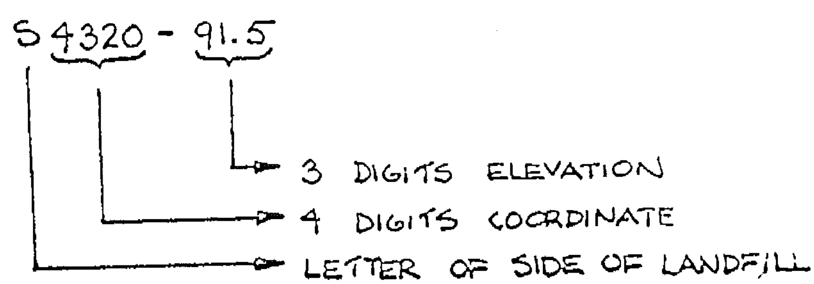
SEE ATTACHED DIAGRAM

SIGNED [signature]

SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 7-1-80 JOB NO: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER clear TEMP RANGE 70 ° TO 80 ° AREA WORKED West Wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☐ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☒ Vib sheepsfoot

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 2-4 FT

MAX. DENSITY OF MATERIAL ☐ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☐ BALLOON ☐ ____

134.2 #/ CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

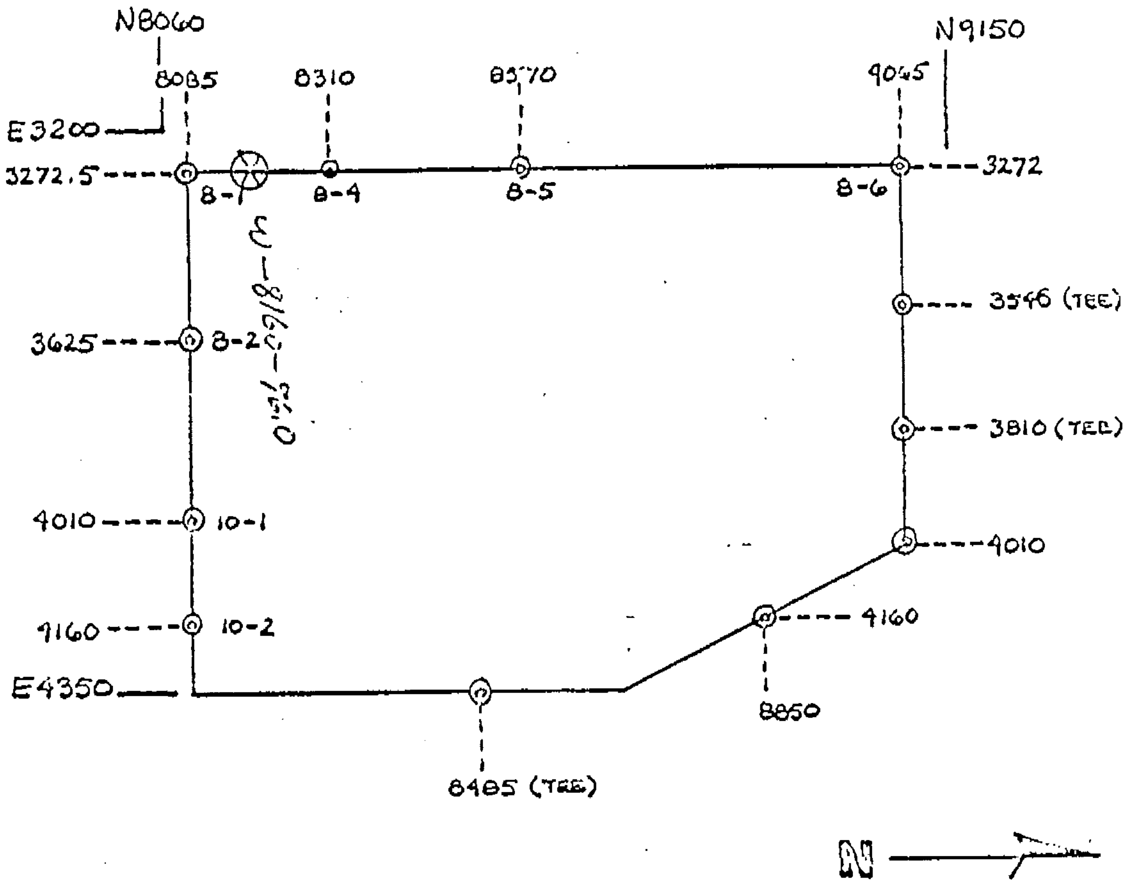
TEST NO.	LOCATION	ELEVATION	PERCENT MOISTURE	PERCENT COMPACTI[ON]
	W - 8160	96.0	16.3	83

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

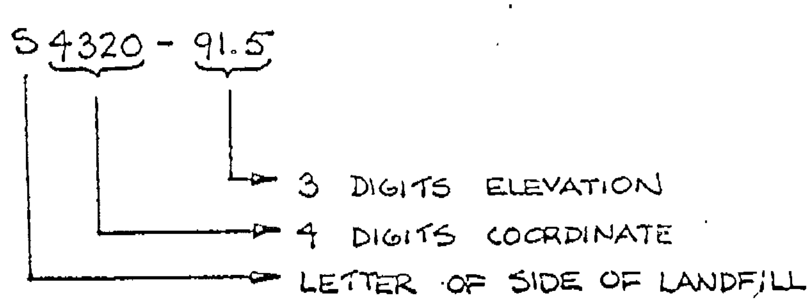
(SEE ATTACHED DIAGRAM)

SIGNED William [signature]

SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 7-2-80 JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER clear TEMP RANGE 70 ° TO 80 ° AREA WORKED West Wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM ☐

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☐ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☒ Vib sheepsfoot

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM ☐

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 24 IN. PLANNED DEPTH OF FILL 10 FT. PLACED TO DATE 2-4 FT.

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOON ☐

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE NO. OF TESTS TO DATE -

LOCATION AND RESULTS OF TESTS

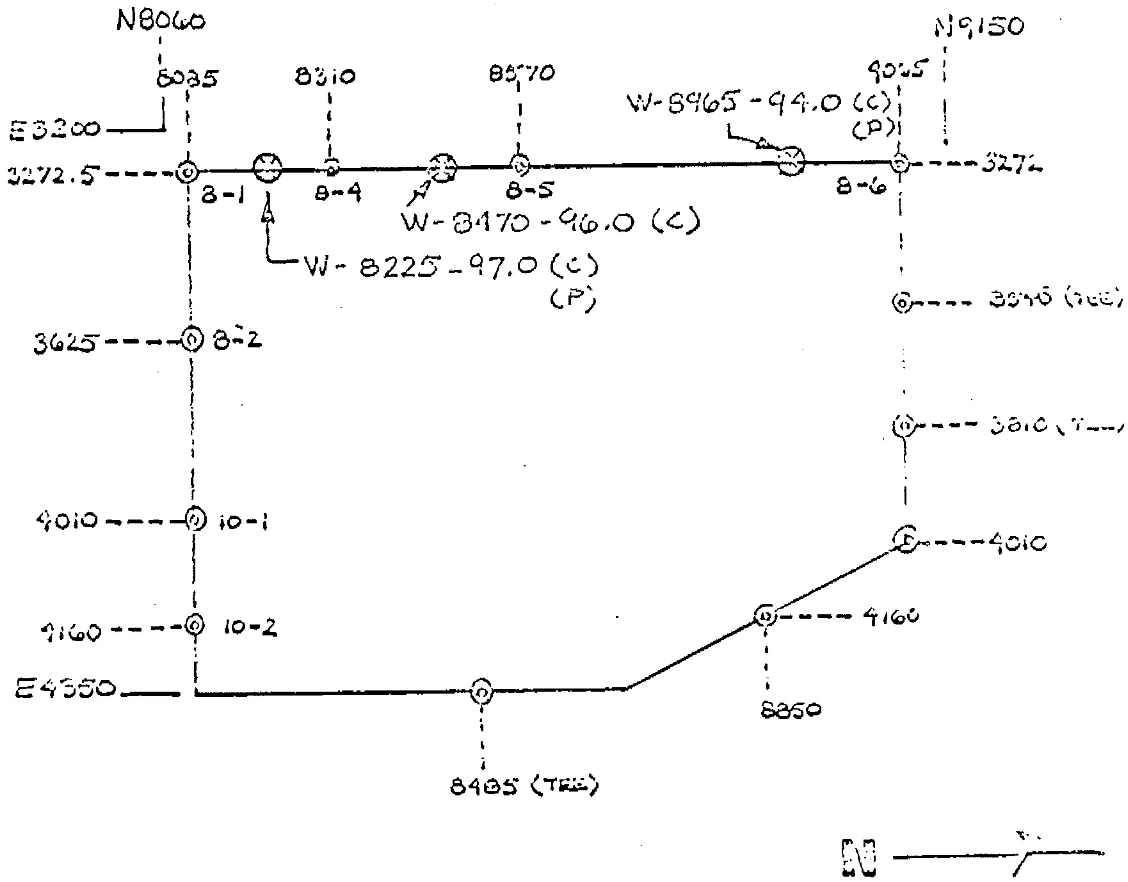
TEST NO.	LOCATION	ELEVATIONS	PERCENT MOISTURE	PERCENT COMPACTION
	W - 8965 (Existing)	94.0	22.0	-
2	W - 8470	97.0	10.7	—
3	W - 8225	97.0	10.1	92
	Permeability:			
	W-8965 - 3.4×10^{-8} cm/sec.			

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

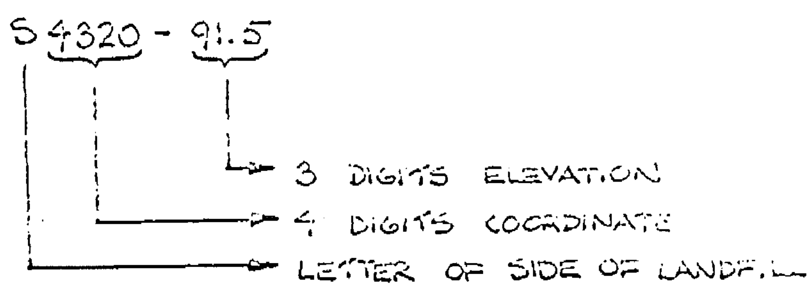
(SEE ATTACHED DIAGRAMS)

SIGNED William [signature]

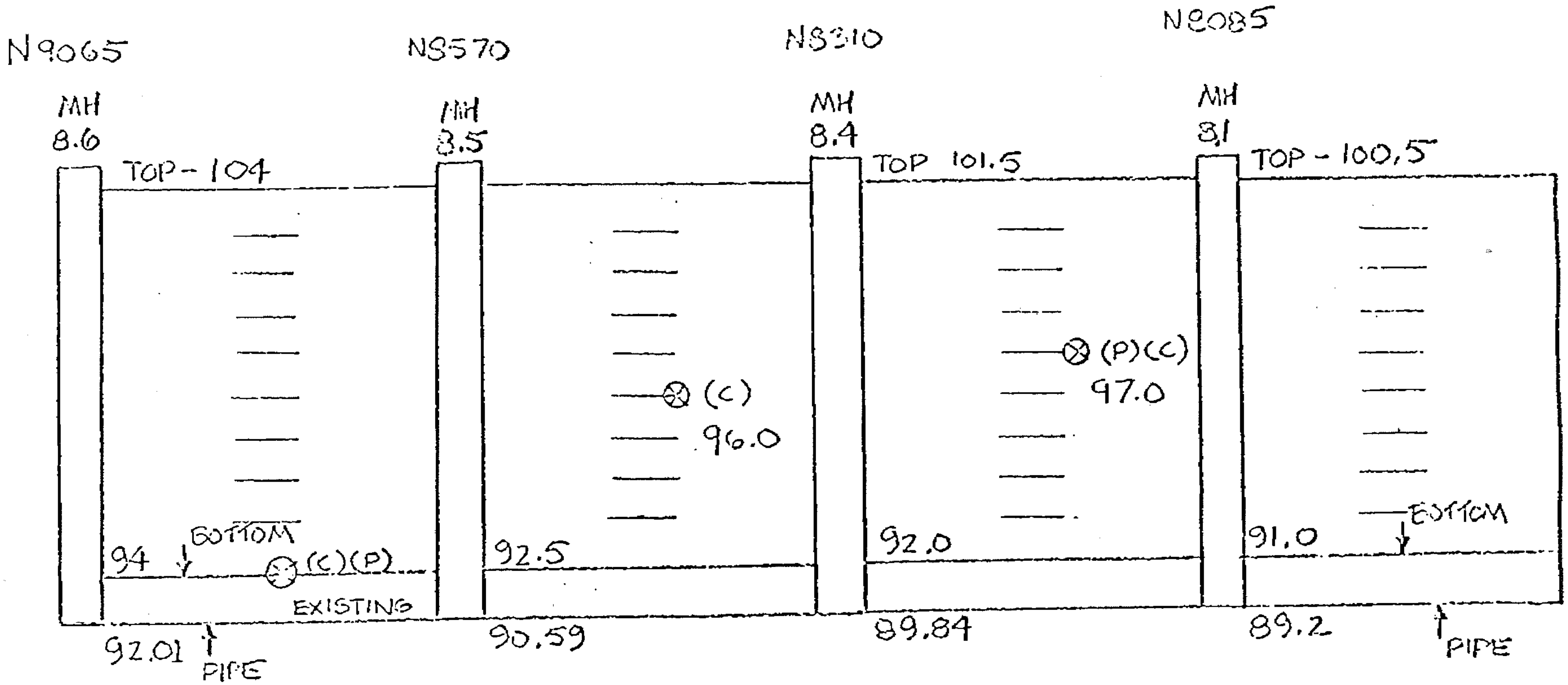
SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



WEST WALL



(DOW CORNING WASTE DISPOSAL)

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DAILY SOILS REPORT

DATE: 7-3-80 JOB NO: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER clear TEMP RANGE 70 ° TO 80 ° AREA WORKED West wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM. ☐ ____

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☐ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☒ Vib. Sheepsfoot

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM. ☐ ____

CONDITION OF GRADE: ☐ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 6 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 1-3 FT.

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOON ☐ ____

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

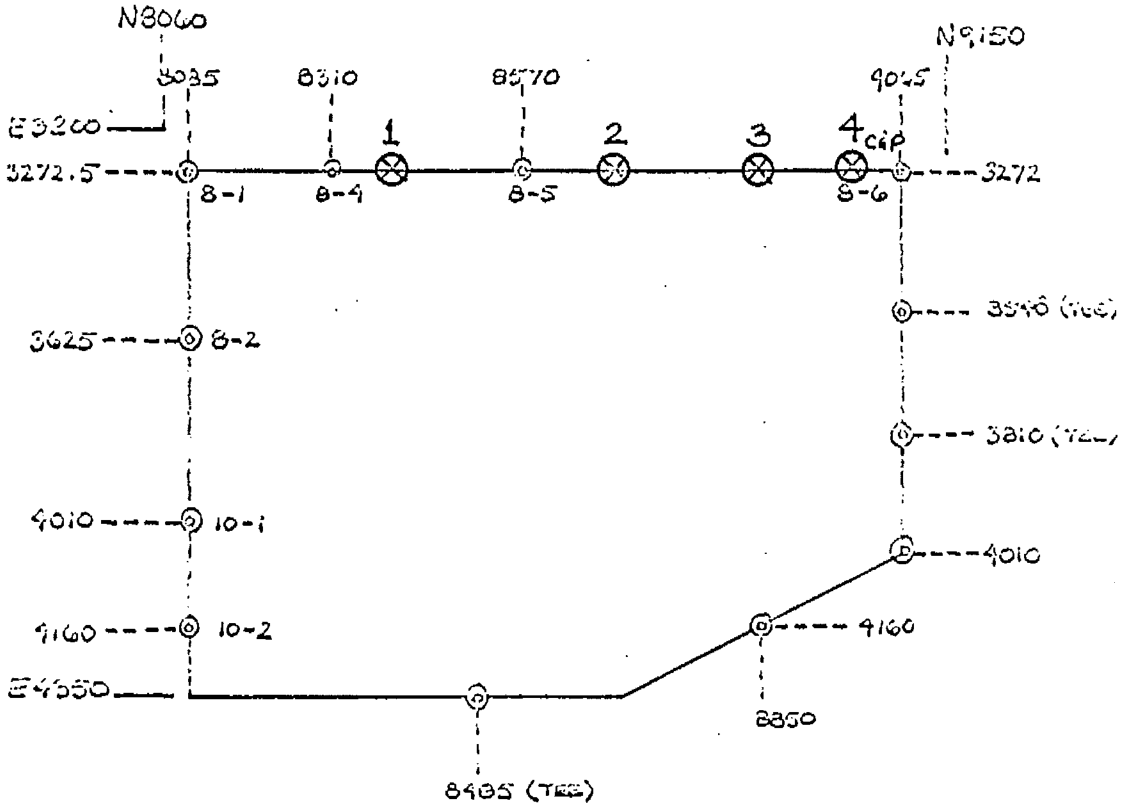
TEST NO.	LOCATION	ELEVATION	PERCENT MOISTURE	PERCENT COMPACTION
1	W - 8395	95.0	11.6	9[illegible]
2	W - 8670	95.0	12.1	96
3	W - 8740	94.0	12.4	94
4	W - 9045	94.0	12.0	91
	Permeability:			
	W-9045 - 4.1×10^{-9} cm/sec.			

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

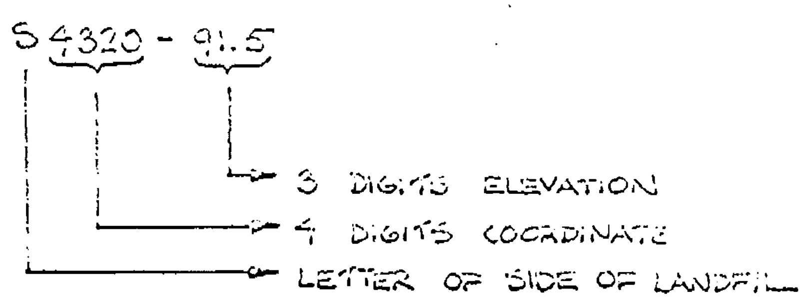
(SEE ATTACHED DIAGRAM)

SIGNED William [signature]

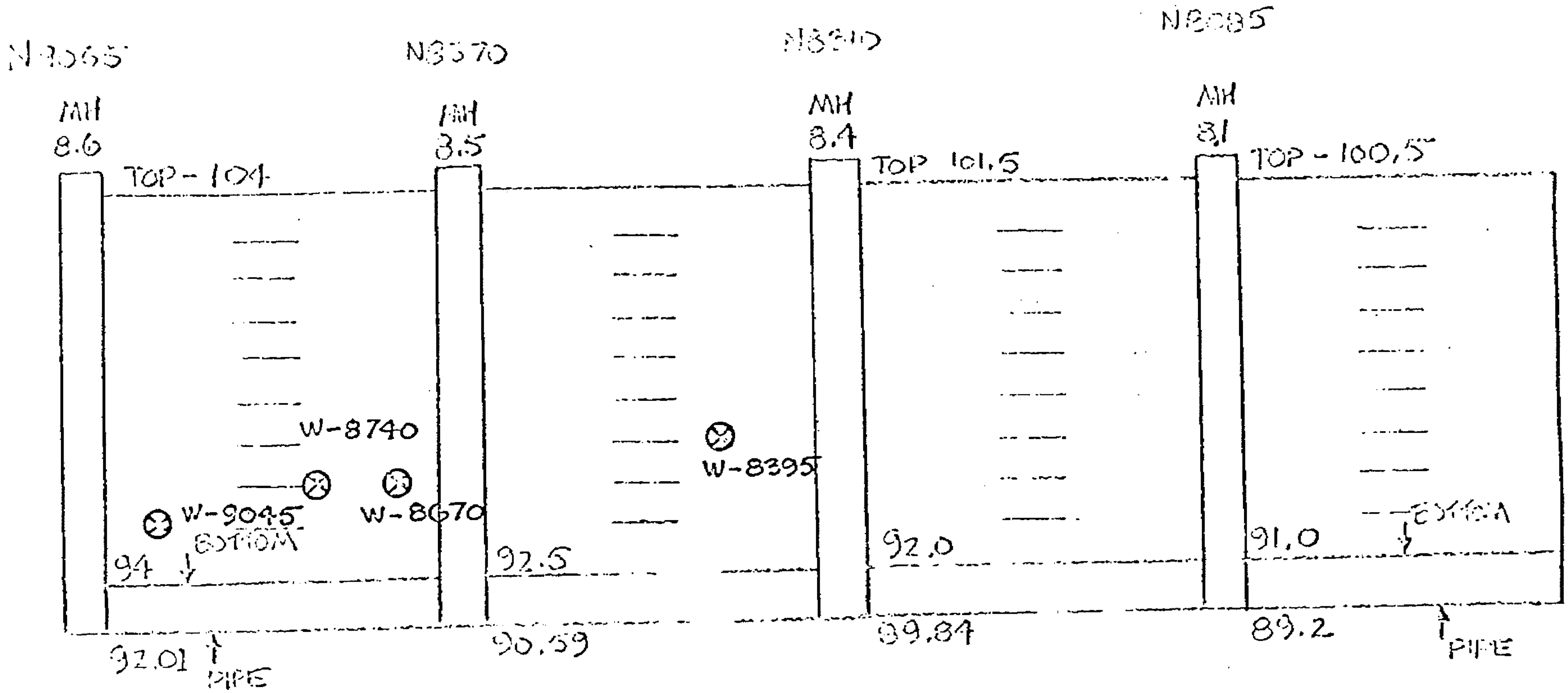
SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



WEST WALL.



(DOW COOLING WASTE DISPOSAL)

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DAILY SOILS REPORT

DATE: 7-7-80 JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER clear TEMP RANGE 70 ° TO 80 ° AREA WORKED West wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☐ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☒ Vib. Sheepsfoot

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

CONDITION OF GRADE: ☐ ROUGH ☒ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 6 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 7-10 FT

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOO[N] ☐ ____

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

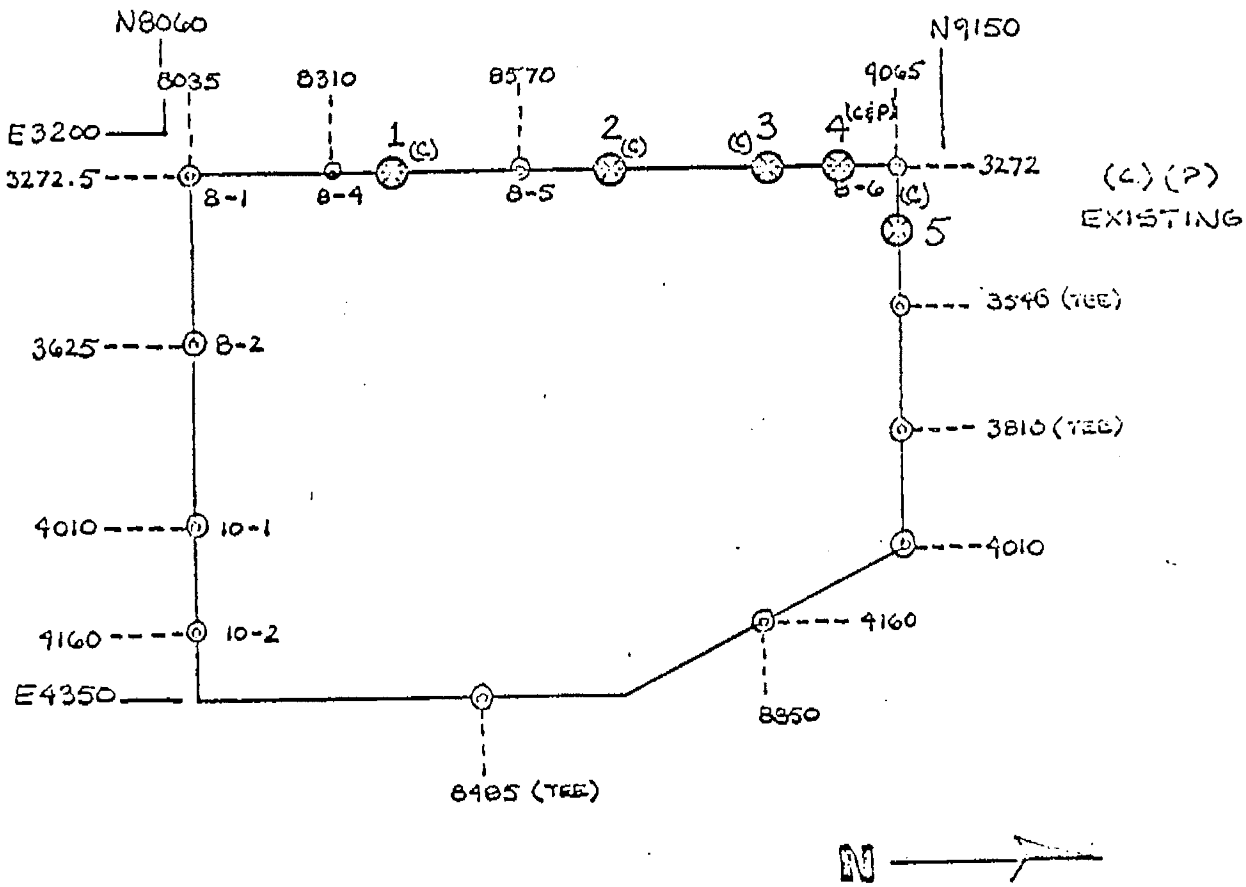
LOCATION AND RESULTS OF TESTS

TEST NO.	LOCATION	ELEVATION	PERCENT MOISTURE	PERCEN[T] COMPACT
[illegible]	W - 8390	100.0	10.5	96
2	W - 8705	97.0	11.0	[illegible]
3	W - 8990	98.0	13.1	94
4	W - 9035	97.0	10.7	95
5	N - 3460 (existing)	94.3	23.6	---
	Permeability:			
	W-9035 - 3.2×10^{-9} cm/sec.			

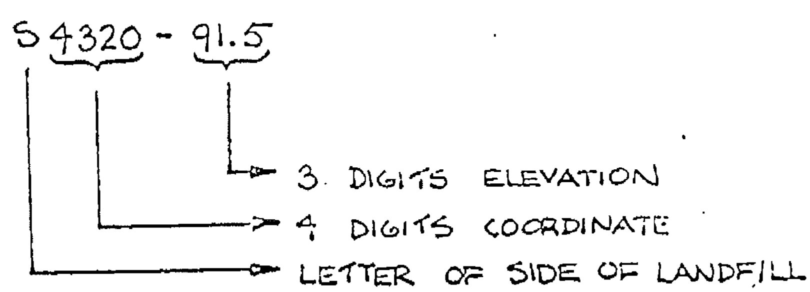
BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

SIGNED William [signature]

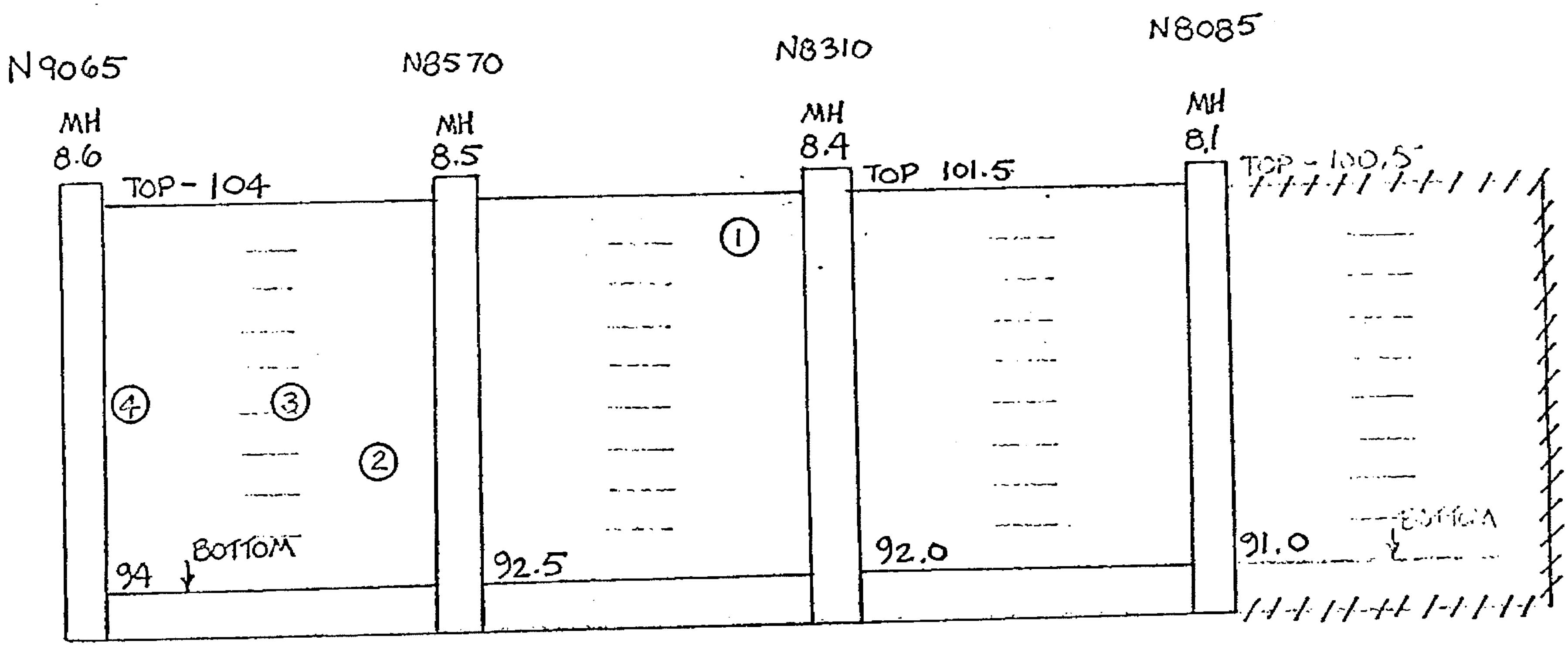
SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



WEST WALL (VIEWED FROM WEST SIDE OF SITE)



1 W-8390 - 100.0 (c)(P)
2 W-8705 - 97.0 (c)
3 W-8890 - 98.0 (c)
4 W-9035 - 97.0 (c)(P)

(DOW CORNING WASTE DISPOSAL)

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DAILY SOILS REPORT

DATE: 7-9-80 JOB NO: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.: ____
CONTRACTOR: ____

WEATHER: cloudy TEMP RANGE: 70° TO 80° AREA WORKED: N. & E. Walls

TYPE OF FILL: ☐ SAND ☐ CLAY ☐ LOAM ☐ ____

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☐ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☐ ____

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS: existing PLANNED DEPTH OF FILL: - FT PLACED TO DATE: - FT

MAX. DENSITY OF MATERIAL: ☐ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST: ☐ SANDCONE ☐ BALLOON ☐ ____

NA #/CU. FT. OPTIMUM MOISTURE NA %

DENSITY REQUIRED NA % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

TEST NO.	LOCATION	ELEVATION	PERCENT MOISTURE	PERCENT COMPACTION
1	N - 3845 (Existing Nat. Unit Wt. - 133.9)	96.0	23.7	
2	E - 8470 (Existing Nat. Unit Wt. - 130.9)	94.0	27.2	NA
	Permeability:			
	E-8470 - 1.9×10^{-8} cm/sec.			

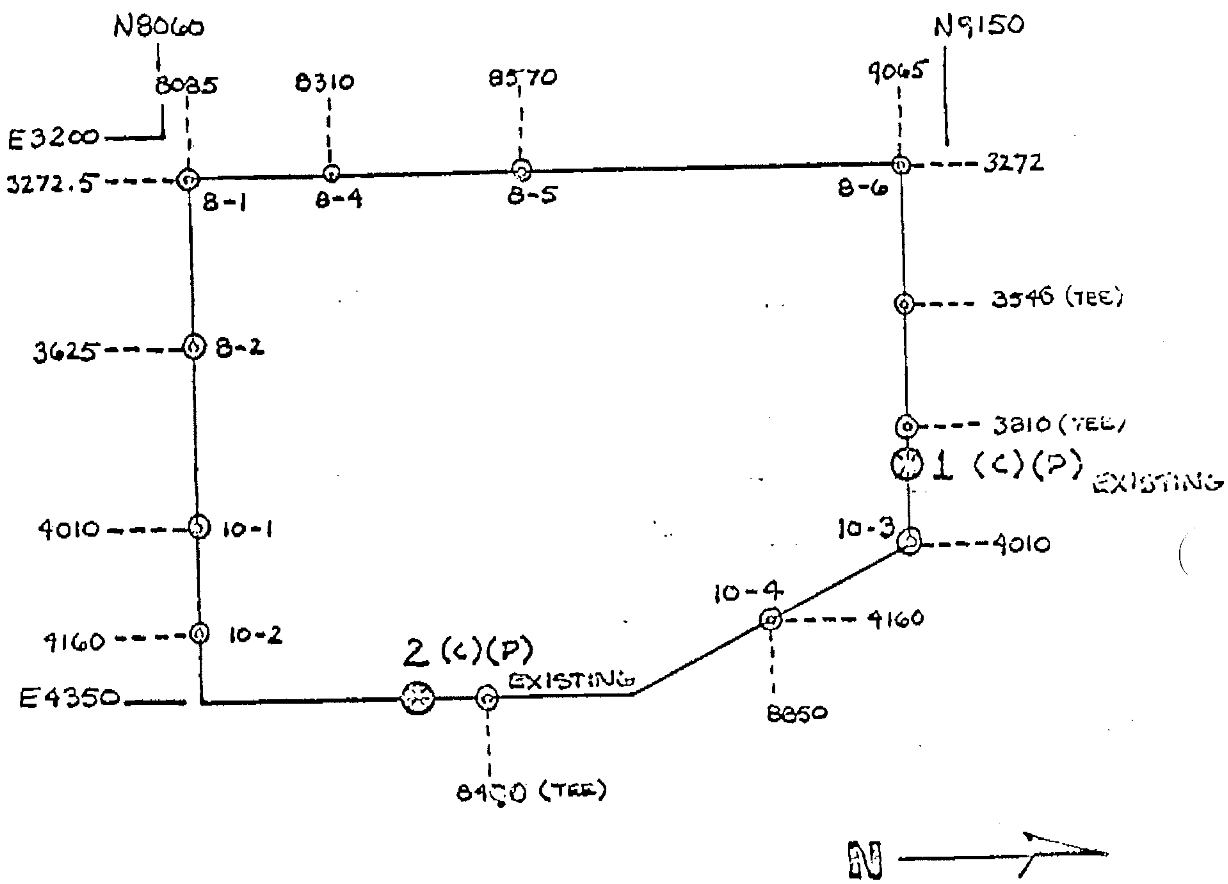
BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

Based on a sp.g. value of 2.65 this corresponds to zero voids in the naturally deposited existing clay soil subgrade.

(SEE ATTACHED DIAGRAM)

SIGNED William [illegible]

SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM

S 4320 - 91.5

- 3 DIGITS ELEVATION
- 4 DIGITS COORDINATE
- LETTER OF SIDE OF LANDFILL

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DAILY SOILS REPORT

DATE: 7-10-80 JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER sunny TEMP RANGE 80 ° TO 85 ° AREA WORKED North Wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM ☐

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☐ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☒ Vib Sheepsfoot

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM ☐

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 6 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 2-3 FT

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOON ☐

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ______ NO. OF TESTS TO DATE ______

LOCATION AND RESULTS OF TESTS

TEST NO.	LOCATION	ELEVATION	PERCENT MOISTURE	PERCENT COMPACTION
1	N - 3950	98.0	10.8	
2	N - 3843	99.0	12.2	86
3	N - 3441	97.0	11.9	95
4	N - 3681	97.0	12.3	98
	Permeability:			
	N-3950 - 1.1×10^{-8} cm/sec.			

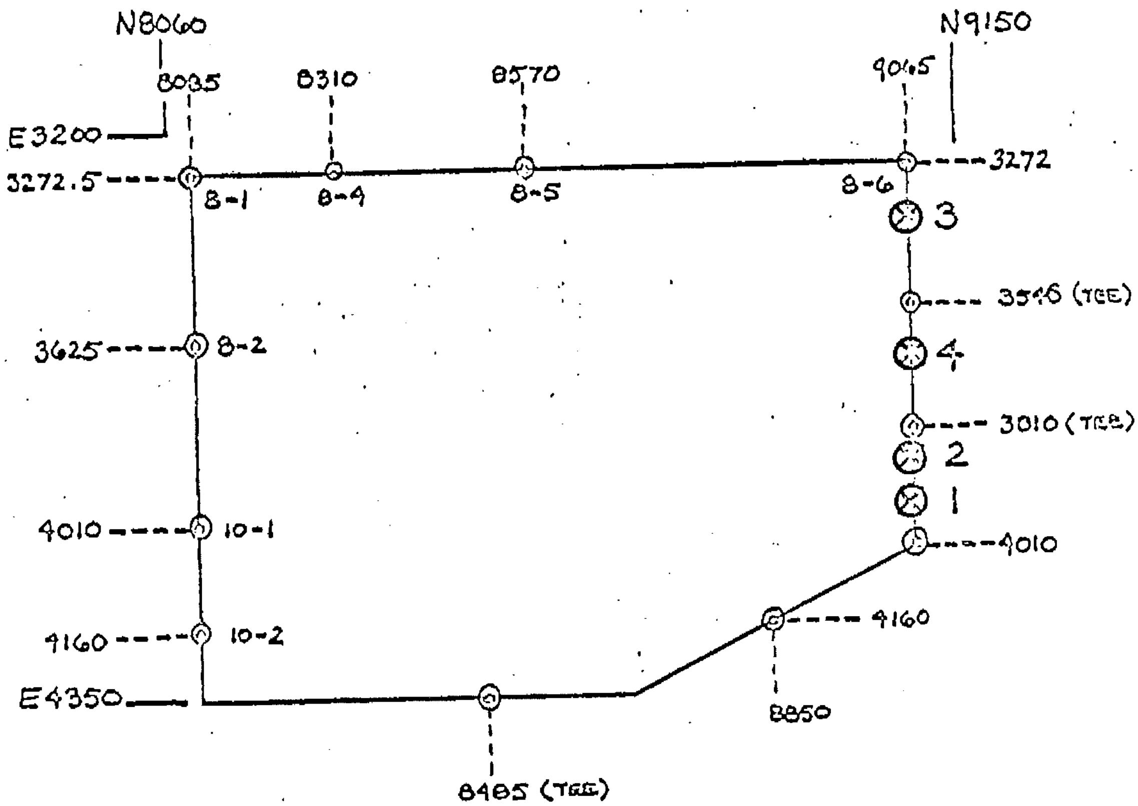
BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

(SEE ATTACHED DIAGRAMS)

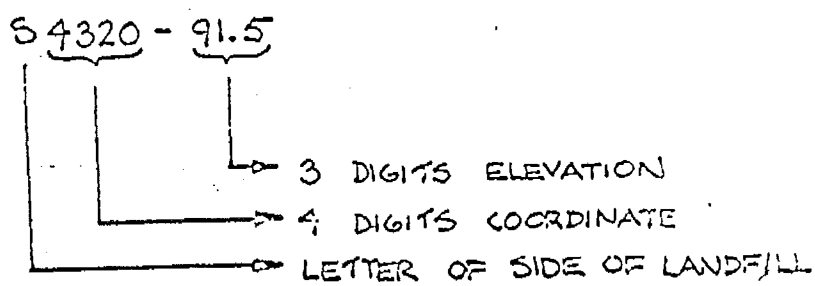
SIGNED William [signature]

DOW CORNING WASTE DISPOSAL
DOW CORNING CORPORATION
PROJECT # 80-352

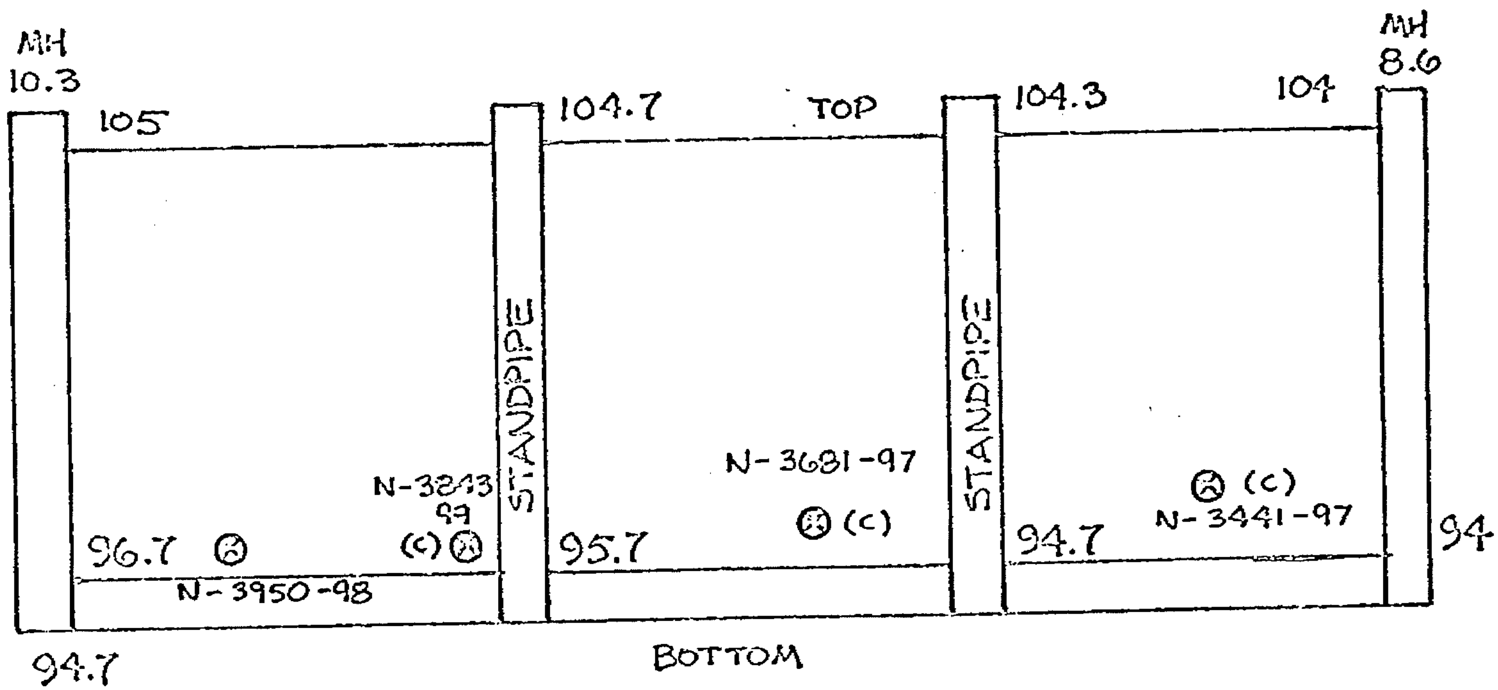
SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



NORTH WALL (LOOKING SOUTH)



DOW CORNING WASTE DISPO:
DOW CORNING CORPORATION
PROJECT # 80-352

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DAILY SOILS REPORT

DATE: 7-11-80 JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.: ______
CONTRACTOR: ______

WEATHER sunny TEMP RANGE 80 ° TO 90 ° AREA WORKED North Wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM. ☐ ______

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☐ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☒ Vib Sheepsfoot

TYPE OF SUBGRADE: ☐ SAND ☐ CLAY ☐ LOAM. ☐ ______

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 6 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 2-3 FT

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOO[N] ☐ ______

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ______ NO. OF TESTS TO DATE ______

LOCATION AND RESULTS OF TESTS

TEST NO.	LOCATION	ELEVATION	PERCENT MOISTURE	PERCEN[T] COMPACTI[ON]
	N - 3950 (Retest)	98.0	12.3	1[illegible]
2	N - 3843 (Retest)	99.0	10.5	[illegible]

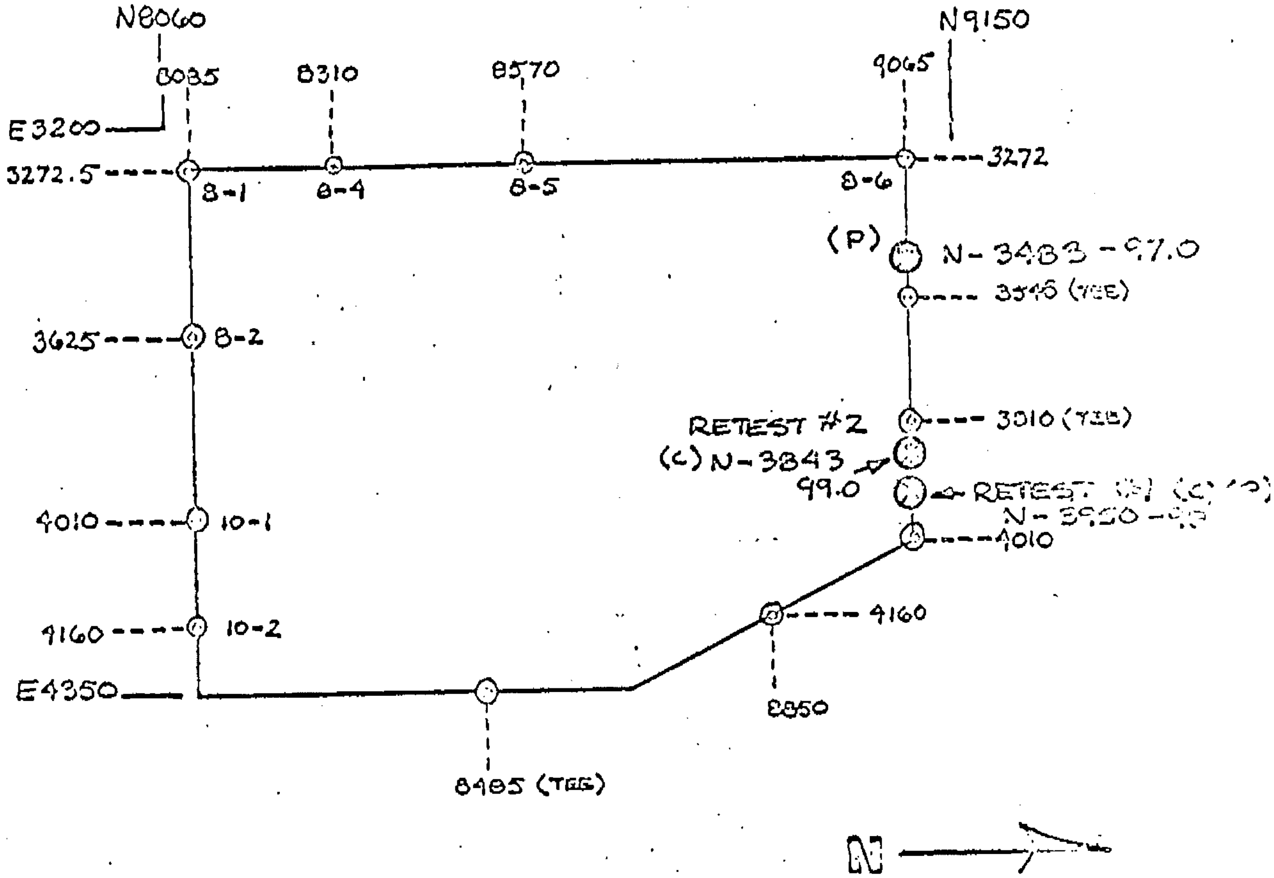
BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

(SEE ATTACHED DIAGRAM)

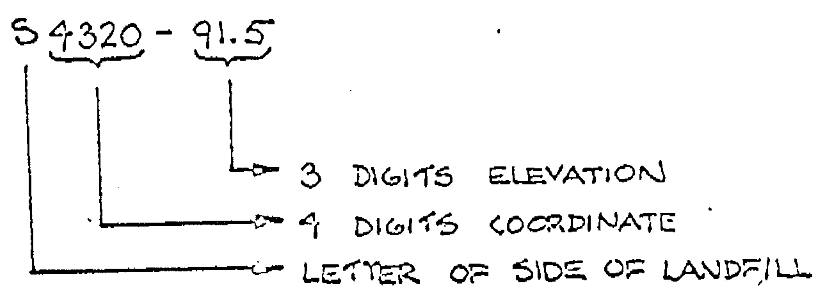
SIGNED William O[illegible]

DOW CORNING WASTE DISPO...
DOW CORNING CORPORATION
PROJECT # 80-35

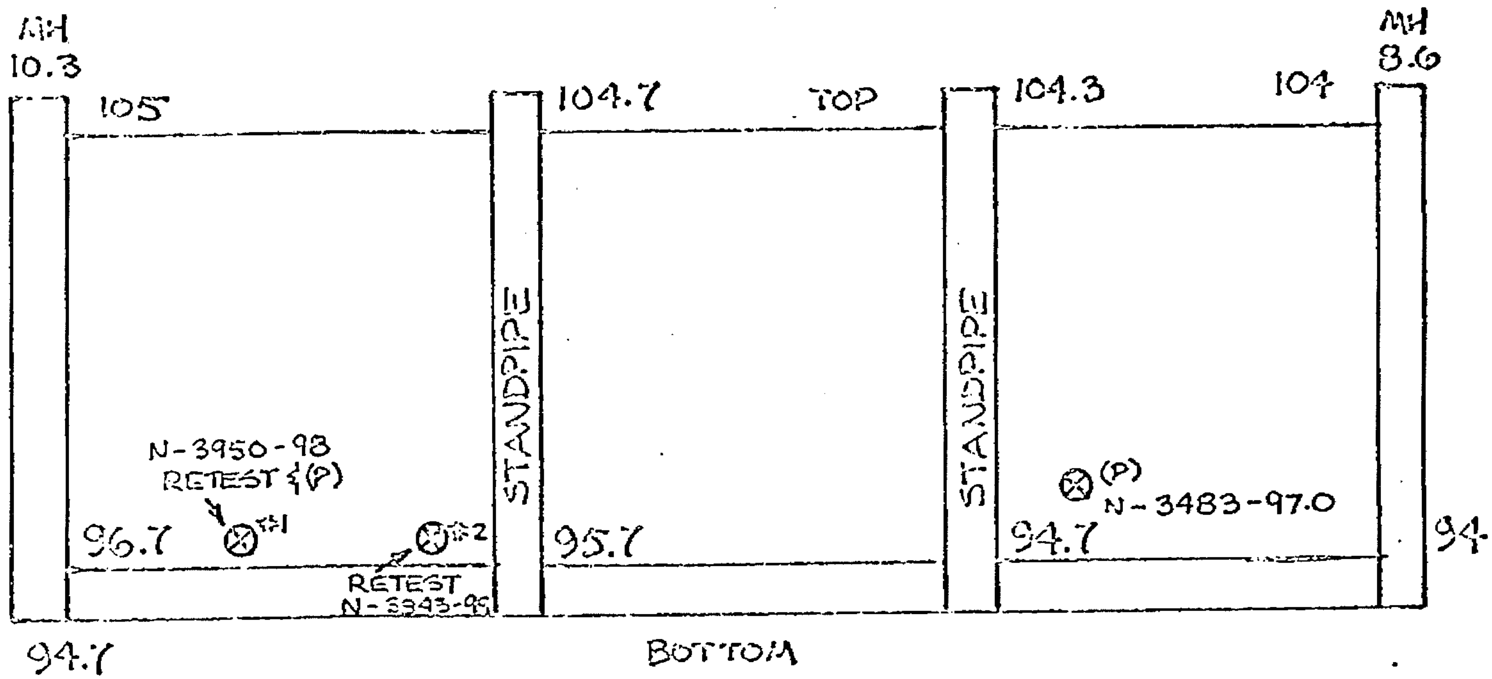
SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



NORTH WALL (LOOKING SOUTH)



DOW CORNING WASTE DISPOSAL
DOW CORNING CORPORATION
PROJECT #80-352

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DAILY SOILS REPORT

DATE: 7-14-80 JOB NO: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.: ____
CONTRACTOR: ____

WEATHER Clear TEMP RANGE 80° TO 90° AREA WORKED N. Wall & E. Wall

TYPE OF FILL: [ ] SAND [X] CLAY [ ] LOAM [ ] ____

METHOD OF COMPACTION: [ ] VIBRATORY PLATE [ ] PNEUMATIC TAMP. [ ] SHEEPSFOOT [ ] RUBBER TIRED [ ] STEEL WHEEL [ ] VIB. STEEL WHEEL [ ] VIB. PNEUMATIC [X] Vib sheepsfoot

TYPE OF SUBGRADE: [ ] SAND [X] CLAY [ ] LOAM [ ] ____

CONDITION OF GRADE: [X] ROUGH [ ] SMOOTH [ ] WET [ ] DRY [ ] FROZEN [ ] LOOSE [ ] HARD [ ] RUTTED

THICKNESS OF LIFTS 6 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 10 FT

MAX. DENSITY OF MATERIAL [X] MOD. AASHO T 180 [ ] STD. AASHO T-99

METHOD OF TEST [ ] SANDCONE [X] BALLOON [ ] ____

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

TEST NO.	LOCATION	ELEVATION	PERCENT MOISTURE	PERCENT COMPACTION
1	E - 8880 *2.9×10^{-8} cm/sec. Existing	96.0	21.5	-
2	N - 3300	99.0	10.2	96
3	N - 3350 *4.9×10^{-9} cm/sec.	101.0	11.7	94
4	N - 3430	99.0	10.8	95
5	N - 3460	100.0	11.0	96
6	N - 3590 *7.1×10^{-9} cm/sec.	101.0	10.6	98
7	N - 3840	101.0	10.3	97
8	N - 3875	102.0	11.1	96

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

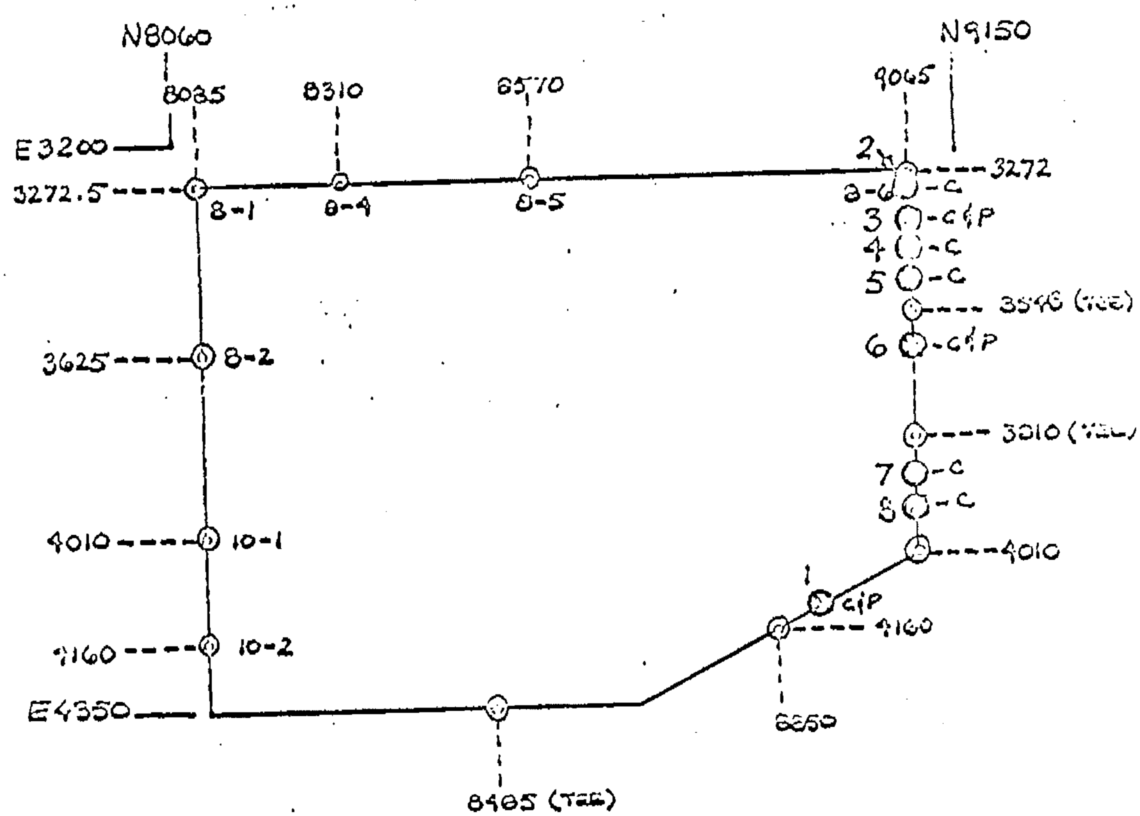
* Represents permeability

(SEE ATTACHED DIAGRAM)

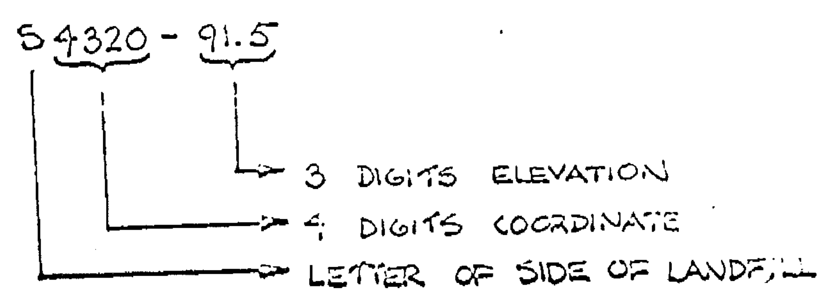
SIGNED William [illegible]

DOW CORNING WASTE DISPOSAL
DOW CORNING CORPORATION
PROJECT #80-35

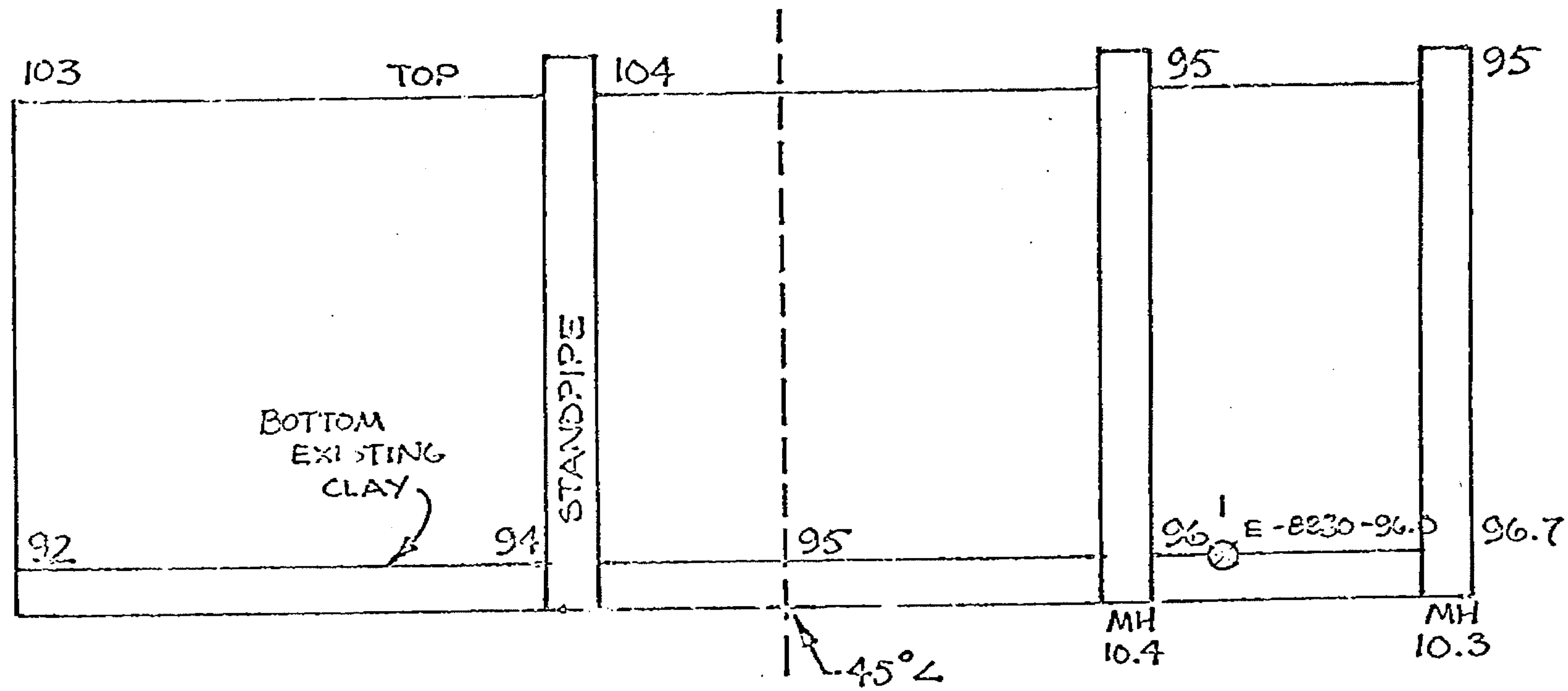
SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM

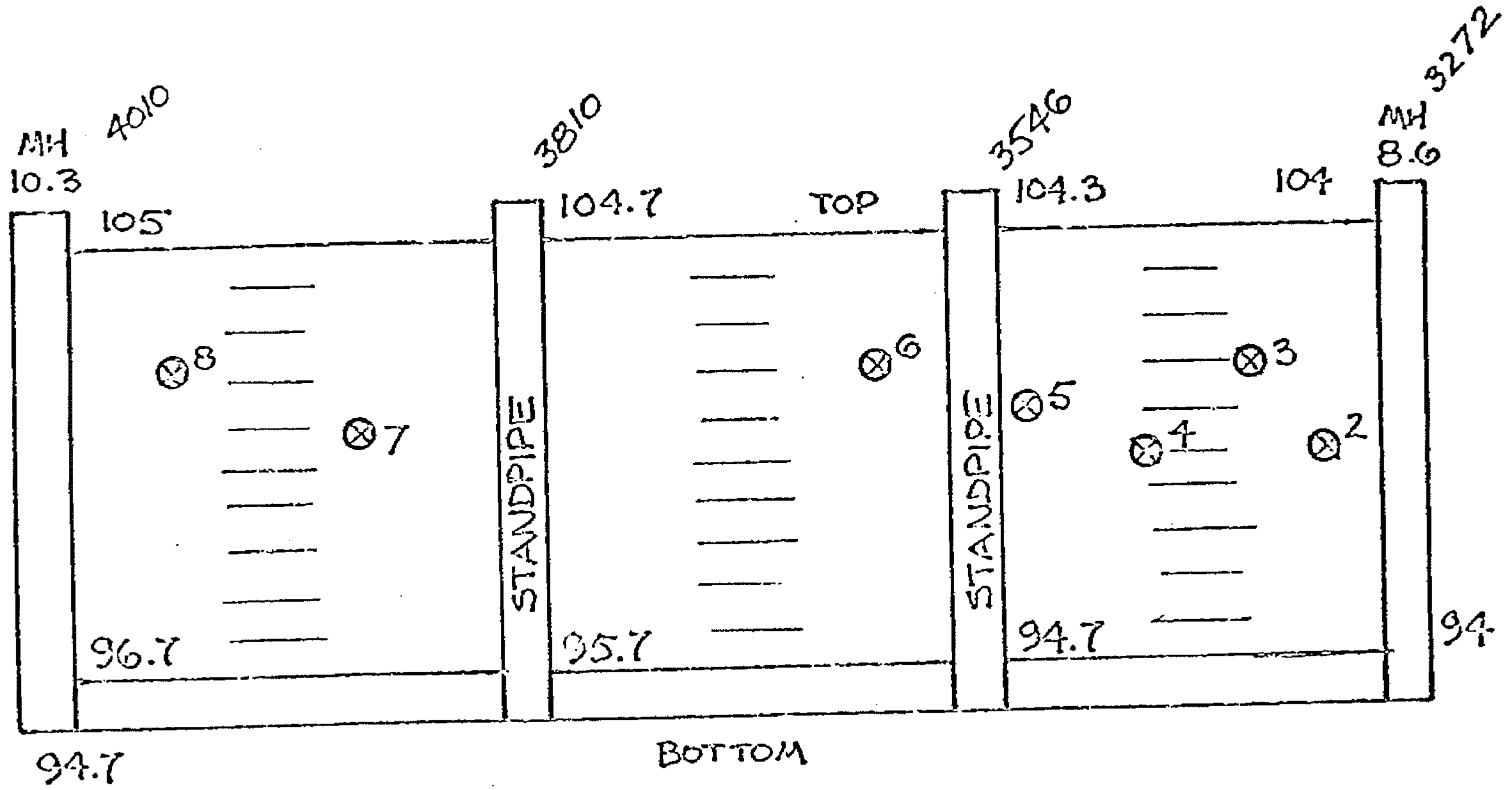


EAST WALL (LOOKING WEST)



DOW CORNING WASTE DISPO
DOW CORNING CORPORATION
PROJECT # 80-352

NORTH WALL (LOOKING SOUTH)



DOW CORNING WASTE DISPOS
DOW CORNING CORPORATION
PROJECT #CO-352

DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 7-18-80 JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corp. JOB NO.:
CONTRACTOR:

WEATHER Clear TEMP RANGE 70 ° TO 80 ° AREA WORKED East Wall

TYPE OF FILL
- [ ] SAND
- [x] CLAY
- [ ] LOAM
- [ ] ____

METHOD OF COMPACTION
- [ ] VIBRATORY PLATE
- [ ] PNEUMATIC TAMP.
- [ ] SHEEPSFOOT
- [ ] RUBBER TIRED
- [ ] STEEL WHEEL
- [ ] VIB. STEEL WHEEL
- [ ] VIB. PNEUMATIC
- [x] Vib. Sheepsfoot

TYPE OF SUBGRADE
- [ ] SAND
- [x] CLAY
- [ ] LOAM
- [ ] ____

CONDITION OF GRADE
- [x] ROUGH
- [ ] SMOOTH
- [ ] WET
- [ ] DRY
- [ ] FROZEN
- [ ] LOOSE
- [ ] HARD
- [ ] RUTTED

THICKNESS OF LIFTS 6 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 2 FT

MAX. DENSITY OF MATERIAL
- [x] MOD. AASHO T 180
- [ ] STD. AASHO T-99

METHOD OF TEST
- [ ] SANDCONE
- [x] BALLOON
- [ ] ____

134.2 #/ CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCENT COMPACTIO
	E-8965	98.0	9.5	9
2	N-4010	99.0	8.6	99
3	E-8710	97.0	9.2	95
4	E-8610	96.0	12.1	96
5	E-8370	96.0	13.3	95
	Permeability:			
	E-8965 - $4.0x10^{-9}$cm/sec.			

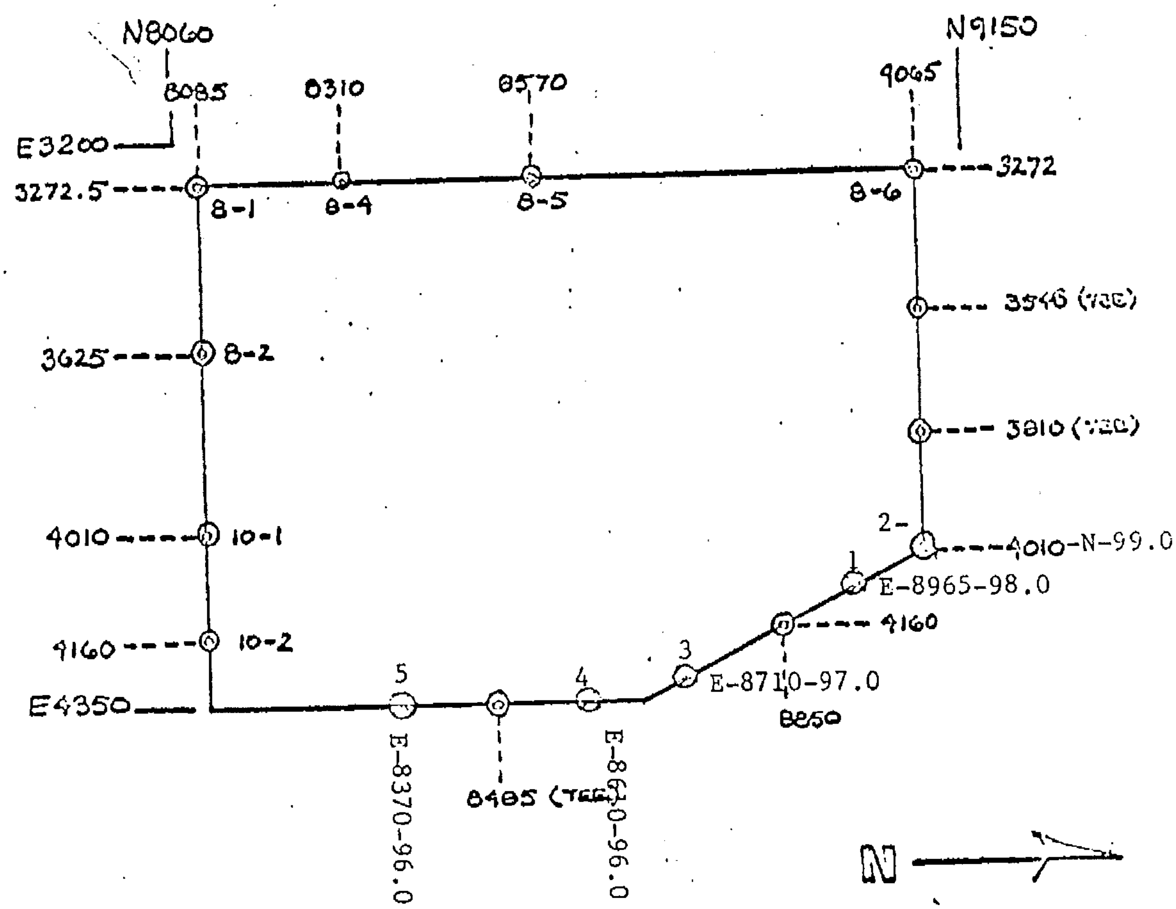
BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

See Diagram

SIGNED William Atwo[illegible]

DOW CORNING WASTE DISPOSAL
DOW CORNING CORPORATION
PROJECT # 80-352

SOIL TEST NUMBERING SYSTEM

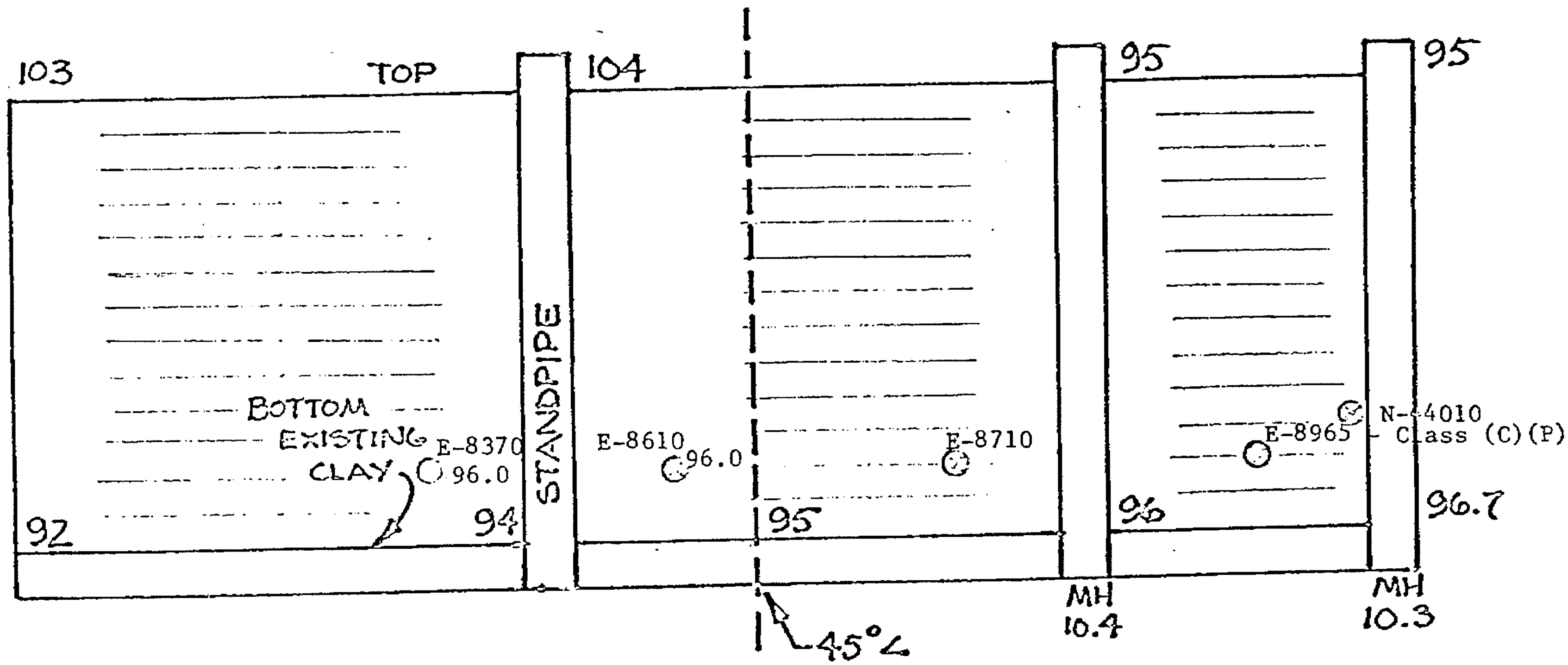


TEST NUMBER SYSTEM

S 4320 - 91.5

- 3 DIGITS ELEVATION
- 4 DIGITS COORDINATE
- LETTER OF SIDE OF LANDFILL

EAST WALL (LOOKING WEST)



DOW CORNING W TE DISPO
DOW CORNING CORPORATIC
PROJECT # 80-352

DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 7-25-80 JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal Plant
CLIENT: Dow Corning Corp. JOB NO.:
CONTRACTOR:

WEATHER Slightly overcast TEMP RANGE 70° TO 80° AREA WORKED East Wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☒ SHEEPSFOOT Vibratory ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☐ ____

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 6 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 6 FT.

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOON ☐ ____

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

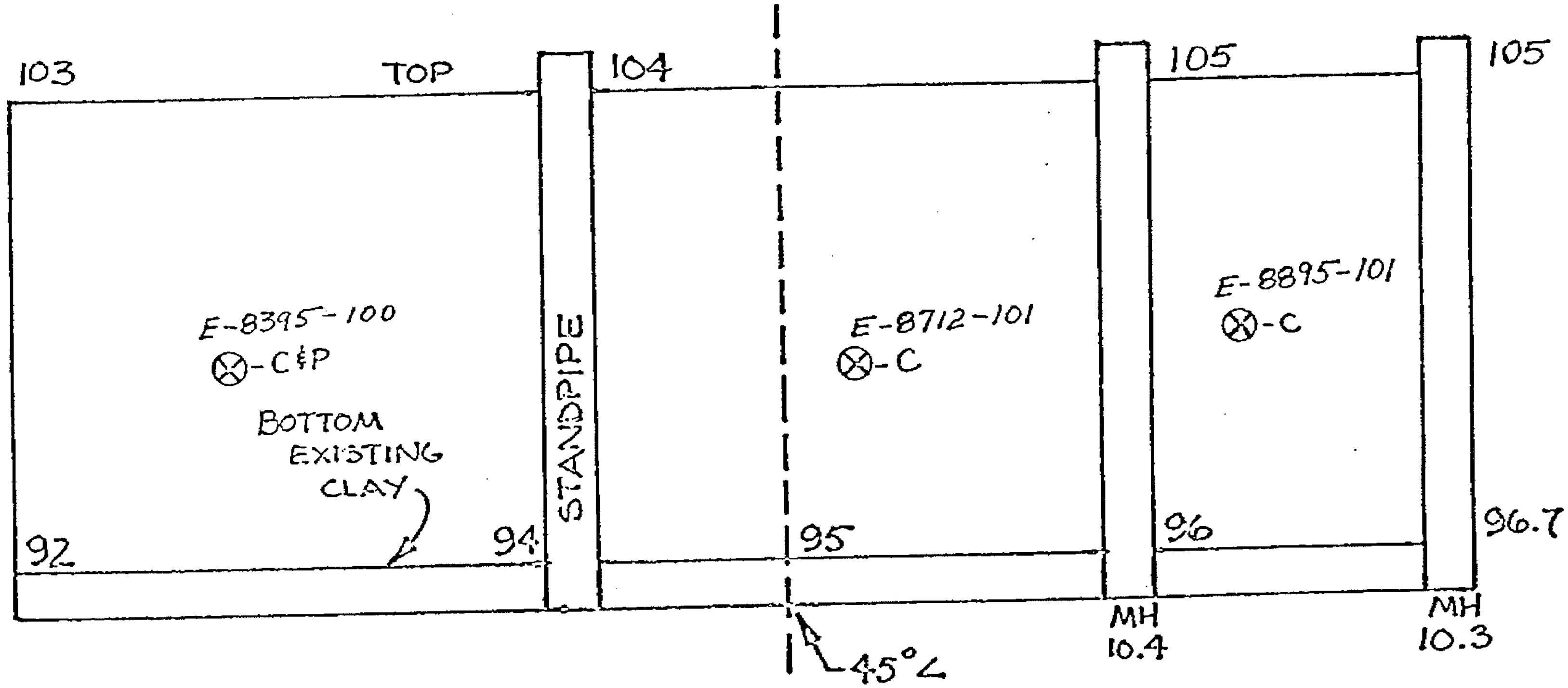
TEST NO.	LOCATION	ELEVATION	PERCENT MOISTURE	PERCENT COMPACTION
	E-8895-101	101.0	9.6	93
2	E-8712-101	101.0	9.3	
3	E-8395-100	100.0	10.1	96
	Permeability:			
	8.3×10^{-9} cm/sec. for E-8395			

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

See Attached Diagram

SIGNED [signature]

EAST WALL (LOOKING WEST)



DOW CORNING WASTE DISPO
DOW CORNING CORPORATIC
PROJECT # 80-352

DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 7-31-80 JOB NO: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corp. JOB NO.:
CONTRACTOR:

WEATHER Overcast TEMP RANGE 70° TO 75° AREA WORKED EAST WALL

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☒ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☐ ____

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM ☐ ____

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 6 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 7 FT

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOON ☐ ____

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

TEST NO.	EAST WALL LOCATION	ELEVATION	PERCENT MOISTURE	PERCENT COMPACT
	E-8904 - 101 Retest	101	11.8	97
2	E-8793 - 101 Retest	101	12.9	
3	E-8485 - 101	101	10.6	96

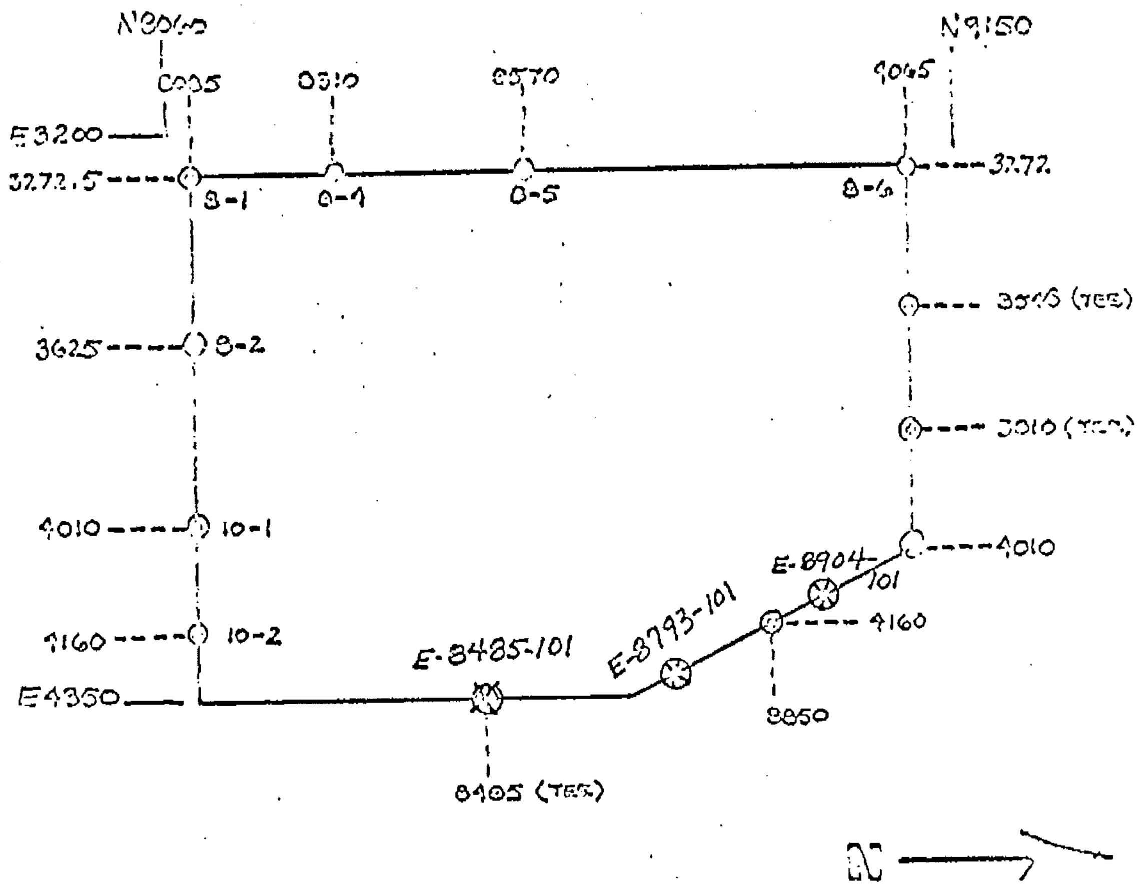
BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

SEE ATTACHED DIAGRAMS

SIGNED William [signature]

DOW CORNING CORPORATION
PROJECT # [illegible]

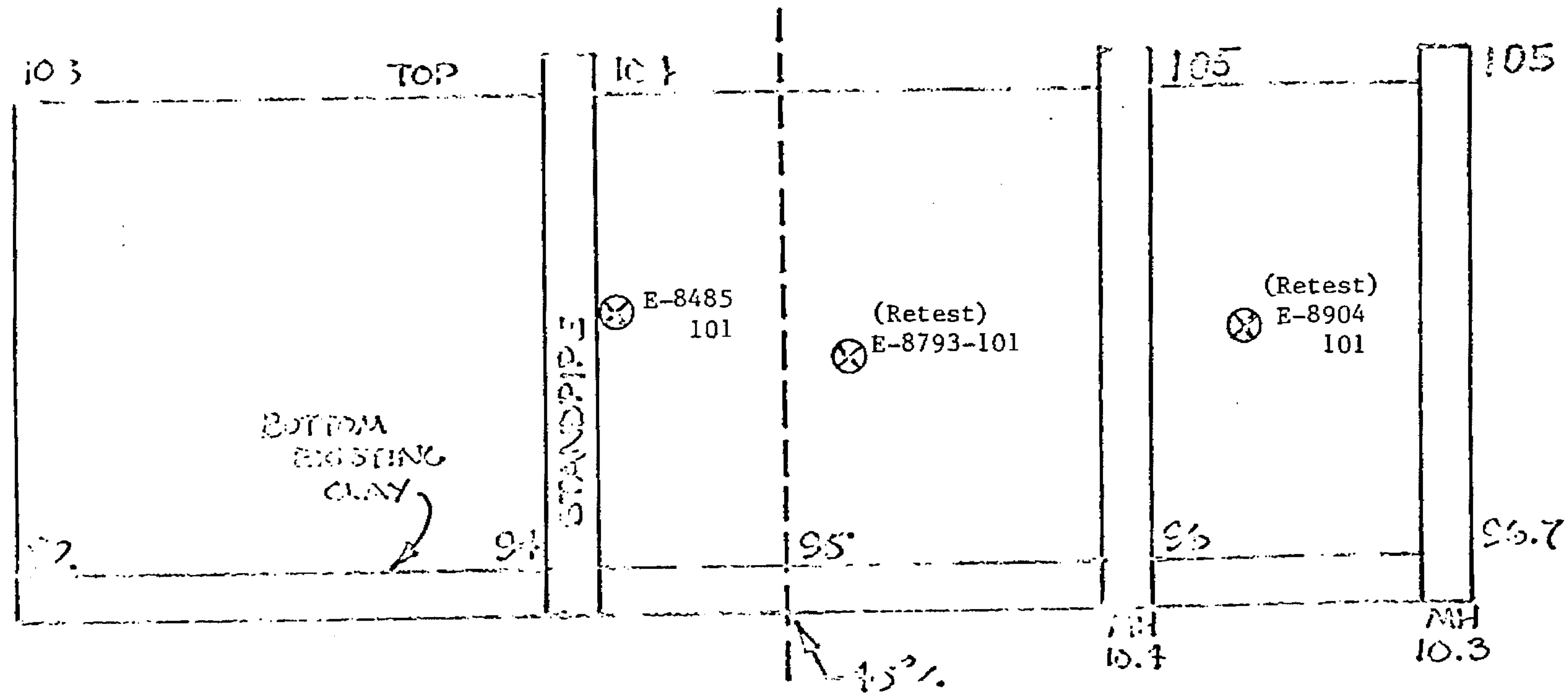
SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM

S 4320 - 91.5

- 91.5 → 3 DIGITS ELEVATION
- 4320 → 4 DIGITS COORDINATE
- S → LETTER OF SIDE OF LANDFILL



TOP
BOTTOM EXISTING CLAY
STANDPIPE
E-8485 101
(Retest) E-8793-101
(Retest) E-8904 101
105
95
MH 10.3

DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 7-31-80 JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corp. JOB NO.:
CONTRACTOR:

WEATHER Overcast TEMP RANGE 75 ° TO 80 ° AREA WORKED East Wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM. ☐ ____

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☒ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☐ ____

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM. ☐ ____

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 12 IN. PLANNED DEPTH OF FILL 10 FT. PLACED TO DATE 9 FT

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOON ☐ ____

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCENT COMPACTION
1	E-8284 102	102	11.7	9[illegible]
2	E-8628-103	103	11.8	9[illegible]
3	E-4064-104	104	11.0	94
	Permeabilities:			
	E-8284 - 1.4×10^{-8} cm/sec.			
	E-4064 - 4.3×10^{-9} cm/sec.			

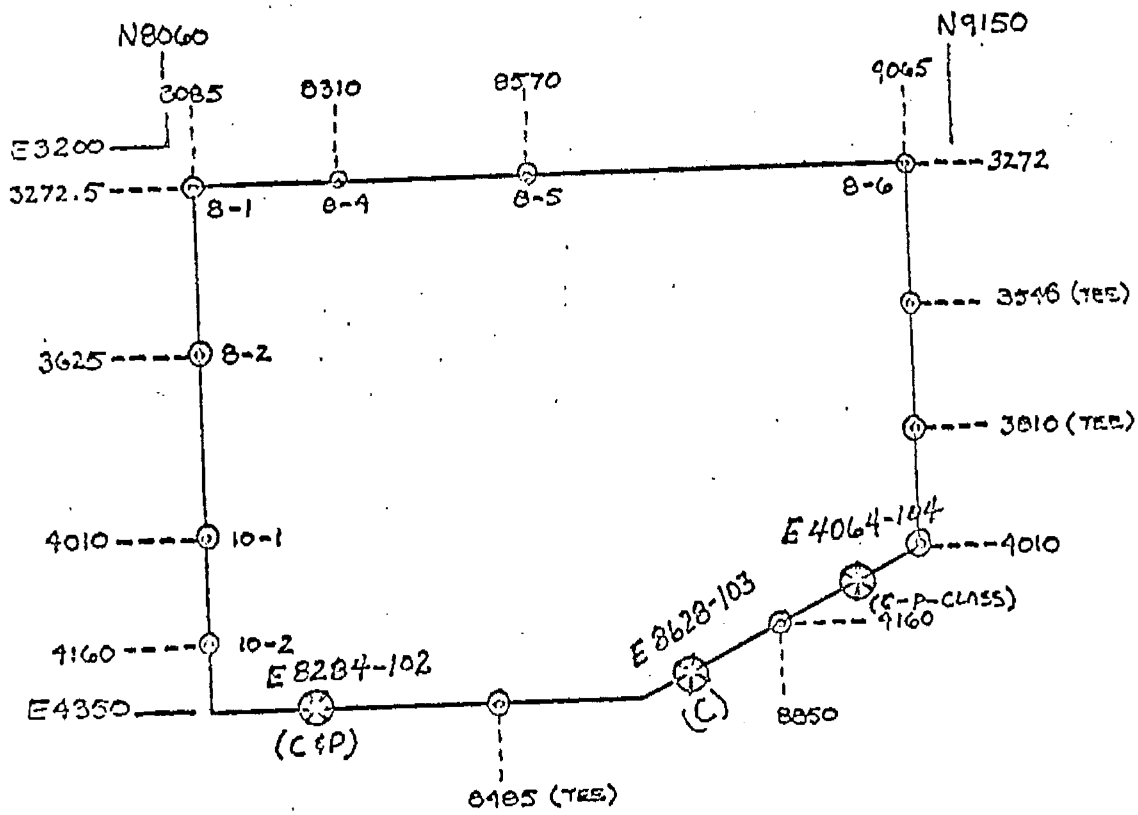
BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

See Attached Diagrams

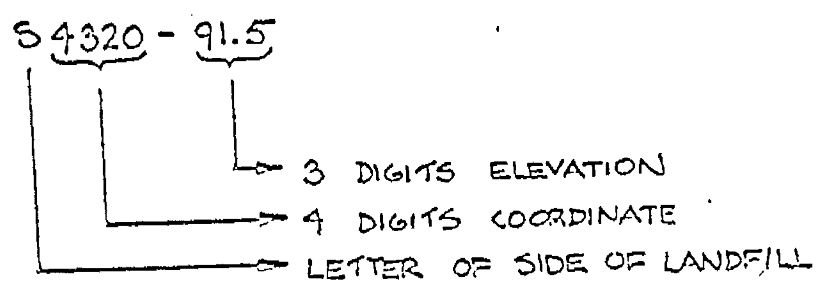
SIGNED [signature]

DOW CORNING WASTE DISPOSAL
DOW CORNING CORPORATION
PROJECT # 80-352

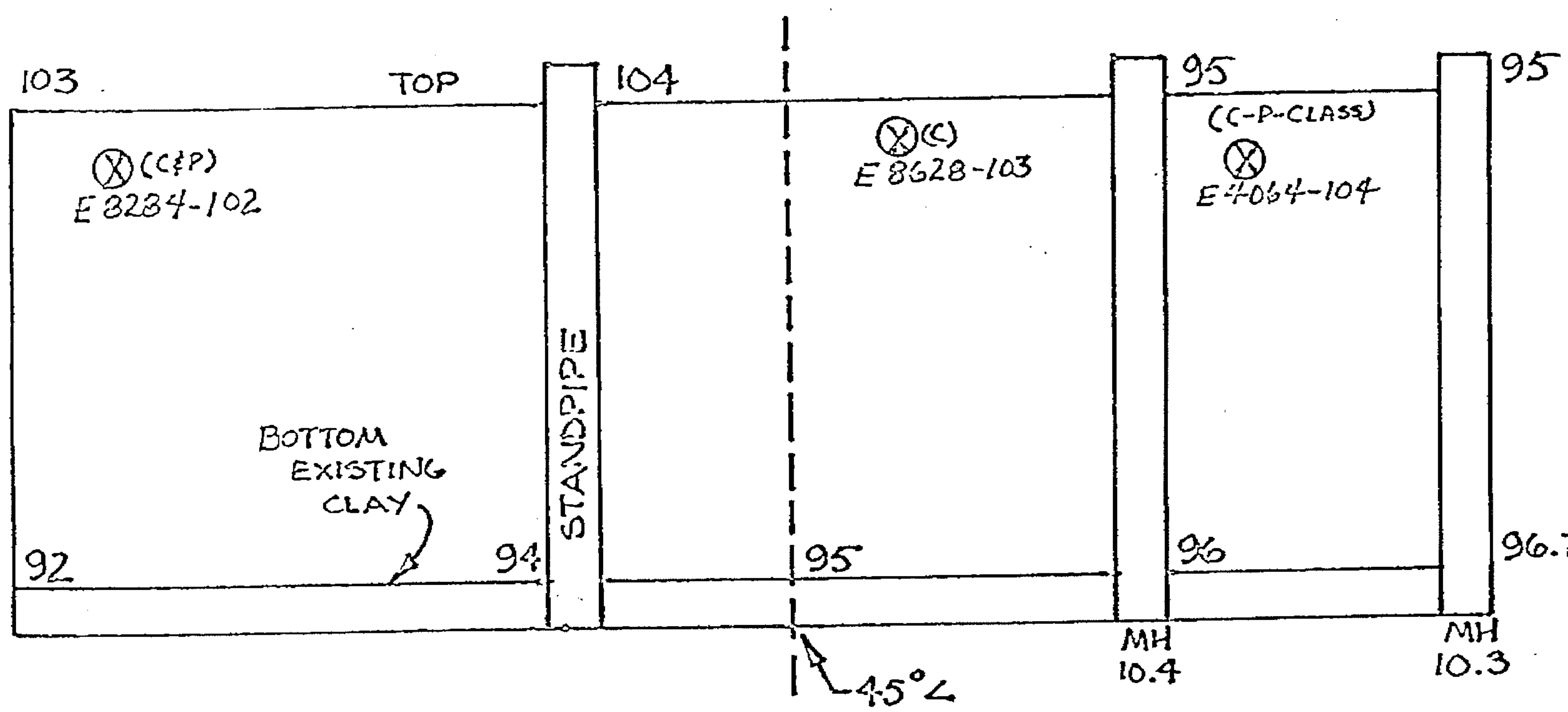
SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



EAST WALL (LOOKING WEST)



DOW CORNING WASTE DISPOSAL
DOW CORNING CORPORATION
PROJECT # 80-352
8-1-80

DAILY COMPACTION REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 8-4-80 JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER Clear & Sunny TEMP RANGE 80 ° TO 85 ° AREA WORKED East Wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM ☐

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☒ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☐

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM ☐

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 12 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 10 FT

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOON ☐

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE NO. OF TESTS TO DATE

LOCATION AND RESULTS OF TESTS

TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCENT COMPACTION
[illegible]	E-8380-103	103	11.3	92
2	E-8560-104	104	10.4	[illegible]
3	E-8748-105	105	10.9	93

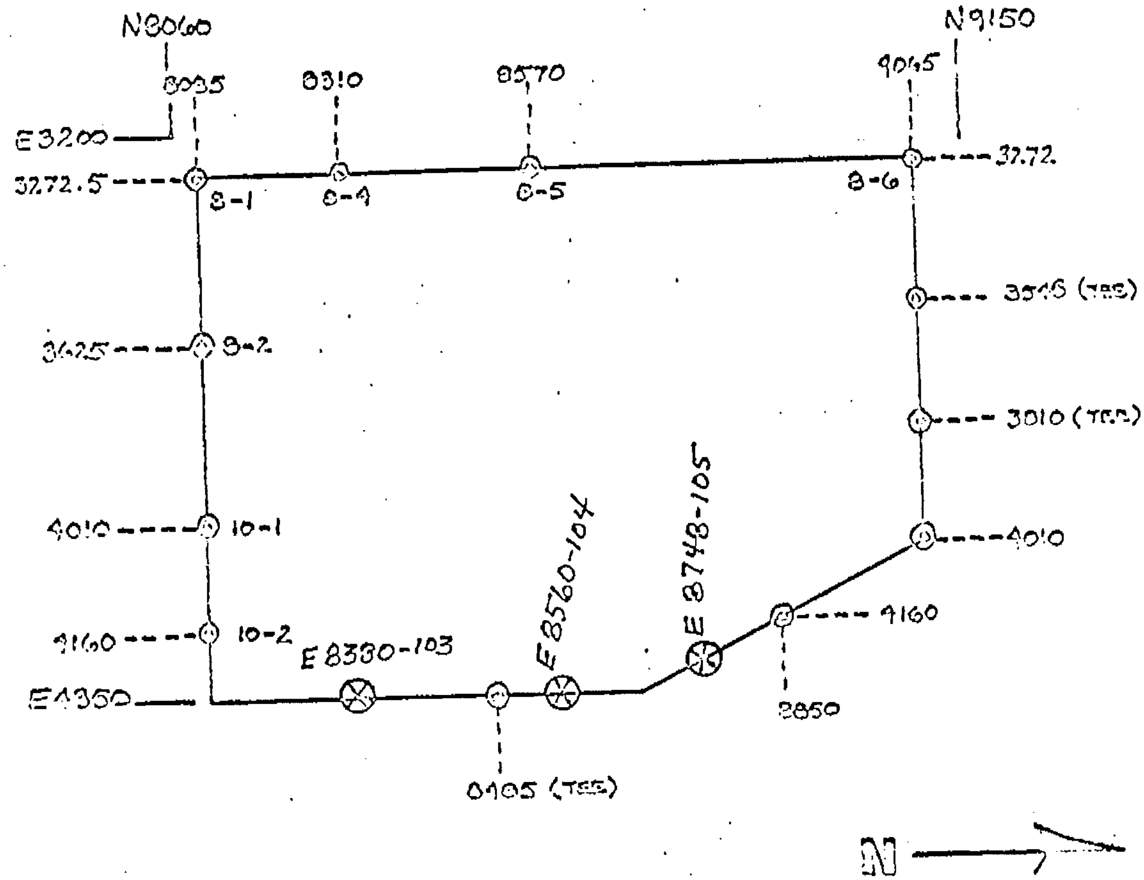
BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

See Attached Diagrams

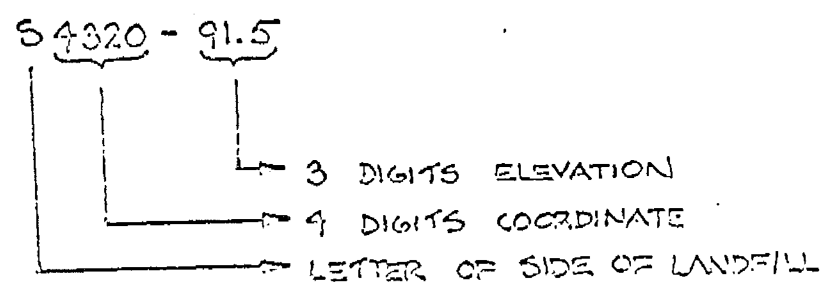
SIGNED [signature]

DOW CORNING WASTE DISPOSAL
DOW CORNING CORPORATION
PROJECT # 80-35?

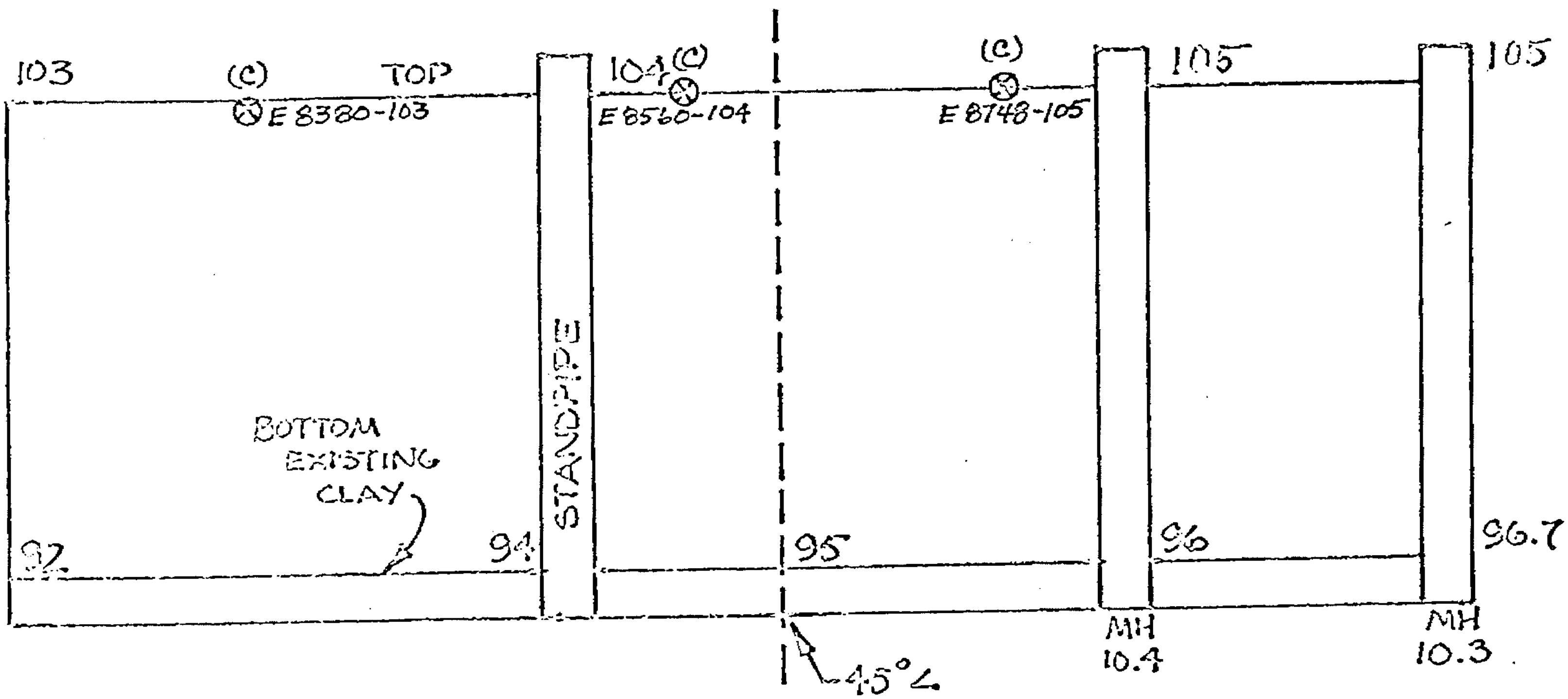
SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



EAST WALL (LOOKING WEST)



DOW CORNING WASTE DISPOSAL
DOW CORNING CORPORATION
PROJECT # 80-352

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 8-6-80 JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corp. JOB NO.:
CONTRACTOR:

WEATHER Cloudy & Hot TEMP RANGE 80 ° TO 85 ° AREA WORKED East Wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM. ☐ ____

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☒ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☐ ____

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM. ☐ ____

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 12 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 10 FT

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOON ☐ ____

____ #/ CU. FT. OPTIMUM MOISTURE ____ %

DENSITY REQUIRED ____ % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

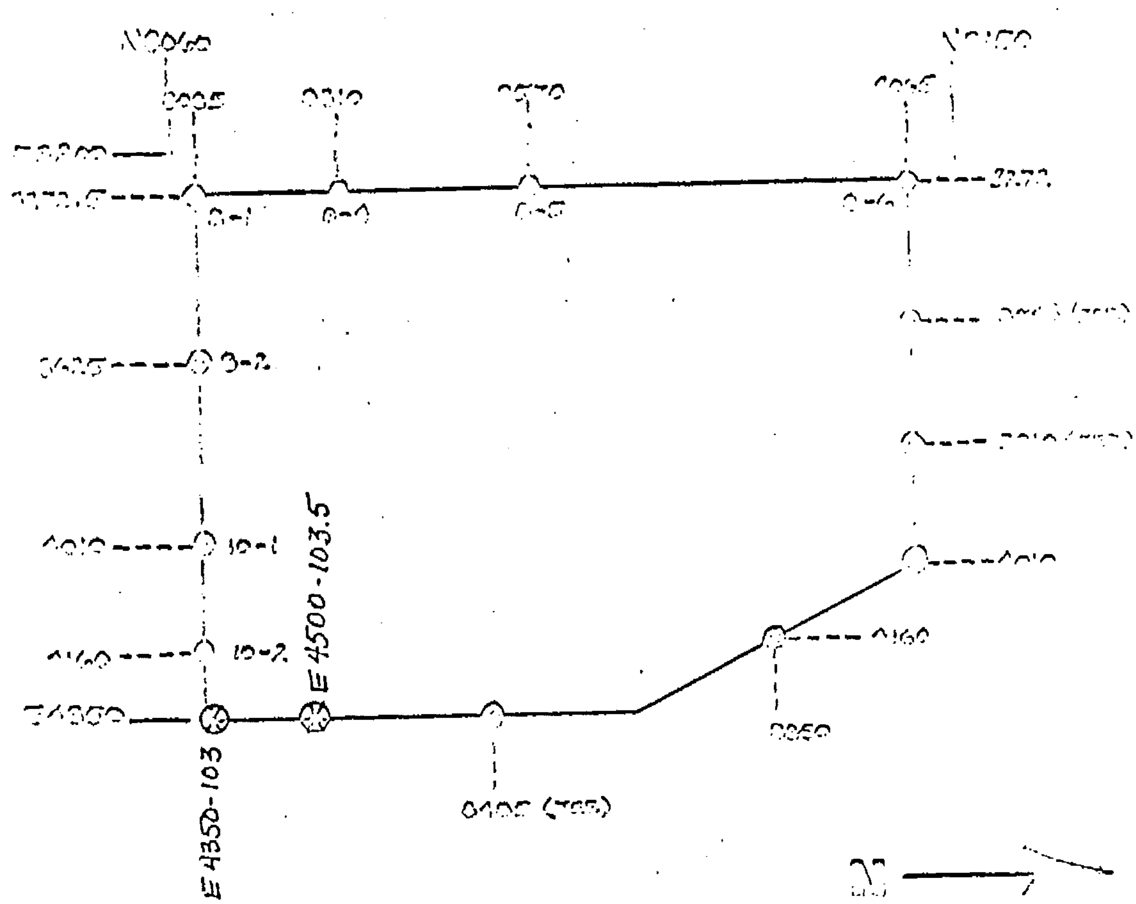
TEST NO.	LOCATION	Elevation	PERCENT MOISTURE	PERCENT COMPACTION
	E-4350-103	103'	13.8	85
	E-4500-103.5	103.5'	12.3	95

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

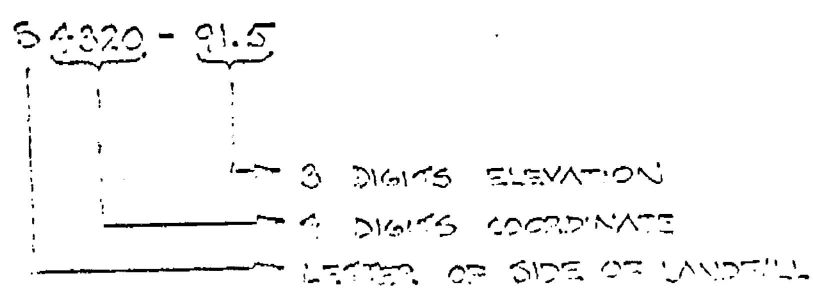
See Attached Diagram

SIGNED William [signature]

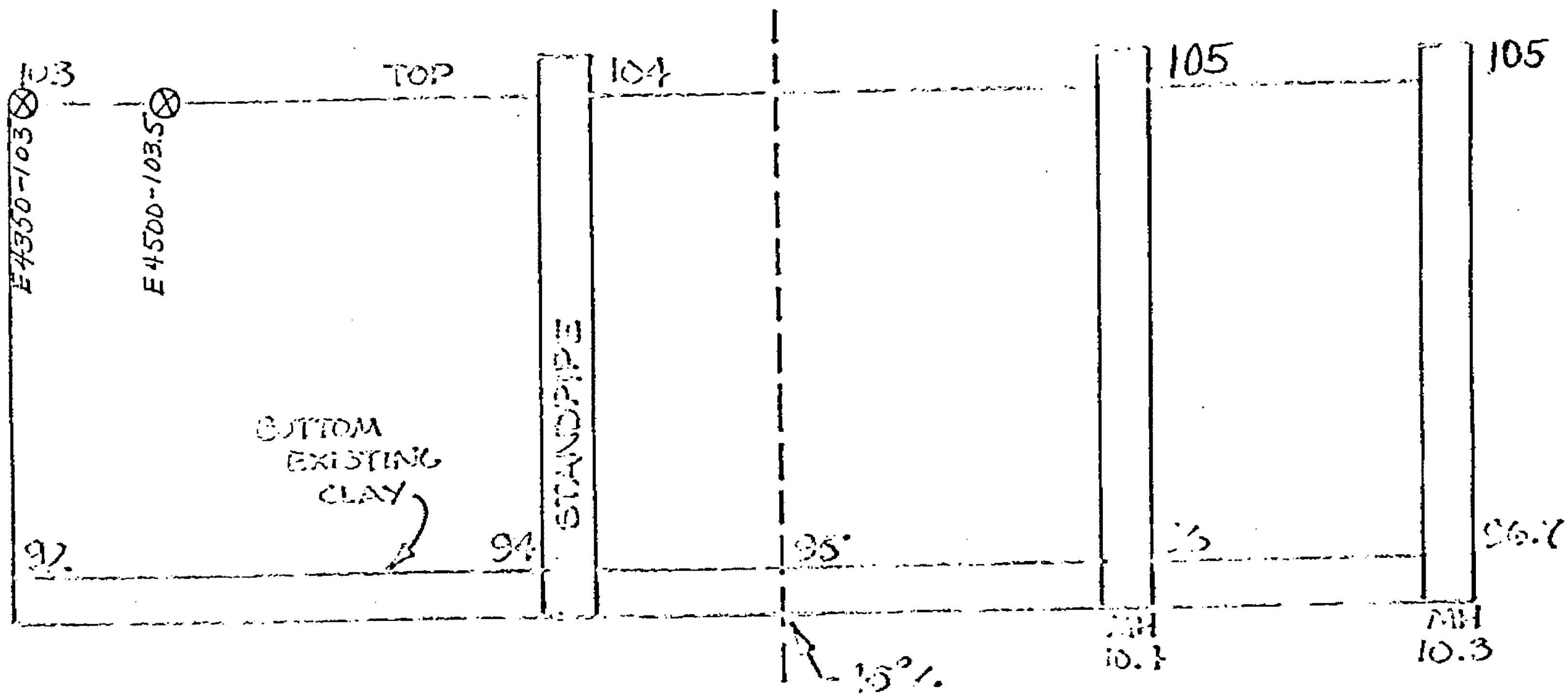
SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



EAST WALL (



103
E4350-103
E4500-103.5
TOP
104
105
105
STANDPIPE
BOTTOM
EXISTING
CLAY
92
94
95
96.7
MH
10.3

DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 8-14-80 JOB NO: 80-352
PROJECT: Waste Disposal Site
CLIENT: Dow Corning Corporation JOB NO.:
CONTRACTOR:

WEATHER cloudy & hot TEMP RANGE 80 ° TO 85 ° AREA WORKED S. end of E. Wall

TYPE OF FILL: ☐ SAND ☒ CLAY ☐ LOAM ☐

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☒ SHEEPSFOOT (VIBRATORY) ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☐

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY ☐ LOAM ☐

CONDITION OF GRADE: ☒ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS 6 IN. PLANNED DEPTH OF FILL 10 FT PLACED TO DATE 10 F

MAX. DENSITY OF MATERIAL ☒ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☒ BALLOO[N] ☐

134.2 #/CU. FT. OPTIMUM MOISTURE 8.7 %

DENSITY REQUIRED 95 % NO. OF TESTS THIS DATE NO. OF TESTS TO DATE

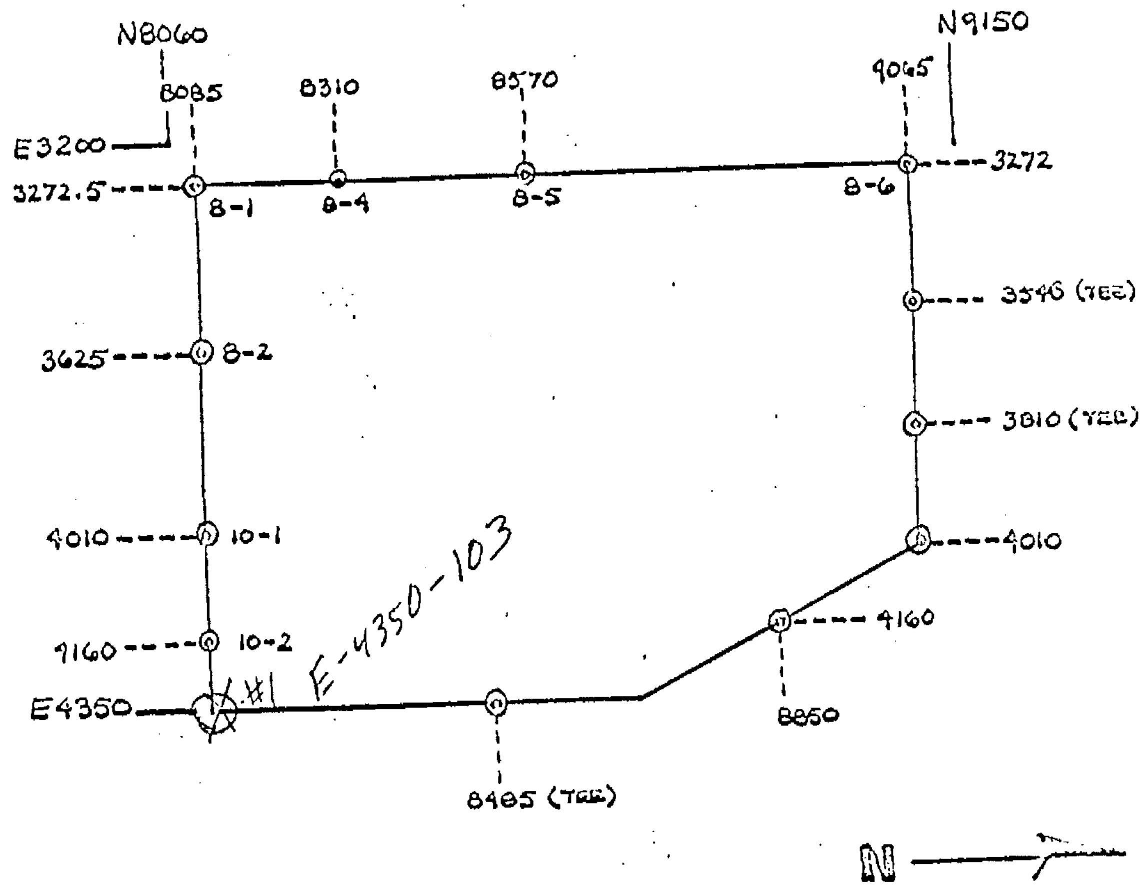
LOCATION AND RESULTS OF TESTS

TEST NO.	LOCATION	ELEVATION	PERCENT MOISTURE	PERCENT COMPACT[ION]
1	East Corner Wall - 4350	103	11.0	93.[illegible]

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

SIGNED William [illegible]

SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM

S4320 - 91.5

- 3 DIGITS ELEVATION
- 4 DIGITS COORDINATE
- LETTER OF SIDE OF LANDFILL

DAILY SOILS REPORT

SAMTEST, INC.
P.O. Box 1444
Midland, Michigan 48640
Phone 496-3610

DATE: 9-8-80 JOB NO.: 80-352
PROJECT: Dow Corning Waste Disposal
CLIENT: Dow Corning Corp. JOB NO.:
CONTRACTOR:

WEATHER Clear TEMP RANGE 70 ° TO 80 ° AREA WORKED Cell A

TYPE OF FILL: ☐ SAND ☐ CLAY ☐ LOAM. ☐ ____

METHOD OF COMPACTION: ☐ VIBRATORY PLATE ☐ PNEUMATIC TAMP. ☐ SHEEPSFOOT ☐ RUBBER TIRED ☐ STEEL WHEEL ☐ VIB. STEEL WHEEL ☐ VIB. PNEUMATIC ☐ ____

TYPE OF SUBGRADE: ☐ SAND ☒ CLAY -Existing ☐ LOAM. ☐ ____

CONDITION OF GRADE: ☐ ROUGH ☐ SMOOTH ☐ WET ☐ DRY ☐ FROZEN ☐ LOOSE ☐ HARD ☐ RUTTED

THICKNESS OF LIFTS ____ IN. PLANNED DEPTH OF FILL ____ FT. PLACED TO DATE ____

MAX. DENSITY OF MATERIAL ☐ MOD. AASHO T 180 ☐ STD. AASHO T-99

METHOD OF TEST ☐ SANDCONE ☐ BALL(☐ ____

____ #/ CU. FT. OPTIMUM MOISTURE ____ %

DENSITY REQUIRED ____ % NO. OF TESTS THIS DATE ____ NO. OF TESTS TO DATE ____

LOCATION AND RESULTS OF TESTS

TEST NO.	LOCATION	ELEVATION	PERCENT MOISTURE	natu Unit
-	Cell A - N.W. Corner - Existing	90.0'	15.5	141.7
2	Cell A - E. side Center - Existing	"	12.9	[illegible]
3	Cell A - S. Center - Existing	"	14.2	141.(
	PERMEABILITIES FOR THE ABOVE (3) TESTS:			
#1 **	2.0×10^{-8} cm/sec.			
#2	5.1×10^{-9} cm/sec.			
#3	4.4×10^{-8} cm/sec.			
	**Vertical permeability corrected to 20°C for water determined in segmented liner cel			

BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

SEE ATTACHED DIAGRAM

NUCLEAR DENSITY TESTS * taken adjacent to the above tests are listed below:

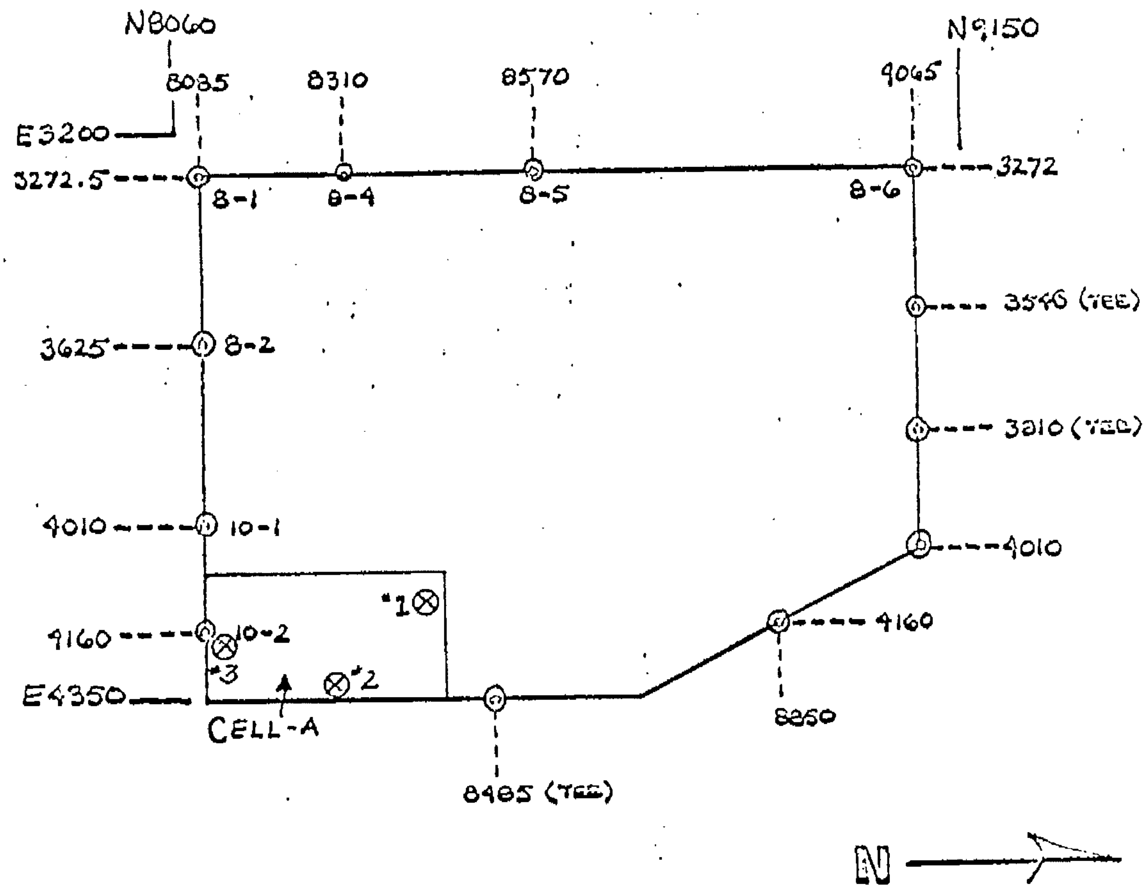
	% Moisture	Wet Density
Test #2	14.3	141.5
#3	16.9	142.0

Troxler 2401 using 8 in transmission position

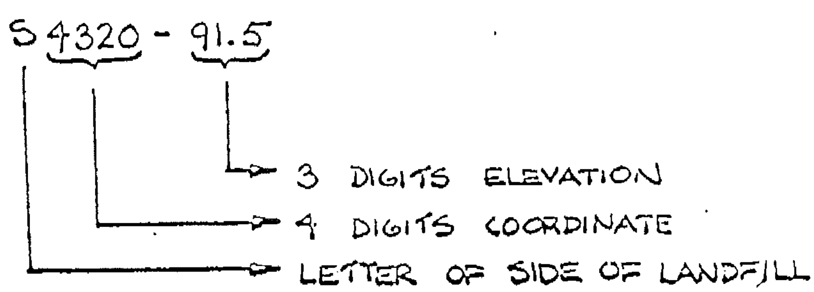
SIGNED William Crozier

DOW CORNING WASTE DISPOSAL
DOW CORNING CORPORATION
PROJECT # EO-35

SOIL TEST NUMBERING SYSTEM



TEST NUMBER SYSTEM



, INC.
GENERAL TESTING SERVICES
O. BOX 1444
OLAND, MI. 48640
496-3610

FIELD ENGINEERS DAILY REPORT

PROJECT: Dow Corning Waste Disposal Site REPORT NO. 1

LOCATION: Dow Corning - Midland, MI OUR JOB NO. 80-352

CLIENT: Dow Corning Corporation CLIENT'S JOB NO.

WEATHER: Clear DATE: 9-8-80

TEMPERATURE RANGE: 50° TO: 80°

ESTIMATED TIME REMAINING ON JOB:

TYPE OF INSPECTION BEING PERFORMED

- [X] SOILS
  - [X] FOUNDATIONS - Bottom of Cell A
  - [ ] CAISSONS
  - [ ] CONTROLLED FILL (COMPACTION)

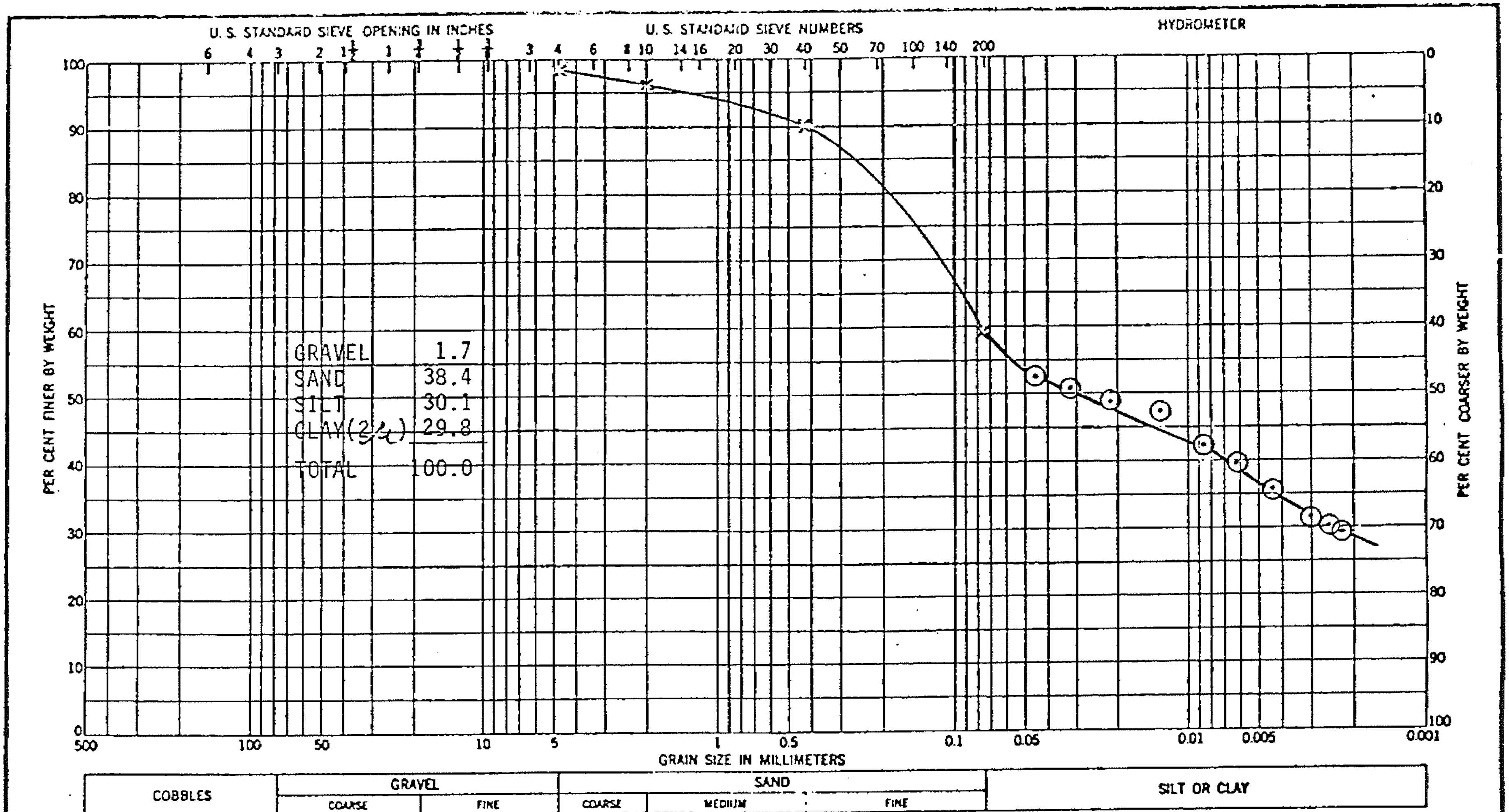
BRIEF RESUME OF WORK ACCOMPLISHED THIS DATE:

We have inspected the bottom of Cell A as excavated by the contractor to elevation 90.0'. No poor quality cohesive soils or seams of sand were exposed on the bottom. Three random locations were tested for natural unit weight, moisture, classification and undisturbed sample permeability. The tests extended approximately one foot below the present elevation and indicated uniformly consistent cohesive soil (CL).

French drains exist on the east and south perimeters allowing for collection of any leachate generated during the filling operation.

William Crozier
William Crozier, Ph.D.

DOW CORNING CORPORATION
DOW CORNING WASTE DISPOSAL
FILE #80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
N-3350	101	CL-Clay, brown, sandy with some silt.		24.6	14.3	10.3

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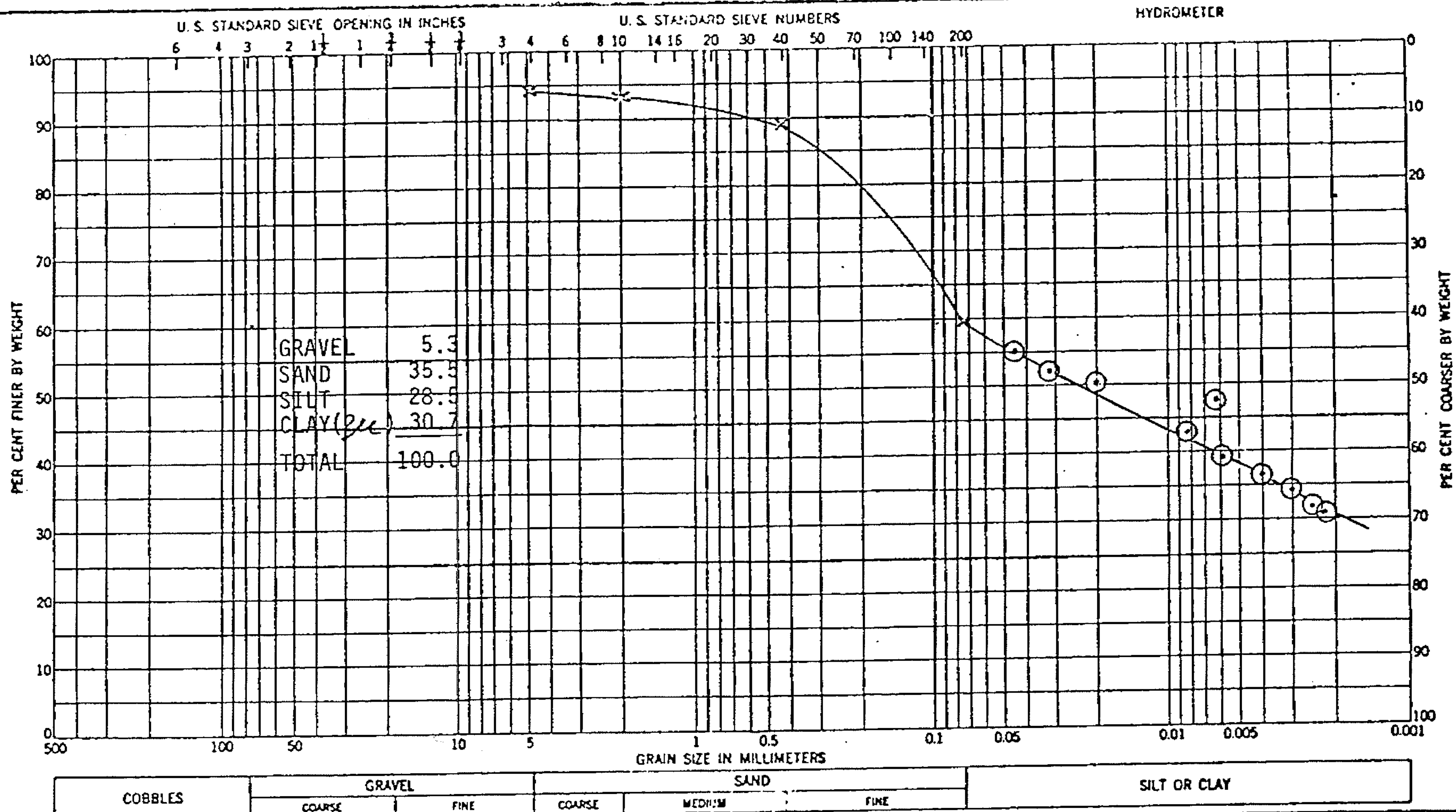
GRADATION CURVES

DOW CORNING CORPORATION
DOW CORNING WASTE DISPOSAL
FILE #80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
N-3590	101	Clay-brown, silty, some sand brown CL		41.8	24.6	17.2

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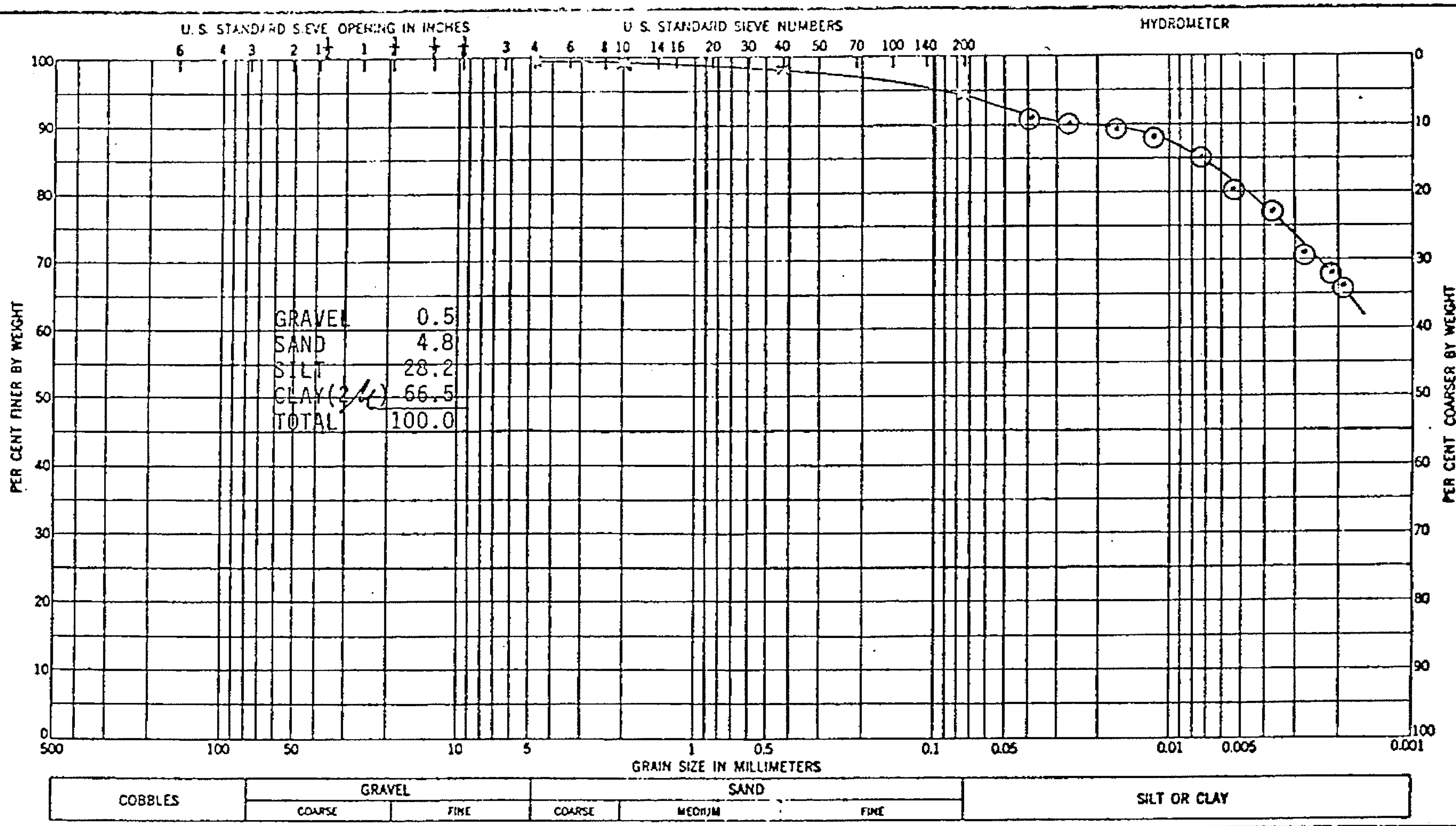
DOW CORNING WASTE DISPOSAL
FILE #80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
N-3845	96.0	Clay-brown, silty, trace of sand CL		43.3	25.2	18.1

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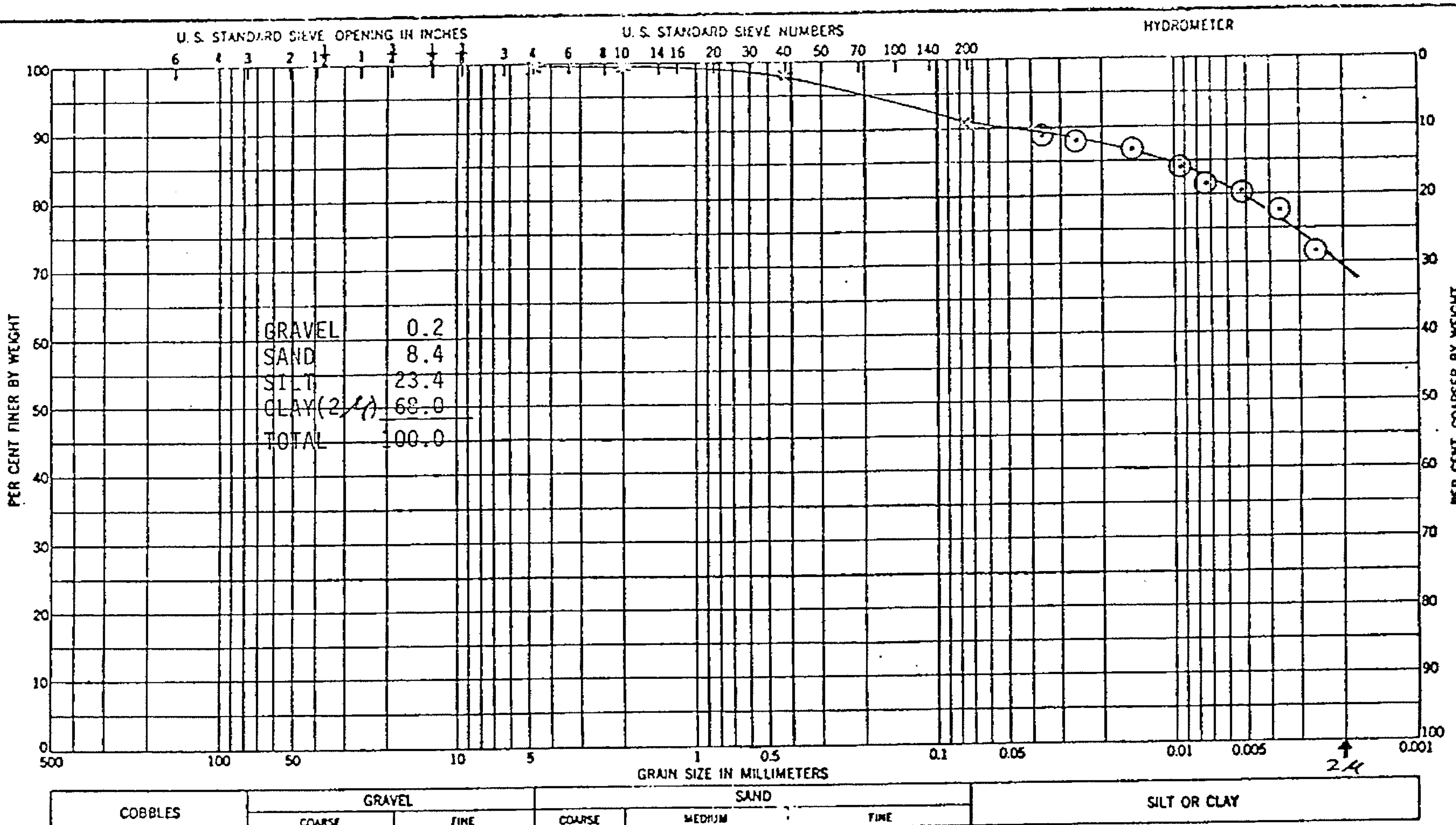
DOW CORNING CORPORATION
DOW CORNING WASTE DISPOSAL
FILE #80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
N-3460	94.3	Clay-brown, silty, some sand CL		41.0	22.6	18.4

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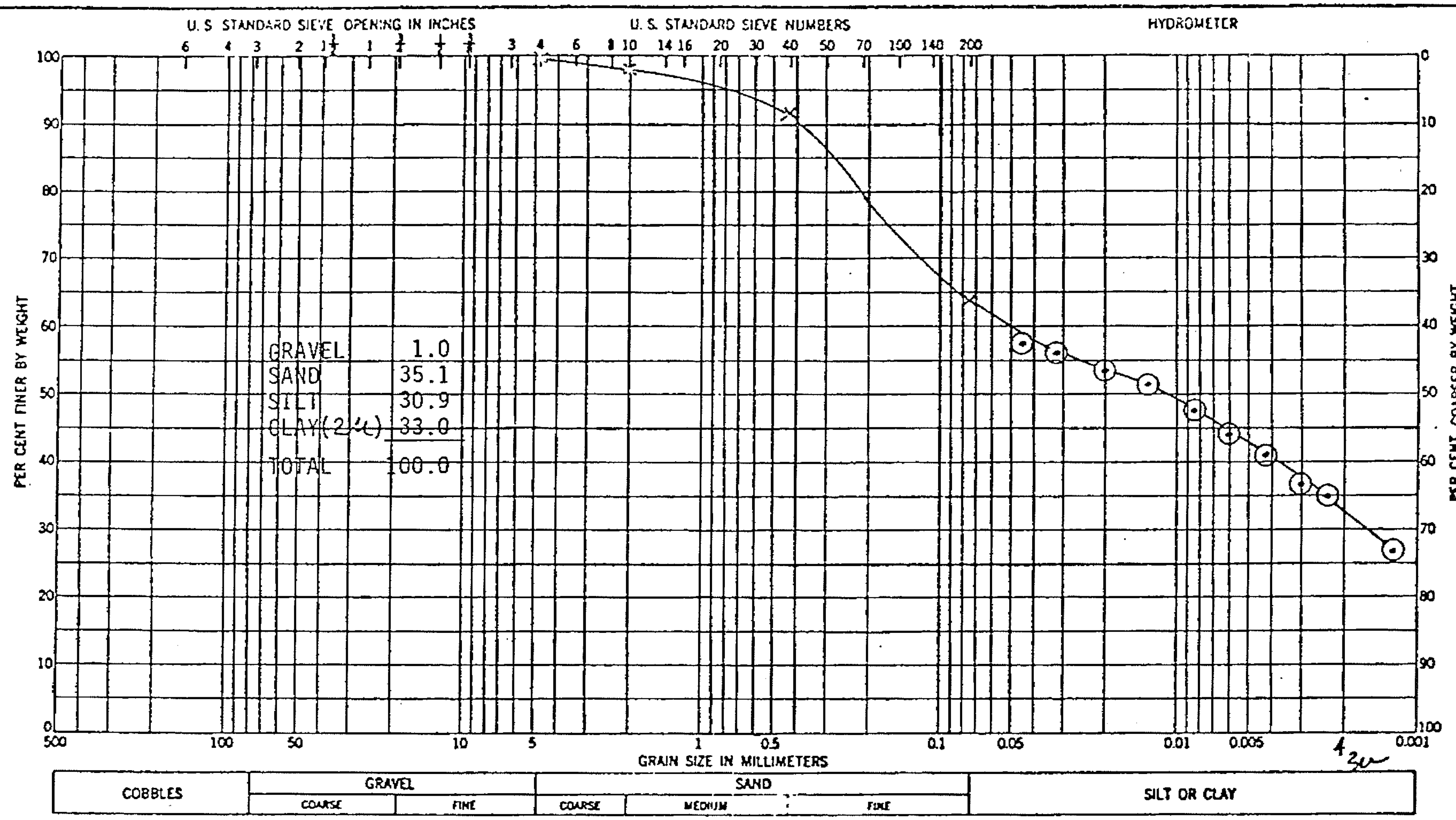
GRADATION CURVES

DOW CORNING CORP.
DOW CORNING WASTE DISPOSAL
FILE #80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
S-3285	98.0	CL - brown, silty clay		26.4	13.1	13.3

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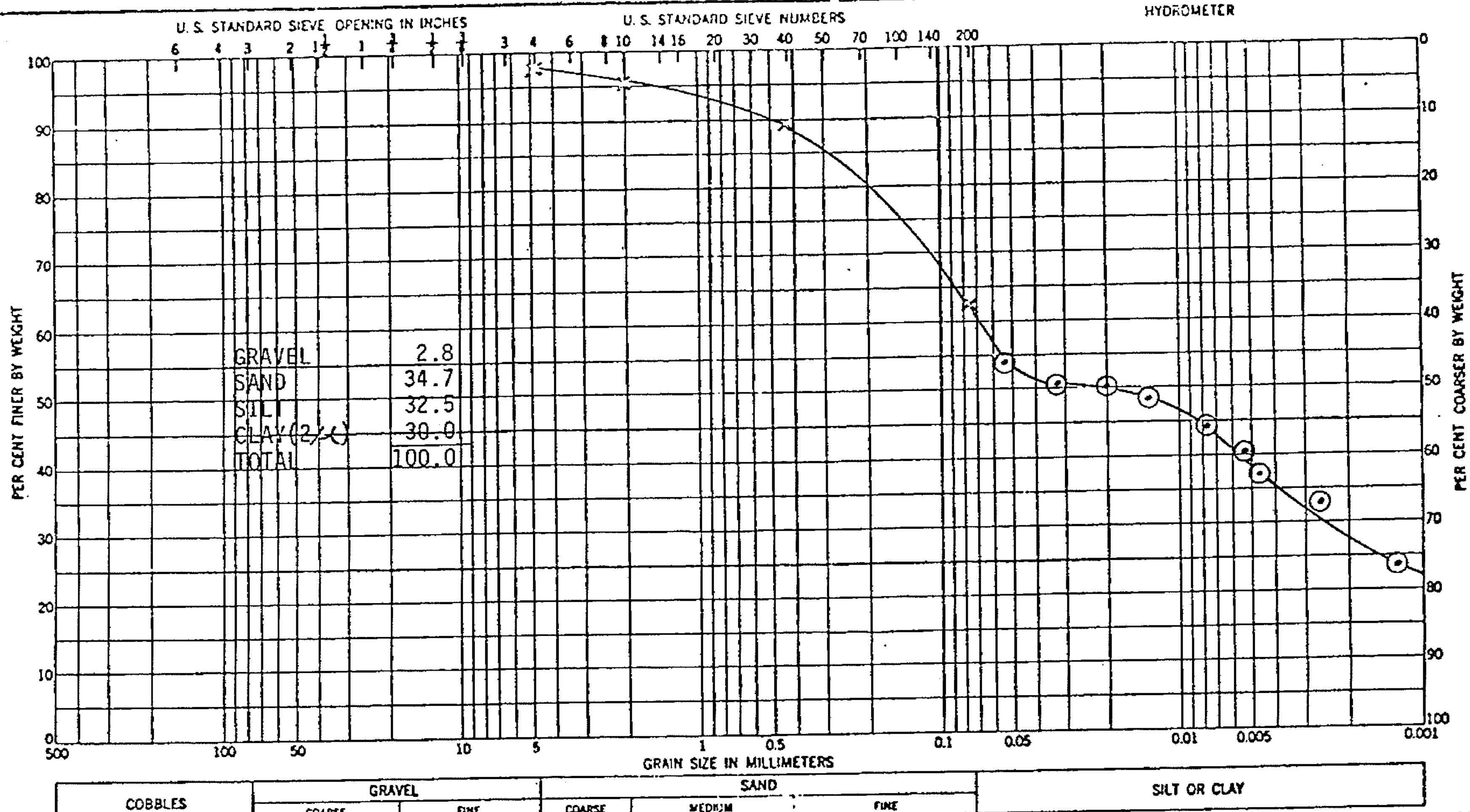
Dow Corning Corporation
Dow Corning Waste Disposal
File#80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
S-3475	93.0	Clay-brown, silty, sandy CL		25.8	12.9	12.9

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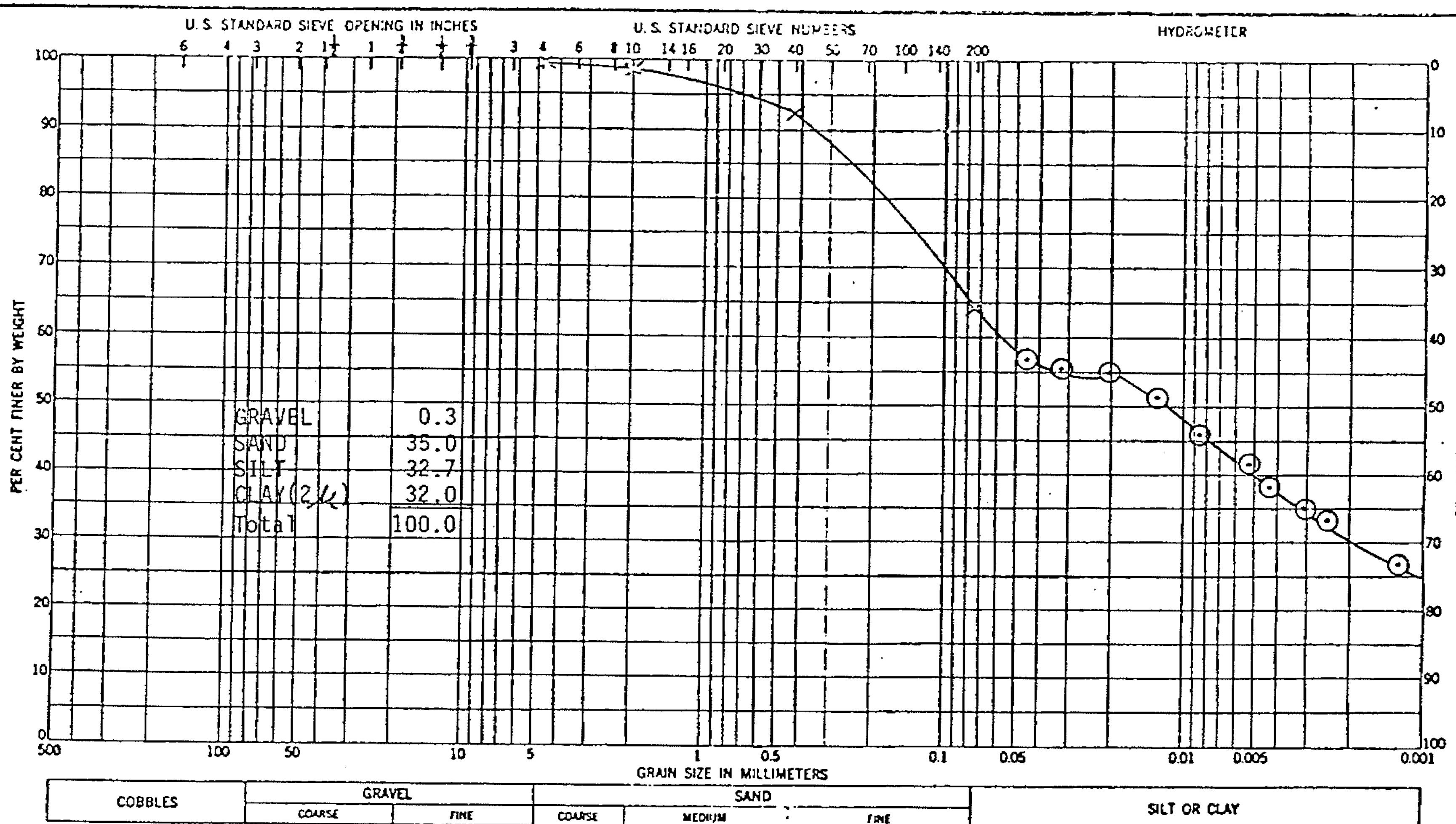
Dow Corning Corporation
Dow Corning Waste Disposal
File #80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
S-3725	94.0	Clay-brown, silty, sandy CL		25.0	14.4	10.6

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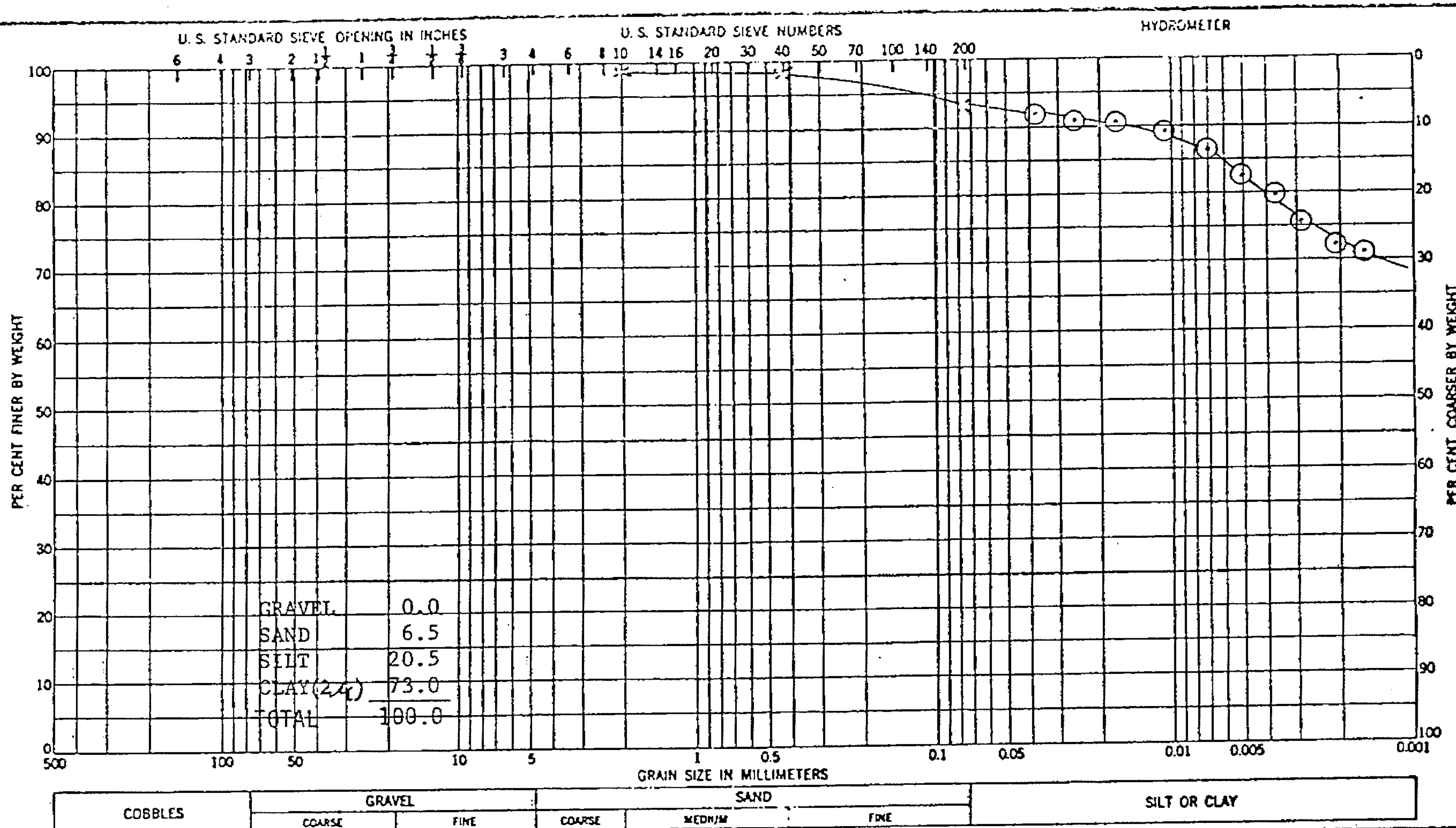
DOW CORNING CORP.
File#80-352
WEST - CENTER



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
S-4150	93.0	Clay, brown silty, trace of sand. CL	24.9	41.7	17.7	24.0

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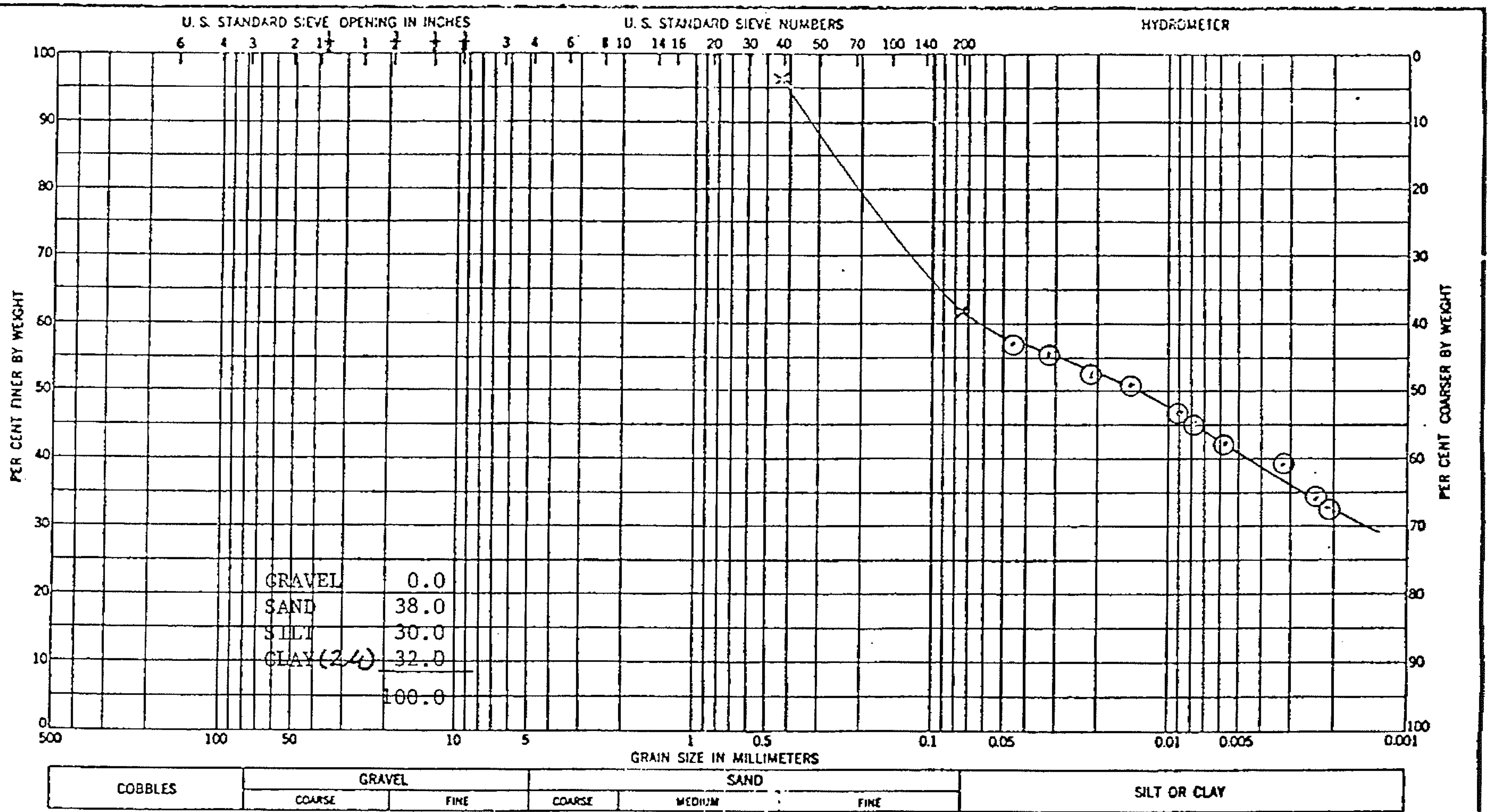
DOW CORNING CORP.
File#80-352
East



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
S-4300	91.5	Clay-sandy, brown, silty CL - ML	13.3	19.4	12.7	6.7

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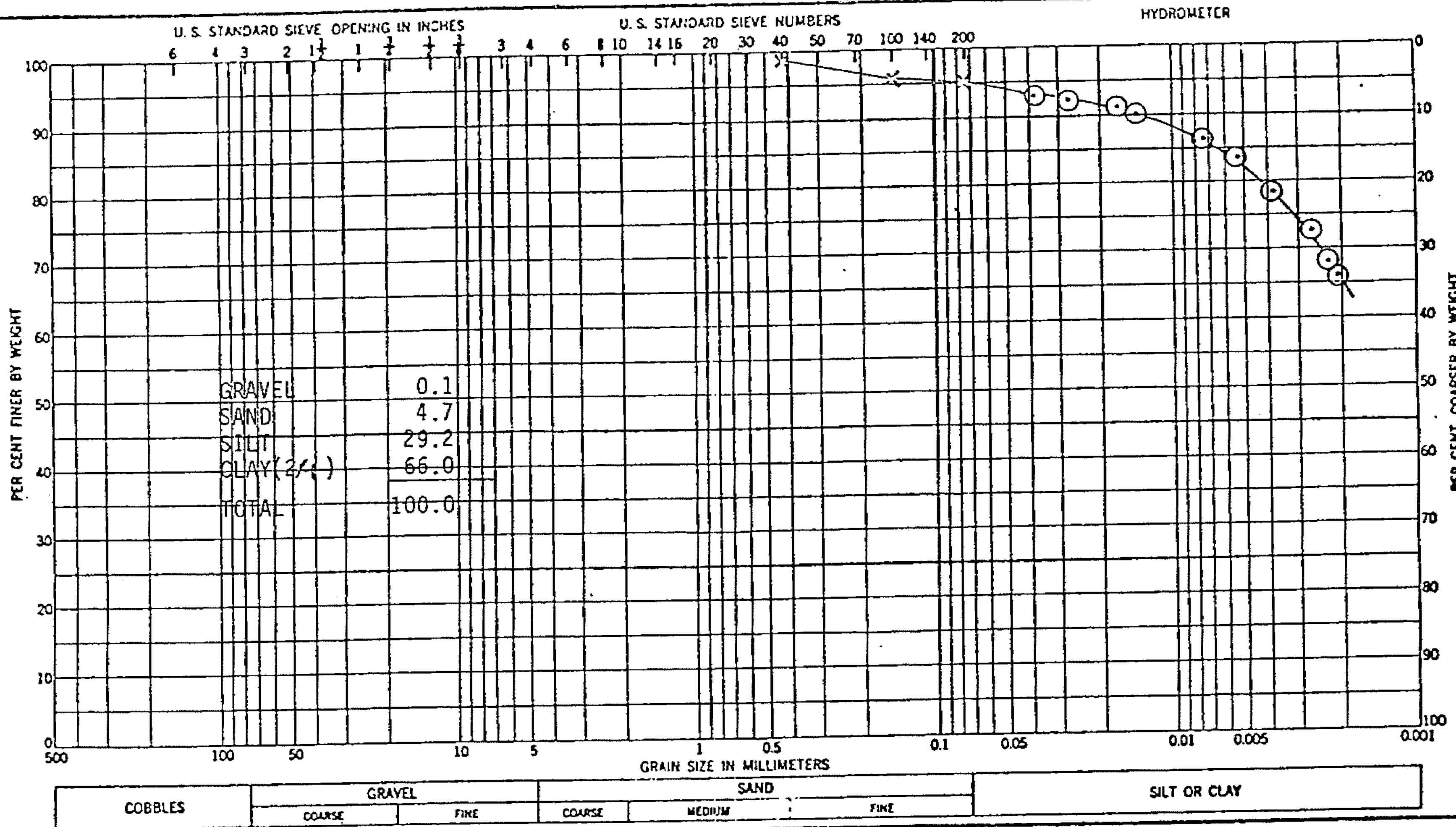
DOW CORNING WASTE DISPOSAL
FILE #80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
E-8470	94	Clay-brown, silty trace sand CH		43.6	24.7	18.9

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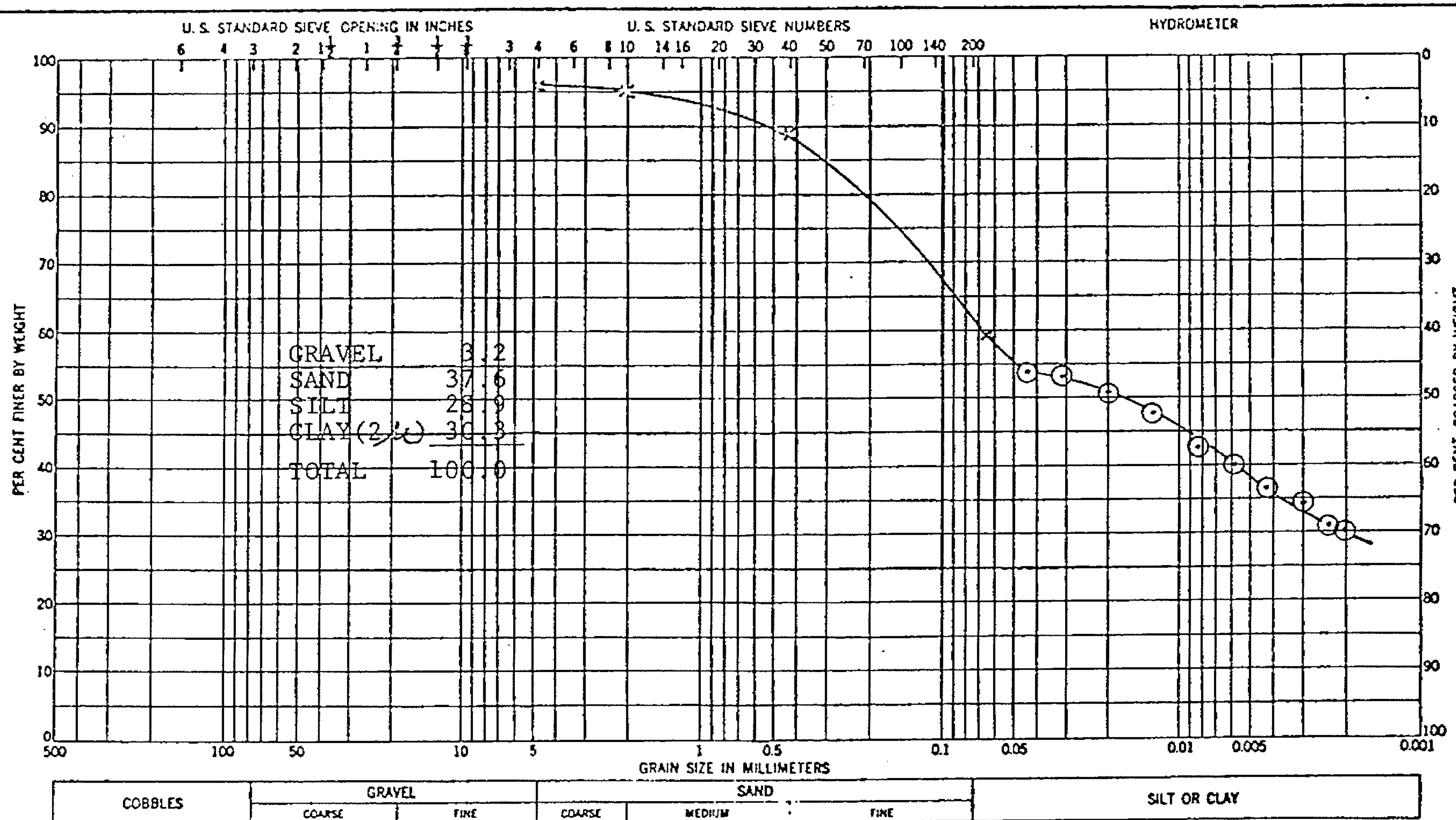
DOW CORNING WASTE DISPOSAL
FILE #80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
E-8965	98	Clay-brown, silty CL		23.7	13.1	10.6

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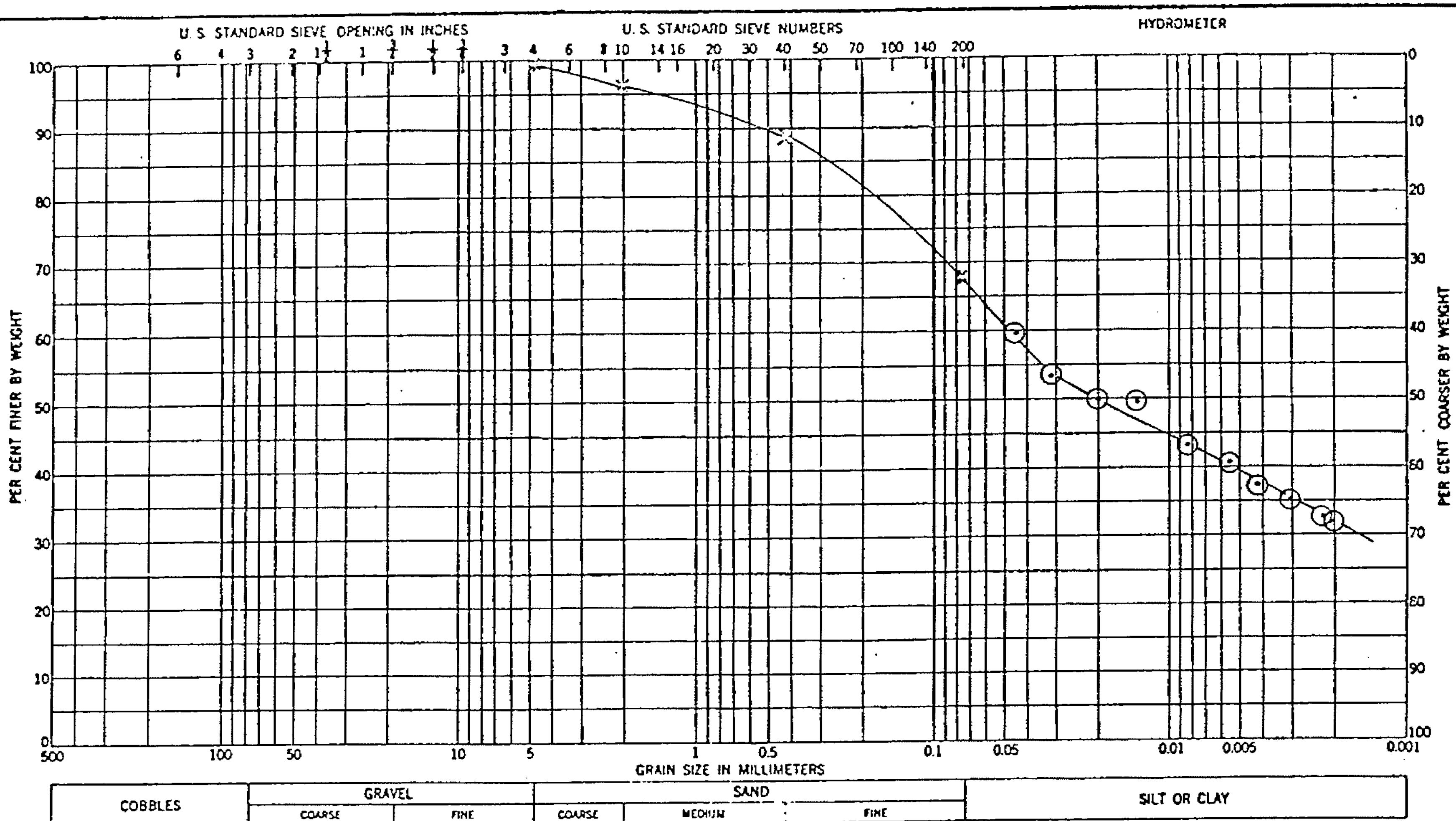
DOW CORNING WASTE DISPOSAL
FILE #80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
E-4064	104	Clay-brown, silty some sand CL		24.8	15.8	9.0

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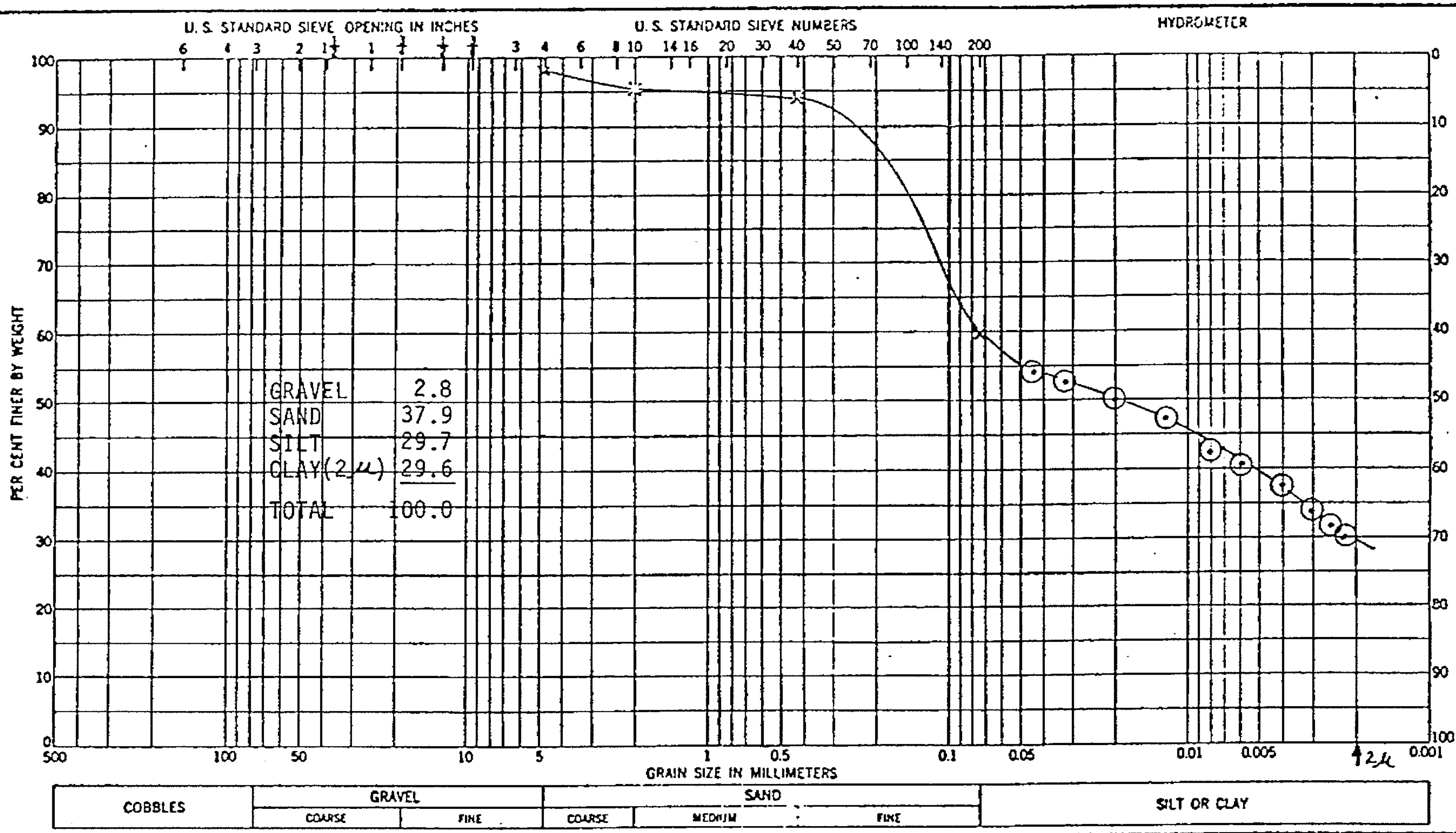
DOW CORNING CORP.
DOW CORNING WASTE DISPOSAL
FILE #80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
W-8225	92.0	CL Brown clay		24.8	13.6	11.2

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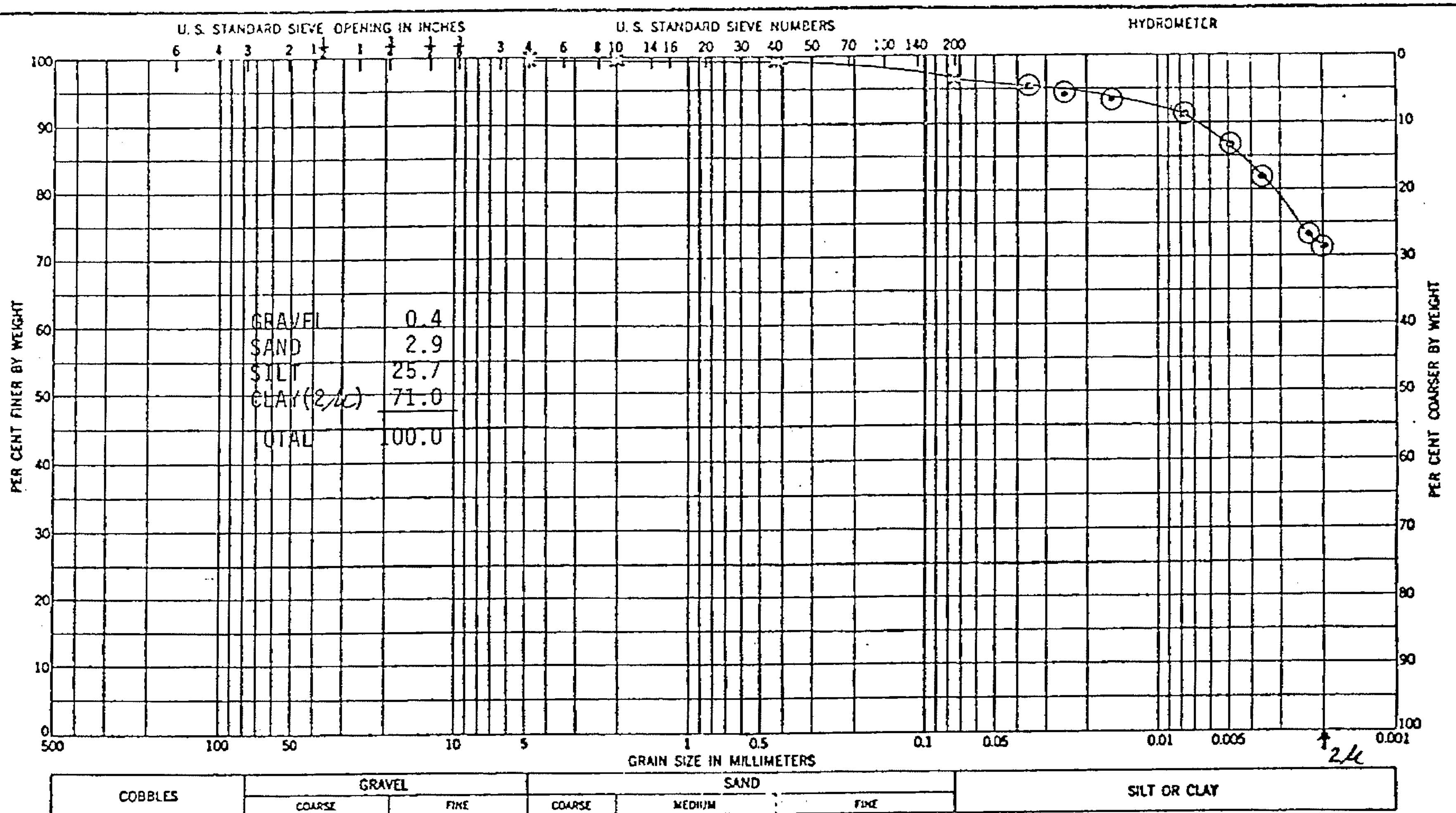
File #80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
8610-W	92.5	CL - Clay, brown silty		24.9	13.3	11.6

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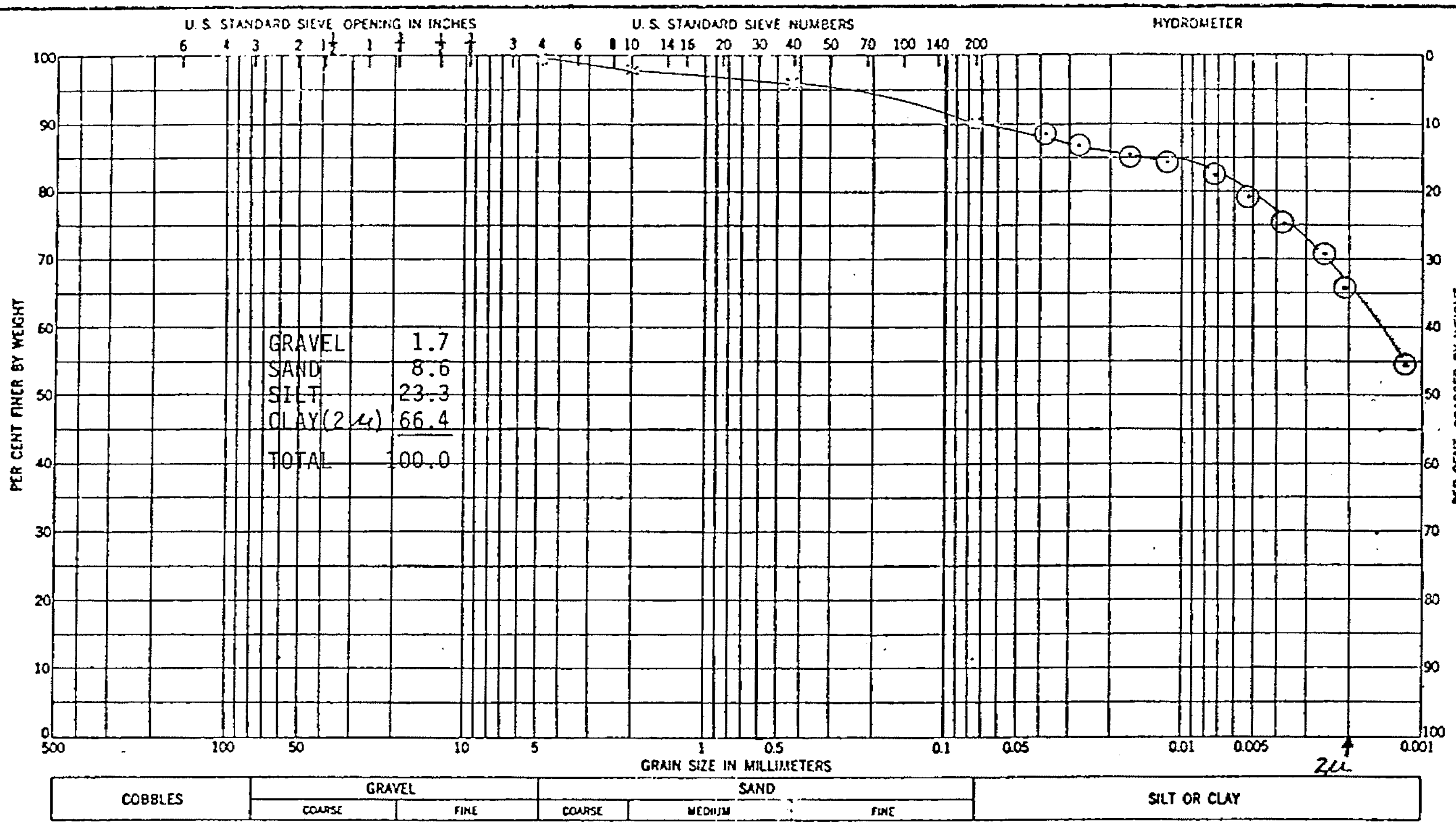
DOW CORNING WASTE DISPOSAL
FILE #80-352



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
W-8965	94.0	CL - Brown clay		46.2	26.2	20.0

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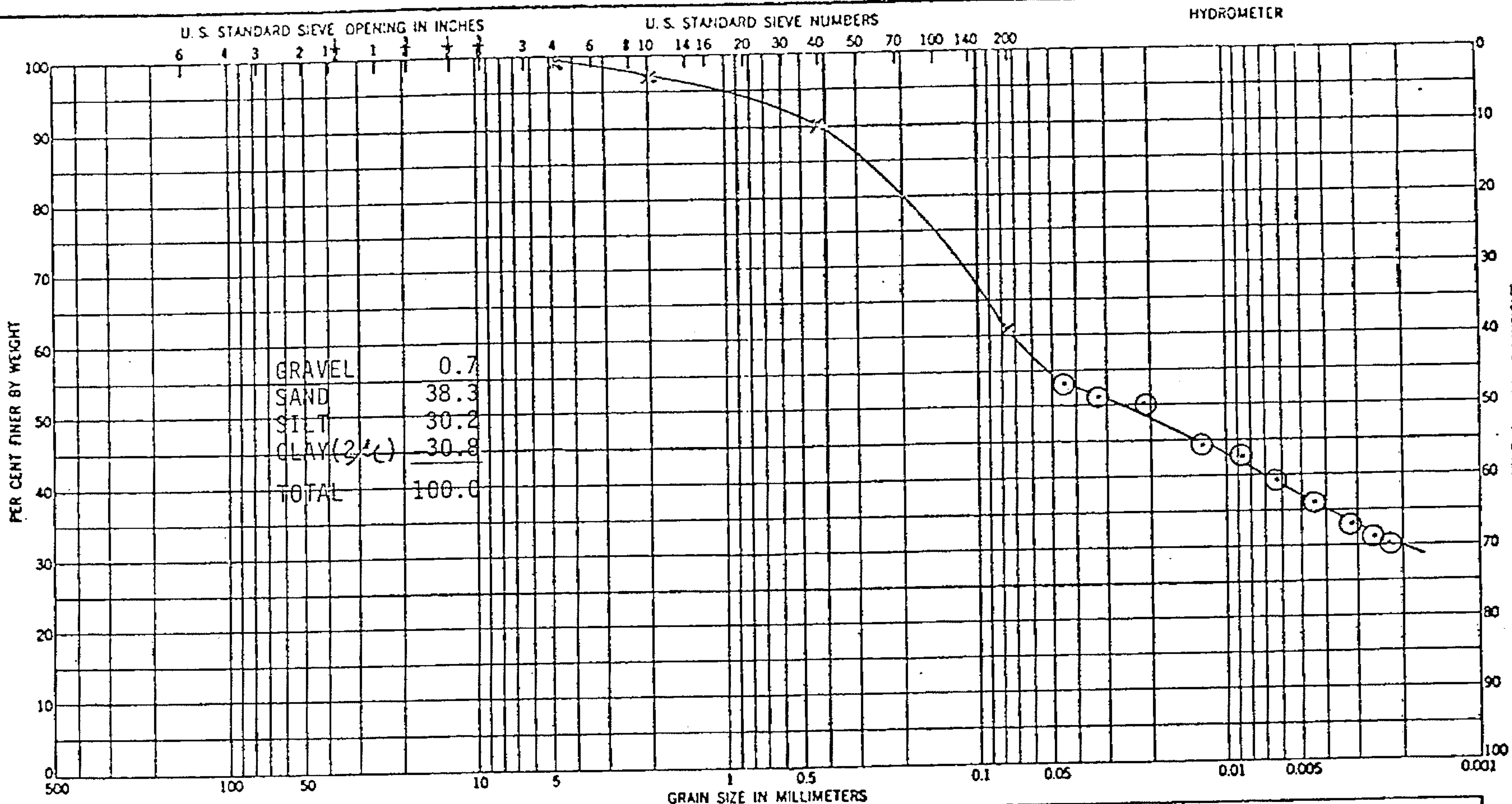
DOW CORNING WASTE DISPOSAL
FILE #80-352



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
W-9035	97	Clay-brown, silty some sand CL		23.6	13.5	10.1

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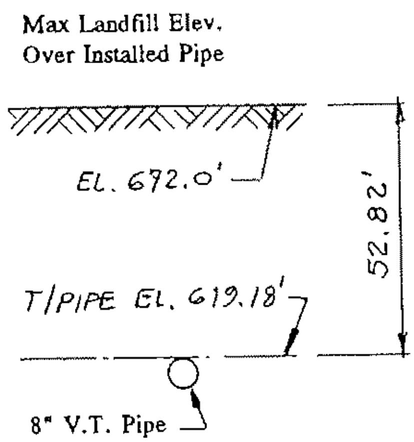
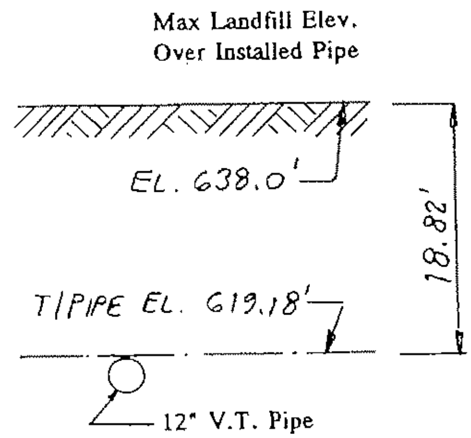
Landfill V.T. Sewer Lines
Stress Calculation
D.C. Midland Plant





Information From:

Dwg.	Y1-36615	Rev. B	Closure Plan for Haz. Waste Landfill Final Topography
	Y1-31900	Rev. V	Landfill Development Site Plan
	Y1-23606	Rev. B	Leachate Collection System Sewer Profiles

Note: Plant Elevation 0.00' = 526.18' USGS.

ASTM Standard Spec C 700-88

V.T. Clay Pipe, Extra Strength, Standard Strength and Perforated

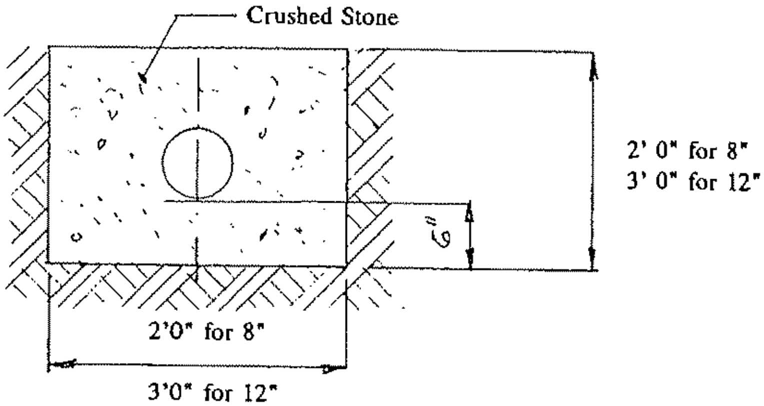
Specified Minimum 3-point Bearing Strength:

8" Pipe	=	2200 PLF
12" Pipe	=	2600 PLF

Landfill V.T. Sewer Lines
Stress Calculation
D.C. Midland Plant

BEDDING CLASS

Reference: Clay Pipe Engineering Manual
by NCPI, 1990 Issue



This bedding would exceed requirement of Class "CS" (Crushed Stone)

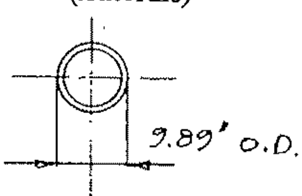
Load Factor = 2.2

Trench Section per Installation
Dwg. Y1-31900 and Y1-23606.

Check Pipe for Overburden: Landfill for 100 PCF due to poor compaction & bulk material.

8" Pipe: = 52.82' x 100 PCF x 9.89"/12"
(Laterals)

= 4353 PLF of Pipe



Pipe capacity: 2200 PLF at 3 pt. bearing x 2.2 Load Factor (Class CS) = 4840 PLF

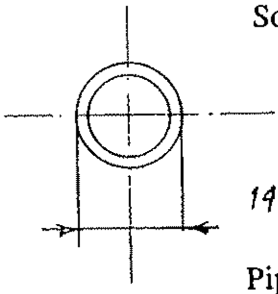
Safety Factor = $\frac{4840}{4353}$ = 1.11 > 1.0

NOTE: This condition, comparatively high load, will exit at the final closure height over one leachate line only, partial segment. At most cases overburden over the installed pipes will be much less than 52.82' as shown here.

Landfill V.T. Sewer Lines
Stress Calculation
D.C. Midland Plant

<u>12" Pipe</u> (Main Collection Pipe)

Soil = 18.82' x 100 PCF x 14.41"/12"
= <u>2260 PLF of pipe</u>



Pipe capacity based on 3 pt. bearing strength and bedding class CS load factor:

2600 PCF x 2.2 = <u>5720 PCF/Ft</u>

Safety Factor = $\frac{5720}{2260}$ = <u>2.53 > 1.0</u>

<u>NOTE:</u> This is common condition for 12" sewer main located on the perimeter of the landfill.

<u>CONCLUSION:</u> **<u>Leachate field installation of V.T. Pipe has adequate strength.</u>** **<u>For chemical resistance</u> see enclosed statement supplied by the V.T. pipe manufacturer. The Logan Clay Products Co. Logan, OH. (14 pages).**

R.O.

LOGAN

The Logan Clay Products Company
P. O. Box 698
Logan, OH 43138

APPENDIX A-4E

WATS 800/848-2141
City 614/385-2184
FAX 614/385-9336

Chemical Resistance

The world's oldest industrial product, Vitrified Clay Pipe, becomes more important with the passage of time. As chemical technology reaches into far greater areas of use, the resulting highly corrosive industrial sewage requires piping systems made of materials with superior chemical resistance. Virtually impervious to every chemical except hydrofluoric acid, natural clay pipe is the choice for today.

Logan Clay Pipe is helping to meet the needs in such applications as those at Love Canal and the Franklin County, Ohio Landfill.

Here's why using Natural Vitrified Clay Pipe makes more sense than ever:

- Clay pipe can pass rigid specifications requirements.
- Is chemically inert, unaffected by sewer gases and acids.
- Rigid, will not flatten out or sag.
- Rust-proof.
- Unaffected by harsh household cleaning compounds and solvents.
- Withstands the extra stresses of heavy backfill loads.
- Will not soften or swell under any condition.
- Is durable, will not roughen, erode or wear out.
- Is unaffected by gases and acids generated by ground garbage.
- Made impervious through vitrification.

Attached are test results using various chemicals on our pipe, "O" Ring joint and gaskets. We will be happy to provide you with samples on which to conduct your own tests and to contact the manufacturer of our "O" Ring jointing materials for their test results.

The Logan Clay Products Company

Product
Chemical Resistance

Visual Observation Key

Sample

1. No visible difference from control
2. Slight discoloration
3. Moderate discoloration
4. Severe discoloration
5. Hardening
6. Softening
7. Deteriorating

Solution

A. No discoloration

B. Slight discoloration

C. Moderate discoloration

D. Severe discoloration

N. Could not tell
—solutions were initially dark

Six Months' exposure.
Solutions reconditioned weekly.

The Logan Clay Products Company

Table I
Chemical Resistance Data
Shale Body - 8" Pipe

	Room Temp. 73°F.			120° ± 4°F.			150° ± 4°F.		
Solution	Absorbed Weight Change	Recond. Weight Change	Vis. Obs.	Absorbed Weight Change	Recond. Weight Change	Vis. Obs.	Absorbed Weight Change	Recond. Weight Change	Vis. Obs.
Acetic Acid 5%	+6.10	-0.22	A-1	+5.92	-0.19	A-1	+6.32	-0.14	A-1
Acetone	+5.32	-0.01	A-1						
Aluminum Sulfate 5%	+5.51	+0.11	A-1	+6.00	+0.16	B-1	+6.29	+0.49	A-1
Ammonium Chloride 5%	+6.23	+0.17	A-1	+5.63	+0.22	B-1	+6.75	+0.36	B-1
Ammonium Hydroxide 5%	+4.99	-0.02	A-1	-					
Ammonium Hydroxide 10%	+5.70	-0.01	A-1	-					
Aniline	+5.85	+0.37	A-1	-					
Antifreeze, Zerex	+5.89	+2.25	A-1	-					
Benzene	+5.78	-0.01	A-1	-					
Borax 3%	+6.08	+0.16	A-1	+5.54	+0.17	A-1	+6.52	+0.43	A-1
Carbon Tetrachloride	+9.44	-0.01	A-1						
Carburetor Cleaner	+6.04	-0.01	A-1						
Citric Acid 10%	+5.88	+0.19	A-1	+5.78	+0.14	B-1	+6.74	+0.23	B-1
Chromic Acid 40%	+7.52	+2.79	N-1	+7.68	+2.85	N-1	+8.00	+2.68	A-1
hlorox	+6.34	+0.76	A-1						
Copper Sulfate 3%	+6.16	+0.28	A-1	+6.10	+0.28	A-1	+6.33	+0.37	A-1
Cottonseed Oil	+5.31	+5.04	A-1	+5.98	+5.63	A-1	+6.08	+5.55	A-1
Tide Soap 0.25%	+5.67	-0.00	A-1	+6.29	+0.10	A-1	+6.73	+0.28	A-1
Calgonite 0.25%	+5.56	+0.00	A-1	+6.22	+0.09	A-1	+6.29	+0.21	A-1
Joy 0.25%	+6.22	-0.05	A-1	+6.17	+0.06	A-1	+6.72	+0.23	A-1
Distilled Water	+6.14	-0.03	A-1	+6.20	+0.04	A-1	+6.30	+0.17	A-1
Drano-Dry 25%	+7.33	+0.70	A-1	+2.33	-11.57	C-6	+10.65	-13.26	C-6
Drano-Liquid 50%	+6.44	-0.13	A-1	+5.55	-0.05	A-1	+6.55	-0.25	B-2
Enzymes	+6.12	+0.18	A-1	+6.26	+0.31	B-1	+6.89	+0.45	B-1
Ethyl Acetate	+5.89	-0.01	A-1						
Ferric Chloride 1%	+5.59	-0.04	A-1	+6.09	-0.30	A-1	+6.44	-0.28	A-1
Formaldahyde 35-40%	+5.99	+0.02	A-1						
Gasoline	+5.33	+0.02	A-1						
Heptane	+4.34	+0.01	A-1						
Hydrochloric Acid 10%	+5.39	-0.47	A-1	+5.90	-1.05	B-1			
Hydrogen Peroxide 3%	+4.88	-0.02	A-1						
Kerosene	+5.11	+0.44	A-1	+4.96	+0.59	B-1			
Lactic Acid 30%	+5.55	+0.87	A-1	+6.82	+0.82	B-1	+6.74	+0.87	B-1
ime 10%	+5.29	+0.16	A-1	+6.61	+0.53	A-2	+7.18	+0.53	[illegible]
Methyl Alcohol	+5.01	-0.02	A-1						

Table I - Chemical Resistance Data
Shale Body - 8" Pipe

Solution	Room Temp. 73°F.			120° ± 4°F.			150° ± 4°F.		
	Absorbed Weight Change	Recond. Weight Change	Vis. Obs.	Absorbed Weight Change	Recond. Weight Change	Vis. Obs.	Absorbed Weight Change	Recond. Weight Change	Vis. Obs.
Mineral Oil	+4.85	+4.00	A-1	+5.39	+4.67	A-1	+5.61	+4.83	A-1
Nitric Acid 1%	+5.66	-0.43	A-1	+6.17	-0.40	A-1	+6.55	-0.36	A-1
Nitric Acid 10%	+6.12	-0.51	A-1	+6.33	-0.65	A-1	+6.12	-1.19	A-1
Nitric Acid 20%	+6.30	-0.50	A-1	+5.65	-0.67	A-1	+5.59	-1.39	A-1
20-20W Oil, Texaco	+5.82	+5.33	A-1	+5.64	+5.16	A-1	+5.80	+5.51	A-1
Oleic Acid	+5.81	+5.14	A-1	+5.80	+5.45	B-1	+6.00	+5.53	B-1
Saniflush	+7.20	+1.48	A-1	+7.77	+1.41	A-1	+7.86	+1.85	B-1
Ivory Soap 1%	+5.80	+0.18	A-1	+6.25	+0.26	A-1	+6.36	+0.42	A-1
Sodium Carbonate 20%	+6.49	+2.15	A-1	+7.44	+2.90	A-1	+6.95	+3.64	A-1
Sodium Chloride 10%	+6.20	+0.55	A-1	+6.14	+0.57	A-1	+6.94	+0.80	A-1
Sodium Chloride 30%	+6.66	+2.63	A-1	+6.86	+2.80	A-1	+7.18	+3.10	A-1
Sodium Hypochlorite, 4-6% Chlorine	+6.29	+0.75	A-1						
Sodium Hydroxide 1% Ph buffered with NaHCO3	+6.30	+0.18	A-1	+5.95	+0.00	A-1	+6.14	-0.17	B-1
Sodium Hydroxide 10%	+3.50	-5.52	A-1	-0.11	-11.60	B-1	-2.96	-16.75	B-1
lium Nitrate 10%	+6.46	+0.56	A-1	+6.31	+0.60	A-1	+7.02	+0.83	A-1
dium Sulfate 10%	+5.97	+0.51	A-1	+6.35	+0.53	A-1	+7.14	+0.88	A
Sodium Sulfite 10%	+6.37	+0.65	A-1	+7.05	+0.70	A-1	+7.47	+1.03	A-
Sulfur Acid 3%	+5.99	+2.36	A-1	+5.99	+2.16	B-1	+6.30	+1.20	A-1
Sulfuric Acid 20%	+6.58	+1.16	A-1	+6.16	+1.11	B-1	+5.34	+0.26	A-1
Sulfuric Acid 30%	+6.80	-0.04	A-1	+6.31	-0.24	A-1	+6.30	-0.47	
Toluene	+5.60	-1.01	A-1	+5.71	+0.02	A-1			
Trisodium Phosphate 5%	+6.39	+0.12	A-1	+6.35	+0.19	A-1	+6.05	+0.35	A-1
Turpentine	+5.37	+1.04	A-1	+6.02	+0.73	B-1			

Table II
Chemical Resistance Data
Flexible Polyester

Solution	Room Temp. 73°F. Absorbed Weight Change	Room Temp. 73°F. Recond. Weight Change	Room Temp. 73°F. Vis. Obs.	120° ± 4°F. Absorbed Weight Change	120° ± 4°F. Recond. Weight Change	120° ± 4°F. Vis. Obs.	150° ± 4°F. Absorbed Weight Change	150° ± 4°F. Recond. Weight Change	150° ± 4°F. Vis. Obs.
Acetic Acid 5%	+4.15	-1.47	A-6	+0.50	-5.15	B-6-2	-7.31	-12.06	C-4
Acetone	+23.08	-11.48	B-6-3	-	-	-	-	-	-
Aluminum Sulfate 5%, pH7	+1.32	-1.34	A-2	-4.17	-4.17	B-6-3	-6.69	+8.95	A-35
Ammonium Chloride 5%, pH 6.1	+0.64	-1.27	C-6-3	-1.85	-4.33	B-6-4	-6.17	-10.21	C-4
Ammonium Hydroxide 5%	-1.64	-17.54	D-2	-	-	-	-	-	-
Ammonium Hydroxide 10%	-5.18	-20.53	D-3-5	-	-	-	-	-	-
Aniline	Disnt.	Disnt.	D-7	-	-	-	-	-	-
Antifreeze, Zerex	+1.56	-0.79	A-1	-	-	-	-	-	-
Benzene	+59.35	-10.04	7	-	-	-	-	-	-
Borax 3%	+4.45	-3.35	B-2-6	+3.75	-8.75	B-2-6	+8.49	-17.08	C-2
Carbon Tetrachloride	+63.58	-0.06	B-2-6	-	-	-	-	-	-
Carburetor Cleaner	+55.05	-8.89	A-6	-	-	-	-	-	-
Citric Acid 10%	+1.55	-1.25	A-2	+0.72	-4.68	B-2-6	-5.06	-12.45	C-35
Chromic Acid 40%	-1.19	-19.57	N-3	+8.20	-16.18	N-3-7	-6.84	-24.42	N-4
lorox	+4.28	-1.89	A-2	-	-	-	-	-	-
opper Sulfate 3%, Ph 3.6	+2.67	-1.16	A-1	-1.95	-4.83	B-6-4	-7.65	-11.37	B-4
Cottonseed Oil	+0.26	-0.21	A-1	-0.86	-1.03	A-1	-4.05	-4.38	A-1
Tide Soap 0.25%	+3.94	-2.13	A-2	+2.56	-5.08	B-3-6	-2.91	-10.35	B-36
Calgonite 0.25%	+4.15	-2.10	A-2	+0.01	-5.35	B-3-6	-5.98	-9.96	C-4
Joy 0.25%	+3.61	-1.50	A-2	-0.61	-4.78	-	-3.55	-9.75	C-46
Distilled Water	+3.38	-1.47	A-2	+0.41	-5.09	B-2-6	-6.12	-11.55	C-46
Drano-Dry 25%	+2.51	-15.95	N-2-5	+5.39	-10.41	N-3	Disnt.	Disnt.	N-7
Drano-Liquid 50%	Disnt.	Disnt.	C-7	Disnt.	Disnt.	C-7	Disnt.	Disnt.	C-7
Enzymes	+0.85	-1.72	N-4	-1.84	-4.83	N-3	-6.58	NA	N-26
Ethyl Acetate	+32.23	-11.22	A-7	-	-	-	-	-	-
Ferric Chloride 1%, pH 1.9	+3.96	-1.28	C-3	+4.18	-3.86	C-36	+1.09	-2.06	D-36
Formaldahyde 35-40%	+2.69	-1.05	A-2	-	-	-	-	-	-
Gasoline	+3.03	+0.88	A-1	-	-	-	-	-	-
Heptane	+0.08	-0.26	A-1	-	-	-	-	-	-
Hydrochloric Acid 10%	+0.65	-1.03	B-2	+1.76	-6.66	B-26	-	-	-
Hydrogen Peroxide 3%	+3.02	-2.03	A-2	-	-	-	-	-	-
Kerosene	+0.35	-0.33	A-1	+0.95	+0.30	A-1	-	-	-
Lactic Acid 30%, pH 1.3	+3.14	-0.94	C	-3.18	-5.12	C-2-6	-13.31	-14.58	C-3-6
								blister	
ne 10%, pH 11.8	+7.26	-3.92	A-3	+6.16	-7.98	A-5	+1.00	-1.40	B-3[illegible]
						blistered			
Methyl Alcohol	+0.71	-9.93	B-1	-	-	-	-	-	-

Solution	Room Temp. 73°F. Absorbed Weight Change	Room Temp. 73°F. Recond. Weight Change	Room Temp. 73°F. Vis. Obs.	120° ± 4°F. Absorbed Weight Change	120° ± 4°F. Recond. Weight Change	120° ± 4°F. Vis. Obs.	150° ± 4°F. Absorbed Weight Change	150° ± 4°F. Recond. Weight Change	150° ± 4°F. Vis. Obs.
Mineral Oil	+0.68	-0.33	A-1	-0.37	-0.72	A-1	-1.05	-2.86	A-2
Nitric Acid 1%	+4.22	-1.40	A-3	+5.05	-5.80	B-3-6	-11.59	-7.97	B-3
Nitric Acid 10%	-4.49	-1.98	B-3	+23.01	-15.16	B-4	Disnt.	Disnt.	N-7
Nitric Acid 20%	+4.40	-4.69	B-4	-	*	B-4-5-7	Disnt.	Disnt.	N-7
			*Couldn't get sample out of bottle.						
20-20W Oil, Texaco	+1.40	+1.02	A-2	-0.60	-0.83	A-5	-2.69	-3.57	A-45
Oleic Acid	+0.10	-0.10	A-1	-0.34	-0.63	C-6	-	-	-
Saniflush	+0.19	-1.47	B-3	-0.37	-2.80	B-36	-6.91	-1.58	B-4
Ivory Soap 1%	+6.39	-2.70	A-2	+1.95	-3.81	B-36	+3.40	-6.61	B-36
Sodium Carbonate 20%, pH 10.9	-0.17	-3.83	B-2	-8.98	-18.43	B-4	-5.80	-0.65	C-5
Sodium Chloride 10%	+0.51	-1.04	A-2	-1.87	-3.48	B-3-6	-6.81	-9.14	B-4
Sodium Chloride 30%	+0.56	-0.51	A-2	-0.94	-2.18	B-3	-5.75	-7.10	B-7
Sodium Hypochlorite, 4-6% Chlorine	+0.14	-3.37	B-2	-	-	-	-	-	-
Sodium Hydroxide 1%, pH 9.8, buffered with NaHCO3	+3.81	-3.79	B-1	-1.09	-15.21	B-26	+5.96	-25.09	B-36
dium Hydroxide 10%	-3.60	-21.45	C-2-6	-14.11	-31.50	C-3	Disnt.	Disnt.	C-7
dium Nitrate 10%	+1.00	-1.36	B-2	-1.83	-4.43	B-6	-6.07	-10.43	[illegible]
Sodium Sulfate 10%, pH 7.7	+0.61	-1.26	A-2	-2.32	-3.95	B-26	-7.73	-9.01	[illegible]
Sodium Sulfite 10%, pH 9.5	+1.65	-2.47	B-2	-0.99	-6.47	B-26	-7.79	-12.32	C-3
Sulfur Acid 3%, pH 0.8	+2.31	-0.62	A-2	+2.89	-5.09	B-36	+27.91	-13.37	B-4
Sulfuric Acid 20%	+1.21	-0.70	A-3	+2.37	-3.95	B-36	+14.80	-7.28	C-3
Sulfuric Acid 30%	+0.63	-1.25	A-3-6	+0.81	-3.36	B-36	+22.21	-4.71	B-35
Toluene	+42.40	-8.18	B-6	Disnt.	Disnt.	B-7	-	-	-
Trisodium Phosphate 5%, pH 11.6	+1.78	-15.10	C-2	+7.04	-22.27	C-26	-7.43	-27.85	C-2-6
Turpentine	+1.70	+0.77	A-2	+10.33	+8.27	B-26	-	-	-

Table III
Chemical Resistance Data
Rubber - Polyisoprene

	Room Temp. 73°F.			120° ± 4°F.			150° ± 4°F.		
Solution	Absorbed Weight Change	Recond. Weight Change	Vis. Obs.	Absorbed Weight Change	Recond. Weight Change	Vis. Obs.	Absorbed Weight Change	Recond. Weight Change	Vis. Obs.
Acetic Acid 5%	+15.68	+1.43	A-3	+90.04	+17.82	A-6	+116.40	+25.38	A-6
Acetone	-8.77	-20.17	C-1	-	-	-	-	-	-
Aluminum Sulfate 5%, pH7	+2.35	-0.32	A-2-6	+2.39	-1.39	A-2	+2.24	-1.35	A-2
Ammonium Chloride 5%, pH 6.1	+1.45	-0.12	A-2	+1.91	-1.33	A-1	+2.19	-1.27	B-1
Ammonium Hydroxide 5%	+5.22	+0.22	A-6	-	-	-	-	-	-
Ammonium Hydroxide 10%	+4.85	+0.17	A-1	-	-	-	-	-	-
Aniline	-7.52	-20.18	D-1	-	-	-	-	-	-
Antifreeze, Zerex	+1.00	+0.57	A-1	-	-	-	-	-	-
Benzene	+135.77	-28.35	B-6	-	-	-	-	-	-
Borax 3%	+1.94	-0.33	A-1	+4.51	-1.83	A-3	+7.51	-2.66	A-4
Carbon Tetrachloride	+276.72	-28.42	B-6	-	-	-	-	-	-
Carburetor Cleaner	+26.27	-27.70	A-6	-	-	-	-	-	-
Citric Acid 10%	+2.01	-0.22	B-1	+3.33	-1.33	A-1	+4.24	-1.15	A-1
Chromic Acid 40%	-52.76	-62.95	A-7	-80.01	-88.17	N-7	Disnt.	Disnt.	N-7
orox	+5.96	+0.68	B-5	-	-	-	-	-	-
pper Sulfate 3%, Ph 3.6	+2.00	-0.12	A-1	+6.01	-1.10	A-3	+7.06	-1.23	A-3
Cottonseed Oil	+35.61	+35.42	A-6	+35.64	+33.19	A-6	+37.79	+37.61	A-6
Tide Soap 0.25%	+2.10	-0.70	A-1	+6.78	-1.32	B-2	+12.21	-1.53	B-3
Calgonite 0.25%	+2.31	-0.77	A-1	+7.21	-1.79	B-1	+9.68	-1.54	B-2
Joy 0.25%	+2.59	-0.57	A-1	+8.86	+0.16	B-2	+11.59	-0.17	B-3
Distilled Water	+2.19	-0.10	A-1	+6.84	-0.02	N-2	+8.89	-0.74	B-3
Drano-Dry 25%	+2.25	-0.51	A-1	+9.00	+5.55	B-5-2	+26.73	+2.64	C-5-3
Drano-Liquid 50%	+142.07	-23.07	C-6	+173.58	+9.33	C-6	+68.53	-21.30	C-6-2
Enzymes	+2.72	+0.01	A-1	+8.42	+2.87	A-5-3	+8.91	-2.16	A-4-5
Ethyl Acetate	+7.15	-27.62	C-6	-	-	-	-	-	-
Ferric Chloride 1%, pH 1.9	+5.54	-0.65	A-2	+14.83	-1.51	A-5	+18.88	-1.65	C-5
Formaldahyde 35-40%	+2.26	-0.46	A-1	-	-	-	-	-	-
Gasoline	+98.19	-28.91	A-6	-	-	-	-	-	-
Heptane	+20.22	-29.41	B-6	-	-	-	-	-	-
Hydrochloric Acid 10%	+2.04	+0.03	A-1	+21.62	+2.16	C-1	-	-	-
Hydrogen Peroxide 3%	+10.94	+0.04	A-2	-	-	-	-	-	-
Kerosene	+57.19	-28.05	A-6	+65.37	-30.09	B-6	-	-	-
Lactic Acid 30%, pH 1.3	+4.82	+1.27	B-1	+37.60	+8.68	A-6	+55.66	-12.40	B-6
ne 10%, pH 11.8	+2.19	-0.39	A-1	+9.07	+0.47	A-3	+8.88	-2.51	A-
thyl Alcohol	+3.21	-5.63	B-1	-	-	-	-	-	-

Solution	Room Temp. 73°F. Absorbed Weight Change	Room Temp. 73°F. Recond. Weight Change	Room Temp. 73°F. Vis. Obs.	120° ± 4°F. Absorbed Weight Change	120° ± 4°F. Recond. Weight Change	120° ± 4°F. Vis. Obs.	150° ± 4°F. Absorbed Weight Change	150° ± 4°F. Recond. Weight Change	150° ± 4°F. V[illegible] Obs.
Mineral Oil	+13.68	+12.68	A-6	+23.97	+18.84	A-6	+21.81	+18.92	A-6
Nitric Acid 1%	+23.70	+0.72	A-1	+99.01	+1.37	A-5	+99.13	-1.91	A-5-7
Nitric Acid 10%	+11.61	+1.80	A-5	Disnt.	Disnt.	C-7	Disnt.	Disnt.	C-7
Nitric Acid 20%	+5.79	+1.18	A-5	Disnt.	Disnt.	C-7	Disnt.	Disnt.	C-7
20-20W Oil, Texaco	+14.10	+13.45	A-6	+23.86	+21.50	A-1	+20.87	+20.04	A-1
Oleic Acid	+56.12	+55.41	B-6	+38.30	+36.04	D-6	+38.03	+35.63	D-6
Saniflush	+1.77	+0.09	B-1	+3.37	+0.47	B-2	+2.41	-0.89	C-1
Ivory Soap 1%	+2.64	+0.16	A-1	+16.25	+4.17	B-4	+22.10	-1.88	C-3
Sodium Carbonate 20%, pH 10.9	-0.20	-1.19	B-1	-11.74	-3.07	B-1	-1.55	-3.02	C-2
Sodium Chloride 10%	+1.12	+0.02	A-1	+0.64	-0.87	B-3	+0.92	-1.04	A-2
Sodium Chloride 30%	+0.90	-0.03	A-1	+0.53	-0.40	B-3	+0.66	-1.99	A-3
Sodium Hypochlorite, 4-6% Chlorine	+3.19	-0.09	B-5	-	-	-	-	-	-
Sodium Hydroxide 1%, pH 9.8, buffered with NaHCO3	+1.64	-0.55	B-1	+2.11	-2.93	C-2	+1.75	-3.09	C-2
Sodium Hydroxide 10%	+2.95	-0.29	B-1	+1.42	-1.31	B-2	+3.15	-1.25	D-3
[illegible]dium Nitrate 10%	+1.29	-0.13	A-1	+3.24	+0.17	B-3	+4.04	-1.12	A-2
[illegible]dium Sulfate 10%, pH 7.7	+1.38	-0.17	A-1	+4.35	+0.07	B-3	+5.95	-1.52	[illegible]
Sodium Sulfite 10%, pH 9.5	+1.32	-0.29	B-1	+0.86	-2.57	C-2	-0.90	-3.09	[illegible]
Sulfur Acid 3%, pH 0.8	+3.28	-0.38	A-1	+5.73	-1.13	B-1	+8.81	-0.85	A-2
Sulfuric Acid 20%	+3.51	+0.39	A-1	+15.29	+3.38	B-1	+13.95	+2.91	B-6
Sulfuric Acid 30%	+2.54	+0.72	B-1	+17.55	+7.00	B-1	+18.51	+7.31	B-6
Toluene	+141.81	-28.61	C-6	+152.35	-30.97	A-6	-	-	-
Trisodium Phosphate 5%, pH 11.6	+1.16	-1.00	B-1	+2.33	-1.59	A-1	+3.11	-1.45	B-2
Turpentine	-	Disnt.	D-7	Disnt.	Disnt.	D-7	-	-	-

LOGAN

The **Logan Clay Products Co.**

P O BOX 698 LOGAN, OHIO 43138-0698
(614) 385-2184 FAX (614) 385-9336 WATS (800) 848 2141

MEMBER NCPI

CHEMICAL RESISTANCE
LOGAN CLAY PIPE AND "O" RING JOINTS

Procedure for Testing of Joint

1. 12 - 4" pipe spigots were cut off pipe 8-10 inches from the spigot.
2. Step 1 was repeated for the socket ends of each pipe.
3. Caps were epoxied onto the cut ends of the socket sections and allowed to cure 24 hours.
4. The spigot sections were then slipped into the socket sections to make complete joints.
5. With the pipe setting, open end up, 1N Sulfuric Acid was poured into the pipe until it was 3/4 full.
6. The pipe end was then covered with poly ethylene (held on by a rubber-band) and allowed to sit for 7 days at 72±3°F.
7. Steps 5 and 6 were repeated using the following chemicals:
   - 1N Hydrochloric Acid
   - 5% V/V Acetic Acid
   - 7.5 N Ammonium Hydroxide
   - 5% W/W Sodium Hydroxide
   - 5% W/W Sodium Chloride
   - 50% V/V Bleach
   - 5% V/V Alkl-Aryl Sulfonate
   - Carbon Tetrachloride
   - Toluene
   - Kerosene
   - Mineral Spirits
8. The pipe joints were then drained of the chemicals and filled with water.
9. A hand tighten stopper with a water inlet was placed in the open end of the first pipe and tightened.
10. A clamp was placed on the pipe, such that they could not slip apart.
11. One end of a hose was then elevated ten feet above the pipe joint with the other end attached to a tee.
12. The tee was attached to the threaded stopper and a water supply line attached to the last opening of the tee.
13. Water was allowed to run into the elevated hose until it ran out the end, then shut down to a trickle.
14. The joint was watched for leaks for 5 minutes. If none occurred, the joint passed; if a leak occurred before the five minutes were up, the joint failed. Below are the results:

Chemical	Temp. ±3°F	Results
1N Sulfuric Acid	72°F	Pass
1N Hydrochloric Acid	"	Pass
5% V/V Acetic Acid	"	Pass

Continued next page...

Chemical	Temp. ±3°F	Results
7.5 N. Ammonium Hydroxide	72°F	Pass
5% W/W Sodium Hydroxide	"	Pass
5% W/W Sodium Chloride	"	Pass
50% V/V Bleach	"	Pass
5% V/V Alkyl-Aryl Sulfonate	"	Pass
Carbon Tetrachloride	"	Pass
Toluene	"	Pass
Kerosene	"	Pass
Mineral Spirits		

The joints with Toluene showed some deterioration, but passed the water test.

If you require information on chemicals not listed above, we will be happy to contact the manufacturer of the materials used in our "O" Ring jointing system for results of tests using those chemicals, or provide you with samples on which to conduct your own tests.

Chemical Resistance - Clay Pipe

Clay pipe is virtually impervious to every chemical except hydrofluoric acid. Samples for testing will be furnished upon request.

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The **Logan Clay Products Co.**

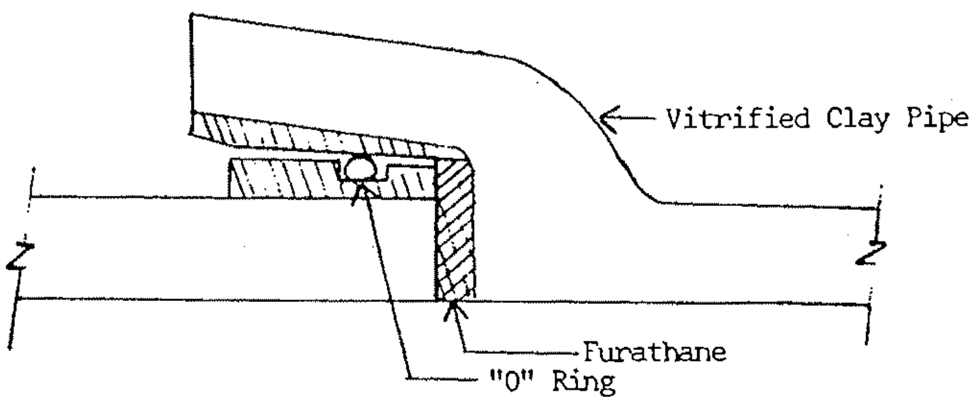
P O BOX 698 LOGAN OHIO 43138-0698
(614) 385-2184 FAX (614) 385 9336 WATS (800) 848-2

FURATHANE/"O" RING JOINT FOR INDUSTRIAL CHEMICAL-
RESISTANT JOINTS FOR VITRIFIED CLAY PIPE AND FITTINGS

Description

FURATHANE is a thermosetting furan resin based corrosion-resistant mortar containing a 100% carbon filler. Set and cured, FURATHANE exhibits the chemical and thermal resistance of furan mortar with the high bond strength of epoxy mortar.

Vitrified clay bell and spigot pipe lines carrying corrosive spent acids and solvents may require the use of FURATHANE/"O" RING combination joint. A fillet and bead of FURATHANE Mortar at the pipe junction provides the necessary resistance against attack from non-oxidizing acids, chlorinated organic solvents, and detergents to a maximum operating temperature of 140° F. (60° C.). (See diagram below.)



Bedding Pipe

THE BEDDING OF PIPE IN TRENCHES MUST BE IN ACCORDANCE WITH ASTM C-12. The recommended guidelines for installation of pipe incorporated in this specification must be implicitly followed. The use of FURATHANE between each pipe results in a rigid line that must be uniformly supported by the pipe bedding.

Installing the Joint

The following procedure is recommended for installing the FURATHANE/"O" RING combination joint. The temperature at time of construction must be 60° F. - 90° F. (16° C. - 32° C.). All vitrified clay pipe must meet ASTM C-700 specifications, and joints must meet ASTM C-425.

If the temperature is above 90° F. (32° C.), cover trench area with temporary shelters such as tarps, black plastic sheeting, etc., in order to protect against direct rays of the sun. If the temperature is below 60° F. (16° C.), the temporary shelter can be used to confine heat provided by portable hot air blowers. Alternatively, the pipe can be used as a warm air duct for conveying heated air provided by portable hot air blowers. Care should be taken to insure that the pipe temperature does not become excessive during installation. Ideal temperature is 75° F. ± 5° F. (24° C. - 3° C.).

1) Before pipe laying is started, remove all water that may have entered the trench. The trench must be kept dry during installation and curing period of the mortars.

2) Whenever possible, start pipe laying at the lowest point and install the pipe so that the spigot ends point in the direction of the flow.

3) Inspect the bell and spigot joint surfaces to be sure they are clean.

4) Mix FURATHANE in accordance with instructions given on the bottom of this data sheet and continued on page 3.

5) Apply "O" Ring to spigot end of joint, but do not lubricate until you butter a complete and continuous circle of FURATHANE Mortar onto the spigot end of the pipe and onto the shoulder of the bell prior to positioning the spigot end into the bell. Lubricate "O" Ring and bell surface and push joints together.

6) The pipe is shoved home, forcing the FURATHANE Mortar evenly around the shoulder of the bell in order to form a uniform and continuous bead of mortar at the bell and spigot intersect. The interior planes of the pipe sections should be flush within dimensional limits of the specification against which the pipe was supplied. In all cases, it is essential that the FURATHANE set hard and be continuous in the interior of the pipe.

Preparation of FURATHANE Mortar

Mixing Ratio - 1 part resin to 1.75 parts powder by weight. (Do not exceed 1 part resin to 2 parts powder.)

Preparation - FURATHANE Mortar is prepared by combining FURATHANE Powder with FURATHANE Resin to form a workable mix.

1) Place 2 pounds of previously measured FURATHANE Resin in a suitable shallow mixing pan.

Preparation of FURATHANE Mortar (Cont'd)

2) Add most of 3.5 pounds of previously measured FURATHANE Powder and mix thoroughly to form a smooth mortar. Add remainder of powder and mix until mortar is free from lumps and entrapped air.

3) If mortar is too stiff for proper buttering, increase amount of resin slightly.

4) Spread in thin layer in mixing pay (not more than 3/4" thick) to slow the setting time, and mortar is ready to use.

5) Do not mix more mortar than can be used in 15 minutes. Mortar that has started to set cannot be tempered with resin. Clean the mixing pan thoroughly between batches.

6) At temperatures above 90° F., both powder and resin should be cooled to extend working life, and small batches should be mixed so the mortar is used up quickly.

7) At temperatures below 60° F., store resin and powder in a warm area removing materials only as required.

IMPORTANT

FURATHANE is thermosetting mortar. The temperature at time of installation will affect the final set of the mortars. At a minimum of 75° F., the mortars are sufficiently set to allow testing and backfilling after 24 hours. If FURATHANE is used below 60° F. (16° C.), Furan Catalyst LT is required to hasten the initial set. Additional heat will be required to hasten final set if the job is to proceed without disturbing pipe alignment of partially cured joint.

Package Sizes

FURATHANE Powder	FURATHANE Resin
100 lb. bag	50 lb. pail

Storage Life
When stored in original unopened containers in a cool, dry place, FURATHANE Resin and Powder has a shelf life in excess of one year. All materials must be kept at 60 - 90° F. (16 - 32° C.) for several hours prior to use.

Cleaning Equipment
Water and detergent or methyl ethyl ketone can be used to remove FURATHANE before it has started to chemically harden. FURATHANE is difficult to remove from any surface after it has set.

CAUTIONS

FURATHANE Powder

Contains carbon and/or silica and acid. Eye irritant. May cause skin irritation and allergic respiratory responses. May be harmful if swallowed.

Avoid breathing dust. Wear a respirator suitable for acid vapor and dust. Provide adequate ventilation. Wear rubber gloves and eye goggles. Brush from clothing immediately after contact. Do not take internally.

Keep container closed when not in use. Handle carefully to keep dusting at a minimum. In case of spillage, sweep up and discard.

FURATHANE Liquid Resin

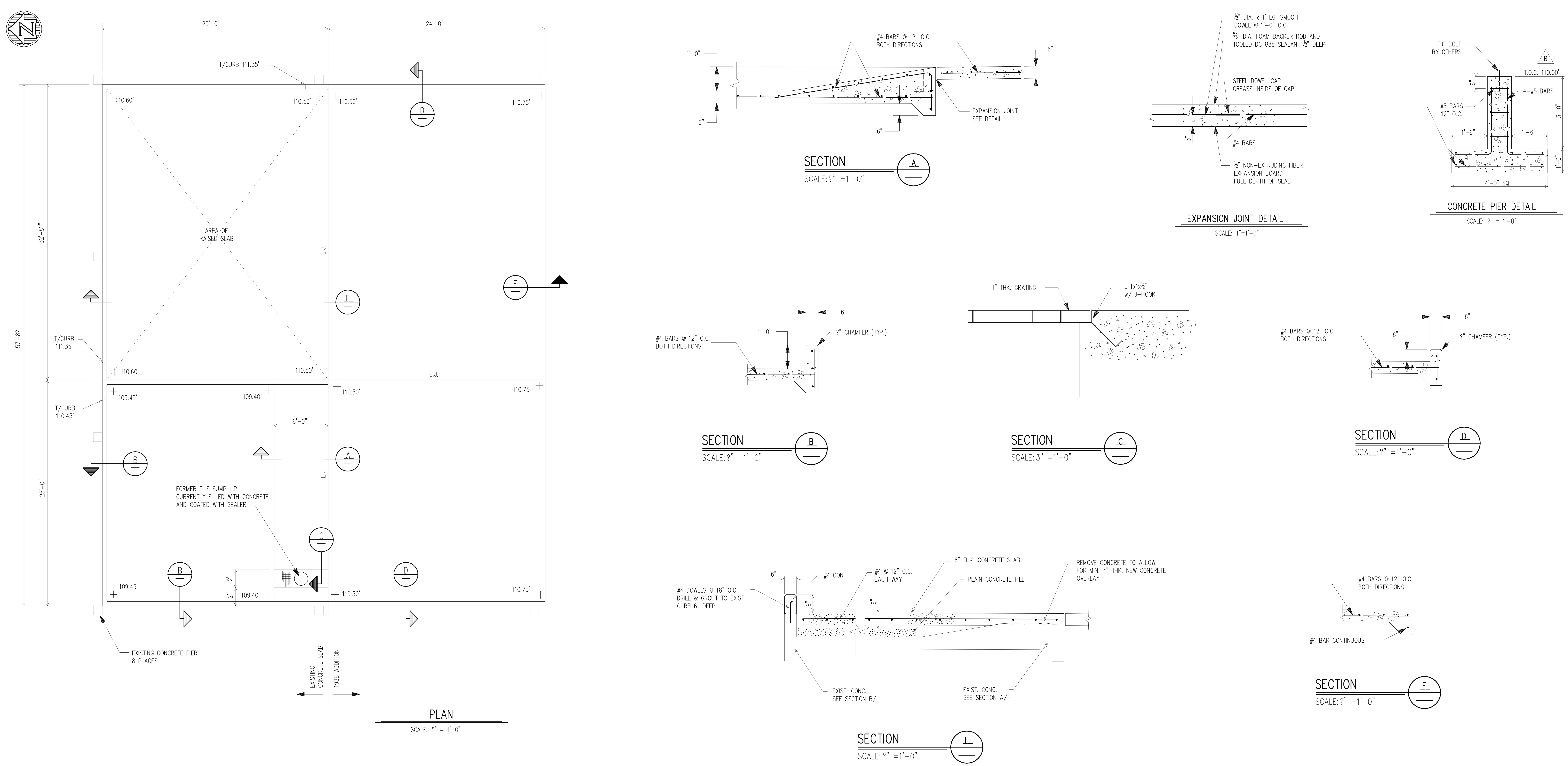
Combustible. May cause skin and eye irritation. Harmful if swallowed. Contamination with strong acids causes violent reaction with heat.

Keep away from heat, sparks or open flame. Use only with adequate ventilation. Avoid breathing vapors. Wear a respirator suitable for organic solvent vapors. Avoid contact with skin, eyes, or clothing. Wear rubber gloves and goggles. Do not take internally.

Keep containers closed tight and upright to prevent leakage. Keep containers closed when not in use. In case of spillage, absorb and dispose of in accordance with local applicable regulations.

8/23/82

Appendix 14-5
Landfill Drawings



LAST GENERAL UPDATE: 04JAN2010

CADD

MARK	LOC.	REVISIONS	BY	DATE	APP
A	GEN	ADDED 50' EXTENSION TO SOUTH OF SLAB	RJF	04-05-89	PJM
B	L-7	CHANGED T.O.C. TO 110.00', WAS 111.50'	LSA	06-23-89	PJM
C	GEN	REMOVED PLANNED 1989 ADDITION, RAISED SLAB IN N.E. QUADRANT	RJF	02MAR93	PC
D	GEN	REVISED SUMP DESCRIPTION	NLW	02-02-10	MG
E					
F					
G					
H					
J					

DESIGNED	J.L. VanderMale	DATE	04-22-88
DRAWN	R.J. Fortier	DATE	04-22-88
CHECKED	M.W. Thomas	DATE	04-25-88
APPROVED	M.L. Marchione	DATE	04-25-88

DOW CORNING CORPORATION

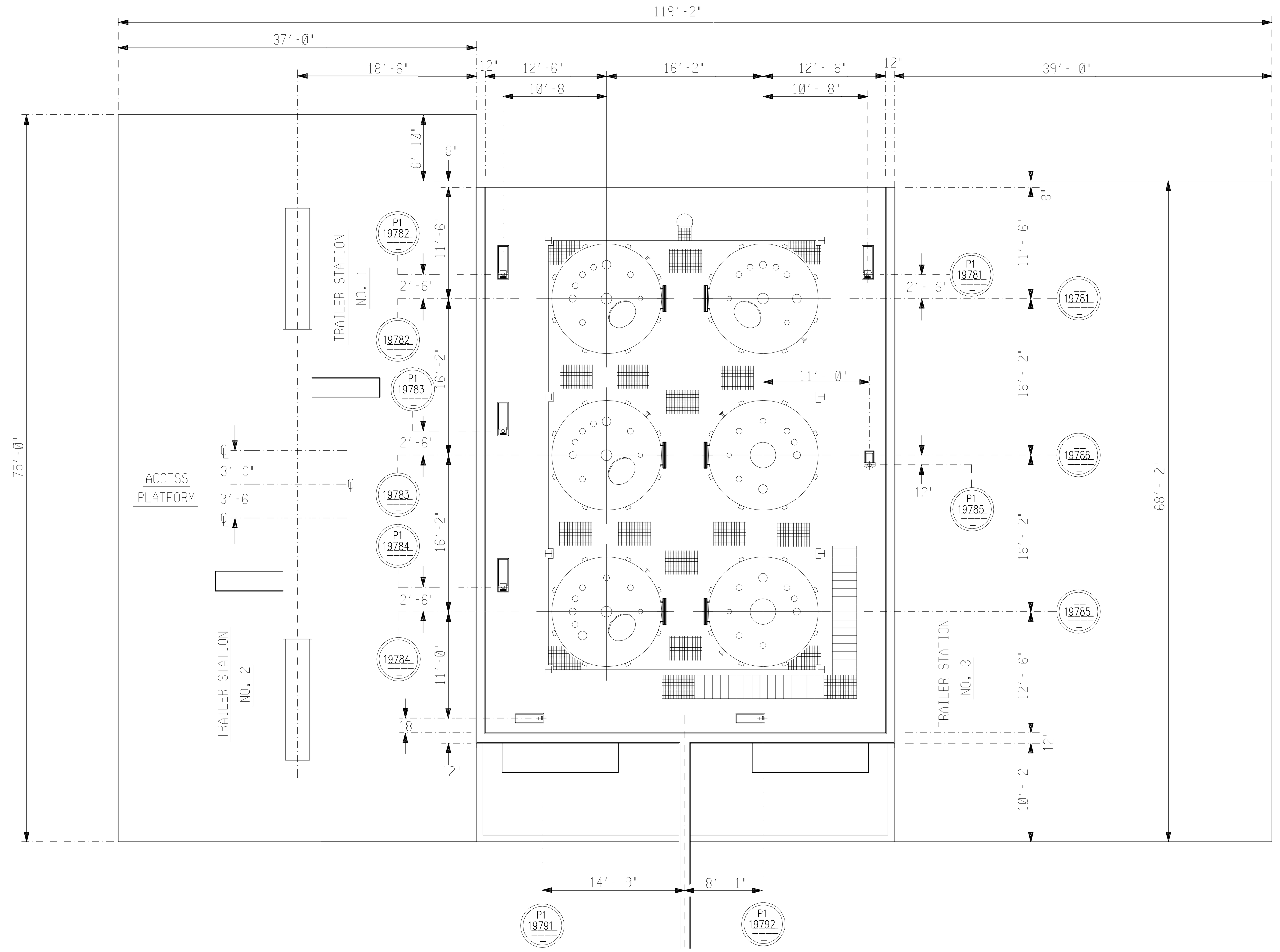
MIDLAND PLANT BLDG. 801

SLAB

PLAN AND DETAILS

SCALE	INCH / FOOT	DRAWING NUMBER	REVISION
	AS NOTED	X1-38058	C


SECTION B
SCALE: 1"=1'-0"
X1-60882
SECTION H
SCALE:?" =1'-0"
X1-60882
SECTION J
SCALE: 1"=1'-0"
X1-60882
SECTION K
SCALE: 1"=1'-0"
X1-60882
SECTION C
SCALE: 1"=1'-0"
X1-60882
SECTION L
SCALE: 1"=1'-0"
X1-60882
PLAN VIEW
SECTION D
SCALE: 1"=1'-0"
X1-60882
SECTION E
SCALE: 1"=1'-0"
X1-60882
PLAN
SECTION F
SCALE: 1"=1'-0"
X1-60882
SECTION G
SCALE: 1"=1'-0"
X1-60882
SLABS
TRENCH WALLS
TANK FOUNDATION
TYPICAL EXPANSION JOINTS
NO SCALE
SEE DWG. X1-60882
TYPICAL CONTROL JOINT
NO SCALE
SEE DWG. X1-60882
TYPICAL HANDRAIL CONNECTION
SCALE: 1?"=1'-0"
SEE DWG. X1-60882
PIPE POLE FOUNDATION DETAIL "1"
SCALE:?"=1'-0"
TYPICAL EQUIP.PAD LAYOUT
SCALE:?"=1'-0"
"NEENAH" R-4990 DUCTILE IRON HEAVY DUTY TRENCH FRAME & COVER (SOLID TOP) FROM INTERSECTION OF 12" TRENCH TO POND
"NEENAH" R-4991 DUCTILE IRON LIGHT DUTY TRENCH FRAME & COVER (SOLID TOP) ALONG SOUTH SIDE OF TANK FARM - T.O. TRENCH VARIES 106.50' TO 106.17'
LAST GENERAL UPDATE: 04JAN2010
CADD
A | C-2 | 09-26-89 | AS BUILT | D.A.W. | K.J.W. | 09-26-89
B | A-2 | 27FEB04 | ADDED PIPE POLE FOUNDATION | RFP | ABK | 09-26-89
MARK LOCATION DATE REVISIONS CHANGED APPROVED DATE
DESIGNED K.J.WALKER DATE 01-11-88
DRAWN L.K.O./ D.A.W. DATE 01-29-88
CHECKED K.J.WALKER DATE 06-08-88
APPROVED R.L.ZITTA DATE 06-10-88
DOW CORNING CORPORATION
WASTE CONTROL
BLDG. 806
TANK FARM
SLAB AND FOUNDATION DETAILS
SCALE AS NOTED
DRAWING NUMBER X1-60883
REVISION B



PLAN VIEW TANK FARM 806 BLDG.

SCALE: 1 / 8"=1'-0"

LAST GENERAL UPDATE: 04JAN2010

CADD

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
H						
J						
K						
L						
M						
N						
P						

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
A						
B						
C						
D						
E						
F						
G						

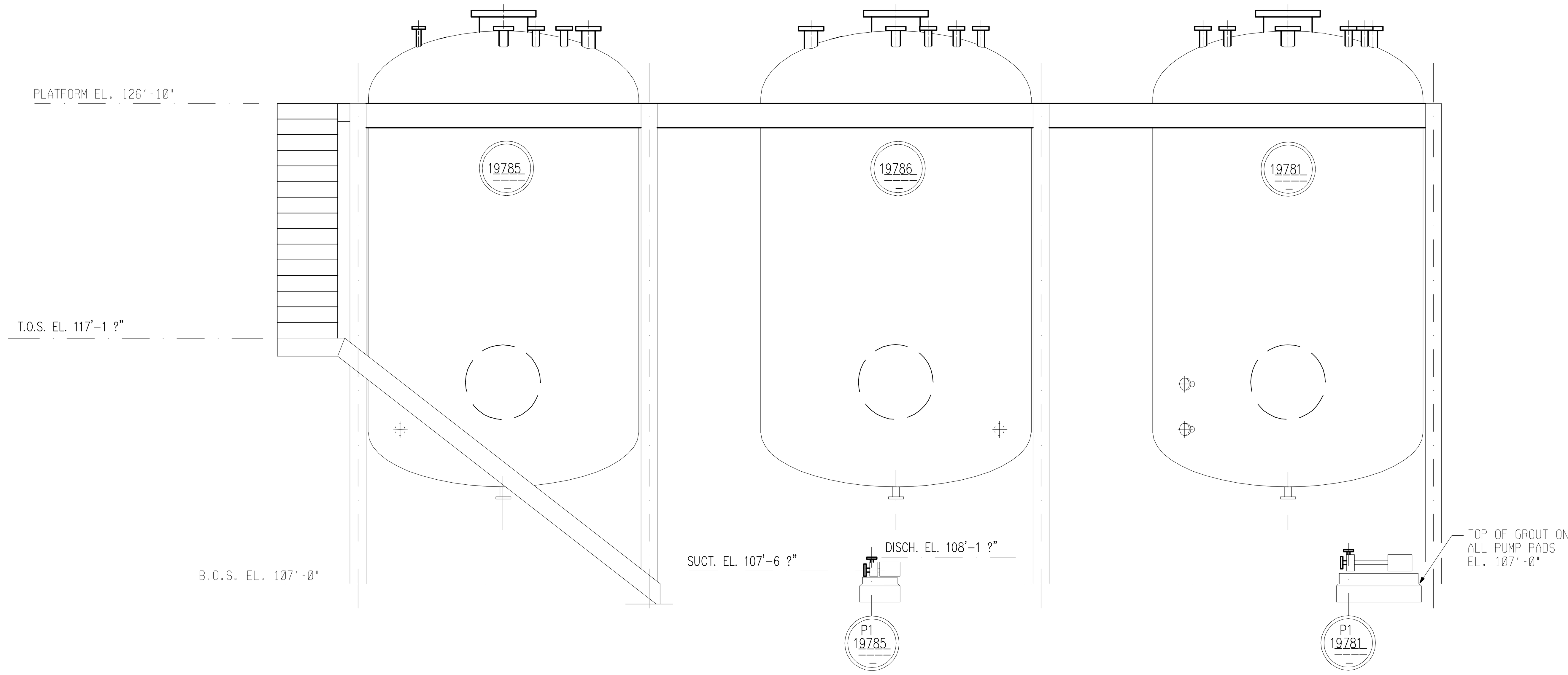
DESIGNED J. MOQUIN	DATE 04-13-88
DRAWN DEBOLT DESIGN	DATE 05-15-88
CHECKED S.K. SAHA	DATE 05-15-88
APPROVED S.K. SAHA	DATE 05-15-88

DOW CORNING CORPORATION

MIDLAND PLT BLDG 806

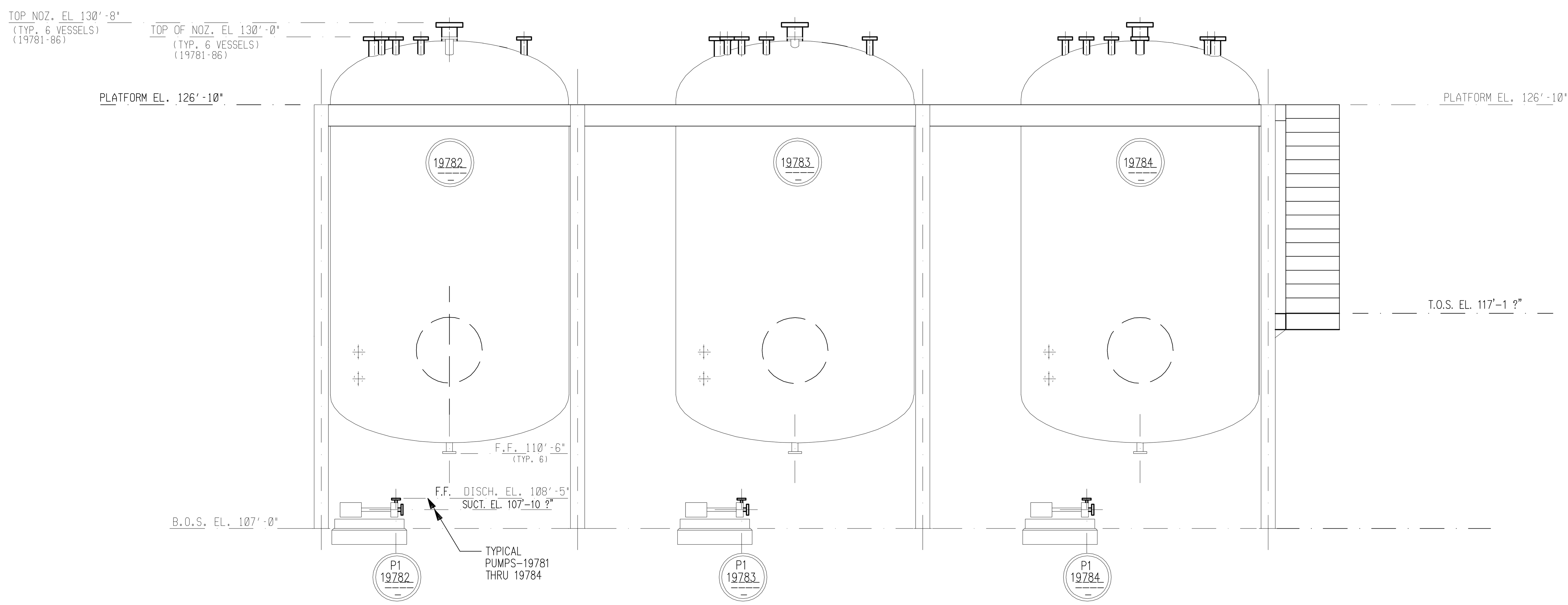
TANK FARM
EQUIPMENT LOCATION PLAN

SCALE INCH	FOOT	DRAWING NUMBER	REVISION
1 / 8"=1'-0"		W1-71228	0



ELEVATION LOOKING WEST

SCALE: 1 / 4"=1'-0"



ELEVATION LOOKING EAST

SCALE: 1 / 4"=1'-0"

LAST GENERAL UPDATE: 04JAN2010

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
H						
J						
K						
L						
M						
N						
P						

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
A	D-1	8-8-88	CHANGED SUCT.& DISCH.ELEV.ON PUMPS P1-19781 THRU P1-19784	J.MOQUIN	SKS	8-8-88
B						
C						
D						
E						
F						
G						

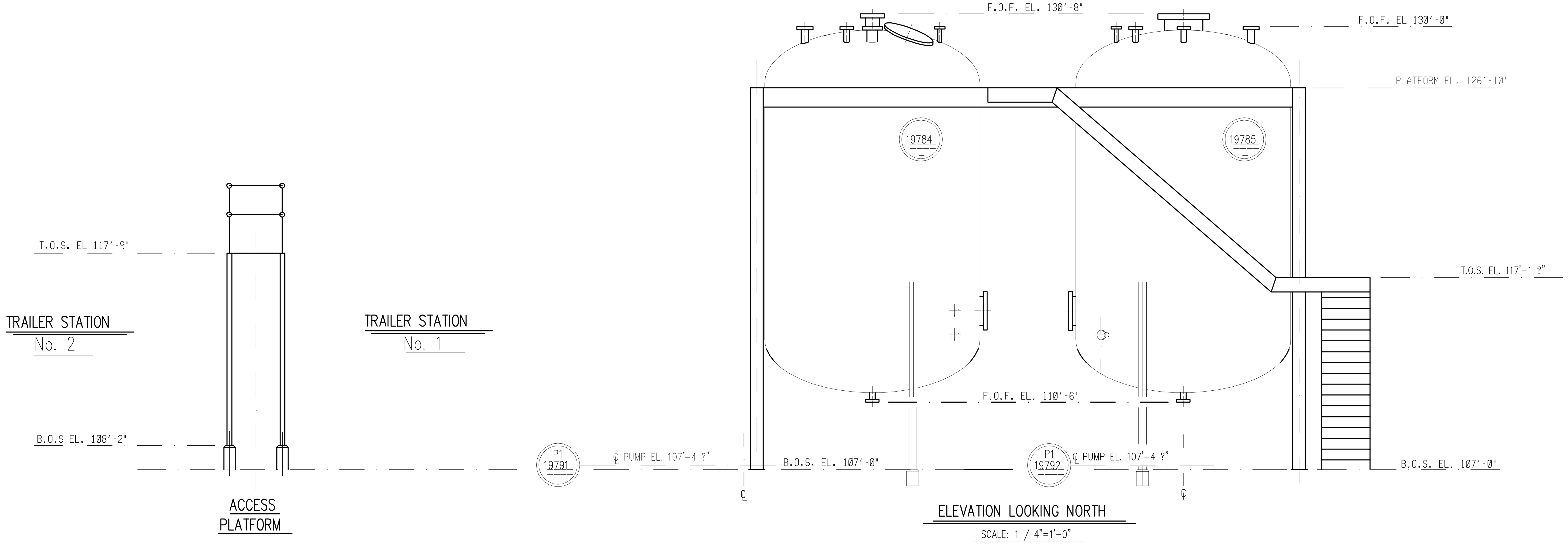
DESIGNED J. MOQUIN	DATE 04-13-88
DRAWN DEBOLT DESIGN	DATE 05-03-88
CHECKED S.K. SAHA	DATE 05-15-88
APPROVED S.K. SAHA	DATE 05-15-88

DOW CORNING CORPORATION

MIDLAND PLT. BLDG 806

TANK FARM
EQUIPMENT – EAST & WEST ELEVATION

SCALE	INCH / FOOT	DRAWING NUMBER	REVISION
	1 / 4"=1'-0"	W1-71229	A



LAST GENERAL UPDATE: Ø4JAN2Ø1Ø

CADD

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
H						
J						
K						
L						
M						
N						
P						

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
A						
B						
C						
D						
E						
F						
G						

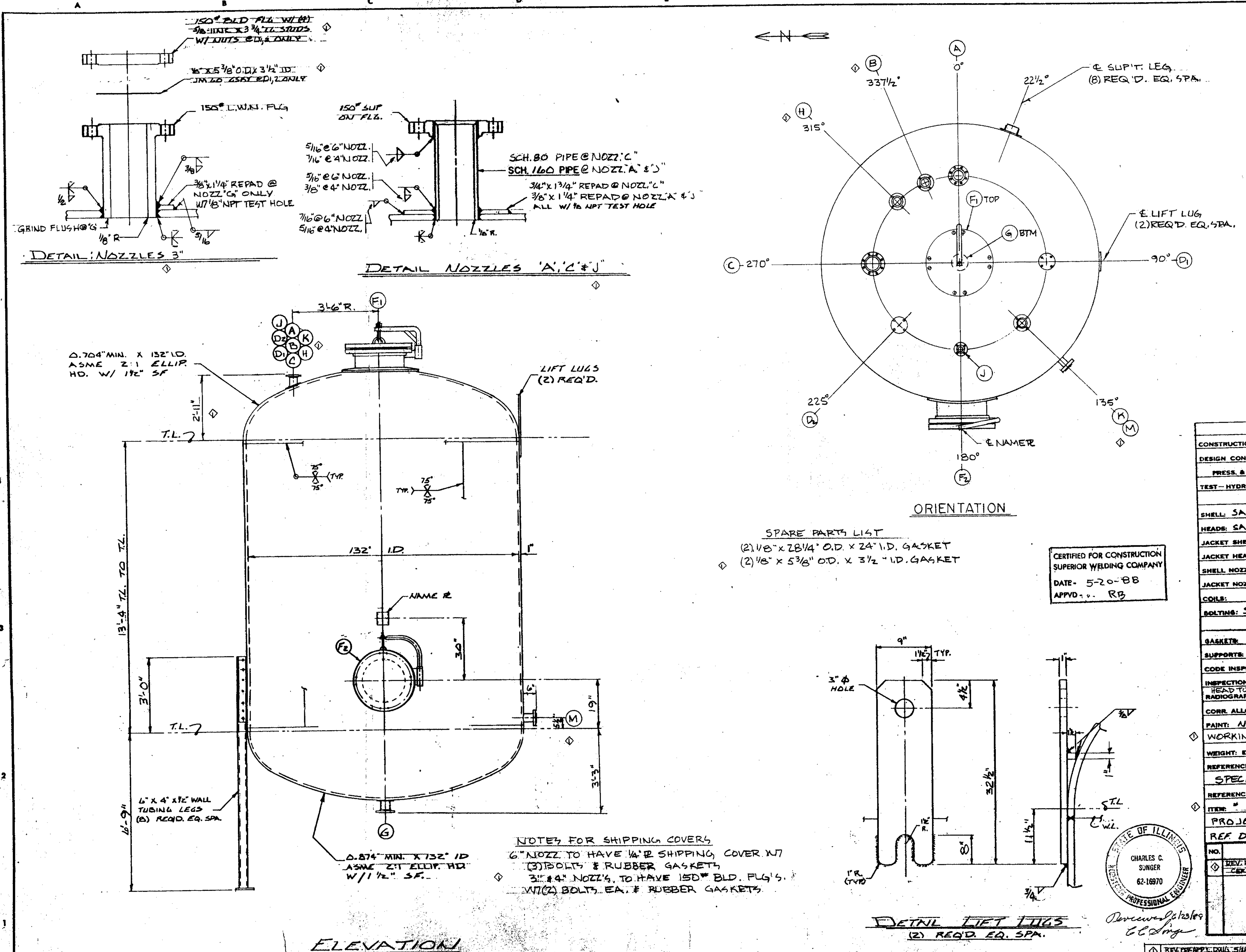
DESIGNED J. MOQUIN	DATE Ø3-29-88
DRAWN DEBOLT DESIGN	DATE Ø5-15-88
CHECKED S.K. SAHA	DATE Ø5-15-88
APPROVED S.K. SAHA	DATE Ø5-15-88

DOW CORNING CORPORATION

MIDLAND PLT BLDG 806

TANK FARM
EQUIPMENT – SOUTH ELEVATION

SCALE	INCH	FOOT	DRAWING NUMBER	REVISION
	1 / 4"=1'-Ø"		W1-7123Ø	0



FITTING SCHEDULE

MK	NO. REQ'D	DESCRIPTION	REMARKS
A	1	4"-150# NOZZ. SO	INLET
B	1	3"-150# NOZZ. L.W.N.	RECIRC.
C	1	6"-150# NOZZ. SO	RELIEF
D1	1	3"-150# NOZZ. L.W.N.	SPARE W/ BLIND
E			
F1, F2	2	24" 150# NOZZ SO	MANWAY
G	1	3" 150# NOZZ L.W.N.	OUTLET
H	1	3" 150# NOZZ L.W.N.	LEVEL SWITCH
D2	1	3"-150# NOZZ L.W.N.	SPARE W/ BLIND
K	1	3"-150# NOZZ L.W.N.	LEVEL INST.
J	1	4"-150# NOZZ SO.	N2 BLANKET
M	1	3" 150# NOZZ. L.W.N.	LEVEL SWITCH

WELD NOTES

CS - TO CS	MG-1D	R-70 WIRE
" "	M18	E 7018 STICK
" "	SA1-70	L-50 WIRE 860 FLUX

NOZZLE FLANGE DIMENSIONS TO CONFORM TO 150# ANSI SLIP ON FLG STDS. BOLT HOLES TO STRADDLE €'s PARALLEL TO PRINCIPAL VESSEL €'s

SPARE PARTS LIST

(2) 1/8" x 28 1/4" O.D. x 24" I.D. GASKET
(2) 1/8" x 5 3/8" O.D. x 3 1/2" I.D. GASKET

CERTIFIED FOR CONSTRUCTION SUPERIOR WELDING COMPANY
DATE - 5-20-88
APPV'D - RB

NOTES FOR SHIPPING COVERS

6" NOZZ. TO HAVE 1/4" R SHIPPING COVER W/ (3) BOLTS & RUBBER GASKETS
3" & 4" NOZZ'S. TO HAVE 150# BLD. FLG'S. W/ (2) BOLTS EA. & RUBBER GASKETS.

VESSEL SPECIFICATIONS

CONSTRUCTION: CODE - ASME SECT. VIII DIV. I 1986 EDIT. 12-31-86 ADD.

DESIGN CONDITIONS: SHELL / JACKET, COIL OR TUBE

PRESS. & TEMP. F.V. & 150 PSIG @ -20°F TO 520°F

TEST - HYDROSTATIC HORIZ. @ 245 PSIG

MATERIAL

SHELL: SA-516-70
HEADS: SA-516-70
JACKET SHELL:
JACKET HEADS:
SHELL NOZZLES: NECKS SA-106-B — FLANGES SA-105
JACKET NOZZLES: NECKS — FLANGES
COILS:
BOLTING: SA-193-B7 W/ SA-194-2H NUTS SHIPPING: CS
RE-PADS: SA-516-70 — LIFT LUGS: SA-516-70
GASKETS: JM-60 SHIPPING GSKTS.: RUBBER
SUPPORTS: SA-36
CODE INSPECTION & STAMP: ASME BY LUMBERMENS MUTUAL CASUALTY CO.
INSPECTION - OTHER - BY CUSTOMER
RADIOGRAPH: HEAD TO SHELL - PER UW-11(a)(5)(b) SPOT X-RAY — THERMAL TREATMENT NOT REQ'D.
CORR. ALLOW: TOP HD & SHELL: 0.125" BTM HD.: 0.25" — SANDBLAST: NOT REQ'D.
PAINT: NOT REQ'D.
WORKING VOLUME: 10000 GAL.
WEIGHT: EMPTY = 34549 LBS. FULL OF H2O = 135507 LBS. VOL. = 12115 GAL.
REFERENCE DWG. & SPECS: DOW CORNING DATA SHTS. M800-V007 SHT 1 & 2, SPEC. NO. 2149 REV. 1, SK. NO. M800-19875 & 6
REFERENCE ORDER: 132610
ITEM: # 19785
PROJECT 107021
REF. DWG L88-0054-C — NO. REQ'D (1)

NO.	REVISIONS	DATE
1	REV. PER APPL. 5/12/88 CERT. FOR CONST.	5-11-88

SUPERIOR WELDING COMPANY
DECATUR, ILLINOIS

JOB NO. C88-0054-01
DWG. L88-0054-C

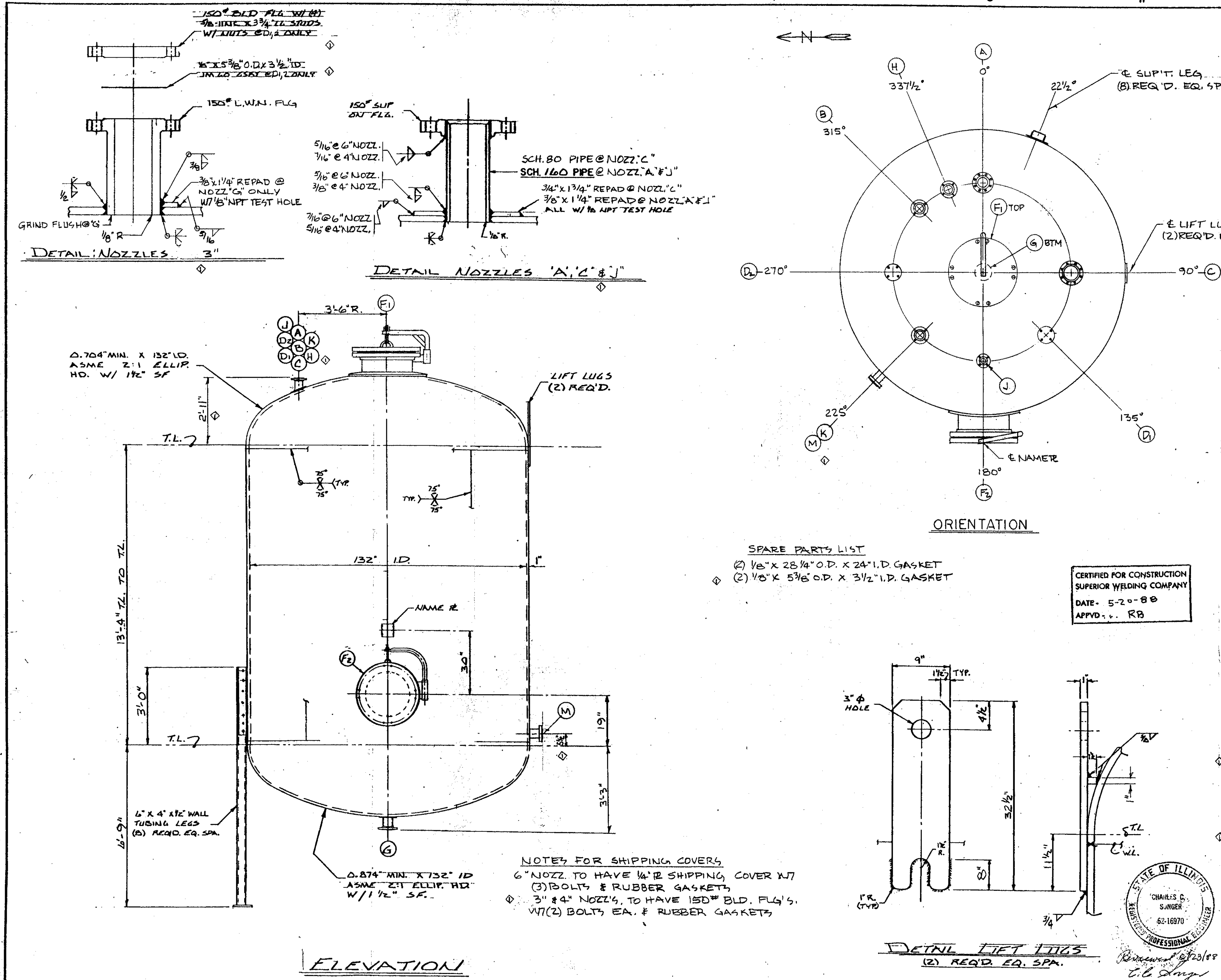
CHARLES C. SUNGER 62-16970 STATE OF ILLINOIS REGISTERED PROFESSIONAL ENGINEER

Reviewed 6/23/89 CC Sungr

REV. PER APPL. DWG. 5/11/88 CERT. FOR CONST.

DESIGNED BY / DATE
DRAWN BY / DATE
CHECKED BY / DATE
APPROVED BY / DATE

DOW CORNING CORPORATION
MIDLAND PLANT TANK FARM
WASTE IPA/SILOXANE STORAGE TANK
SCALE — DRAWING NUMBER 71485



NOTES FOR SHIPPING COVERS
6" NOZZ. TO HAVE 1/4" PL SHIPPING COVER W/ (3) BOLTS & RUBBER GASKETS
3" & 4" NOZZ'S. TO HAVE 150# BLD. FLG'S. W/ (2) BOLTS EA. & RUBBER GASKETS

SPARE PARTS LIST
(2) 1/8" x 28 1/4" O.D. x 24" I.D. GASKET
(2) 1/8" x 5 3/16" O.D. x 3 1/2" I.D. GASKET

CERTIFIED FOR CONSTRUCTION SUPERIOR WELDING COMPANY
DATE - 5-20-88
APPVD. - RB

FITTING SCHEDULE

MK	NO. REQ'D	DESCRIPTION	REMARKS
A	1	4"-150# NOZZ. SO	INLET
B	1	3"-150# NOZZ. L.W.N.	RECIRC.
C	1	6" 150# NOZZ. SO	RELIEF
D1	1	3"-150# NOZZ. L.W.N.	SPARE W/ BLIND
E			
F2	2	24" 150# NOZZ SO	MANWAY
G	1	3" 150# NOZZ L.W.N.	OUTLET
H	1	3" 150# NOZZ L.W.N.	LEVEL SWITCH
D2	1	3"-150# NOZZ L.W.N.	SPARE W/ BLIND
K	1	3"-150# NOZZ L.W.N.	LEVEL INST.
J	1	4"-150# NOZZ S.O.	N2 BLANKET
M	1	3" 150# NOZZ. L.W.N.	LEVEL SWITCH

WELD NOTES

CS - TO CS		MG-1D	R-70 WIRE
"	"	M1B	E 7018 STICK
"	"	SA1-70	L-50 WIRE 860 FLUX

NOZZLE FLANGE DIMENSIONS TO CONFORM TO 150# ANSI SLIP ON FLG STDS. BOLT HOLES TO STRADDLE ℄'s PARALLEL TO PRINCIPAL VESSEL ℄'s

VESSEL SPECIFICATIONS

CONSTRUCTION: CODE - ASME SECT. VIII DIV. I 1986 EDIT. 12-31-86 ADD.

DESIGN CONDITIONS:	SHELL	JACKET, COIL OR TUBE
PRESS. & TEMP.	F.V. & 150 PSIG @ -20°F TO 520°F	
TEST - HYDROSTATIC	HORIZ. @ 245 PSIG	

MATERIAL

SHELL: SA-516-70
HEADS: SA-516-70
JACKET SHELL:
JACKET HEADS:
SHELL NOZZLES: NECKS SA-106-B — FLANGES SA-105
JACKET NOZZLES: NECKS — FLANGES
COILS:
BOLTING: SA-193-B7 W/ SA-194-2H NUTS — SHIPPING: CS
RE-PADS: SA-516-70 — LIFT LUGS: SA-516-70
GASKETS: JM-60 — SHIPPING GSKTS.: RUBBER
SUPPORTS: SA-36
CODE INSPECTION & STAMP: ASME BY LUMBERMENS MUTUAL CASUALTY CO.
INSPECTION - OTHER - BY CUSTOMER
RADIOGRAPH: HEAD TO SHELL PER UW-11(a)(5)(b) SPOT X-RAY — THERMAL TREATMENT: NOT REQ'D.
CORR. ALLOW.: TOP HD & SHELL: 0.125" BTM. HD.: 0.25" — SANDBLAST: NOT REQ'D.
PAINT: NOT REQ'D.
WORKING VOLUME: 10000 GAL.
WEIGHT: EMPTY - 34549 LBS — FULL OF H_2O - 135507 LBS. VOL. - 12115 GAL.
REFERENCE DWG. & SPECS: DOW CORNING DATA SHTS. M800-V002 SHT 1 & 2, SPEC. NO. 2149 REV. 1, SK. NO. M800-19875 #6
REFERENCE ORDER: 132610
ITEM: # 19786
PROJECT 107021
REF. DWG L88-0054-C — NO. REQ'D. (1)

NO.	REVISIONS	DATE
1	REV. PER APPL 5/2/88, CERT. FOR CONST.	5-11-88

SUPERIOR WELDING COMPANY
DECATUR, ILLINOIS

JOB NO 05-88-0054-02
DWG. L88-0054-B
REV.

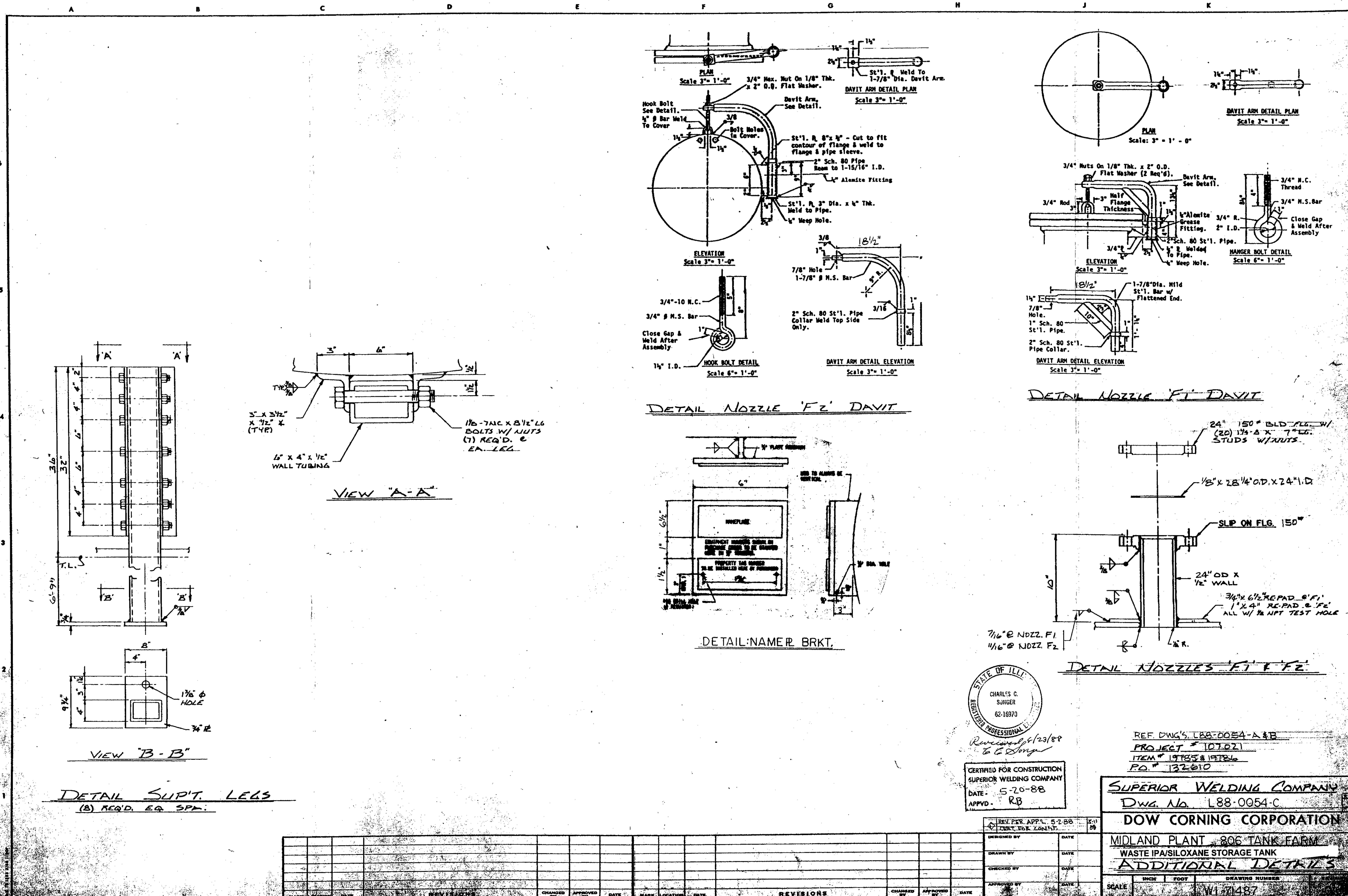
STATE OF ILLINOIS — REGISTERED PROFESSIONAL ENGINEER — CHARLES G. SANGER 62-16970
Reviewed 5/23/88 C.E. Sanger

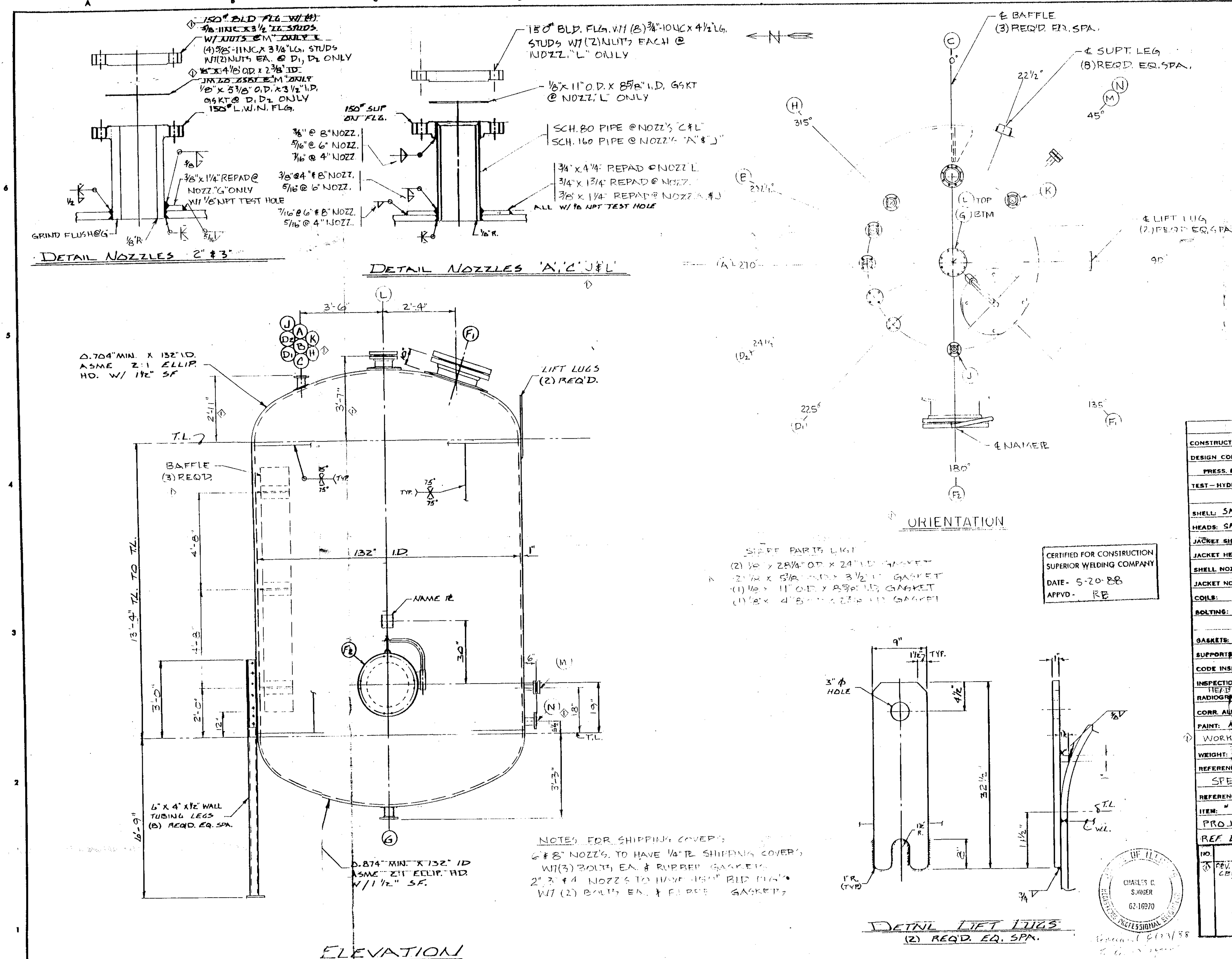
MARK | LOCATION | DATE | REVISIONS | CHANGED BY | APPROVED BY | DATE
DESIGNED BY | DRAWN BY | CHECKED BY | APPROVED BY | DATE

DOW CORNING CORPORATION

MIDLAND PLANT 806 TANK FARM
WASTE IPA/SILOXANE STORAGE TANK

SCALE | INCH | FOOT | DRAWING NUMBER W1-71486 | REVISION 0


DETAIL SUP'T. LEGS
(8) REQ'D. EQ. SPA.
VIEW "B-B"
1 3/16" ϕ HOLE
3/4" ℞
VIEW "A-A"
3" x 3 1/2" x 1/2" ∠ (TYP)
6" x 4" x 1/2" WALL TUBING
1 1/8-7NC x 8 1/2" LG BOLTS W/ NUTS (7) REQ'D. @ EA. LEG
PLAN Scale 3"= 1'-0"
3/4" Hex. Nut On 1/8" Thk. x 2" O.D. Flat Washer.
St'l. ℞ Weld To 1-7/8" Dia. Davit Arm.
DAVIT ARM DETAIL PLAN Scale 3"= 1'-0"
Hook Bolt See Detail.
3/4" ϕ Bar Weld To Cover
Davit Arm, See Detail.
Bolt Holes in Cover.
St'l. ℞ 8"x 3/8" - Cut to fit contour of flange & weld to flange & pipe sleeve.
2" Sch. 80 Pipe Ream to 1-15/16" I.D.
1/4" Alemite Fitting
St'l. ℞ 3" Dia. x 1/4" Thk. Weld to Pipe.
1/4" Weep Hole.
ELEVATION Scale 3"= 1'-0"
3/4"-10 N.C.
3/4" ϕ M.S. Bar
Close Gap & Weld After Assembly
1 1/4" I.D.
HOOK BOLT DETAIL Scale 6"= 1'-0"
7/8" Hole
1-7/8" ϕ M.S. Bar
2" Sch. 80 St'l. Pipe Collar Weld Top Side Only.
DAVIT ARM DETAIL ELEVATION Scale 3"= 1'-0"
DETAIL NOZZLE 'F2' DAVIT
PLAN Scale: 3" = 1' - 0"
DAVIT ARM DETAIL PLAN Scale 3"= 1'-0"
3/4" Nuts On 1/8" Thk. x 2" O.D. Flat Washer (2 Req'd).
Davit Arm, See Detail.
3/4" Rod
Half Flange Thickness
1/4" Alemite Grease Fitting.
2" Sch. 80 St'l. Pipe.
1/4" ℞ Welded To Pipe.
1/4" Weep Hole.
ELEVATION Scale 3"= 1'-0"
3/4" N.C. Thread
3/4" M.S. Bar
Close Gap & Weld After Assembly
HANGER BOLT DETAIL Scale 6"= 1'-0"
1-7/8"Dia. Mild St'l. Bar w/ Flattened End.
7/8" Hole.
1" Sch. 80 St'l. Pipe.
2" Sch. 80 St'l. Pipe Collar.
DAVIT ARM DETAIL ELEVATION Scale 3"= 1'-0"
DETAIL NOZZLE 'F1' DAVIT
NAMEPLATE
DETAIL: NAME ℞ BRKT.
24" 150# BLD FLG W/ (20) 1 1/8-8 x 7" LG. STUDS W/NUTS
1/8" x 28 1/4" O.D. x 24" I.D.
SLIP ON FLG. 150#
24" OD x 1/2" WALL
3/4" x 6 1/2" REPAD @ 'F1' 1" x 4" RE-PAD @ 'F2' ALL W/ 1/4 NPT TEST HOLE
7/16" @ NOZZ. F1
11/16" @ NOZZ. F2
DETAIL NOZZLES 'F1' & 'F2'
STATE OF ILLINOIS CHARLES C. SINGER 62-16970 REGISTERED PROFESSIONAL ENGINEER
Reviewed 6/23/88 C.C. Singer
CERTIFIED FOR CONSTRUCTION SUPERIOR WELDING COMPANY DATE 5-20-88 APPVD RB
REF. DWG'S. L88-0054-A & B
PROJECT # 107021
ITEM # 19785 & 19786
P.O. # 132610
SUPERIOR WELDING COMPANY
DWG. NO. L88-0054-C
REV. PER APP'L. 5-2-88 CERT. FOR CONST.
REVISIONS
DOW CORNING CORPORATION
MIDLAND PLANT 806 TANK FARM
WASTE IPA/SILOXANE STORAGE TANK
ADDITIONAL DETAILS
W1-71487



FITTING SCHEDULE

MK	NO. REQ'D	DESCRIPTION	REMARKS
A	1	4"-150# NOZZ. SO	INLET
B	1	3"-150# NOZZ. L.W.N.	RECIRC.
C	1	6"-150# NOZZ. SO	RELIEF
D1	1	3" 150# NOZZ. L.W.N.	SPARE W/ BLIND
E			
F2	2	24" 150# NOZZ SO	MANWAY
G	1	3" 150# NOZZ L.W.N.	OUTLET
H	1	3" 150# NOZZ L.W.N.	LEVEL SWITCH
D2	1	3"-150# NOZZ L.W.N.	SPARE W/ BLIND
K	1	3"-150# NOZZ L.W.N.	LEVEL INST.
J	1	4"-150# NOZZ SO	N2 BLANKET

WELD NOTES

CS - TO CS — MG-ID — R-70 WIRE
" " — MIB — E 7018 STICK
" " — SA1-70 — L-50 WIRE B60 FLUX

-	1	8" 150# NOZZ. SO	AGITATOR W/ BLIND
A	1	2" 150# NOZZ. L.W.N.	SPARE W/ BLIND
H	1	3" 150# NOZZ. L.W.N.	LEVEL SWITCH

NOZZLE FLANGE DIMENSIONS TO CONFORM TO 150# ANSI SLIP ON FLG STDS. BOLT HOLES TO STRADDLE ℄'s PARALLEL TO PRINCIPAL VESSEL ℄'s

VESSEL SPECIFICATIONS

CONSTRUCTION: CODE – ASME SECT. VIII DIV. I 1986 EDIT. 12-31-86 ADD

DESIGN CONDITIONS:	SHELL	JACKET, COIL OR TUBE
PRESS. & TEMP.	F.V. & 150 PSIG @ -20°F TO 520°F	
TEST – HYDROSTATIC	HORIZ. @ 245 PSIG	

MATERIAL

SHELL: SA-516-70
HEADS: SA-516-70
JACKET SHELL:
JACKET HEADS:
SHELL NOZZLES: NECKS SA-106-B — FLANGES SA-105
JACKET NOZZLES: NECKS — FLANGES
COILS:
BOLTING: SA-193-B7 W/ SA-194-2H NUTS SHIPPING: CS
RE-PADS: SA-516-70 — LIFT LUGS: SA-516-70
GASKETS: JM-60 SHIPPING GSKTS.: RUBBER
SUPPORTS: SA-36
CODE INSPECTION & STAMP: ASME BY LUMBERMENS MUTUAL CASUALTY CO.
INSPECTION – OTHER – BY CUSTOMER
RADIOGRAPH: SPOT X-RAY — THERMAL TREATMENT NOT REQ'D.
CORR. ALLOW: TOP HD & SHELL: 0.125" BTM HD.: 0.25" — SANDBLAST: NOT REQ'D.
PAINT: NOT REQ'D.
WORKING VOLUME: 10000 GAL.
WEIGHT: EMPTY = 36016 LBS FULL OF H_2O = 137034 LBS VOL. = 12115 GAL
REFERENCE DWG. & SPECS.: DOW CORNING DATA SHTS. M800-V001 SHT 1 & 2
SPEC. 2149 REV. 1 SK. NO. M800-19781 THRU 4
REFERENCE ORDER: 132610
ITEM: # 19781
PROJECT 10721
REF DWG L88-0035-E — NO. REQ'D. (1)

NO.	REVISIONS	DATE
1	REV. PER APP'L 5/2/88 CERT FOR CONST.	5-11-88

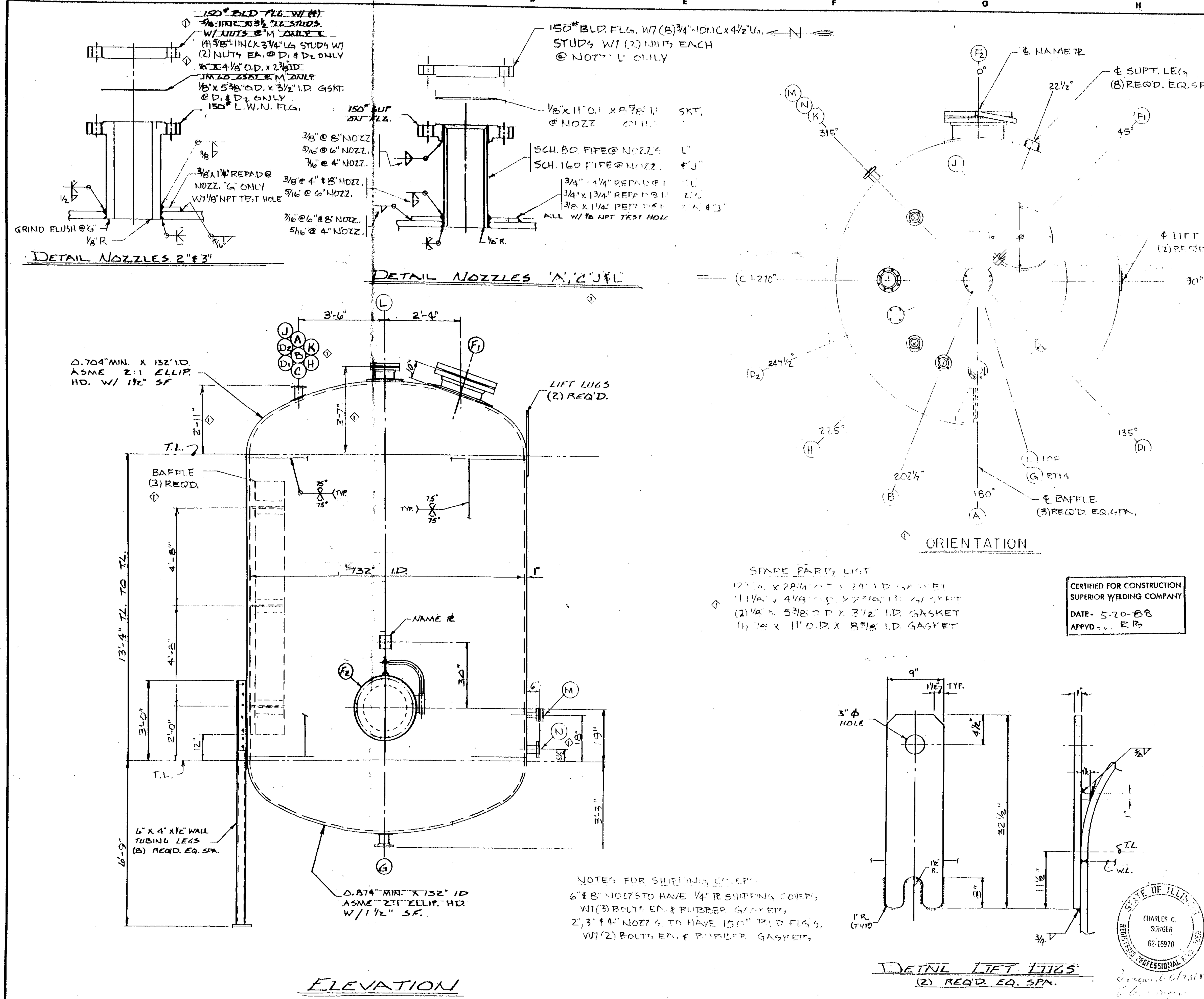
SUPERIOR WELDING COMPANY
DECATUR, ILLINOIS

JOB NO. 05-88-0055-01
DWG. L88-0055-A
REV. 1

DOW CORNING CORPORATION

MIDLAND PLANT 806 TANK FARM
WASTE SOLVENT STORAGE TANK

SCALE	INCH	FOOT	DRAWING NUMBER	REVISION
			WI-71488	0



FITTING SCHEDULE

MK	NO. REQ'D	DESCRIPTION	REMARKS
A	1	4"-150# NOZZ. SO	INLET
B	1	3"-150# NOZZ. L.W.N.	RECIRC.
C	1	6"-150# NOZZ. SO	RELIEF
D1	1	3" 150# NOZZ. L.W.N.	SPARE W/ BLIND
E			
F1, F2	2	24" 150# NOZZ SO	MANWAY
G	1	3" 150# NOZZ L.W.N.	OUTLET
H	1	3" 150# NOZZ L.W.N.	LEVEL SWITCH
D2	1	3"-150# NOZZ L.W.N.	SPARE W/ BLIND
K	1	3"-150# NOZZ L.W.N.	LEVEL INST.
J	1	4"-150# NOZZ S.O.	N2 BLANKET

WELD NOTES

CS-TO CS	MG-ID	R-70 WIRE
" "	MIB	E 7018 STICK
" "	SAI-70	L-50 WIRE 860 FLUX

L	1	8" 150# NOZZ. S.O.	AGITATOR W/ BLIND
M	1	2" 150# NOZZ. L.W.N.	SPARE W/ BLIND
N	1	3" 150# NOZZ. L.W.N.	LEVEL SWITCH

NOZZLE FLANGE DIMENSIONS TO CONFORM TO 150# ANSI SLIP ON FLG STDS. BOLT HOLES TO STRADDLE ℄'s PARALLEL TO PRINCIPAL VESSEL ℄'s

VESSEL SPECIFICATIONS

CONSTRUCTION: CODE- ASME SECT. VIII DIV. I 1986 EDIT. 12-31-86 ADD.

DESIGN CONDITIONS:	SHELL	JACKET, COIL OR TUBE
PRESS. & TEMP. F.V. & 150 PSIG @ -20°F TO 520°F		
TEST—HYDROSTATIC HORIZ. @ 245 PSIG		

MATERIAL

SHELL: SA-516-70
HEADS: SA-516-70
JACKET SHELL:
JACKET HEADS:
SHELL NOZZLES: NECKS SA-106-B — FLANGES SA-105
JACKET NOZZLES: NECKS — FLANGES
COILS:
BOLTING: SA-193-B7 W/ SA-194-2H NUTS SHIPPING: CS
RE-PADS: SA-516-70 LIFT LUGS: SA-516-70
GASKETS: JM-60 SHIPPING GSKTS.: RUBBER
SUPPORTS: SA-36
CODE INSPECTION & STAMP: ASME BY LUMBERMENS MUTUAL CASUALTY CO.
INSPECTION—OTHER— BY CUSTOMER
RADIOGRAPH: SPOT X-RAY — THERMAL TREATMENT NOT REQ'D.
CORR. ALLOW: TOP HD & SHELL: 0.125" BTM. HD.: 0.25" — SANDBLAST: NOT REQ'D.
PAINT: NOT REQ'D.
WORKING VOLUME: 10000 GAL.
WEIGHT: EMPTY= 36016 LBS FULL OF H2O= 137034 LBS VOL= 12115 GAL
REFERENCE DWG. & SPECS: DOW CORNING DATA SHTS. M800-V001 SHT. 1 & 2
SPEC. 2149 REV. 1 SK. NO. M800-19781 THRU 4
REFERENCE ORDER: 132610
ITEM: # 19782
PROJECT 10721
REF. DWG L88-0055-E — NO. REQ'D. (1)

NO.	REVISIONS	DATE
1	REV. PER APPL. DATED 5/13/88 CERT. FOR CONST.	

SUPERIOR WELDING COMPANY
DECATUR, ILLINOIS

JOB NO. 05-88-0055-02 — REV. 1
DWG L88-0055-B

DOW CORNING CORPORATION

MIDLAND PLANT 806 TANK FARM
WASTE SOLVENT STORAGE TANK

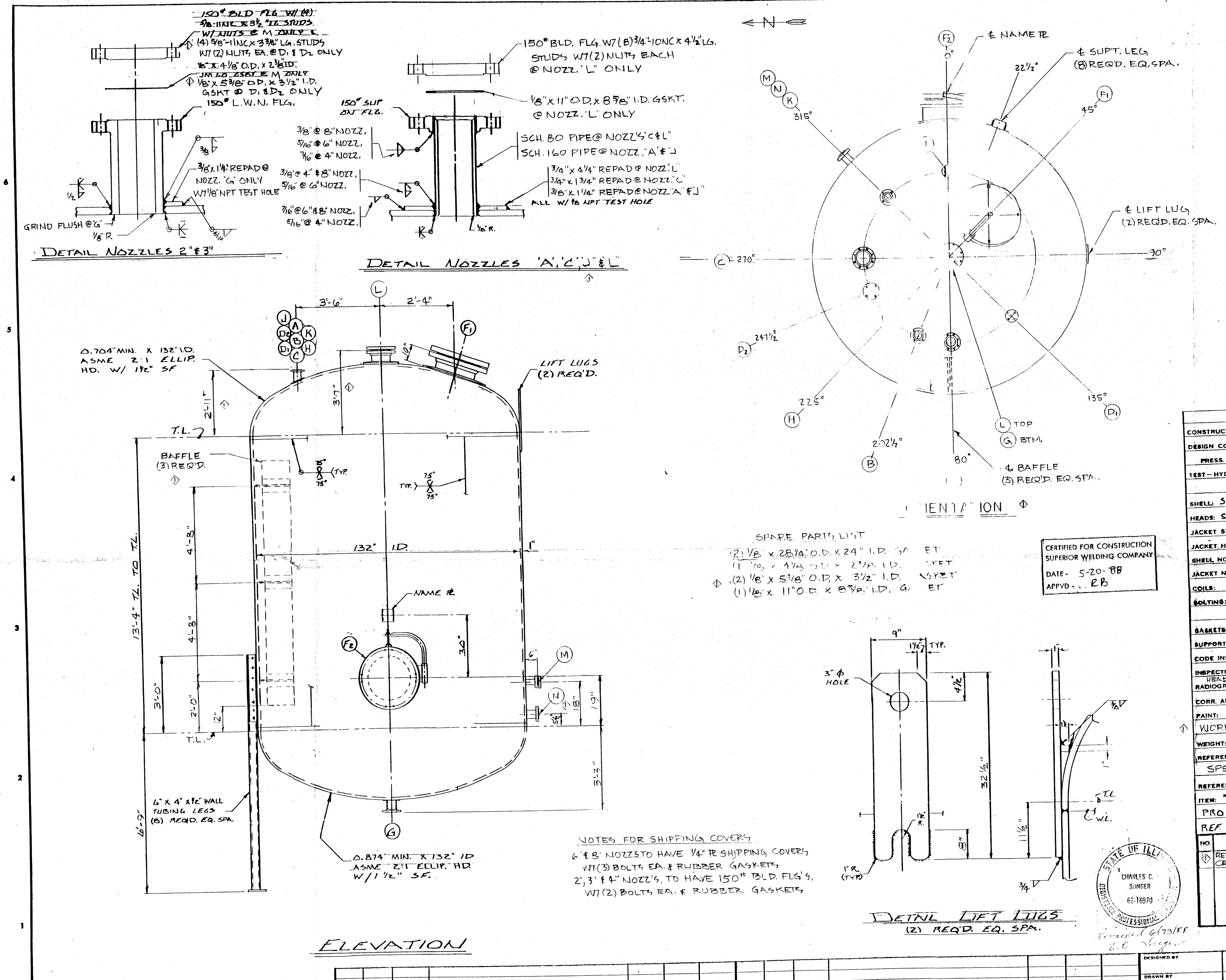
SCALE	INCH	FOOT	DRAWING NUMBER	REVISION
			WI-71489	0

MARK	LOCATION	DATE	REVISIONS	CHANGED BY	APPROVED BY	DATE	MARK	LOCATION	DATE	REVISIONS	CHANGED BY	APPROVED BY	DATE

DESIGNED BY — DATE
DRAWN BY — DATE
CHECKED BY — DATE
APPROVED BY — DATE

03/24/99

03/24/99



FITTING SCHEDULE

MK	NO. REQ'D	DESCRIPTION	REMARKS
A	1	4"-150# NOZZ. S.O.	INLET
B	1	3"-150# NOZZ. L.W.N.	RECIRC.
C	1	6"-150# NOZZ. S.O.	RELIEF
D1	1	3"-150# NOZZ. L.W.N.	SPARE W/ BLIND
E			
F2	2	24" 150# NOZZ S.O.	MANWAY
G	1	3" 150# NOZZ L.W.N.	OUTLET
H	1	3" 150# NOZZ L.W.N.	LEVEL SWITCH
D2	1	3"-150# NOZZ L.W.N.	SPARE W/ BLIND
K	1	3"-150# NOZZ L.W.N.	LEVEL INST.
J	1	4"-150# NOZZ S.O.	N2 BLANKET

WELD NOTES

CS-TO CS — MG-1D — R-70 WIRE
" " — MIB — E 7018 STICK
" " — SAI-70 — L-50 WIRE 860 FLUX

L	1	8" 150# NOZZ. S.O.	AGITATOR W/ BLIND
M	1	2" 150# NOZZ. L.W.N.	SPARE W/ BLIND
N	1	3" 150# NOZZ. L.W.N.	LEVEL SWITCH

NOZZLE FLANGE DIMENSIONS TO CONFORM TO 150# ANSI SLIP ON FLG STDS. BOLT HOLES TO STRADDLE € PARALLEL TO PRINCIPAL VESSEL €

VESSEL SPECIFICATIONS

CONSTRUCTION: CODE - ASME SECT. VIII DIV. I 1986 EDIT. 12-31-86 ADD

DESIGN CONDITIONS: SHELL | JACKET, COIL OR TUBE

PRESS. & TEMP. F.V. & 150 PSIG @ -20°TO 520°F.

TEST - HYDROSTATIC HORIZ. @ 245 PSIG

MATERIAL

SHELL: SA-516-70
HEADS: SA-516-70
JACKET SHELL:
JACKET HEADS:
SHELL NOZZLES: NECKS SA-106-B — FLANGES SA-105
JACKET NOZZLES: NECKS — FLANGES
COILS:
BOLTING: SA-193-B7 W/ SA-194-2H NUTS SHIPPING: CS
RE-PADS: SA-516-70 — LIFT LUGS: SA-516-70
GASKETS: JM-60 SHIPPING GSKTS.: RUBBER
SUPPORTS: SA-36
CODE INSPECTION & STAMP: ASME BY LUMBERMENS MUTUAL CASUALTY CO.
INSPECTION - OTHER - BY CUSTOMER
RADIOGRAPH: SPOT X-RAY — THERMAL TREATMENT: NOT REQ'D.
CORR. ALLOW: TOP HD & SHELL: 0.125" BTM. HD.: 0.25" — SANDBLAST: NOT REQ'D.
PAINT: NOT REQ'D.
WORKING VOLUME: 10000 GAL.
WEIGHT: EMPTY = 36276 LBS FULL OF H2O = 137034 LBS VOL = 12115 GAL
REFERENCE DWG. & SPECS: DOW CORNING DATA SHTS. M800-V001 SHT. 1 & 2
SPEC. 2149 REV. 1 SK. NO. M800-19781 THRU 4
REFERENCE ORDER: 132610
ITEM: # 19783
PROJECT 10721
REF DWG L88-0055-E — NO. REQ'D. (1)

NO.	REVISIONS	DATE
1	REV. PER APP'L. 5/2/88 CERT. FOR CONST.	5/11/88

SUPERIOR WELDING COMPANY
DECATUR, ILLINOIS

JOB NO. 05-88-0055-03 — REV. 1
DWG L88-0055-C

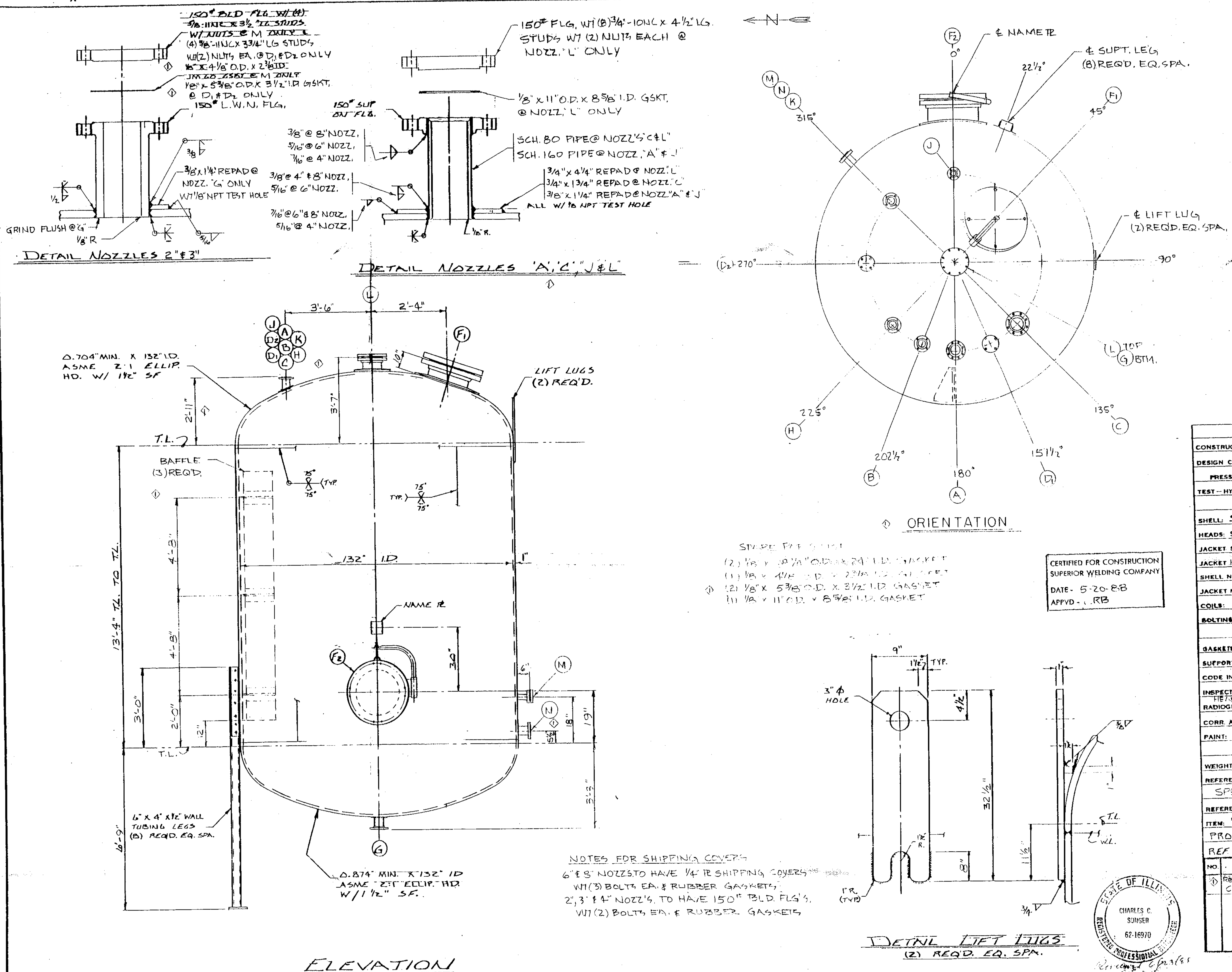
MARK	LOCATION	DATE	REVISIONS	CHANGED BY	APPROVED BY	DATE	MARK	LOCATION	DATE	REVISIONS	CHANGED BY	APPROVED BY	DATE

DESIGNED BY — DATE
DRAWN BY — DATE
CHECKED BY — DATE
APPROVED BY — DATE

DOW CORNING CORPORATION

MIDLAND PLANT 806 TANK FARM
WASTE SOLVENT STORAGE TANK

SCALE	INCH	FOOT	DRAWING NUMBER	REVISION
			W-71490	0



SHIPPING COVERS
(2) 1/8 x 10 3/4" O.D. x 24" I.D. GASKET
(1) 1/8 x 4 1/8 O.D. x 2 3/8 I.D. GASKET
(2) 1/8" x 5 3/8 O.D. x 3 1/2 I.D. GASKET
(1) 1/8 x 11 O.D. x 8 5/8 I.D. GASKET

NOTES FOR SHIPPING COVERS
6" & 8" NOZZS TO HAVE 1/4" PL SHIPPING COVERS W/ (3) BOLTS EA. & RUBBER GASKETS.
2", 3" & 4" NOZZ'S. TO HAVE 150# BLD. FLG'S. W/ (2) BOLTS EA. & RUBBER GASKETS.

CERTIFIED FOR CONSTRUCTION
SUPERIOR WELDING COMPANY
DATE - 5-20-88
APPVD - RB

STATE OF ILLINOIS — CHARLES C. SONSER — 62-16970 — REGISTERED PROFESSIONAL ENGINEER

FITTING SCHEDULE

MK	NO. REQ'D	DESCRIPTION	REMARKS
A	1	4"-150# NOZZ. SO	INLET
B	1	3"-150# NOZZ. L.W.N.	RECIRC.
C	1	6"-150# NOZZ. SO	RELIEF
D1	1	3" 150# NOZZ. L.W.N.	SPARE W/ BLIND
E			
F1, F2	2	24" 150# NOZZ SO	MANWAY
G	1	3" 150# NOZZ L.W.N.	OUTLET
H	1	3" 150# NOZZ L.W.N.	LEVEL SWITCH
D2	1	3"-150# NOZZ L.W.N.	SPARE W/ BLIND
K	1	3"-150# NOZZ L.W.N.	LEVEL INST.
J	1	4"-150# NOZZ S.O.	N_2 BLANKET

WELD NOTES

CS - TO CS	MG-ID	R-70 WIRE
" "	MIB	E 7018 STICK
" "	SA1-70	L-50 WIRE 860 FLUX

MK	NO.	DESCRIPTION	REMARKS
L	1	8" 150# NOZZ. S.O.	AGITATOR W/ BLIND
M	1	2" 150# NOZZ. L.W.N.	SPARE W/ BLIND
N	1	3" 150# NOZZ. L.W.N.	LEVEL SWITCH

NOZZLE FLANGE DIMENSIONS TO CONFORM TO 150# ANSI SLIP ON FLG STDS. BOLT HOLES TO STRADDLE ℄'s PARALLEL TO PRINCIPAL VESSEL ℄'s

VESSEL SPECIFICATIONS

CONSTRUCTION: CODE - ASME SECT. VIII DIV. I 1986 EDIT. 12-31-86 ADD.

DESIGN CONDITIONS: SHELL / JACKET, COIL OR TUBE

PRESS. & TEMP. F.V. & 150 PSIG @ -20°TO 520°F.

TEST - HYDROSTATIC HORIZ. @ 245 PSIG

MATERIAL

SHELL: SA-516-70

HEADS: SA-516-70

JACKET SHELL:

JACKET HEADS:

SHELL NOZZLES: NECKS SA-106-B FLANGES SA-105

JACKET NOZZLES: NECKS FLANGES

COILS:

BOLTING: SA-193-B7 W/ SA-194-2H NUTS SHIPPING: CS

RE-PADS: SA-516-70 LIFT LUGS: SA-516-70

GASKETS: JM-60 SHIPPING GSKTS.: RUBBER

SUPPORTS: SA-36

CODE INSPECTION & STAMP: ASME BY LUMBERMENS MUTUAL CASUALTY CO.

INSPECTION - OTHER - BY CUSTOMER

RADIOGRAPH: SPOT X-RAY THERMAL TREATMENT: NOT REQ'D.

CORR. ALLOW: TOP HD & SHELL: 0.125" BTM. HD.: 0.25" SANDBLAST: NOT REQ'D.

PAINT: NOT REQ'D.

WEIGHT: EMPTY - 36,216 LBS FULL OF H_2O - 137034 LBS VOL. = 12115 GAL

REFERENCE DWG. & SPECS: DOW CORNING DATA SHTS. M800-V001 SHT. 1 & 2, SPEC. 2143 PE/1 S.N. NO. M800-19781 THRU 4

REFERENCE ORDER: 132610

ITEM: # 19704

PROJECT 10721

REF DWG L88-0055-E NO. REQ'D. (1)

NO.	REVISIONS	DATE
1	REISSUED CERT. FOR CONST.	5-12 RB

SUPERIOR WELDING COMPANY
DECATUR, ILLINOIS

JOB NO. 05-88-0055-04
DWG L88-0055-D
REV. 1

DOW CORNING CORPORATION

MIDLAND PLANT - 806 TANK FARM
WASTE SOLVENT STORAGE TANK

SCALE | DRAWING NUMBER WI-71491 | REVISION 0

03/24/99

** PROPRIETARY ** CADD

LINE NUMBER SCHEDULE			FLANGE NUMBER SCHEDULE		
FROM	TO	LAST NUMBER USED	FROM	TO	LAST NUMBER USED
001	030	028	001	099	022

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
H	GEN	10-24-94	ADDED FALNGE NUMBERS AND SCHEDULE	MRN	MET	10-24-94
J	GEN	10-29-96	ADDED ACTUATORS TO PLUG VALVES 3 & 9	JAM	DLW	10-29-96
K	GEN	14OCT98	FIELD REVISIONS	RDR	SVP	14OCT98
L	GEN	05NOV98	ADDED ESD TO TSV'S AND PUMPS	DLB	FPY	05NOV98
M	GEN	22JUL99	FIELD REVISIONS	DLB	MDS	22JUL99
N	GEN	29OCT99	ADDED SEAL POTS/PIPING TO P1-19781/19782	RDR	JLW	29OCT99
P	GEN	05NOV99	ADDED LINE #2"-176-SN2 & HV-13852	RKW	RKW	05NOV99
Q	GEN	9-7-00	REVISED PER PCR 800-99-5	PAP	MRN	9-7-00
R	GEN	25FEB04	REVISE PER HAZOP WALK DOWN	RLB	MGS	25FEB04
S	GEN	12JAN09	REVISED PER HAZOP WALKDOWN	LCA	MGS	12JAN09
T						
E	GEN	6-30-94	800 BLOCK HAZOP AS-BUILT REVISIONS	KDM	KDM	6-30-94
F	GEN	8-19-94	REVISED VALVE NUMBERS TO DATE	MRN	MET	8-19-94
G	GEN	9-22-94	REVISED VALVE NUMBERS TO DATE	MRN	MET	9-22-94

DESIGNED	C.G.ROWE	DATE 11-19-87
DRAWN	S.UDELL	DATE 11-23-87
CHECKED	SBR/TSW	DATE 02-26-88
APPROVED	S.B.ROELOFS	DATE 03-04-88

DOW CORNING CORPORATION

MIDLAND PLT — 806 TANK FARM

WASTE SOLVENT STORAGE

P&ID — SHEET 1 OF 6

SCALE	INCH / FOOT	DRAWING NUMBER	REVISION
	NONE	W1-60789	S

NOTES:

1. ALL ALARMS ON W1-60789 TO W1-60791 ARE ECHOED UX-39B,A HORN IN THE FIELD CONTROLLER'S OFFICE AREA.
2. ALL "TSV" FIRE SHUTOFF VALVES ON W1-60789 TO W1-60791 WILL HAVE NITROGEN SUPPLIED BY A DEDICATED NITROGEN HEADER, AND CAN BE CLOSED BY A SINGLE VALVE ON THAT HEADER OR ESD SOLENOID XY-112.
3. THESE VALVES WILL CLOSE AND PUMPS WILL SHUT DOWN WHEN ESD BUTTON HS-18A OR HS-18B IS PRESSED.
4. WET TEST WELL FOR LEVEL SWITCH HIGH HIGH.

01-04-2010

LINE NUMBER SCHEDULE			FLANGE NUMBER SCHEDULE		
FROM	TO	LAST NUMBER USED	FROM	TO	LAST NUMBER USED
031	060	060	100	199	132

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
H	GEN	10-24-94	ADDED FLANGE NUMBERS AND SCHEDULE	MRN	MET	10-24-94
J	GEN	10-29-96	ADDED ACTUATORS TO PLUG VALVES 15 & 21	JAM	DLW	10-29-96
K	GEN	15OCT98	FIELD REVISIONS	DLB	CVP	15OCT98
L	GEN	05NOV98	ADDED ESD TO TSV'S AND PUMPS	DLB	FPY	05NOV98
M	GEN	20OCT99	AS BUILT REVISIONS	JDW	MGS	20OCT99
N	GEN	29OCT99	ADDED SEAL POT/PIPING TO P1-19783/4	RDR	JLW	29OCT99
P	GEN	07SEP00	REVISED PER PCR 800-99-5	PAP	MRN	07SEP00

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
Q	GEN	26FEB04	REVISE PER HAZOP WALK DOWN	RLB	MGS	26FEB04
R	GEN	12JAN08	REVISED PER HAZOP WALKDOWN	LCA	MGS	12JAN08
S						
D	GEN	2-3-92	ADDED VALVE NUMBERS	HAD	JRH	2-92
E	GEN	6-30-94	800 BLOCK HAZOP AS-BUILT REVISIONS	KDM	KDM	6-30-94
F	B-5 F-5	7-25-94	CHANGED EQID #'S ON N2 REGS & RELIEF VALVES	MRN	JAW	7-25-94
G	GEN	8-19-94	REVISED VALVE NUMBERS TO DATE	MRN	MET	8-19-94

DESIGNED	C.G.ROWE	DATE	11-19-87
DRAWN	S.UDELL	DATE	11-23-87
CHECKED	SBR/TSW	DATE	02-26-88
APPROVED	S.B.ROELOFS	DATE	03-04-88

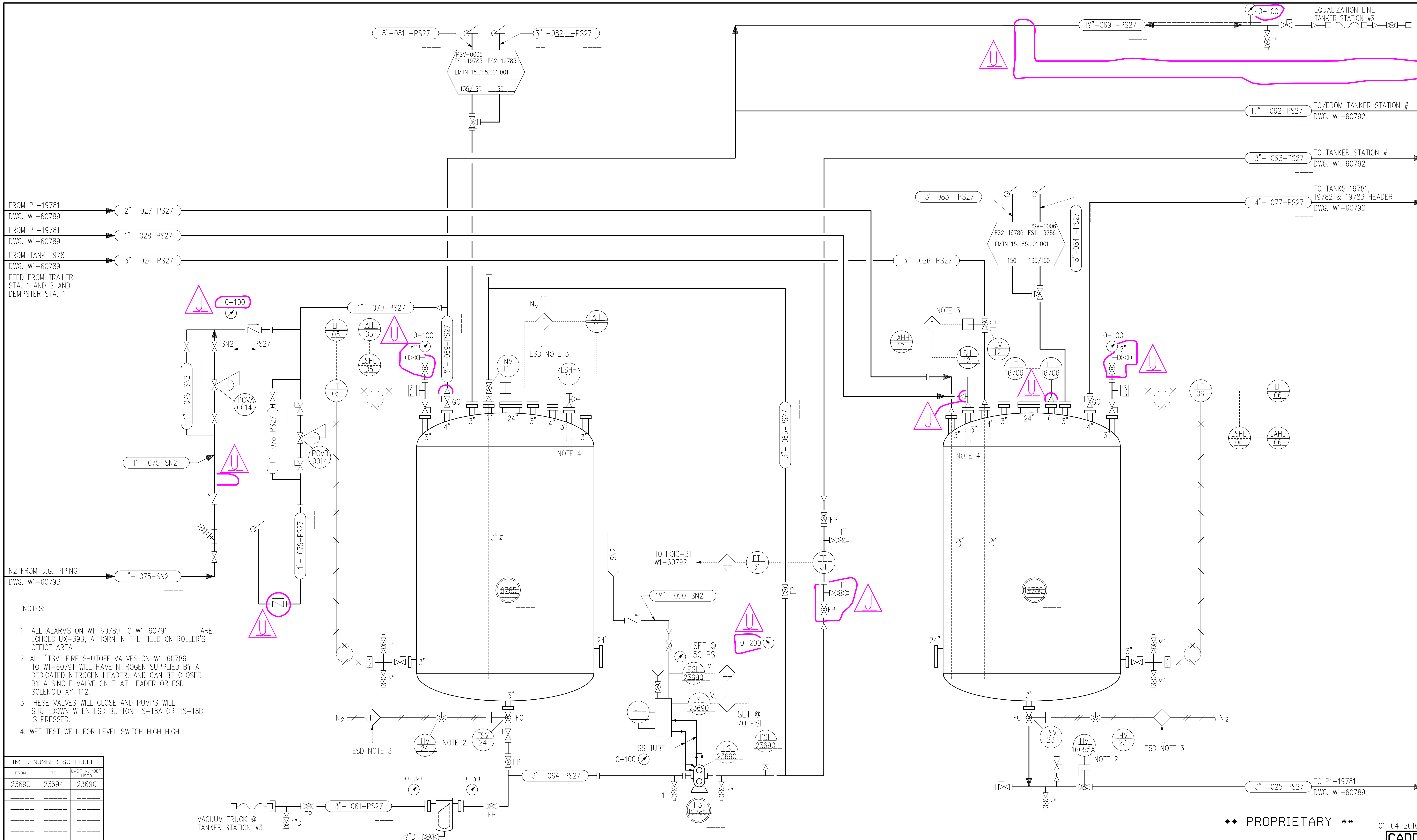
DOW CORNING CORPORATION

MIDLAND PLT — 806 TANK FARM

WASTE SOLVENT STORAGE

P&ID — SHEET 2 OF 6

SCALE INCH	SCALE FOOT	DRAWING NUMBER	REVISION
NONE		W1-60790	R



NOTES:

1. ALL ALARMS ON W1-60789 TO W1-60791 ARE ECHOED UX-39B, A HORN IN THE FIELD CNTROLLER'S OFFICE AREA
2. ALL "TSV" FIRE SHUTOFF VALVES ON W1-60789 TO W1-60791 WILL HAVE NITROGEN SUPPLIED BY A DEDICATED NITROGEN HEADER, AND CAN BE CLOSED BY A SINGLE VALVE ON THAT HEADER OR ESD SOLENOID XY-112.
3. THESE VALVES WILL CLOSE AND PUMPS WILL SHUT DOWN WHEN ESD BUTTON HS-18A OR HS-18B IS PRESSED.
4. WET TEST WELL FOR LEVEL SWITCH HIGH HIGH.

INST. NUMBER SCHEDULE

FROM	TO	LAST NUMBER USED
23690	23694	23690

LINE NUMBER SCHEDULE

FROM	TO	LAST NUMBER USED
061	090	090

FLANGE NUMBER SCHEDULE

FROM	TO	LAST NUMBER USED
200	299	220

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
H	GEN	8-19-94	REVISED VALVE NUMBERS TO DATE	MRN	MET	8-19-94
J	GEN	10-25-94	ADDED FLANGE NUMBERS AND SCHEDULE	MRN	MET	10-25-94
K	D-5	04-23-96	REPLACED CHECK VALVE W/ SHUT OFF VALVE	JKL	SWN	04-23-96
L	GEN	15OCT98	FIELD REVISIONS	DLB	CVP	15OCT98
M	GEN	05NOV98	ADDED ESD TO PUMPS AND TSV'S	DLB	FPY	05NOV98
N	GEN	17DEC98	ADDED LINE 089 TO DRAWING	WRL	JEH	17DEC98
P	J-5	21JAN99	REVISED VALVE PER AS-BUILT	WRL	GMP	21JAN99
Q	GEN	9-06-00	REVISED PER PCR 800-99-5	PAP	MRN	9-06-00
R	GEN	8-27-03	REMOVED LINES, PUMP AND RESERVOIR REVISED FOR TEMPORARY PCR	CAF	MGS	8-27-03
S	GEN	07JAN04	REVISED/ADDED EQUALIZATION LINES	RFP	ABK	03MAR04
T	E-1	16NOV05	REPLACED P3-19785 PER PCR#806-06-01	TAK	LES	14JUN06
U	GEN	12JAN09	REVISED PER HAZOP WALKDOWN	LCA	MGS	12JAN09
V						

** PROPRIETARY **

01-04-2010

CADD

DESIGNED C.G.ROWE	DATE 11-19-87		
DRAWN S.UDELL	DATE 11-23-87		
CHECKED SBR/TSW	DATE 02-26-88		
APPROVED S.B.ROELOFS	DATE 03-04-88		

DOW CORNING CORPORATION

MIDLAND PLT — 806 TANK FARM

WASTE IPA/SILOXANE STORAGE

P&ID — SHEET 3 OF 6

SCALE	INCH	FOOT	DRAWING NUMBER	REVISION
	NONE		W1-60791	U

3. THESE VALVES WILL CLOSE WHEN ESD BUTTON HS-18A OR HS-18B IS PRESSED

P1 19789 DQ UNLOADING PUMP

19788

19790 STRAINERS

P2 19789 UNLOADING PUMP

01-04-2010

** PROPRIETARY **

CADD

LINE NUMBER SCHEDULE			FLANGE NUMBER SCHEDULE		
FROM	TO	LAST NUMBER USED	FROM	TO	LAST NUMBER USED
091	120	119	300	399	328

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
H	GEN	10-25-94	ADDED FLANGE NUMBERS AND SCHEDULE	MRN	MET	10-25-94
J	GEN	10-29-96	ADDED ACTUATORS TO PLUG VALVES 56 & 57	JAM	DLW	10-29-96
K	GEN	14OCT98	FIELD REVISIONS	RDR	SVP	14OCT98
L	GEN	05NOV99	REVISED LINES #056,99,103,112,100 & 119	RKW	MGS	05NOV99
M	GEN	07SEP00	REVISED PER PCR 800-99-5	PAP	MRN	07SEP00
N	GEN	09JAN04	ADDED/REVISED EQUALIZATION LINES	RFP	ABK	03MAR04
P	GEN	12JAN09	REVISED PER HAZOP WALKDOWN	LCA	MGS	12JAN09
Q						
B	D,J-2	5-3-89	ADDED P1,P2-19789	MOQUIN	SBR	5-3-89
C	GEN	3-16-90	ADDED EQUALIZATION LINE (1?"-056)	HAD	JJ	3-90
D	GEN	2-4-92	ADDED VALVE NUMBERS	HAD	JRH	2-92
E	GEN	6-30-94	800 BLOCK HAZOP AS-BUILT REVISIONS	KDM	KDM	6-30-94
F	GEN	8-19-94	REVISED VALVE NUMBERS TO DATE	MRN	MET	8-19-94
G	GEN	9-22-94	REVISED VALVE NUMBERS TO DATE	MRN	MET	9-22-94

DESIGNED	C.G.ROWE	DATE 11-19-87
DRAWN	T.A.KAMINSKI	DATE 11-24-87
CHECKED	SBR/TSW	DATE 02-26-88
APPROVED	S.B.ROELOFS	DATE 03-04-88

DOW CORNING CORPORATION

MIDLAND PLT — 806 TANK FARM

WASTE SOLVENT TRAILER LOADING/UNLOADING STATION

P&ID — SHEET 4 OF 6

SCALE	INCH	FOOT	DRAWING NUMBER	REVISION
	NONE		W1-60792	P

2. ALL "TSV" FIRE SHUTOFF VALVES ON W1-60789 TO W1-60791 WILL HAVE NITROGEN SUPPLIED BY A DEDICATED NITROGEN HEADER, AND CAN BE CLOSED BY A SINGLE VALVE ON THAT HEADER

3. THESE VALVES WILL CLOSE WHEN ESD BUTTON HS-18A OR HS-18B IS PRESSED

LINE NUMBER SCHEDULE			FLANGE NUMBER SCHEDULE		
FROM	TO	LAST NUMBER USED	FROM	TO	LAST NUMBER USED
121	130	130	400	499	406
176	195	184			

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
H	GEN	07SEP00	REVISED PER PCR 800-99-5	PAP	MRN	07SEP00
J	GEN	28AUG03	REMOVED LINES 62, 121, 122 AND 123	CAF	MGS	27AUG03
K	GEN	02MAR04	REVISE PER HAZOP WALK DOWN	RLB	MGS	02MAR04
L	GEN	14JAN09	REVISED PER HAZOP WALKDOWN	LCA	MGS	14JAN09
M						
N						
P						

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
A			ISSUED FOR CONSTRUCTION		SBR	3-25-88
B	K-6	10-4-91	ADDED LINE FOR EQUIP # 197840	HAD	JRH	10-4-91
C	GEN	2-5-92	ADDED VALVE NUMBERS	HAD	JRH	2-92
D	GEN	9-22-94	REVISED VALVES AND VALVE NUMBERS TO DATE	MRN	MET	9-22-94
E	GEN	10-25-94	ADDED FLANGE NUMBERS AND SCHEDULE	MRN	MET	10-25-94
F	GEN	15OCT98	FIELD REVISIONS	DLB	CVP	15OCT98
G	GEN	03NOV99	FIELD REVISIONS AND ADDED LINE #176	JDW	MGS	03NOV99

04JAN2010

** PROPRIETARY ** CADD

DESIGNED	C.G. ROWE	DATE 11-23-87
DRAWN	PW NELSON	DATE 11-23-87
CHECKED	SBR/TSW	DATE 02-26-88
APPROVED	S.B.ROELOFS	DATE 03-04-88

DOW CORNING CORPORATION

WASTE CONTROL — 806 TANK FARM

NITROGEN DISTRIBUTION

P&ID — SHEET 5 OF 6

SCALE (INCH / FOOT)	DRAWING NUMBER	REVISION
NONE	W1-60793	L

01-04-2010

** PROPRIETARY ** CADD

LINE NUMBER SCHEDULE			FLANGE NUMBER SCHEDULE		
FROM	TO	LAST NUMBER USED	FROM	TO	LAST NUMBER USED
131	160	155	500	599	511

MARK	LOCATION	DATE	REVISIONS	CHANGED	APPROVED	DATE
H	GEN	9-22-94	REVISED VALVES & VALVE NUMBERS TO DATE	MRN	MET	9-22-94
J	GEN	10-25-94	ADDED FLANGE NUMBERS AND SCHEDULE	MRN	MET	10-25-94
K	G-3	12-24-97	ADDED DURA CIRULATOR PUMP & COOLER COIL	WRL	DLW	12-24-97
L	GEN	14OCT98	FIELD REVISIONS	RDR	CVP	14OCT98
M	GEN	07SEP00	REVISED PER PCR 800-99-5	PAP	MRN	07SEP00
N	GEN	08AUG03	REMOVED LINES AND PUMP P2-19785	CAF	MGS	27AUG03
P	GEN	02MAR04	REVISE PER HAZOP WALK DOWN	RLB	MGS	02MAR04
Q	GEN	14JAN09	REVISED PER HAZOP WALKDOWN	LCA	MGS	14JAN09
R						
C	G-3	4-2-90	ADDED DRAIN VALVE, AND NOTE	HAD	JMJ	4-90
D	GEN	2-5-92	ADDED VALVE NUMBERS	HAD	JRH	2-92
E	GEN	10-13-92	ADDED LINE #151	KDM	KDM	3-93
F	GEN	6-30-94	800 BLOCK HAZOP AS-BUILT REVISIONS	KDM	KDM	6-30-94
G	GEN	8-19-94	REVISED VALVES & VALVE NUMBERS TO DATE	MRN	MET	8-19-94

DESIGNED C.G. ROWE	DATE 11-23-87
DRAWN PW NELSON	DATE 11-23-87
CHECKED SBR/TSW	DATE 02-26-88
APPROVED S.B.ROELOFS	DATE 03-04-88

DOW CORNING CORPORATION

MIDLAND PLT 806 TANK FARM

WASTE SOLVENT
DEMPSTER UNLOADING STATION

P&ID SHEET 6 OF 6

SCALE (INCH / FOOT)	DRAWING NUMBER	REVISION
NONE	W1-60794	Q

LAST GENERAL UPDATE: 04JAN2010

GENERAL CONCRETE NOTES:

1. CONCRETE SHALL DEVELOP A MINIMUM COMPRESIVE STRENGTH OF 4000 PSI IN 28 DAYS.
2. REINFORCING STEEL SHALL BE INTERMEDIATE GRADE, DEFORMED, NEW BILLET-STEEL MEETING ASTM SPECIFICATIONS A615-87, GRADE 60.
3. ALL FILL SHALL BE COMPACTED TO 95% MODIFIED PROCTOR.
4. ALL FILL SHALL BE COMPACTED SAND; 6" MINIMUM THICKNESS UNDER SLABS.
5. ALL EXPOSED CONCRETE CORNERS CHAMFERED ?" x 45^.
6. ALL ANCHOR BOLTS SHALL CONFORM TO ASTM SPEC. A-36.
7. ALL CONCRETE SHALL BE AIR-ENTRAINED.
8. WORK SHALL BE DONE IN ACCORDANCE WITH ACI-318, "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE".
9. PLASTIC FIBER-REINFORCED CONCRETE SHALL BE "FORTA FIBRE".
10. STEEL FIBER-REINFORCED CONCRETE SHALL BE "DRAMIX".
11. UNLESS OTHERWISE NOTED, #4 BARS SHALL BE LAPPED 21" MINIMUM, #5 BARS SHALL BE LAPPED 26" MINIMUM AND #6 BARS SHALL BE LAPPED 31" MINIMUM.
12. NO JOINTS ALLOWED OTHER THAN THOSE SHOWN ON DRAWINGS.
13. ALLOWABLE SOIL PRESSURE 2000 P.S.F.. FOR SOILS REPORT SEE FILE #87-356 IN RECORD PRINT #5839.

CADD

MARK	LOC.	REVISIONS	BY	DATE	TECH APPR	INITIALS
A	GEN	ADDED SECTION "N"	JAM	02JAN98	NSD	
B	GEN	ADDED SECTION "P"	RFP	27FEB04	ABK	

DESIGNED BY:	K.J.WALKER	DATE 01-11-88
DRAWN BY:	D.A.W./L.K.O.	DATE 01-29-88
TECHNICAL APPROVAL:	K.J.WALKER	DATE 06-04-88
APPROVED FOR ISSUE:	R.L.ZITTA	DATE 06-06-88

RELATED DRAWINGS

NUMBER	TITLE
X1-60833	TANK FARM SLAB & FOUNDATION DETAIL

PMSS INFORMATION	ENGRG. DISC.	DWG. TYPE
	CA CONC	PLAN

DOW CORNING CORPORATION

MIDLAND PLANT BLDG. 806

TANK FARM

SLAB AND FOUNDATION PLAN

SCALE (INCH FOOT)	DRAWING NUMBER	REVISION
1" = 1'-0"	X1-60882	B

RF:

04Mar93

Run-on and Run-off Capture Systems
Capacity Evaluation

Calculations

A. Run-on Evaluation

Requirements per R 299.9604 - Facility Design and Operation Standards, Rule 604 requires a run-on control system capable of preventing flow onto the active portions of the facility during peak discharge from at least a 24 hour - 25 year storm.

Current landfill operation is elevated substantially above surrounding areas thus preventing any run-on from adjacent areas outside landfill perimeter clay wall. Therefore there is no run-on case to deal with.

B. Run-off Evaluation

Requirements per R 299.9604 - Facility Design and Operating Standards, Rule 604 requires a run-off management system to collect and control at least the water volume resulting form active portions of the facility from a 24-hour, 100 year storm.

Calculations:
Currently no section of landfill received final cover system. Therefore, total landfill area, 24.34 acres, is drained to chemical sewer and all run-off storm water is treated in chemical sewer treatment plant.

Dwg. Y1-93774 Rev. A, 1992 topography, shows all active catch basins within landfill area.

24 hours, 100 year storm rainfall for Midland Area:
4.56 in.
Average one hour rain intensity within this storm.

$$I = \frac{4.56''}{24} = 0.19''/hr$$

Determination of run-off volume:

Q = A x R x I

Where: Q = Run-off Volume
A = Run-off Area
R = Rainfall Intensity
I = Run-off Coefficient

Description of rainfall run-off system:
All run-off from the entire landfill area is collected by total of 24 catch basins tied to chemical sewer as follows:

1. Landfill Perimeter - Interim Closure Banks
   5 Catch Basins
   Grassy area, 25% slope banks, ditches.
   I = 0.4
   A = 5.83 acres

2. 1000 Block Active Landfill Area - Diked from Interim Closure Banks
   5 Catch Basins
   Clay and permeable soil cover, flat area.
   I = 0.3
   A = 4.71 acres

3. 800 Block Area - Partially Active Landfill Area in East Section, Interim Closure Surface Area is West Section of this block.
   14 Catch Basins
   Surface varies from daily cover soil to asphalt and concrete pavement.
   I = 0.55
   A = 13.81 acres

Calculation for Area 1:

$$Q_1 = A \times R \times I = (5.83 \times 43560)\ \text{sq. ft.} \times 0.4 \times \frac{0.19}{12}\ \text{ft/hr} =$$

= 1608 cu. ft./hr.
= 12,030 gal./hr. = 201 GPM

Minimum catch basin laterals: 8" line, 1 % slope.
Capacity of each of 5 Catch Basins:
560 GPM
Capacity of Catch Basins (5 @ 560 GPM) greatly exceeds rain run-off volume.

Calculation for Area 2:

Q_2 = A x R x I = (4.71 x 43560) sq. ft. x 0.3 x $\frac{0.19}{12}$ ft/hr =

= 975 cu.ft./hr
= 7290 gal/hr = 121 GPM

Minimum catch basin laterals: 8" line, 1% slope
Capacity of each of 5 catch basins:
560 GPM
Capacity of Catch Basins (5 @ 560 GPM) greatly exceeds rain run-off volume.

Calculation for Area 3:

Q_3 = A x R x I = (13.81 x 43560) sq/ ft. x 0.55 x $\frac{0.19}{12}$ ft/hr =

= 5239 cu.ft./hr
= 39185 gal/hr = 653 GPM

Minimum catch basin laterals: 8" line, 1% slope
Capacity of each of 14 catch basins:
560 GPM
Capacity of Catch Basins (14 @ 560 GPM) greatly exceeds rain run-off volume.

All area run-off is combined to landfill perimeter V.T. chem sewer lines. Check lines capacity for total run-off:

12" V.T., Min. slope = 0.287% along roadway C
Capacity: 870 GPM (West Main)

8" V.T. Min. slope = 0.356% along roadway 2
Capacity 335 GPM (North Branch)

12" V.T., Min. slope = 0.217% along roadway 3
Capacity 760 GPM (South Branch)

Total Landfill Outfall Capacity for Chemical Sewer is as follows:

12" HDPE line from M.H. # 28-4, West, S = 0.5%
Capacity 1150 GPM

12" HDPE line from M.H. # 8-14, West, S = 0.15%
Capacity 640 GPM

12" HDPE line from M.H. # 8-14, South, $S = 0.323\%$
Capacity 950 GPM

Total Sewer Capacity:
1150 + 640 + 950 = **2740 GPM**

Total landfill run-off from 24 hr, 100 yr storm, per hour:
$\mathbf{Q = Q_1 + Q_2 + Q_3 = 201 + 121 + 653 = \underline{975\ GPM}}$

CHEMICAL SEWER CAPACITY: **2740 GPM > 975 GPM**

Therefore, landfill drainage system is fully capable to handle requirements of continuous run-off water flow from 24 hr - 100 yr storm.

c:\wpfiles\crr\PCAPPA4D

FINAL COVER INFILTRATION EVALUATION

Objective

Calculate the quantity of surface water infiltrating into the drainage layer component of the final cover using the USEPA Hydrologic Evaluation of Landfill Performance Version 3.07 ("HELP") computer modeling program. This analysis was performed to provide base data for the evaluation of the final cover drainage layer.

Design Criteria and Assumptions

HELP Model Version 3.07 Input:

1. Temperature, precipitation, and solar radiation data can be default data, user input or synthetically generated by the HELP Model. Synthetically generated temperature, and solar radiation data for East Lansing, Michigan and synthetically generated precipitation data for Detroit, Michigan were used to simulate site weather conditions.

2. Geomembrane liner pinhole density and size were assumed to account for possible manufacturing defects during geomembrane production. The HELP Model User's Guide for Version 3.07 states that the pinhole density for a typical geomembrane is 0.5 to 1 pinhole per acre. The pinhole density at the upper end of the recommended range, or one hole per acre was assumed. The diameter of the hole was assumed to be 1 mm, therefore the area of the hole was 0.008 cm^2.

3. The placement quality for the geomembrane liner was assumed to be "good." According to the HELP Model User's Guide for Version 3.07, a "good" placement quality "assumes good field installation with well-prepared, smooth soil surface and geomembrane wrinkle control to insure good contact between geomembrane and adjacent soil that limits drainage rate."

4. The installation defects for the geomembrane liner were assumed to be four holes per acre. The area of the hole is 1 cm^2.

5. Various final cover slopes and drainage lengths will be present on the final cover. To provide conservative results and simplify the analysis, the maximum and minimum slopes are considered. To be conservative the maximum slope length for each slope is used in the analysis. The final cover slopes and flow paths used in the HELP model are as follows:
   a. 4% Minimum Slope top area: 305 ft.
   b. 25% Maximum Slope sideslopes: 196 ft.

6. Two cover scenarios were analyzed for the 4% top slope and two for the 25% sideslopes. The cover scenarios are described in Tables 1 through 4.

7. The initial moisture content of the soil layers were calculated by the HELP Model to be nearly steady state (i.e., the HELP Model automatically generates the initial moisture content for each layer based on weather inputs and layer data).

8. An assumed 1-acre unit design area was used for modeling purposes to compute unit quantities.

9. As presented in Table 5 of this appendix, soil layers were modeled using HELP Model default soil characteristics (porosity, field capacity, wilting point and saturated hydraulic conductivity).

10. When present, the compacted clay component of the final cover was assumed to have a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec.

11. Final Cover Condition Inputs:

    a. Fair grass conditions
    b. Evaporative zone depth = 20 inches (recommended by the HELP Model for fair grass conditions for East Lansing, Michigan)
    c. Maximum leaf area index = 2.0 (recommended by the HELP Model for fair grass conditions)
    d. Fraction of area allowing run-off = 100 percent
    e. Run-off curve number = calculated by HELP model based on soil types and slope information input.
    f. Length of model run = 30 years (chosen to allow for more representative average values).

12. The HELP model does not allow the modeling of two "barrier" layers adjacent to one another. To overcome this software limitation, the GCL is modeled as a vertical percolation layer.

13. The use of geotextiles does not affect infiltration in the HELP model and therefore geotextiles are not included in the analysis.

14. To be conservative for this analysis, a geocomposite with a 250 mil geonet is assumed. Per the geocomposite capacity analysis, a geocomposite with a 300 mil geonet is recommended. An effective hydraulic conductivity of 0.0293 m/s will be used for the assumed geocomposite drainage layer as calculated in the Geocomposite Capacity Analysis provided in Attachment 1.

15. The 4 percent top slope area drainage layer discharges to the diversion berms.

CALCULATION SHEET

AECOM

Client	DOW Corning Corp.	**Subject**	Final Cover	**Project No.**	60134827
Project	Midland Plant Landfill Renewal Application		Infiltration Evaluation	**Prepared By**	TCR **Date** 5/23/11
				Reviewed By	NKW **Date** 5/23/11
				Approved By	DFP **Date** 5/23/11

HELP MODEL GENERAL LAYOUT

Table 1: 4% Top Slope, Cover A - HELP Model Layout

(Layer Number) Layer Description	Flow	Thickness	Saturated Hydraulic Conductivity	Soil Type/ Texture Number
(1)vertical percolation	↓	6 inches	1.2×10^{-4} cm/sec	topsoil/#10
(2)vertical percolation	↓	18 inches	1.2×10^{-4} cm/sec	protective soil/#10
(3)lateral drainage	→	0.25 inches	2.93 cm/sec	geonet/#46
(4)geomembrane liner	↓	0.06 inch	4.0×10^{-13} cm/sec	geomembrane/#36
(5) GCL	↓	0.25 inches	3.0×10^{-9} cm/sec	GCL/#17
(6)barrier soil liner	↓	12 inches	1.0×10^{-7} cm/sec	barrier layer/#16

Table 2: 4% Top Slope, Cover B - HELP Model Layout

(Layer Number) Layer Description	Flow	Thickness	Saturated Hydraulic Conductivity	Soil Type/ Texture Number
(1)vertical percolation	↓	6 inches	1.2×10^{-4} cm/sec	topsoil/#10
(2)vertical percolation	↓	6 inches	1.2×10^{-4} cm/sec	protective soil/#10
(3)lateral drainage	→	12 inches	5.8×10^{-3} cm/sec	sand/#2
(4)geomembrane liner	↓	0.06 inch	4.0×10^{-13} cm/sec	geomembrane/#36
(5)barrier soil liner	↓	36 inches	1.0×10^{-5} cm/sec	barrier layer/#16

Table 3: 25% Side Slope, Cover A - HELP Model Layout

(Layer Number) Layer Description	Flow	Thickness	Saturated Hydraulic Conductivity	Soil Type/ Texture Number
(1)vertical percolation	↓	6 inches	1.2×10^{-4} cm/sec	topsoil/#10
(2)vertical percolation	↓	18 inches	1.2×10^{-4} cm/sec	protective soil/#10
(3)lateral drainage	→	0.25 inches	2.93 cm/sec	geonet/#46
(4)geomembrane liner	↓	0.06 inch	4.0×10^{-13} cm/sec	geomembrane/#36
(5)barrier soil liner	↓	36 inches	1.0×10^{-7} cm/sec	barrier layer/#16

Table 4: 25% Top Slope, Cover B - HELP Model Layout

(Layer Number) Layer Description	Flow	Thickness	Saturated Hydraulic Conductivity	Soil Type/ Texture Number
(1)vertical percolation	↓	6 inches	1.2×10^{-4} cm/sec	topsoil/#10
(2)vertical percolation	↓	18 inches	1.2×10^{-4} cm/sec	protective soil/#10
(3)lateral drainage	→	0.25 inches	2.93 cm/sec	geonet/#46
(4)geomembrane liner	↓	0.06 inch	4.0×10^{-13} cm/sec	geomembrane/#36
(5) GCL	↓	0.25 inches	3.0×10^{-9} cm/sec	GCL/#17
(6)barrier soil liner	↓	12 inches	1.0×10^{-7} cm/sec	barrier layer/#16

Table 5: Soil Texture Properties

Soil Texture No.	Soil Classification		Comments, Properties, and Uses
	USDA	USCS	
2	S	---	HELP Model default parameter to model drainage sand. The effective saturated hydraulic conductivity = 5.8×10^{-3} cm/sec.
10	SCL	SC	Assumed HELP model default soil to model the topsoil and vegetative support soil.
16	C Clay	CH Clay	HELP Model default parameter for a barrier soil. This soil was modeled for the compacted clay layer. This soil type was used based on an effective saturated hydraulic conductivity = 1×10^{-7} cm/sec.
17	---	---	HELP Model default parameter for a bentonite mat, used to model the GCL. The effective saturated hydraulic conductivity = 3×10^{-9} cm/sec
36	---	---	HELP Model default parameters for the LLDPE geomembrane, used to model the 60-mil VLDPE geomembrane in the final cover. Effective saturated hydraulic conductivity of the geomembrane is 4×10^{-13} cm/sec.
46	---	---	Based on the HELP Model default parameter for a drainage net, used to model the geocomposite drainage layer. The effective saturated hydraulic conductivity of the default parameter has been modified to 2.93 cm/sec.

NOTE: All soil properties are defaults of HELP Model, Version 3.07.

Calculations

HELP Model output files are provided in Attachments 2 and 3 for the 4% Top Slope and Attachments 4 and 5 for the 25% Side Slope. Summaries of HELP Model results for peak daily values are provided in Table 6. Peak daily values are presented in the HELP Model output file in both inches per day and cubic feet per day. These results are equivalent but presented in different units.

The drainage collected from the drainage layer is also the geocomposite surface water impingement rate. The HELP model presents the drainage collected in inches per day, a sample conversion to meters per second is provided below.

Sample Conversion: 1 inch/day x 1 day/86,400 sec x 1 inch/0.0254 meters = 4.56×10^{-4} m/s

Table 6: Peak Daily Values

	4 Top Slope		25% Side Slope	
	Cover A	Cover B	Cover A	Cover B
Drainage collected from drainage layer - Impingement Rate (inches/day)	0.54474	0.04996	0.71355	0.71355
Drainage collected from drainage layer - Impingement Rate (meters/second)	0.000248	2.28E-05	0.000325	0.000325
Head in drainage layer (inches)	18.108	20.098	0.036	0.036

Conclusions

As shown in Table 6, the surface water infiltration rate (impingement rate) to the drainage layer and the liquid head in the drainage layer varies based on the cover option and slope. These values were used for the stability analysis and design of the final cover drainage system.

References

Schroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjostrom, J.W., and Peyton, R.L., 1994. “The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3,” EPA/600/9-94/xxx, U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, Ohio

Attachment 1

Geocomposite Capacity Analysis

Client DOW Corning Corp.	**Subject** Geocomposite	**Prepared By** TCR	**Date** 5/20/11
Project Midland Plant Landfill	Capacity Analysis	**Reviewed By** NKW	**Date** 5/20/11
Renewal Application		**Approved By** DFP	**Date** 5/20/11

GEOCOMPOSITE CAPACITY ANALYSIS

Objective

Estimate the long-term hydraulic conductivity of the geocomposite drainage layer component of the final cover for use in the HELP model analysis.

Design Criteria and Assumptions

1. To be conservative for the HELP model analysis, assume a geocomposite drainage layer that consists of a double-sided geocomposite with a 250 mil geonet component. For the purposes of this calculation assume a GSE FabriNet HF product is utilized. The actual recommended geocomposite is GSE FabriNet TRx which provides a higher transmissivity and is manufactured with creep and intrusion resistant construction. It is manufactured by heat-bonding two layers of non-woven geotextile to a central geonet core.

2. Manufacturer's data for the FabriNet HF and Fabrinet TRx product is included in Attachment 1. At the time of construction, the transmissivity of the actual geocomposite to be used should be reviewed to ensure the geocomposite to be used performs equivalent to the Fabrinet TRx specifications.

Calculations

Based on Koerner (Reference 1), a series of long-term partial safety factors were introduced as shown below:

1. Geonet Intrusion $F.S._{in}$ = 1.5 (chosen due to possible variability in loads and particle size distribution of cover soils)
2. Geonet Creep $F.S._{cr}$ = 1.2 (chosen based on strength of geotextile heat fusion to geonet)
3. Chemical Clogging $F.S._{cc}$ = 1.0 (chosen based on low chemical content of rain water)
4. Biological Clogging $F.S._{bc}$ = 1.5 (chosen due to the possibility of root intrusion, mold, fungus or other organisms)

The list of partial safety factors are provided in Attachment 2. The long-term drainage layer transmissivity is calculated as:

$$\mathbf{T_{lt} = T / (FS_{gin}\ FS_{cr}\ FS_{cc}\ FS_{bc})}$$

$$T_{lt} = (5.0 \times 10^{-4}) / (1.5 \times 1.2 \times 1.0 \times 1.5) = 1.85 \times 10^{-4}\ m^2/s$$

$$\boldsymbol{k = T/t}$$

Where:
- k = T/t, hydraulic conductivity, cm/sec
- T = Transmissivity, m^2/sec (assume 6oz/yd^2 geocomposite)
- t = thickness of geocomposite, ft

$$k = (1.85 \times 10^{-4}\ m^2/s) / 0.0063\ m = 0.0293\ m/s$$

CALCULATION SHEET

		Page 2	**Of** 2
		Project No. 60134827	
Client DOW Corning Corp.	**Subject** Geocomposite	**Prepared By** TCR	**Date** 5/20/11
Project Midland Plant Landfill	Capacity Analysis	**Reviewed By** NKW	**Date** 5/20/11
Renewal Application		**Approved By** DFP	**Date** 5/20/11

Conclusions

The long-term hydraulic conductivity of geocomposite (0.0293 m/s) is used in the HELP model analysis.

References

1. Koerner, R.M., "Designing with Geosynthetics", 4th Edition, Prentice-Hall, 1999.

2. Hydraulic Evaluation of Landfill Performance (HELP) Model, Version 3.07, USAE Waterways Experiment System, November 1997.

ATTACHMENT 1

GSE GEOCOMPOSITE PRODUCT LITERATURE

GSE

The Pioneer Of Geosynthetics

SINCE 1972

Product Data Sheet

GSE FabriNet HF Geocomposite

GSE FabriNet HF geocomposite consists of a 250 mil thick GSE HyperNet HF geonet heat-laminated on one or both sides with a GSE nonwoven needlepunched geotextile. The geotextile is available in mass per unit area range of 6 oz/yd² (200 g/m²) to 16 oz/yd² (540 g/m²). The geocomposite is designed and formulated to perform drainage function under a range of anticipated site loads, gradients and boundary conditions.

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE[1]		
Geocomposite			**6 oz/yd²**	**8 oz/yd²**	**10 oz/yd²**
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716	1/540,000 ft²			
Double-Sided Composite			2.41 (5 x 10⁻⁴)	2.41 (5 x 10⁻⁴)	1.45 (3 x 10⁻⁴)
Single-Sided Composite			7.24 (1.5 x 10⁻³)	7.24 (1.5 x 10⁻³)	4.83 (1 x 10⁻³)
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft²	1.0 (178)	1.0 (178)	1.0 (178)
Geonet Core[3] - GSE HyperNet HF					
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716		14.49 (3 x 10⁻³)	14.49 (3 x 10⁻³)	14.49 (3 x 10⁻³)
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft²	55 (9.6)	55 (9.6)	55 (9.6)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft²	2.0	2.0	2.0
Geotextile[3,4]					
Mass per Unit Area, oz/yd²(g/m²)	ASTM D 5261	1/90,000 ft²	6 (200)	8 (270)	10 (335)
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft²	160 (710)	220 (975)	260 (1,155)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft²	90 (395)	120 (525)	165 (725)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft²	70 (0.212)	80 (0.180)	100 (0.150)
Permittivity, (sec⁻²)	ASTM D 4491	1/540,000 ft²	1.5	1.3	1.0
Flow Rate, gpm/ft² (lpm/m²)	ASTM D 4491	1/540,000 ft²	110 (4,480)	95 (3,865)	75 (3,050)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70
NOMINAL ROLL DIMENSIONS					
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft²	250 (6.3)	250 (6.3)	250 (6.3)
Roll Width[5], ft (m)			15 (4.5)	15 (4.5)	15 (4.5)
Roll Length[5], ft (m)	Double-Sided Composite		230 (70.1)	210 (64.0)	210 (64.0)
	Single-Sided Composite		260 (79.2)	260 (79.2)	250 (76.2)
Roll Area, ft² (m²)	Double-Sided Composite		3,450 (321)	3,150 (293)	3,150 (293)
	Single-Sided Composite		3,900 (362)	3,900 (362)	3,750 (348)

NOTES:

- [1]AOSin mm is a maximum value.
- [2]Gradient of 0.1, normal load of 10,000 psf, water at 70°F between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- [3]Component properties prior to lamination.
- [4]Refer to geotextile product data sheet for additional specifications.
- [5]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

DS8FNHF R05/11/10

GSE

The Pioneer Of Geosynthetics

SINCE 1972

Product Data Sheet

GSE FabriNet TRx Geocomposite

GSE FabriNet TRx high flow geocomposite is produced with a unique one step process that coexrudes creep resistant columns to an intrusion resistant roof. The resulting triaxial geonet is then laminated to a nonwoven geotextile filtration media. This product achieves high in-situ transmissivity from optimally oriented flow channels that maintain porosity because of the intrusion and creep resistant nature of the triaxial structure. The geocomposite provides continuous performance over a broad range of conditions. It is also well suited for use in surface water collection and removal systems, gas venting, and landfill liner system drainage applications.

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE		
Geocomposite			**4 oz/yd²**	**6 oz/yd²**	**8 oz/yd²**
Transmissivity(1), gal/min/ft (m²/sec) Double-Sided Composite Single-Sided Composite	ASTM D 4716	1/540,000 ft²	12.1 (2.5 x10⁻³) 15.7 (3.2 x 10⁻³)	12.1 (2.5 x10⁻³) 15.7 (3.2 x 10⁻³)	10.1 (2.2 x 10⁻³) 13.8 (2.9 x 10⁻³)
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft²	1.0 (178)	1.0 (178)	1.0 (178)
Geonet Core - GSE HyperNet TRx					
Transmissivity(2), gal/min/ft (m²/sec)	ASTM D 4716		43.5 (9.0x 10⁻³)	43.5 (9.0x 10⁻³)	43.5 (9.0x 10⁻³)
Density, g/cm³	ASTM D 1505	1/50,000 ft²	>0.94	>0.94	>0.94
Tensile Strength(3), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft²	75 (13.3)	75 (13.3)	75 (13.3)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft²	>2.0	>2.0	>2.0
Geotextile (prior to lamination)(4)					
Mass per Unit Area, oz/yd²(g/m²)	ASTM D 5261	1/90,000 ft²	4	6	8
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft²	120 (530)	160 (710)	220 (975)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft²	60 (265)	90 (395)	120 (525)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft²	70 (0.212)	70 (0.212)	80 (0.180)
Permittivity, (sec⁻¹)	ASTM D 4491	1/540,000 ft²	1.8	1.5	1.3
Flow Rate, gpm/ft² (lpm/m²)	ASTM D 4491	1/540,000 ft²	135 (5,495)	110 (4,480)	95 (3,865)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70
NOMINAL ROLL DIMENSIONS					
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft²	300 (7.6)	300 (7.6)	300 (7.6)
Roll Width(5), ft (m)			15 (4.5)	15 (4.5)	15 (4.5)
Roll Length(5), ft (m)	Double-Sided Composite Single-Sided Composite		160 (48.8) 180 (54.9)	160 (48.8) 170 (51.8)	150 (45.7) 170 (51.8)
Roll Area, ft² (m²)	Double-Sided Composite Single-Sided Composite		2,400 (223) 2,700 (251)	2,400 (223) 2,550 (237)	2,250 (209) 2,550 (237)

NOTES:

- (1)This is an index transmissivity value measured at stress = 1,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geocomposite/plate. Contact GSE for performance transmissivity value for use in design.
- (2)This is an index transmissivity value measured at stress = 1,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geonet/plate. Contact GSE for performance transmissivity value for use in design.
- (3)Tested in machine direction (MD).
- (4)All properties are minimum average values except AOS (mm) which is a maximum value and UV resistance which is a typical value.
- (5)Roll widths and lengths have a tolerance of ±1%.
- *Modified.

DS10FNTRX R05/11/10

ATTACHMENT 2

PARTIAL SAFETY FACTORS

q_{allow} = allowable flow rate to be used in Eq. (4.3) for final design purposes,
RF_{IN} = reduction factor for elastic deformation, or intrusion, of the adjacent geosynthetics into the geonet's core space,
RF_{CR} = reduction factor for creep deformation of the geonet and/or adjacent geosynthetics into the geonet's core space,
RF_{CC} = reduction factor for chemical clogging and/or precipitation of chemicals in the geonet's core space,
RF_{BC} = reduction factor for biological clogging in the geonet's core space, and
ΠRF = product of all reduction factors for the site-specific conditions.

Some guidelines for the various reduction factors to be used in different situations are given in Table 4.2. Please note that some of these values are based on relatively sparse information. Other reduction factors, such as installation damage, temperature effects, and liquid turbidity, could also be included. If needed, they can be included on a site-specific basis. On the other hand, if the actual laboratory test procedure has included the particular item, it would appear in the above formulation as a value of unity. Examples 4.2 and 4.3 illustrate the use of geonets and serve to point out that high reduction factors are warranted in critical situations.

Example 4.2

What is the allowable geonet flow rate to be used in the design of a capillary break beneath a roadway to prevent frost heave? Assume that laboratory testing was done at the proper design load and hydraulic gradient and that this testing yielded a short-term between-rigid-plates value of 2.5×10^{-4} m²/s.

Solution: Since better information is not known, average values from Table 4.2 are used in Eq. (4.5).

TABLE 4.2 RECOMMENDED PRELIMINARY REDUCTION FACTOR VALUES FOR EQ. (4.5) FOR DETERMINING ALLOWABLE FLOW RATE OR TRANSMISSIVITY OF GEONETS

Application Area	RF_{IN}	RF_{CR}*	RF_{CC}	RF_{BC}
Sport fields	1.0 to 1.2	1.0 to 1.5	1.0 to 1.2	1.1 to 1.3
Capillary breaks	1.1 to 1.3	1.0 to 1.2	1.1 to 1.5	1.1 to 1.3
Roof and plaza decks	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2	1.1 to 1.3
Retaining walls, seeping rock, and soil slopes	1.3 to 1.5	1.2 to 1.4	1.1 to 1.5	1.0 to 1.5
Drainage blankets	1.3 to 1.5	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2
Surface water drains for landfill covers	1.3 to 1.5	1.1 to 1.4	1.0 to 1.2	1.2 to 1.5
Secondary leachate collection (landfills)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0
Primary leachate collection (landfills)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0

*These values are sensitive to the density of the resin used in the geonet's manufacture. The higher the density, the lower the reduction factor. Creep of the covering geotextile(s) is a product-specific issue.

SOURCE: KOERNER, R.M "DESIGNING WITH GEOSYNTHETICS", 4TH ED., P.403 (1999)

Attachment 2

HELP Model Output: 4% Slope, Cover A

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    c:\temp\MID4.D4
TEMPERATURE DATA FILE:      C:\temp\MID7.D7
SOLAR RADIATION DATA FILE:  c:\temp\MID13.D13
EVAPOTRANSPIRATION DATA:    c:\temp\MID11.D11
SOIL AND DESIGN DATA FILE:  c:\temp\MID4-A.D10
OUTPUT DATA FILE:           c:\temp\MID4-A.OUT


TIME:  10:28     DATE:   3/28/2011


******************************************************************************

     TITLE:  Midland Plant Landfill, Cover Evaluation, 4% Slope Cover A

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER  10
           THICKNESS                    =     6.00   INCHES
           POROSITY                     =     0.3980 VOL/VOL
           FIELD CAPACITY               =     0.2440 VOL/VOL
           WILTING POINT                =     0.1360 VOL/VOL
           INITIAL SOIL WATER CONTENT   =     0.3541 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.119999997000E-03 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

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                     LAYER  2
                     --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  10
THICKNESS                  =     18.00   INCHES
POROSITY                   =      0.3980 VOL/VOL
FIELD CAPACITY             =      0.2440 VOL/VOL
WILTING POINT              =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2862 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.119999997000E-03 CM/SEC


                     LAYER  3
                     --------

             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER  46
THICKNESS                  =      0.25   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   2.93000007000     CM/SEC
SLOPE                      =      4.00   PERCENT
DRAINAGE LENGTH            =    305.0    FEET


                     LAYER  4
                     --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  36
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY        =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD


                     LAYER  5
                     --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  17
THICKNESS                  =      0.25   INCHES
POROSITY                   =      0.7500 VOL/VOL
FIELD CAPACITY             =      0.7470 VOL/VOL
```

```
   WILTING POINT               =      0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.7470 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC


                        LAYER  6
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  16
   THICKNESS                   =    12.00   INCHES
   POROSITY                    =      0.4270 VOL/VOL
   FIELD CAPACITY              =      0.4180 VOL/VOL
   WILTING POINT               =      0.3670 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.4270 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.100000001000E-06 CM/SEC


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE #10 WITH A
          FAIR STAND OF GRASS, A SURFACE SLOPE OF  4.%
          AND A SLOPE LENGTH OF  305. FEET.

SCS RUNOFF CURVE NUMBER            =     85.90
FRACTION OF AREA ALLOWING RUNOFF   =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
EVAPORATIVE ZONE DEPTH             =     20.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      6.300  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =      7.960  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      2.720  INCHES
INITIAL SNOW WATER                 =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =     12.589  INCHES
TOTAL INITIAL WATER                =     12.589  INCHES
TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


           EVAPOTRANSPIRATION AND WEATHER DATA
           -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          E. LANSING            MICHIGAN

     STATION LATITUDE                        =  42.60 DEGREES
     MAXIMUM LEAF AREA INDEX                 =   2.00
     START OF GROWING SEASON (JULIAN DATE)   =    123
     END OF GROWING SEASON (JULIAN DATE)     =    283
     EVAPORATIVE ZONE DEPTH                  =  20.0  INCHES
     AVERAGE ANNUAL WIND SPEED               =  10.10 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  77.00 %
```

AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 69.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 75.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 80.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.86	1.69	2.54	3.15	2.77	3.43
3.10	3.21	2.25	2.12	2.33	2.52

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR E. LANSING MICHIGAN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
21.60	23.30	33.00	46.30	57.20	66.80
70.80	69.20	61.70	50.70	38.50	27.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR E. LANSING MICHIGAN
AND STATION LATITUDE = 42.60 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.81	1.77	2.38	3.33	2.97	3.36
	2.93	2.98	2.31	1.66	2.36	2.63
STD. DEVIATIONS	0.65	0.79	1.07	1.30	1.13	1.41
	1.26	1.64	1.37	1.06	1.00	1.05
RUNOFF						
TOTALS	0.493	1.233	2.680	1.238	0.053	0.065
	0.048	0.146	0.018	0.010	0.052	0.235

STD. DEVIATIONS	0.464	1.106	1.947	1.633	0.116	0.132
	0.112	0.276	0.057	0.040	0.107	0.362

EVAPOTRANSPIRATION

TOTALS	0.396	0.338	0.394	2.356	3.283	4.043
	3.021	2.529	1.877	1.086	0.719	0.386
STD. DEVIATIONS	0.068	0.076	0.178	0.988	1.064	1.093
	1.160	1.007	0.893	0.396	0.146	0.088

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.0476	0.0000	0.2675	1.6790	0.3984	0.0218
	0.0330	0.0827	0.0109	0.1257	0.4974	0.5982
STD. DEVIATIONS	0.1584	0.0000	0.6119	0.6851	0.5308	0.0673
	0.1554	0.2638	0.0469	0.2865	0.7876	0.6431

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0007	0.0000	0.0576	0.3264	0.0266	0.0003
	0.0005	0.0027	0.0002	0.0037	0.0286	0.0160
STD. DEVIATIONS	0.0023	0.0000	0.1369	0.2261	0.0992	0.0010
	0.0023	0.0114	0.0007	0.0107	0.0728	0.0257

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	30.46	(3.646)	110581.9	100.00
RUNOFF	6.271	(2.0388)	22762.30	20.584
EVAPOTRANSPIRATION	20.428	(2.5412)	74155.02	67.059
LATERAL DRAINAGE COLLECTED FROM LAYER 3	3.76229	(1.66036)	13657.115	12.35023
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00001	(0.00000)	0.041	0.00004
AVERAGE HEAD ON TOP OF LAYER 4	0.039	(0.015)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00001	(0.00000)	0.041	0.00004
AVERAGE HEAD ON TOP OF LAYER 6	0.000	(0.000)		
CHANGE IN WATER STORAGE	0.002	(1.4875)	7.42	0.007

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	2.92	10599.601
RUNOFF	2.606	9460.8066
DRAINAGE COLLECTED FROM LAYER 3	0.54474	1977.41992
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000011	0.03991
AVERAGE HEAD ON TOP OF LAYER 4	11.463	
MAXIMUM HEAD ON TOP OF LAYER 4	18.108	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	63.7 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000011	0.03991
AVERAGE HEAD ON TOP OF LAYER 6	0.000	
SNOW WATER	9.18	33313.7344

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3635

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1360

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.0459	0.3410
2	4.9265	0.2737
3	0.0025	0.0100
4	0.0000	0.0000
5	0.1867	0.7470
6	5.1240	0.4270
SNOW WATER	0.364	

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****

Attachment 3

HELP Model Output: 4% Slope, Cover B

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    c:\temp\MID4.D4
TEMPERATURE DATA FILE:      C:\temp\MID7.D7
SOLAR RADIATION DATA FILE:  c:\temp\MID13.D13
EVAPOTRANSPIRATION DATA:    c:\temp\MID11.D11
SOIL AND DESIGN DATA FILE:  c:\temp\MID4-B2.D10
OUTPUT DATA FILE:           c:\temp\MID4-B2.OUT


TIME:  10:32     DATE:   5/ 5/2011


******************************************************************************

     TITLE:  Midland Plant Landfill, Cover Evaluation, 4% Slope Cover B

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  10
           THICKNESS                  =     6.00   INCHES
           POROSITY                   =     0.3980 VOL/VOL
           FIELD CAPACITY             =     0.2440 VOL/VOL
           WILTING POINT              =     0.1360 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.3574 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.119999997000E-03 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

```
                    LAYER  2
                    --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  10
THICKNESS                    =      6.00   INCHES
POROSITY                     =      0.3980 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2646 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.119999997000E-03 CM/SEC


                    LAYER  3
                    --------

              TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   2
THICKNESS                    =     12.00   INCHES
POROSITY                     =      0.4370 VOL/VOL
FIELD CAPACITY               =      0.0620 VOL/VOL
WILTING POINT                =      0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2860 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC
SLOPE                        =      4.00   PERCENT
DRAINAGE LENGTH              =    305.0    FEET


                    LAYER  4
                    --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  36
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                    LAYER  5
                    --------

               TYPE 3 - BARRIER SOIL LINER
               MATERIAL TEXTURE NUMBER  16
THICKNESS                    =     36.00   INCHES
```

POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000001000E-06 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 305. FEET.

SCS RUNOFF CURVE NUMBER	=	85.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	5.627	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	8.272	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.824	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	22.537	INCHES
TOTAL INITIAL WATER	=	22.537	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM E. LANSING MICHIGAN

STATION LATITUDE	=	42.60	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	123	
END OF GROWING SEASON (JULIAN DATE)	=	283	
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.10	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	77.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	80.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

1.86	1.69	2.54	3.15	2.77	3.43
3.10	3.21	2.25	2.12	2.33	2.52

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR E. LANSING MICHIGAN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
21.60	23.30	33.00	46.30	57.20	66.80
70.80	69.20	61.70	50.70	38.50	27.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR E. LANSING MICHIGAN
AND STATION LATITUDE = 42.60 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.81	1.77	2.38	3.33	2.97	3.36
	2.93	2.98	2.31	1.66	2.36	2.63
STD. DEVIATIONS	0.65	0.79	1.07	1.30	1.13	1.41
	1.26	1.64	1.37	1.06	1.00	1.05
RUNOFF						
TOTALS	0.481	1.214	2.636	1.204	0.055	0.064
	0.047	0.141	0.017	0.008	0.048	0.229
STD. DEVIATIONS	0.455	1.096	1.941	1.600	0.123	0.130
	0.111	0.268	0.054	0.035	0.104	0.355
EVAPOTRANSPIRATION						
TOTALS	0.396	0.338	0.396	2.336	3.306	3.794
	2.994	2.512	1.909	1.160	0.716	0.386
STD. DEVIATIONS	0.068	0.076	0.180	0.973	1.027	1.096
	1.163	0.974	0.834	0.341	0.158	0.088

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.2582	0.1641	0.1552	0.5549	0.7689	0.5222
	0.3753	0.2922	0.2215	0.1978	0.2510	0.3496
STD. DEVIATIONS	0.1510	0.0912	0.0972	0.3253	0.2295	0.1553
	0.0779	0.0870	0.0776	0.0818	0.2655	0.2600

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0002	0.0001	0.0001	0.0003	0.0004	0.0003
	0.0002	0.0002	0.0001	0.0001	0.0002	0.0002
STD. DEVIATIONS	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001
	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	1.9344	1.3536	1.1632	4.3076	5.7608	4.0431
	2.8123	2.1895	1.7149	1.4823	1.9433	2.6190
STD. DEVIATIONS	1.1315	0.7560	0.7286	2.5328	1.7191	1.2025
	0.5834	0.6518	0.6006	0.6126	2.0556	1.9482

****

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.46 (3.646)	110581.9	100.00
RUNOFF	6.143 (2.0080)	22299.80	20.166
EVAPOTRANSPIRATION	20.243 (2.4798)	73481.12	66.450
LATERAL DRAINAGE COLLECTED FROM LAYER 3	4.11102 (1.16380)	14923.017	13.49499
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00247 (0.00065)	8.957	0.00810
AVERAGE HEAD ON TOP OF LAYER 4	2.610 (0.742)		
CHANGE IN WATER STORAGE	-0.036 (2.1159)	-131.01	-0.118

****

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	2.92	10599.601
RUNOFF	2.603	9448.5596
DRAINAGE COLLECTED FROM LAYER 3	0.04996	181.36053
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000030	0.10943
AVERAGE HEAD ON TOP OF LAYER 4	12.941	
MAXIMUM HEAD ON TOP OF LAYER 4	20.098	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	67.8 FEET	
SNOW WATER	9.18	33313.7344
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3644
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0912

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.0400	0.3400
2	1.5288	0.2548
3	2.1486	0.1790
4	0.0000	0.0000
5	15.3720	0.4270
SNOW WATER	0.364	

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Attachment 4

HELP Model Output: 25% Slope, Cover A

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    c:\temp\MID4.D4
TEMPERATURE DATA FILE:      C:\temp\MID7.D7
SOLAR RADIATION DATA FILE:  c:\temp\MID13.D13
EVAPOTRANSPIRATION DATA:    c:\temp\MID11.D11
SOIL AND DESIGN DATA FILE:  c:\temp\MID25-A.D10
OUTPUT DATA FILE:           c:\temp\MID25-A.OUT


TIME:  10:28     DATE:   3/28/2011


******************************************************************************

     TITLE:  Midland Plant Landfill, Cover Evaluation, 25% Slope Cover A

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  10
           THICKNESS                    =      6.00   INCHES
           POROSITY                     =      0.3980 VOL/VOL
           FIELD CAPACITY               =      0.2440 VOL/VOL
           WILTING POINT                =      0.1360 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.3697 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.119999997000E-03 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 10

```
THICKNESS                    =     18.00   INCHES
POROSITY                     =      0.3980 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2853 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.119999997000E-03 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 46

```
THICKNESS                    =      0.25   INCHES
POROSITY                     =      0.8500 VOL/VOL
FIELD CAPACITY               =      0.0100 VOL/VOL
WILTING POINT                =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   2.93000007000     CM/SEC
SLOPE                        =     25.00   PERCENT
DRAINAGE LENGTH              =    196.0    FEET
```

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 36

```
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD
```

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

```
THICKNESS                    =     36.00   INCHES
POROSITY                     =      0.4270 VOL/VOL
FIELD CAPACITY               =      0.4180 VOL/VOL
```

WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000001000E-06 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 196. FEET.

SCS RUNOFF CURVE NUMBER	=	86.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.378	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.960	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.720	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	22.728	INCHES
TOTAL INITIAL WATER	=	22.728	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
E. LANSING MICHIGAN

STATION LATITUDE	=	42.60	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	123	
END OF GROWING SEASON (JULIAN DATE)	=	283	
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.10	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	77.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	80.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.86	1.69	2.54	3.15	2.77	3.43
3.10	3.21	2.25	2.12	2.33	2.52

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR E. LANSING MICHIGAN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
21.60	23.30	33.00	46.30	57.20	66.80
70.80	69.20	61.70	50.70	38.50	27.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR E. LANSING MICHIGAN
AND STATION LATITUDE = 42.60 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.81	1.77	2.38	3.33	2.97	3.36
	2.93	2.98	2.31	1.66	2.36	2.63
STD. DEVIATIONS	0.65	0.79	1.07	1.30	1.13	1.41
	1.26	1.64	1.37	1.06	1.00	1.05
RUNOFF						
TOTALS	0.504	1.249	2.700	1.267	0.073	0.087
	0.066	0.192	0.027	0.018	0.071	0.248
STD. DEVIATIONS	0.475	1.114	1.957	1.623	0.144	0.161
	0.133	0.342	0.076	0.070	0.125	0.372
EVAPOTRANSPIRATION						
TOTALS	0.396	0.338	0.396	2.352	3.272	4.104
	3.044	2.523	1.839	1.081	0.710	0.383
STD. DEVIATIONS	0.068	0.076	0.179	0.986	1.050	1.033
	1.148	1.002	0.879	0.392	0.146	0.085
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0600	0.0000	0.2190	1.5324	0.4532	0.0250
	0.0276	0.0520	0.0115	0.1064	0.4722	0.5588

STD. DEVIATIONS	0.2281	0.0000	0.5159	0.6401	0.5171	0.0725
	0.1405	0.1887	0.0513	0.2451	0.7825	0.6043

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0001	0.0000	0.0004	0.0026	0.0007	0.0000
	0.0000	0.0001	0.0000	0.0002	0.0008	0.0009
STD. DEVIATIONS	0.0004	0.0000	0.0008	0.0011	0.0008	0.0001
	0.0002	0.0003	0.0001	0.0004	0.0013	0.0010

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.46 (3.646)	110581.9	100.00
RUNOFF	6.501 (2.0217)	23600.08	21.342
EVAPOTRANSPIRATION	20.438 (2.4926)	74190.03	67.091
LATERAL DRAINAGE COLLECTED FROM LAYER 3	3.51813 (1.65169)	12770.815	11.54874
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.006	0.00001
AVERAGE HEAD ON TOP OF LAYER 4	0.000 (0.000)		
CHANGE IN WATER STORAGE	0.006 (1.4163)	20.96	0.019

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****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	2.92	10599.601
RUNOFF	2.611	9479.0566
DRAINAGE COLLECTED FROM LAYER 3	0.71355	2590.19995
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00050
AVERAGE HEAD ON TOP OF LAYER 4	0.036	
MAXIMUM HEAD ON TOP OF LAYER 4	0.009	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	168.7 FEET	
SNOW WATER	9.18	33313.7344

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3652
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.0434	0.3406
2	5.1189	0.2844
3	0.0025	0.0100
4	0.0000	0.0000
5	15.3720	0.4270
SNOW WATER	0.364	

****
****

Attachment 5

HELP Model Output: 25% Slope, Cover B

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     c:\temp\MID4.D4
TEMPERATURE DATA FILE:       C:\temp\MID7.D7
SOLAR RADIATION DATA FILE:   c:\temp\MID13.D13
EVAPOTRANSPIRATION DATA:     c:\temp\MID11.D11
SOIL AND DESIGN DATA FILE:   c:\temp\MID25-B.D10
OUTPUT DATA FILE:            c:\temp\MID25-B.OUT


TIME:  10:29     DATE:   3/28/2011


******************************************************************************

     TITLE:  Midland Plant Landfill, Cover Evaluation, 25% Slope Cover B

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  10
           THICKNESS                 =     6.00   INCHES
           POROSITY                  =     0.3980 VOL/VOL
           FIELD CAPACITY            =     0.2440 VOL/VOL
           WILTING POINT             =     0.1360 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.3697 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.119999997000E-03 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

```
                         LAYER  2
                         --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER  10
THICKNESS                    =     18.00   INCHES
POROSITY                     =      0.3980 VOL/VOL
FIELD CAPACITY               =      0.2440 VOL/VOL
WILTING POINT                =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2853 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.119999997000E-03 CM/SEC


                         LAYER  3
                         --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER  46
THICKNESS                    =      0.25   INCHES
POROSITY                     =      0.8500 VOL/VOL
FIELD CAPACITY               =      0.0100 VOL/VOL
WILTING POINT                =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   2.93000007000      CM/SEC
SLOPE                        =     25.00   PERCENT
DRAINAGE LENGTH              =    196.0    FEET


                         LAYER  4
                         --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  36
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                         LAYER  5
                         --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.25   INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
```

```
   WILTING POINT                =      0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT   =      0.7470 VOL/VOL
   EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC


                           LAYER  6
                           --------

                  TYPE 3 - BARRIER SOIL LINER
                  MATERIAL TEXTURE NUMBER  16
   THICKNESS                    =     12.00   INCHES
   POROSITY                     =      0.4270 VOL/VOL
   FIELD CAPACITY               =      0.4180 VOL/VOL
   WILTING POINT                =      0.3670 VOL/VOL
   INITIAL SOIL WATER CONTENT   =      0.4270 VOL/VOL
   EFFECTIVE SAT. HYD. COND.    =  0.100000001000E-06 CM/SEC


               GENERAL DESIGN AND EVAPORATIVE ZONE DATA
               ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE #10 WITH A
           FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.%
           AND A SLOPE LENGTH OF  196. FEET.

 SCS RUNOFF CURVE NUMBER            =     86.90
 FRACTION OF AREA ALLOWING RUNOFF   =    100.0    PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
 EVAPORATIVE ZONE DEPTH             =     20.0    INCHES
 INITIAL WATER IN EVAPORATIVE ZONE  =      6.378  INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE =      7.960  INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE =      2.720  INCHES
 INITIAL SNOW WATER                 =      0.000  INCHES
 INITIAL WATER IN LAYER MATERIALS   =     12.667  INCHES
 TOTAL INITIAL WATER                =     12.667  INCHES
 TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


                EVAPOTRANSPIRATION AND WEATHER DATA
                -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           E. LANSING            MICHIGAN

      STATION LATITUDE                         =  42.60 DEGREES
      MAXIMUM LEAF AREA INDEX                  =   2.00
      START OF GROWING SEASON (JULIAN DATE)    =    123
      END OF GROWING SEASON (JULIAN DATE)      =    283
      EVAPORATIVE ZONE DEPTH                   =  20.0  INCHES
      AVERAGE ANNUAL WIND SPEED                =  10.10 MPH
      AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  77.00 %
```

AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 69.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 75.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 80.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.86	1.69	2.54	3.15	2.77	3.43
3.10	3.21	2.25	2.12	2.33	2.52

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR E. LANSING MICHIGAN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
21.60	23.30	33.00	46.30	57.20	66.80
70.80	69.20	61.70	50.70	38.50	27.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR E. LANSING MICHIGAN
AND STATION LATITUDE = 42.60 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.81	1.77	2.38	3.33	2.97	3.36
	2.93	2.98	2.31	1.66	2.36	2.63
STD. DEVIATIONS	0.65	0.79	1.07	1.30	1.13	1.41
	1.26	1.64	1.37	1.06	1.00	1.05
RUNOFF						
TOTALS	0.504	1.249	2.700	1.267	0.073	0.087
	0.066	0.192	0.027	0.018	0.071	0.248

STD. DEVIATIONS	0.475	1.114	1.957	1.623	0.144	0.161
	0.133	0.342	0.076	0.070	0.125	0.372

EVAPOTRANSPIRATION

TOTALS	0.396	0.338	0.396	2.352	3.272	4.104
	3.044	2.523	1.839	1.081	0.710	0.383
STD. DEVIATIONS	0.068	0.076	0.179	0.986	1.050	1.033
	1.148	1.002	0.879	0.392	0.146	0.085

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.0600	0.0000	0.2190	1.5324	0.4532	0.0250
	0.0276	0.0520	0.0115	0.1064	0.4722	0.5588
STD. DEVIATIONS	0.2281	0.0000	0.5159	0.6401	0.5171	0.0725
	0.1405	0.1887	0.0513	0.2451	0.7825	0.6043

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0001	0.0000	0.0004	0.0026	0.0007	0.0000
	0.0000	0.0001	0.0000	0.0002	0.0008	0.0009
STD. DEVIATIONS	0.0004	0.0000	0.0008	0.0011	0.0008	0.0001
	0.0002	0.0003	0.0001	0.0004	0.0013	0.0010

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.46 (3.646)	110581.9	100.00
RUNOFF	6.501 (2.0217)	23600.08	21.342
EVAPOTRANSPIRATION	20.438 (2.4926)	74190.03	67.091
LATERAL DRAINAGE COLLECTED FROM LAYER 3	3.51813 (1.65169)	12770.820	11.54874
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00000 (0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.000 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 6	0.000 (0.000)		
CHANGE IN WATER STORAGE	0.006 (1.4163)	20.96	0.019

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	2.92	10599.601
RUNOFF	2.611	9479.0566
DRAINAGE COLLECTED FROM LAYER 3	0.71355	2590.20044
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00009
AVERAGE HEAD ON TOP OF LAYER 4	0.036	
MAXIMUM HEAD ON TOP OF LAYER 4	0.009	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	169.9 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00009
AVERAGE HEAD ON TOP OF LAYER 6	0.000	

SNOW WATER	9.18	33313.7344

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3652
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.0434	0.3406
2	5.1189	0.2844
3	0.0025	0.0100
4	0.0000	0.0000
5	0.1867	0.7470
6	5.1240	0.4270
SNOW WATER	0.364	

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CLIENT: Dow Corning	SUBJECT: Final Cover Slope	Prepared By BPS Date 3/23/2011
PROJECT: Midland Facility	Stability Analysis	Reviewed By TW Date 4/5/2011
		Approved By____ Date______

OBJECTIVE

Evaluate the slope stability of the geosynthetic final cover system under static conditions.

REFERENCES

1. Koerner, R. M. and Soong, T.-Y., "Analysis of Design Veneer Cover Soils," Proc. 6th Intl. Conf. on Geosynthetics, IFAI Publ., St. Paul, MN, 1998, pp. 1-23.

2. Soong, Te-Yang and Koerner, R. M., "The Design of Drainage Systems over Geosynthetically Lined Slopes", GRI Report #19, June 17, 1997.

3. Hydraulic Evaluation of Landfill Performance (HELP) Model, Version 3.07, USAE Waterways Experiment Station, November 1997.

METHODOLOGY

The cover soil stability of the proposed final cover system was evaluated using the methodologies presented in References 1 and 2. The authors used limit equilibrium and a finite slope model to analyze the stability of veneer cover soils over geosynthetic-lined slopes for several loading conditions. The development of the free body diagram shows that two zones are present for the finite slope analysis: (1) a small passive wedge at the toe of slope resisting (2) a long thin active wedge extending the length of the slope. The free body diagrams for each of the conditions evaluated are provided on the calculations in Attachment 2 of this calculation brief. By setting the forces on the passive wedge equal to the forces on the active wedge, a quadratic equation is developed to solve for the factor of safety (FS):

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

Static Conditions with Parallel to Slope Seepage Condition

$$a = W_A(\sin\beta)(\cos\beta) - U_h(\cos^2\beta) + U_h$$

$$b = -W_A(\sin^2\beta)(\tan\Phi) + U_h(\sin\beta)(\cos\beta)(\tan\Phi) - N_A(\cos\beta)(\tan\delta) - (W_P - U_V)(\tan\Phi)$$

$$c = N_A(\sin\beta)(\tan\delta)(\tan\Phi)$$

Where:

$$W_A = \frac{\gamma_{dry}(h-h_w)[2H\cos\beta - (h+h_w)] + \gamma_{sat}(h_w)(2H\cos\beta - h_w)}{\sin 2\beta}$$

$$U_h = \frac{\gamma_w(h_w)^2}{2}$$

$$N_A = W_A(\cos\beta) + U_h(\sin\beta) - U_n$$

$$U_n = \frac{\gamma_w(h_w)(\cos\beta)(2H\cos\beta - h_w)}{\sin 2\beta}$$

$$W_P = \frac{\gamma_{dry}(h^2 - h_w^{\ 2}) + \gamma_{sat}(h_w^{\ 2})}{\sin 2\beta}$$

$$U_V = U_h / \tan\beta$$

γ_{dry} = dry unit weight of cover soil (assumed as 119 pcf or 18.69 kN/m^3)

h = height of cover soil (2-ft or 0.61- meters)

h_w = height of saturated cover soil

= PSR x h

PSR = parallel submergence ratio (based on cover soil drainage capacity)

H =vertical height of slope measured from the toe

β = slope angle

γ_{sat} = saturated unit weight of cover soil (assumed as 130 pcf or 20.42 kN/m^3)

γ_w = unit weight of water (9.81 kN/m^3)

L = length of slope

Φ = friction angle of the cover soil (assumed as 20°)

δ = interface friction angle between the cover soil and geosynthetic component (varies)

ASSUMPTIONS

1. Seepage

The head build-up above the LLDPE component of the cap was modeled using the HELP Model (Reference 3). The evaluation was run for several slope scenarios assuming a final cover soil permeability of 1x10^{-4} cm/sec. The results are included in Attachment 1 and are summarized below:

Geocomposite or Sand Drainage Layer	Drainage Layer Slope (%)	Head on LLDPE Liner (inches)
geocomposite	4	18.1
sand	4	20.1
geocomposite	25	0.036
geocomposite	25	0.036

The ratio of the head on the liner to the depth of cover soil is the parallel submergence ratio (PSR). For example, the PSR for 24-inches of head within a 24-inch thick layer of cover soil = 1.0.

2. Liner System Components

Two (2) alternate liner system cross-sections are proposed for the 4% plateau at the peak of the landfill:

Plateau Liner System Alternate 1	Plateau Liner System Alternate 2
2ft Vegetative Soil	2ft Vegetative Soil
Geocomposite	Filter Fabric
60mil Smooth LLDPE	1ft Drainage Sand
Reinforced GCL	60mil Smooth LLDPE
1ft Clay	3ft Clay

Two (2) alternate liner system cross-sections are also proposed for the 4:1 landfill sideslopes.

Sideslope Liner Alternate 1	Sideslope Liner Alternate 2
2ft Vegetative Soil	2ft Vegetative Soil
Geocomposite	Geocomposite
60mil Tex LLDPE	60mil Tex LLDPE
3ft Clay	Reinforced GCL
	1f Clay

3. **Soil Parameters**

The vegetative soil was assumed to be on-site soil with a dry unit weight of 119 pcf (18.69 kN/m^3), a saturated unit weight of 130 pcf (20.42 kN/m^3), and internal friction angle phi = 0°

4. **Critical Interface**

As required by the State of Michigan Department of Natural Resources & Environment Technical Notice of Deficiency date 7 March 2011, "the residual interface and internal shear strengths are to be assessed and considered for the multilayer cover system for design purposes to make the final cover system stable and safe..."

The minimum interface friction angle (phi, °) has been calculated for each alternate liner system. The cohesion/adhesion component (c) of shear strength is neglected in the veneer stability analyses considering seepage.

ANALYSIS

a. The analysis was first carried out to calculate the minimum required friction angle for the plateau liner system alternate 1 with 18.1" of head buildup and the maximum design slope lengths along the landfill crest.

b. The analysis was first carried out to calculate the minimum required friction angle for the plateau liner system alternate 2 with 20.1" of head buildup and the maximum design slope lengths along the landfill crest.

c. The analysis was then carried out to calculate the minimum required friction angle for the sideslope liner system (alternate 1 or 2) with 0.036" of head buildup and the maximum design slope lengths on the landfill side slopes.

RESULTS

Liner Analyzed	Slope Analyzed (%)	Slope Length (m)	Head on Liner (Parallel Seepage) (in)	Required Interface Strength (°)
Plateau Alt 1	4	100	18.1	5.04
Plateau Al2 2	4	100	20.1	5.36
Sideslope Alt 1 or 2	25	59.74	0.036	20.14

CONCLUSIONS

Based on the design assumptions evaluated within this calculation brief, interface shear testing using on-site soils (cover soil and clay as applicable) and the selected geosynthetic materials should be carried out prior to construction to assure the components meet the following criteria:

Liner Analyzed	Required Interface Strength	
	phi (°)	c (psf)
4% Plateau	5.04	0
4:1 Sideslope	20.14	0

Shear tests should be carried out using three loads representing typical loading on the final cover system (250psf, 500psf, and 1000psf or other loadings as determined by the engineer to suit anticipated field conditions). Interfaces should be loaded and soaked a minimum of 24-hours prior to shear. Shearing rates should be selected by the engineer as typical for geosynthetic to geosynthetic or geosynthetic to soil.

ATTACHMENT 1

HELP MODEL CALCULATION BRIEF
(REFERENCE 3)

FINAL COVER INFILTRATION EVALUATION

Objective

Calculate the quantity of surface water infiltrating into the drainage layer component of the final cover using the USEPA Hydrologic Evaluation of Landfill Performance Version 3.07 ("HELP") computer modeling program. This analysis was performed to provide base data for the evaluation of the final cover drainage layer.

Design Criteria and Assumptions

HELP Model Version 3.07 Input:

1. Temperature, precipitation, and solar radiation data can be default data, user input or synthetically generated by the HELP Model. Synthetically generated temperature, and solar radiation data for East Lansing, Michigan and synthetically generated precipitation data for Detroit, Michigan were used to simulate site weather conditions.

2. Geomembrane liner pinhole density and size were assumed to account for possible manufacturing defects during geomembrane production. The HELP Model User's Guide for Version 3.07 states that the pinhole density for a typical geomembrane is 0.5 to 1 pinhole per acre. The pinhole density at the upper end of the recommended range, or one hole per acre was assumed. The diameter of the hole was assumed to be 1 mm, therefore the area of the hole was 0.008 cm^2.

3. The placement quality for the geomembrane liner was assumed to be "good." According to the HELP Model User's Guide for Version 3.07, a "good" placement quality "assumes good field installation with well-prepared, smooth soil surface and geomembrane wrinkle control to insure good contact between geomembrane and adjacent soil that limits drainage rate."

4. The installation defects for the geomembrane liner were assumed to be four holes per acre. The area of the hole is 1 cm^2.

5. Various final cover slopes and drainage lengths will be present on the final cover. To provide conservative results and simplify the analysis, the maximum and minimum slopes are considered. To be conservative the maximum slope length for each slope is used in the analysis. The final cover slopes and flow paths used in the HELP model are as follows:
   a. 4% Minimum Slope top area: 305 ft.
   b. 25% Maximum Slope sideslopes: 196 ft.

6. Two cover scenarios were analyzed for the 4% top slope and two for the 25% sideslopes. The cover scenarios are described in Tables 1 through 4.

7. The initial moisture content of the soil layers were calculated by the HELP Model to be nearly steady state (i.e., the HELP Model automatically generates the initial moisture content for each layer based on weather inputs and layer data).

8. An assumed 1-acre unit design area was used for modeling purposes to compute unit quantities.

9. As presented in Table 5 of this appendix, soil layers were modeled using HELP Model default soil characteristics (porosity, field capacity, wilting point and saturated hydraulic conductivity).

10. When present, the compacted clay component of the final cover was assumed to have a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec.

11. Final Cover Condition Inputs:

    a. Fair grass conditions
    b. Evaporative zone depth = 20 inches (recommended by the HELP Model for fair grass conditions for East Lansing, Michigan)
    c. Maximum leaf area index = 2.0 (recommended by the HELP Model for fair grass conditions)
    d. Fraction of area allowing run-off = 100 percent
    e. Run-off curve number = calculated by HELP model based on soil types and slope information input.
    f. Length of model run = 30 years (chosen to allow for more representative average values).

12. The HELP model does not allow the modeling of two “barrier” layers adjacent to one another. To overcome this software limitation, the GCL is modeled as a vertical percolation layer.

13. The use of geotextiles does not affect infiltration in the HELP model and therefore geotextiles are not included in the analysis.

14. A geocomposite with a 250 mil geonet is assumed. An effective hydraulic conductivity of 0.0293 m/s will be used for the assumed geocomposite drainage layer as calculated in the Geocomposite Capacity Analysis provided in Attachment 1.

15. The 4 percent top slope area drainage layer discharges to the diversion berms.

CALCULATION SHEET

AECOM

Client	DOW Corning Corp.	**Subject**	Final Cover	**Project No.**	60134827
Project	Midland Plant Landfill Renewal Application		Infiltration Evaluation	**Prepared By**	TCR — **Date** 5/5/11
				Reviewed By	NKW — **Date** 5/5/11
				Approved By	DFP — **Date** 5/6/11

HELP MODEL GENERAL LAYOUT

Table 1: 4% Top Slope, Cover A - HELP Model Layout

(Layer Number) Layer Description	Flow	Thickness	Saturated Hydraulic Conductivity	Soil Type/ Texture Number
(1)vertical percolation	↓	6 inches	1.2×10^{-4} cm/sec	topsoil/#10
(2)vertical percolation	↓	18 inches	1.2×10^{-4} cm/sec	protective soil/#10
(3)lateral drainage	→	0.25 inches	2.93 cm/sec	geonet/#46
(4)geomembrane liner	↓	0.06 inch	4.0×10^{-13} cm/sec	geomembrane/#36
(5) GCL	↓	0.25 inches	3.0×10^{-9} cm/sec	GCL/#17
(6)barrier soil liner	↓	12 inches	1.0×10^{-7} cm/sec	barrier layer/#16

Table 2: 4% Top Slope, Cover B - HELP Model Layout

(Layer Number) Layer Description	Flow	Thickness	Saturated Hydraulic Conductivity	Soil Type/ Texture Number
(1)vertical percolation	↓	6 inches	1.2×10^{-4} cm/sec	topsoil/#10
(2)vertical percolation	↓	6 inches	1.2×10^{-4} cm/sec	protective soil/#10
(3)lateral drainage	→	12 inches	5.8×10^{-3} cm/sec	sand/#2
(4)geomembrane liner	↓	0.06 inch	4.0×10^{-13} cm/sec	geomembrane/#36
(5)barrier soil liner	↓	36 inches	1.0×10^{-5} cm/sec	barrier layer/#16

Table 3: 25% Side Slope, Cover A - HELP Model Layout

(Layer Number) Layer Description	Flow	Thickness	Saturated Hydraulic Conductivity	Soil Type/ Texture Number
(1)vertical percolation	↓	6 inches	1.2×10^{-4} cm/sec	topsoil/#10
(2)vertical percolation	↓	18 inches	1.2×10^{-4} cm/sec	protective soil/#10
(3)lateral drainage	→	0.25 inches	2.93 cm/sec	geonet/#46
(4)geomembrane liner	↓	0.06 inch	4.0×10^{-13} cm/sec	geomembrane/#36
(5)barrier soil liner	↓	36 inches	1.0×10^{-7} cm/sec	barrier layer/#16

Table 4: 25% Top Slope, Cover B - HELP Model Layout

(Layer Number) Layer Description	Flow	Thickness	Saturated Hydraulic Conductivity	Soil Type/ Texture Number
(1)vertical percolation	↓	6 inches	1.2×10^{-4} cm/sec	topsoil/#10
(2)vertical percolation	↓	18 inches	1.2×10^{-4} cm/sec	protective soil/#10
(3)lateral drainage	→	0.25 inches	2.93 cm/sec	geonet/#46
(4)geomembrane liner	↓	0.06 inch	4.0×10^{-13} cm/sec	geomembrane/#36
(5) GCL	↓	0.25 inches	3.0×10^{-9} cm/sec	GCL/#17
(6)barrier soil liner	↓	12 inches	1.0×10^{-7} cm/sec	barrier layer/#16

Table 5: Soil Texture Properties

Soil Texture No.	Soil Classification		Comments, Properties, and Uses
	USDA	USCS	
2	S	---	HELP Model default parameter to model drainage sand. The effective saturated hydraulic conductivity = 5.8×10^{-3} cm/sec.
10	SCL	SC	Assumed HELP model default soil to model the topsoil and vegetative support soil.
16	C Clay	CH Clay	HELP Model default parameter for a barrier soil. This soil was modeled for the compacted clay layer. This soil type was used based on an effective saturated hydraulic conductivity = 1×10^{-7} cm/sec.
17	---	---	HELP Model default parameter for a bentonite mat, used to model the GCL. The effective saturated hydraulic conductivity = 3×10^{-9} cm/sec
36	---	---	HELP Model default parameters for the LLDPE geomembrane, used to model the 60-mil VLDPE geomembrane in the final cover. Effective saturated hydraulic conductivity of the geomembrane is 4×10^{-13} cm/sec.
46	---	---	Based on the HELP Model default parameter for a drainage net, used to model the geocomposite drainage layer. The effective saturated hydraulic conductivity of the default parameter has been modified to 2.93 cm/sec.

NOTE: All soil properties are defaults of HELP Model, Version 3.07.

Calculations

HELP Model output files are provided in Attachments 2 and 3 for the 4% Top Slope and Attachments 4 and 5 for the 25% Side Slope. Summaries of HELP Model results for peak daily values are provided in Table 6. Peak daily values are presented in the HELP Model output file in both inches per day and cubic feet per day. These results are equivalent but presented in different units.

The drainage collected from the drainage layer is also the geocomposite surface water impingement rate. The HELP model presents the drainage collected in inches per day, a sample conversion to meters per second is provided below.

Sample Conversion: 1 inch/day x 1 day/86,400 sec x 1 inch/0.0254 meters = 4.56×10^{-4} m/s

Client	DOW Corning Corp.	**Subject**	Final Cover	**Prepared By** TCR	**Date** 5/5/11
Project	Midland Plant Landfill Renewal Application		Infiltration Evaluation	**Reviewed By** NKW	**Date** 5/5/11
				Approved By DFP	**Date** 5/6/11

Table 6: Peak Daily Values

	4 Top Slope		25% Side Slope	
	Cover A	Cover B	Cover A	Cover B
Drainage collected from drainage layer - Impingement Rate (inches/day)	0.54474	0.04996	0.71355	0.71355
Drainage collected from drainage layer - Impingement Rate (meters/second)	0.000248	2.28E-05	0.000325	0.000325
Head in drainage layer (inches)	18.108	20.098	0.036	0.036

Conclusions

As shown in Table 6, the surface water infiltration rate (impingement rate) to the drainage layer and the liquid head in the drainage layer varies based on the cover option and slope. These values were used for the stability analysis and design of the final cover drainage system.

References

Schroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjostrom, J.W., and Peyton, R.L., 1994. “The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3,” EPA/600/9-94/xxx, U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, Ohio

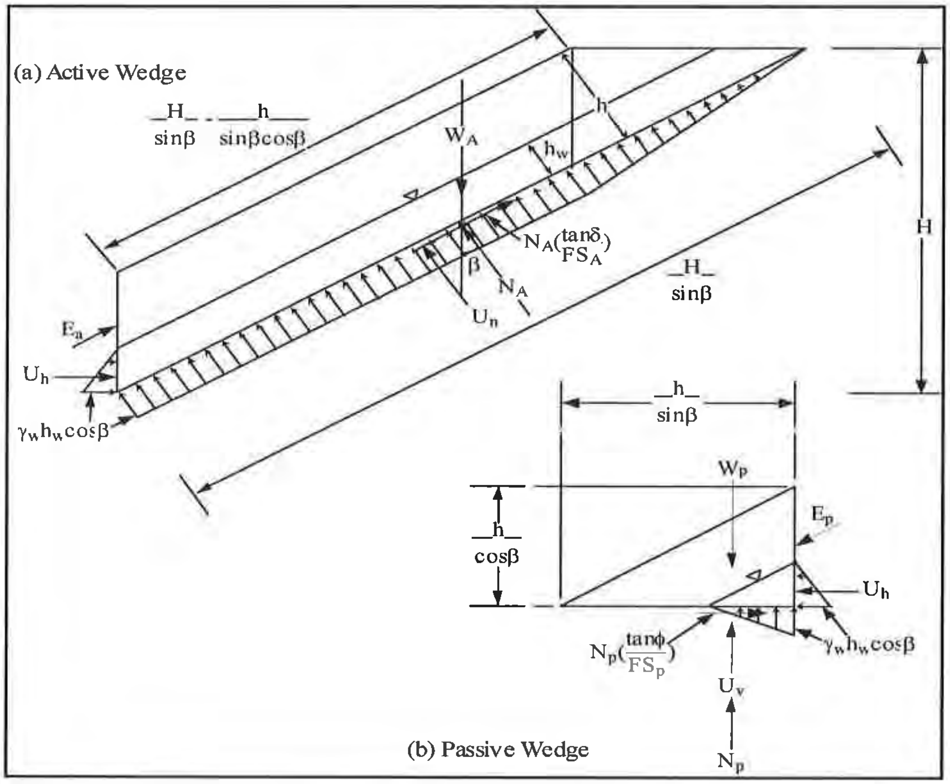
ATTACHMENT 2

STABILITY WORKSHEETS
(REFERENCE 1)

Cover Soil Stability Analysis Worksheet

Seepage Forces with Parallel-to-Slope Seepage Buildup

Plateau Liner - minimum phi to achieve FS of 1.5 for 18.1" head buildup



Calculation of FS

Active Wedge:

WA =	*1127.485*	*kN*
Un =	*424.6861*	*kN*
Uh =	*1.036624*	*kN*
NA =	*701.8567*	*kN*

Passive Wedge:

WP =	*91.5441*	*kN*
Uv =	*25.91573*	*kN*

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

a=	*45.0*
b=	*-68*
c=	*0.0*

FS= 1.502

thickness of cover soil = h =	0.61	m		
length of slope measured along the geomembrane = L =	100.00	m		
soil slope angle beneath the geomembrane = β =	2.29	°	*= 0.04*	*(rad.)*
vertical height of the slope measured from the toe = H =	*4.0*	*m*		
parallel submergence ratio = PSR =	0.754			
depth of the water surface measured from the geomembrane = hw =	*0.460*	*m*		
dry unit weight of the cover soil = γ *dry* =	18.69	kN/m^3		
saturated unit weight of the cover soil = γ *sat'd* =	20.42	kN/m^3		
unit weight of water = γ *w* =	9.81	kN/m^3		
friction angle of the cover soil = ϕ =	0.0	°	*= 0.00*	*(rad.)*
interface friction angle between cover soil and geomembrane = δ =	5.04	°	*= 0.09*	*(rad.)*

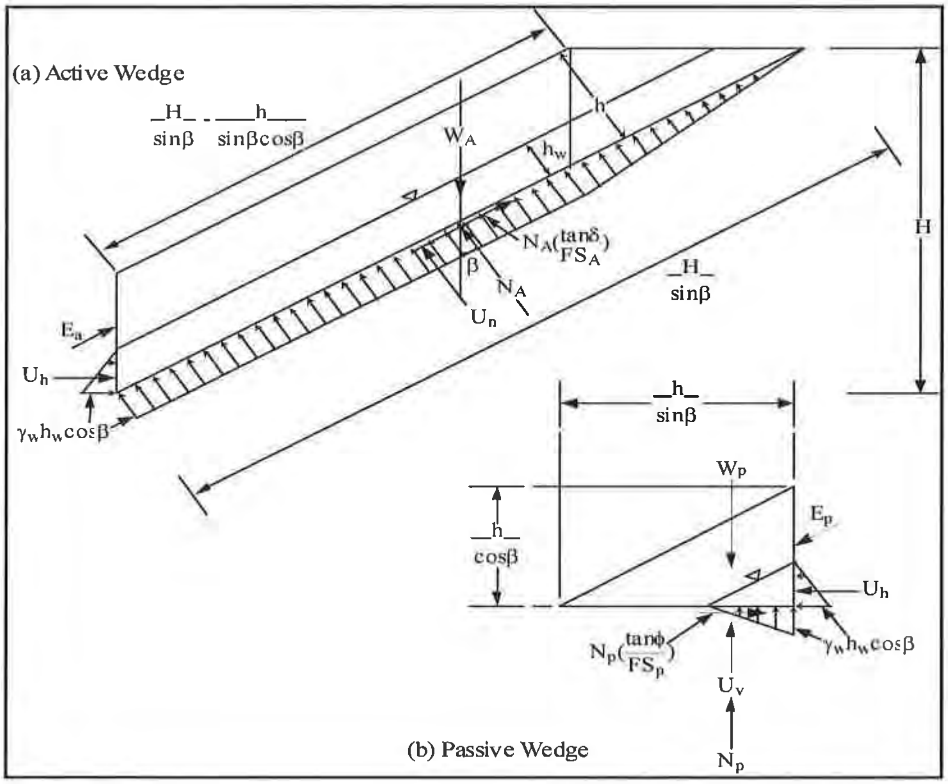
Note: numbers in boxes are input values

numbers in Italics are calculated values

Cover Soil Stability Analysis Worksheet

Seepage Forces with Parallel-to-Slope Seepage Buildup

Plateau Liner - minimum phi to achieve FS of 1.5 for 20.1" head buildup



Calculation of FS

Active Wedge:

WA =	*1135.197*	*kN*
Un =	*468.4302*	*kN*
Uh =	*1.278369*	*kN*
NA =	*665.8088*	*kN*

Passive Wedge:

WP =	*92.61044*	*kN*
Uv =	*31.95939*	*kN*

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

a=	*45.3*
b=	*-68*
c=	*0.0*

FS= 1.502

thickness of cover soil = h =	0.61	m		
length of slope measured along the geomembrane = L =	100.00	m		
soil slope angle beneath the geomembrane = β =	2.29	°	*= 0.04*	*(rad.)*
vertical height of the slope measured from the toe = H =	*4.0*	*m*		
parallel submergence ratio = PSR =	0.838			
depth of the water surface measured from the geomembrane = hw =	*0.511*	*m*		
dry unit weight of the cover soil = γ *dry* =	18.69	kN/m^3		
saturated unit weight of the cover soil = γ *sat'd* =	20.42	kN/m^3		
unit weight of water = γ *w* =	9.81	kN/m^3		
friction angle of the cover soil = φ =	0.0	°	*= 0.00*	*(rad.)*
interface friction angle between cover soil and geomembrane = δ =	5.36	°	*= 0.09*	*(rad.)*

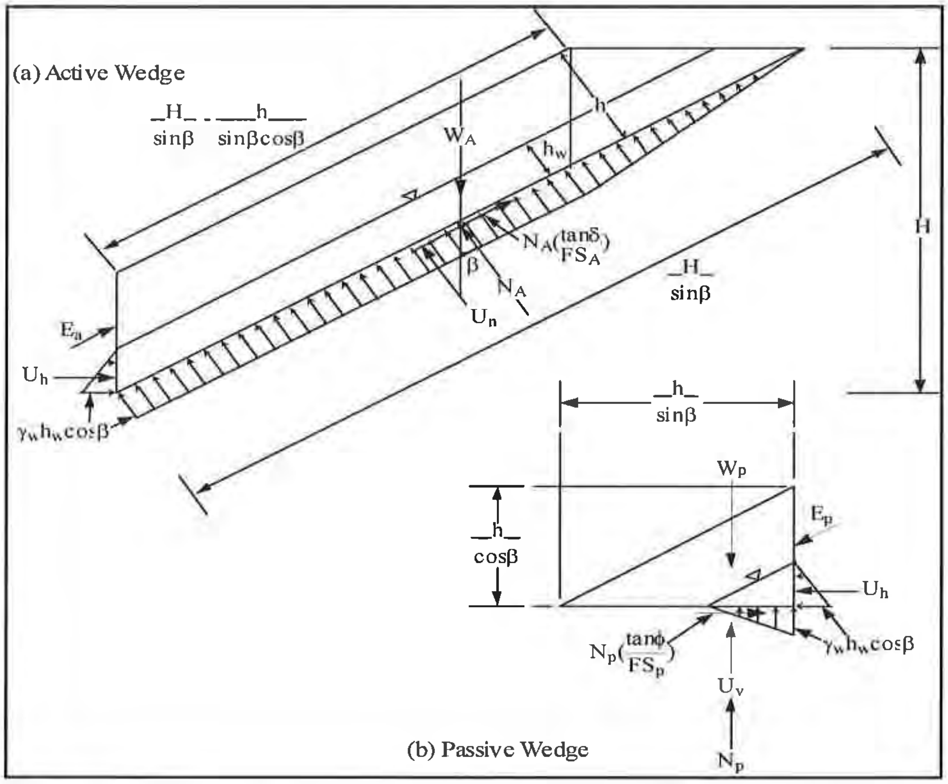
Note: numbers in boxes are input values

numbers in Italics are calculated values

Cover Soil Stability Analysis Worksheet

Seepage Forces with Parallel-to-Slope Seepage Buildup

Sideslope Liner - minimum phi to achieve FS of 1.5 with 0.036" head buildup



Calculation of FS

Active Wedge:

WA =	*666.0972*	kN
Un =	*0.519823*	kN
Uh =	*4.1E-06*	kN
NA =	*645.6894*	kN

Passive Wedge:

WP =	*14.76148*	kN
Uv =	*1.64E-05*	kN

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

a=	*156.7*
b=	*-235*
c=	*0.0*

FS= 1.500

thickness of cover soil = h =	0.61	m		
length of slope measured along the geomembrane = L =	59.74	m		
soil slope angle beneath the geomembrane = β =	14.04	°	= *0.24*	*(rad.)*
vertical height of the slope measured from the toe = H =	*14.5*	*m*		
parallel submergence ratio = PSR =	0.002			
depth of the water surface measured from the geomembrane = hw =	*0.001*	*m*		
dry unit weight of the cover soil = γ *dry* =	18.69	kN/m^3		
saturated unit weight of the cover soil = γ *sat'd* =	20.42	kN/m^3		
unit weight of water = γ *w* =	9.81	kN/m^3		
friction angle of the cover soil = φ =	0.0	°	= *0.00*	*(rad.)*
interface friction angle between cover soil and geomembrane = δ =	20.14	°	= *0.35*	*(rad.)*

Note: numbers in boxes are input values

numbers in Italics are calculated values

CLIENT: Dow Corning
PROJECT: Midland Facility

SUBJECT: Global Stability Analysis

Prepared By BPS Date 04/05/11
Reviewed By TW Date 04/05/11
Approved By ____ Date ____

TASK

Evaluate the global stability of the Dow Corning Midland Facility at final buildout (closure).

REFERENCES

1. Drawing Y1-36615 "Closure Plan for Hazardous Waste Landfill Final Topography", by W.A. Kibbe & Associates, revised 4 January 2010
2. Figure B3-2 "Topography, Cross Section Traces and Locations of Wells and Boring" from Module B3 Revision 2 (March 2010).
3. Appendix B3-2 "Logs of Wells and Borings: Dow Corning Facility" from Module B3 Revision 2 (March 2010).
4. "Summary Report Quality Assurance Testing" by Samtest, Inc., dated 6 February 1981 (perimeter clay barrier construction).
5. Table A11-2 "Native Clay Test Results" from Module A11 Revision 2 (March 2010).
6. "Principles of Geotechnical Engineering", B.Das, PWS Publishers 1985.
7. "Principles of Foundation Engineering, Second Edition", B.Das, PWS-Kent Publishing Company, 1990.

METHODOLOGY

The computer program GeoSlope was used to perform the stability analyses. GeoSlope is based on the program STABL4, developed by Purdue University for the Federal Highway Administration. The simplified Bishop Method for circular arc failure surfaces was used to perform the analysis. The GeoSlope program searches until it finds the surface that produces the lowest factor of safety. This surface is the potential failure surface.

One (1) cross-section was selected to evaluate the global stability of the Midland Facility. The location of the cross-section is shown on the attached Figure S1. Cross-Section A-A was chosen because it represents a worst-case scenario taken through the longest uninterrupted 4H:1V slope and nearly the peak height of refuse.

An analysis of veneer stability of the final closure cap geosynthetics is not included with these calculations and is presented within a separate calculation brief.

ASSUMPTIONS

1. Soil parameters were interpreted from references 3 through 7.

2. As the composition of the in-place industrial waste is unknown, a parametric analysis was performed using a range of unit weights and internal shear characteristics that represent industrial waste and C&D waste with little recycling to waste streams in which metals and uncontaminated material are reclaimed/recycled. The unit weights selected to represent this range are 60pcf and 100pcf. As internal shear strength varies dependent on waste type, compaction, uniformity, etc., several values of friction (phi) were evaluated while cohesion (c) was conservatively neglected.

3. For these calculations, final cover soil was assumed to be constructed of re-compacted native clay soils, which are assumed to be stiff with a cohesion value of c = 1,000 psf. The frictional component of shear strength is assumed to equal "0". Unit weight was estimated assuming re-compaction of native clay to 90% maximum dry density at optimum moisture content as:

   Unit weight = 0.90 x 119 pcf x 1.143 = 122 pcf

4. Clay "curtain wall" and base liner are assumed to be constructed of native clay (reference 4) re-compacted to 95% maximum dry density at optimum moisture content. Shear strength parameters are identical to assumption 3 while unit weight was estimated as:

   Unit weight = 0.95 x 134 pcf x 1.087 = 138 pcf

5. Native soil thicknesses and depth to groundwater were estimated from borings 86B, DMW8, DMW5, 800-002. and 1000-99 from reference 3.

6. The native clay thickness ranges from 15 to 40-ft thick in the area of Cross-Section A-A. Clay parameters are assumed to be consistent with reference 5 and correlations form references 6 and 7. Shear strength parameters are identical to assumption 3. Unit weight is estimated based on reference 5 as:

   Unit weight = 119 pcf x 1.156 = 138 pcf

7. The native silty sand thickness ranges from 5 to 15-ft thick in the area of Cross-Section A-A. Sand parameters are assumed. Review of the boring logs indicates an average standard penetration number of 6. Per Table 13.5 of reference 6, this is indicative of a sandy soil with an angle of friction (phi) = 29°. The cohesion component of shear strength is assumed to equal 0. Unit weight is assumed based on Table 1.3 of reference 7 as based on loose silty sand. Unit weight was estimated as:

   Unit weight = 102 pcf x 1.25 = 128 pcf

8. The elevation of groundwater was measured at an elevation of 3-ft to 10-ft below grade for the borings in the vicinity of Cross Section A-A. An average elevation of 625 was assumed within the silty sand layer from station 0+00 to the intercept with the perimeter clay barrier. Then the groundwater was assumed to follow the base of recompacted clay.

9. The Facility is not within a seismic impact zone. According to the USEPA, "if the maximum horizontal acceleration is less than or equal to 0.1g, then the design of the unit will not have to incorporate an evaluation of seismic effects unless the facility will be situated in an area with low strength foundation soils or soils with potential for liquefaction" (USEPA, 1993). Neither of these conditions exists at the Facility and, therefore, a seismic analysis is not required.

10. Circular failure surfaces are not extended into the glacial till layer assumed to coincide with an average elevation 597 at top of the "gravelly" clay layer from the boring logs.

CLIENT: Dow Corning
PROJECT: Midland Facility

SUBJECT: Global Stability Analysis

Prepared By BPS Date 04/05/11
Reviewed By TW Date 04/05/11
Approved By ____ Date ____

Summary of Soil Parameters

Soil Type No.	Component	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
1	Final Cover	122	0	1,000
2	Compacted Refuse	60	25	0
			30	0
			35	0
		100	25	0
			30	0
			35	0
3	Re-compacted Clay	138	0	1,000
4	Native Clay	138	0	1,000
5	Native Sand	128	29	0

RESULTS

The GeoSlope output is attached for the global circular failure analyses. The results for Cross-Section A-A are summarized below.

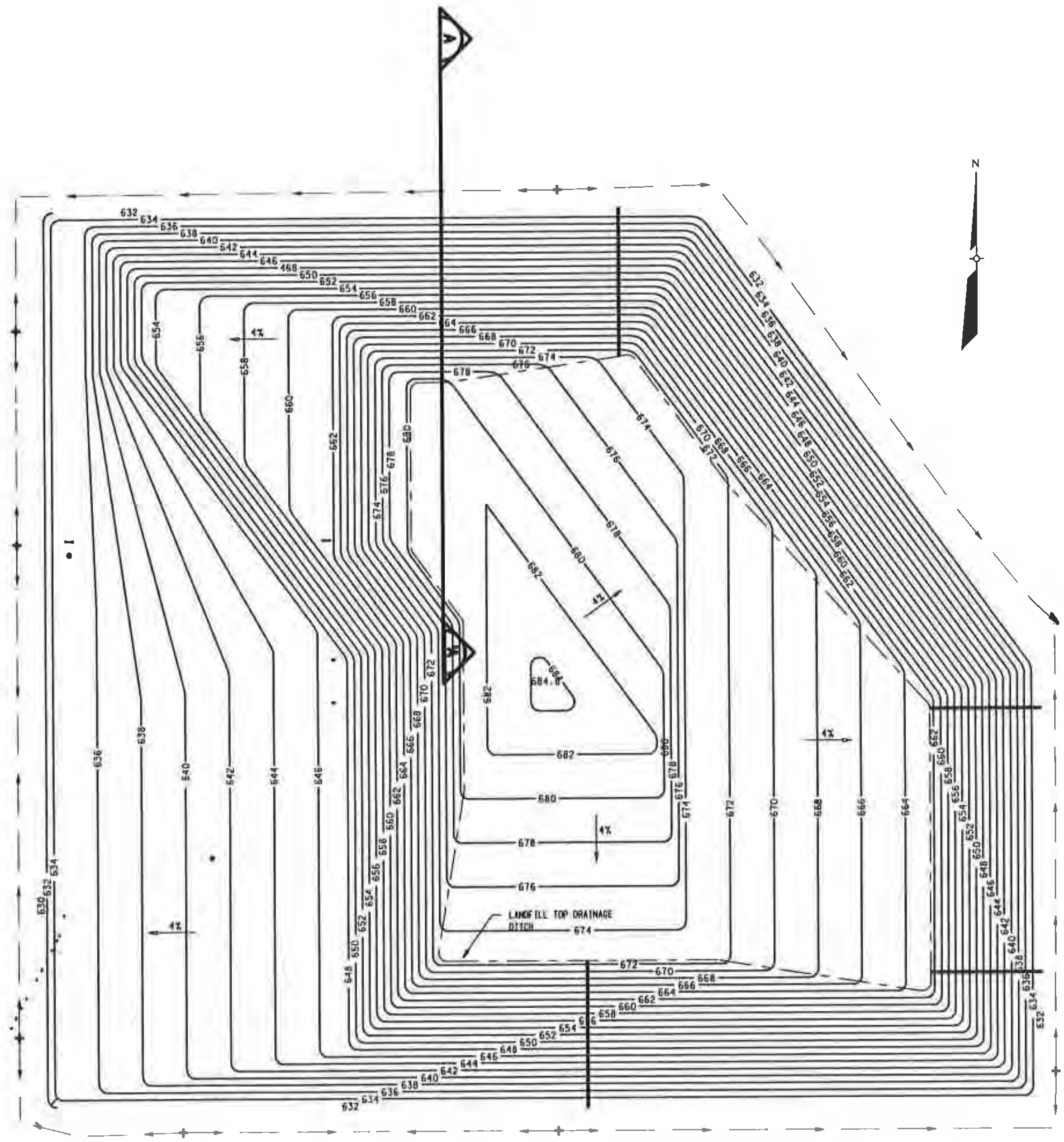
Waste Unit Weight (pcf)	Waste Friction Angle (degrees)	Waste Cohesion (psf)	Static Factor of Safety
60	25	0	2.21
	30	0	2.34
	35	0	2.47
100	25	0	1.53
	30	0	1.63
	35	0	1.74

CONCLUSIONS

Generally, a factor of safety of 1.5 or greater is considered stable for the static condition.

Based on the assumptions for the subsurface soils and the parametric analysis for waste unit weight and internal shear strength, the long-term static factor of safety exceeds 1.5.

CROSS-SECTIONS LOCATION PLAN



AECOM

FIGURE S1
SLOPE STABILITY
CROSS-SECTION
DOW CORNING CORPORATION
MIDLAND PLANT

MARCH 2011

PROJECT 60134827

I:\group\CADD\Dow Corning Midland\stabfig.dgn 3/24/2011

CROSS-SECTION A-A
STATIC CIRCULAR ANALYSIS
$\gamma_{waste} = 60$ pcf
$\Phi_{waste} = 25°$

```
*****************************************************************************
*****                           GeoSlope                               *****
*****                         Version 5.10                             *****
*****                                                                  *****
*****              (c)1992 by GEOCOMP Corp, Concord, MA                *****
*****                       Licensed to RUST                           *****
*****************************************************************************
```

Problem Title : Dow Corning Midland Facility
Description : Slope Stability Cross-Section A-A'
Remarks : Waste unit weight 60pcf, Waste phi=25

```
*****************************************************************************
*****                          INPUT DATA                              *****
*****************************************************************************
```

Profile Boundaries

Number of Boundaries : 29
Number of Top Boundaries : 13

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	628.00	119.79	628.38	5
2	119.79	628.38	141.79	628.38	5
3	141.79	628.38	169.60	628.00	5
4	169.60	628.00	173.60	626.00	5
5	173.60	626.00	177.60	628.00	5
6	177.60	628.00	195.79	632.00	5
7	195.79	632.00	199.79	633.00	5
8	199.79	633.00	207.98	635.05	1
9	207.98	635.05	387.79	680.00	1
10	387.79	680.00	451.02	680.80	1
11	451.02	680.80	639.94	675.50	1
12	639.94	675.50	674.77	675.50	1
13	674.77	675.50	700.00	675.50	1
14	199.79	633.00	199.80	628.00	5
15	199.80	628.00	205.79	628.00	3
16	205.79	628.00	387.79	675.00	2
17	387.79	675.00	451.02	675.80	2
18	451.02	675.80	639.94	670.50	2
19	639.94	670.50	674.77	670.50	2
20	674.77	670.50	700.00	670.50	2
21	205.79	628.00	217.96	620.00	3
22	217.96	620.00	307.96	620.34	3
23	307.96	620.34	700.00	618.85	3
24	199.80	628.00	211.96	620.00	5
25	0.00	622.00	90.00	621.00	4
26	90.00	621.00	211.96	620.00	4
27	211.96	620.00	217.96	617.50	4
28	217.96	617.50	307.96	617.84	4
29	307.96	617.84	700.00	616.35	4

Soil Parameters

Number of Soil Types : 5

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	122.0	122.0	1000.0	0.0	0.00	0.0	0
2	60.0	60.0	0.0	25.0	0.00	0.0	0
3	138.0	138.0	1000.0	0.0	0.00	0.0	0
4	138.0	138.0	1000.0	0.0	0.00	0.0	0
5	128.0	128.0	0.0	29.0	0.00	0.0	0

Piezometric Surfaces

Number of Surfaces : 1
Unit Weight of Water : 62.40 pcf

Piezometric Surface No. : 1
Number of Coordinate Points : 6

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	625.00
2	204.35	625.00
3	211.96	620.00
4	217.96	617.50
5	307.96	617.84
6	700.00	616.35

****
*****   TRIAL SURFACE GENERATION   *****
****

Data for Generating Circular Surfaces

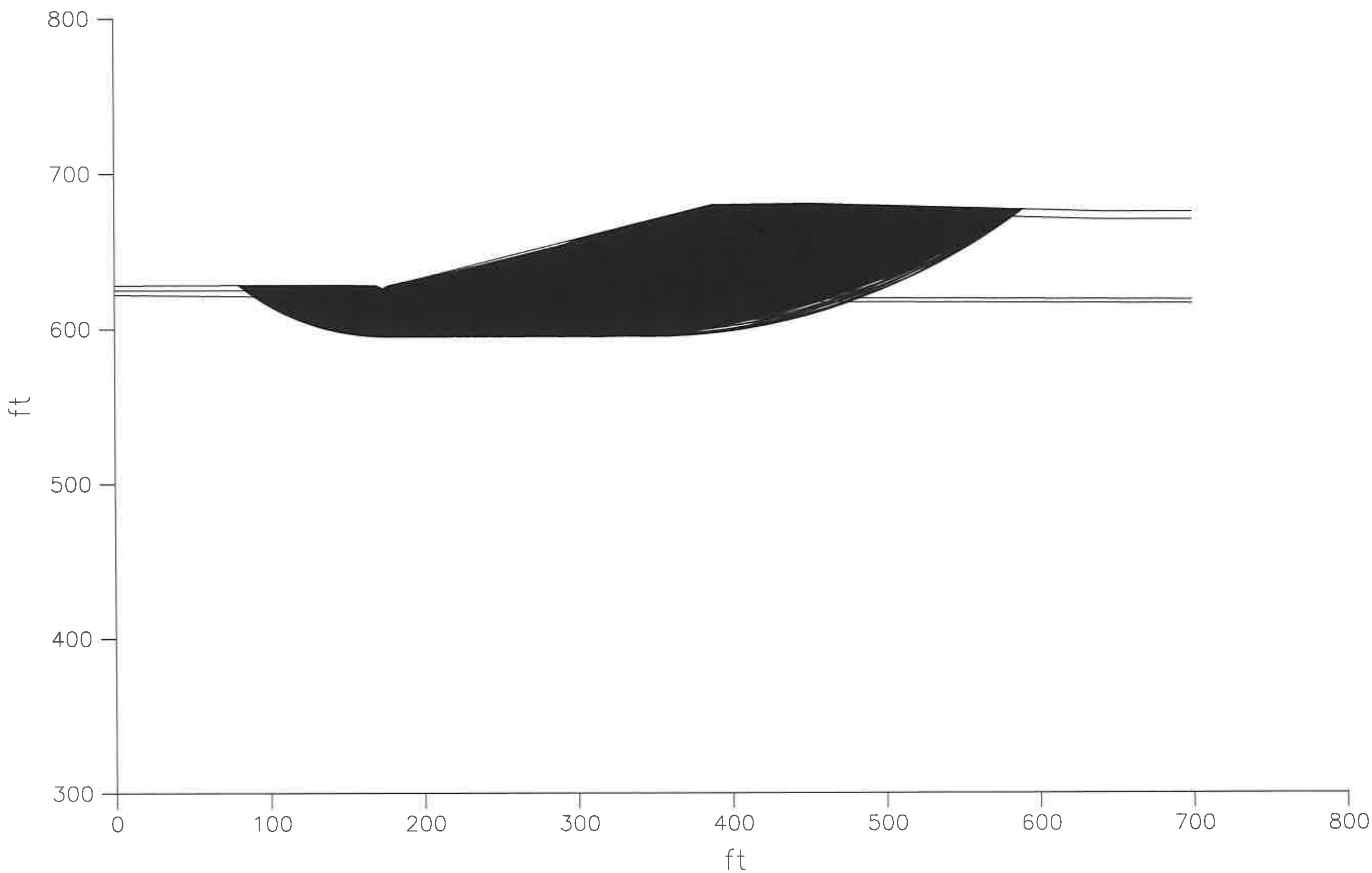
Number of Initiation Points : 100
Number of Surfaces From Each Point : 100
Left Initiation Point : 80.00 ft
Right Initiation Point : 200.00 ft
Left Termination Point : 300.00 ft
Right Termination Point : 590.00 ft
Minimum Elevation : 595.00 ft
Segment Length : 5.00 ft
Positive Angle Limit : 0.00 deg
Negative Angle Limit : 0.00 deg

****
*****   RESULTS   *****
****

Critical Surfaces

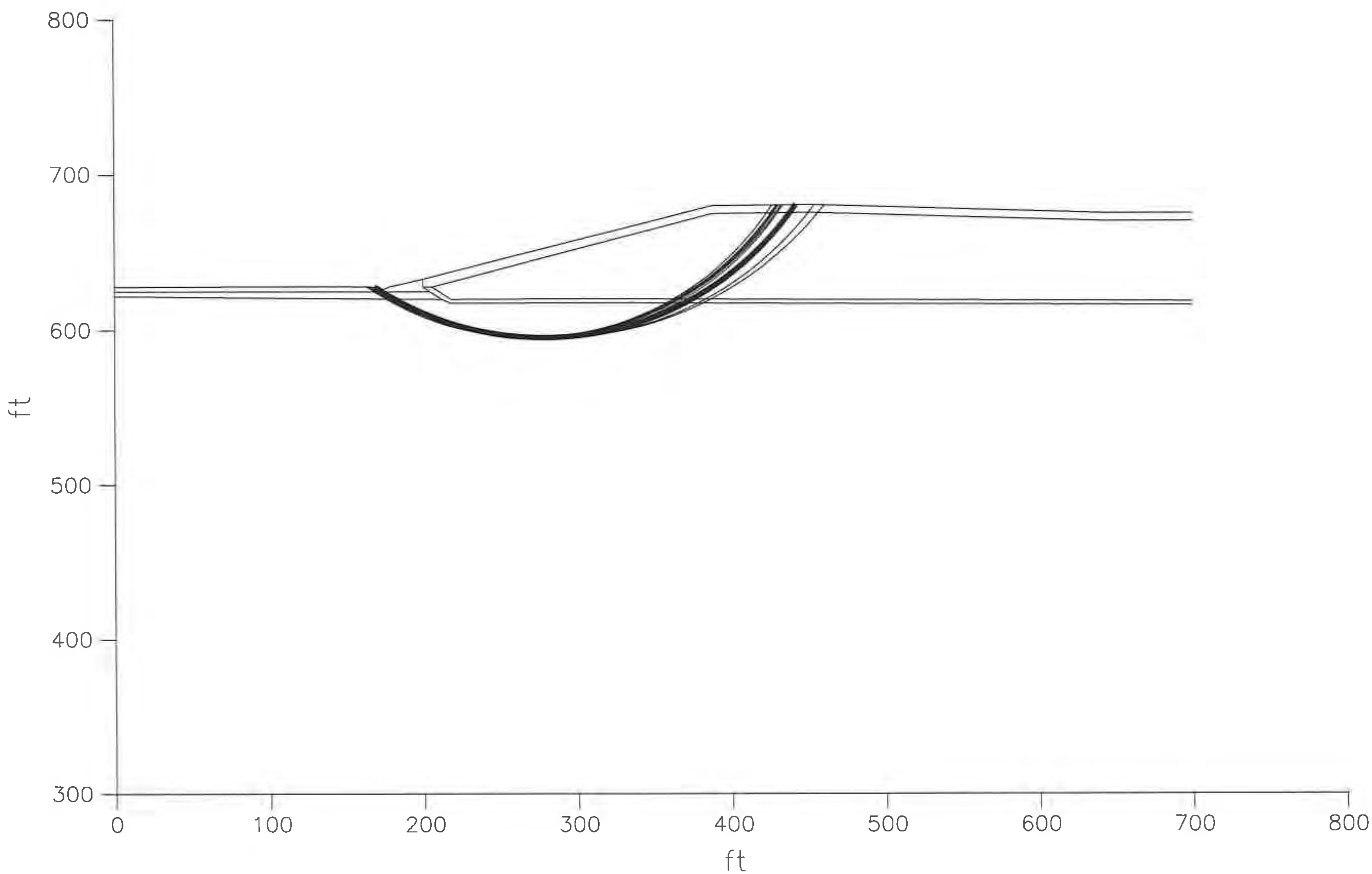
No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	2.212	278.15	795.20	199.94
2	2.215	273.01	781.71	186.54
3	2.215	283.43	808.28	213.20
4	2.216	276.29	783.83	188.33
5	2.220	272.42	789.15	193.70
6	2.223	274.68	783.56	187.38
7	2.223	272.60	785.28	189.26
8	2.225	270.98	786.37	190.59
9	2.226	269.49	783.33	187.90
10	2.228	284.25	820.56	225.27

Bishop Circular Surfaces — Search for Critical Surfaces



Bishop Circular Surfaces — Most Critical Surfaces

Minimum Factor of Safety : 2.212



CROSS-SECTION A-A
STATIC CIRCULAR ANALYSIS

$\gamma_{waste} = 60$ pcf

$\Phi_{waste} = 30°$

```
*****************************************************************************
*****                          GeoSlope                                 *****
*****                        Version 5.10                               *****
*****                                                                   *****
*****             (c)1992 by GEOCOMP Corp, Concord, MA                  *****
*****                     Licensed to RUST                              *****
*****************************************************************************
```

Problem Title : Dow Corning Midland Facility
Description : Slope Stability Cross-Section A-A'
Remarks : Waste unit weight 60pcf, Waste phi=30

```
*****************************************************************************
*****                          INPUT DATA                               *****
*****************************************************************************
```

Profile Boundaries

Number of Boundaries : 29
Number of Top Boundaries : 13

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	628.00	119.79	628.38	5
2	119.79	628.38	141.79	628.38	5
3	141.79	628.38	169.60	628.00	5
4	169.60	628.00	173.60	626.00	5
5	173.60	626.00	177.60	628.00	5
6	177.60	628.00	195.79	632.00	5
7	195.79	632.00	199.79	633.00	5
8	199.79	633.00	207.98	635.05	1
9	207.98	635.05	387.79	680.00	1
10	387.79	680.00	451.02	680.80	1
11	451.02	680.80	639.94	675.50	1
12	639.94	675.50	674.77	675.50	1
13	674.77	675.50	700.00	675.50	1
14	199.79	633.00	199.80	628.00	5
15	199.80	628.00	205.79	628.00	3
16	205.79	628.00	387.79	675.00	2
17	387.79	675.00	451.02	675.80	2
18	451.02	675.80	639.94	670.50	2
19	639.94	670.50	674.77	670.50	2
20	674.77	670.50	700.00	670.50	2
21	205.79	628.00	217.96	620.00	3
22	217.96	620.00	307.96	620.34	3
23	307.96	620.34	700.00	618.85	3
24	199.80	628.00	211.96	620.00	5
25	0.00	622.00	90.00	621.00	4
26	90.00	621.00	211.96	620.00	4
27	211.96	620.00	217.96	617.50	4
28	217.96	617.50	307.96	617.84	4
29	307.96	617.84	700.00	616.35	4

Soil Parameters

Number of Soil Types : 5

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	122.0	122.0	1000.0	0.0	0.00	0.0	0
2	60.0	60.0	0.0	30.0	0.00	0.0	0
3	138.0	138.0	1000.0	0.0	0.00	0.0	0
4	138.0	138.0	1000.0	0.0	0.00	0.0	0

5	128.0	128.0	0.0	29.0	0.00	0.0	0

Piezometric Surfaces

Number of Surfaces : 1
Unit Weight of Water : 62.40 pcf

Piezometric Surface No. : 1
Number of Coordinate Points : 6

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	625.00
2	204.35	625.00
3	211.96	620.00
4	217.96	617.50
5	307.96	617.84
6	700.00	616.35

```
******************************************************************************
*****                     TRIAL SURFACE GENERATION                       *****
******************************************************************************
```

Data for Generating Circular Surfaces

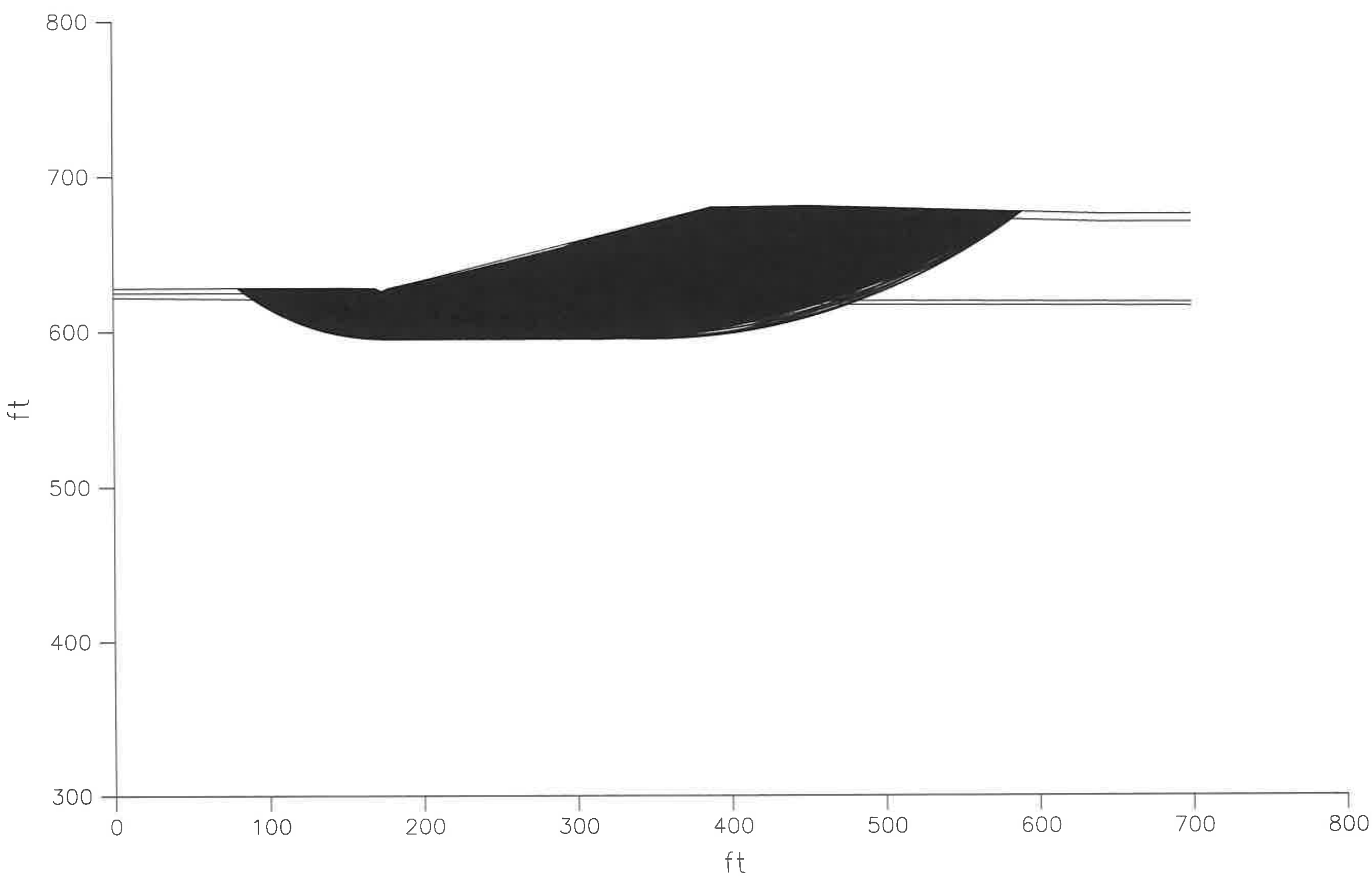
Number of Initiation Points : 100
Number of Surfaces From Each Point : 100
Left Initiation Point : 80.00 ft
Right Initiation Point : 200.00 ft
Left Termination Point : 300.00 ft
Right Termination Point : 590.00 ft
Minimum Elevation : 595.00 ft
Segment Length : 5.00 ft
Positive Angle Limit : 0.00 deg
Negative Angle Limit : 0.00 deg

```
******************************************************************************
*****                              RESULTS                               *****
******************************************************************************
```

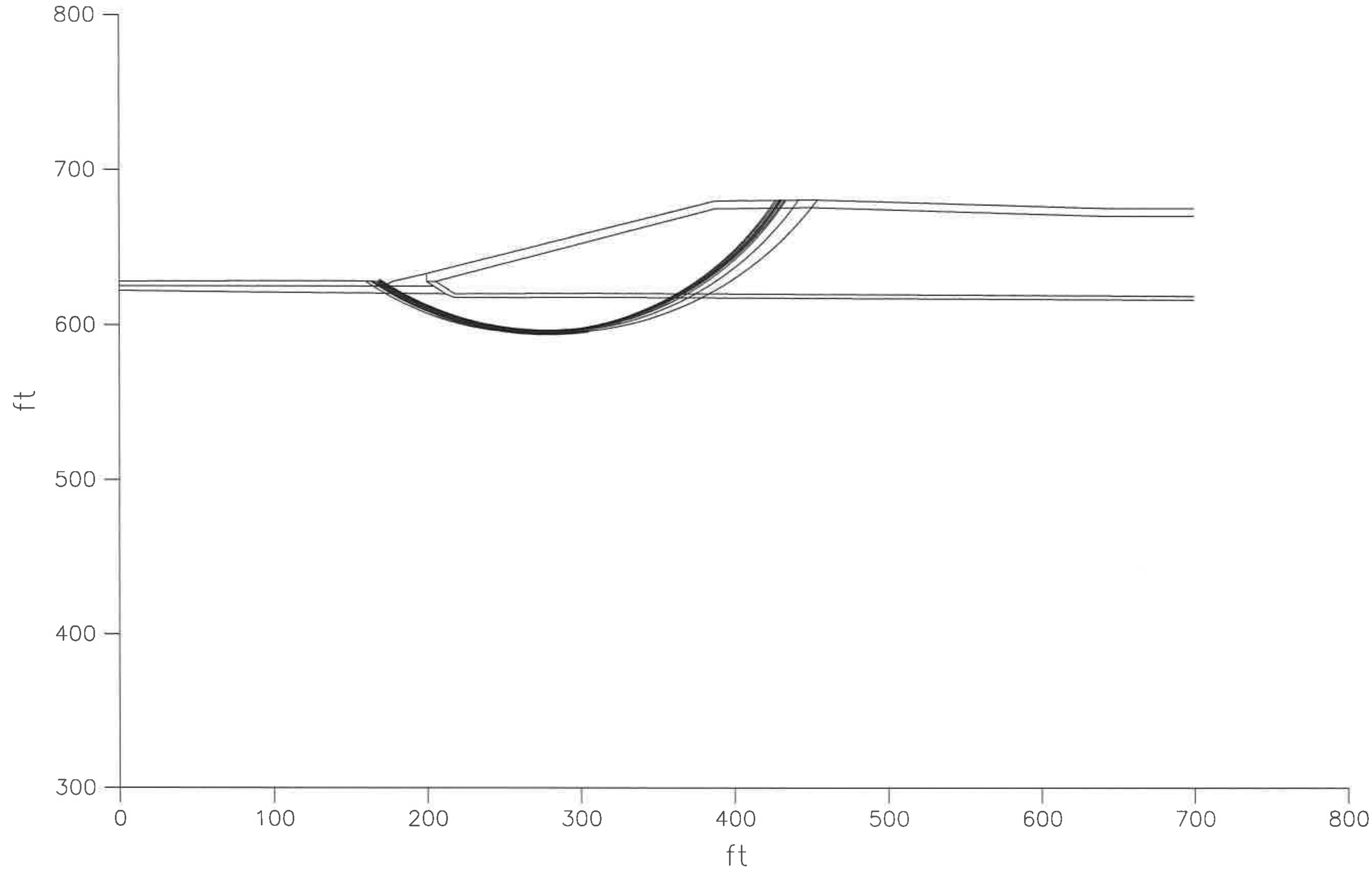
Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	2.339	278.15	795.20	199.94
2	2.339	273.01	781.71	186.54
3	2.342	276.29	783.83	188.33
4	2.344	283.43	808.28	213.20
5	2.345	272.42	789.15	193.70
6	2.351	272.60	785.28	189.26
7	2.351	269.49	783.33	187.90
8	2.351	274.68	783.56	187.38
9	2.351	270.98	786.37	190.59
10	2.358	267.94	788.06	192.94

Bishop Circular Surfaces – Search for Critical Surfaces



Bishop Circular Surfaces – Most Critical Surfaces



CROSS-SECTION A-A
STATIC CIRCULAR ANALYSIS
$\gamma_{waste} = 60$ pcf
$\Phi_{waste} = 35°$

```
*******************************************************************************
*****                          GeoSlope                                  *****
*****                        Version 5.10                                *****
*****                                                                    *****
*****              (c)1992 by GEOCOMP Corp, Concord, MA                  *****
*****                      Licensed to RUST                              *****
*******************************************************************************
```

Problem Title : Dow Corning Midland Facility
Description : Slope Stability Cross-Section A-A'
Remarks : Waste unit weight 60pcf, Waste phi=35

```
*******************************************************************************
*****                          INPUT DATA                                *****
*******************************************************************************
```

Profile Boundaries

Number of Boundaries : 29
Number of Top Boundaries : 13

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	628.00	119.79	628.38	5
2	119.79	628.38	141.79	628.38	5
3	141.79	628.38	169.60	628.00	5
4	169.60	628.00	173.60	626.00	5
5	173.60	626.00	177.60	628.00	5
6	177.60	628.00	195.79	632.00	5
7	195.79	632.00	199.79	633.00	5
8	199.79	633.00	207.98	635.05	1
9	207.98	635.05	387.79	680.00	1
10	387.79	680.00	451.02	680.80	1
11	451.02	680.80	639.94	675.50	1
12	639.94	675.50	674.77	675.50	1
13	674.77	675.50	700.00	675.50	1
14	199.79	633.00	199.80	628.00	5
15	199.80	628.00	205.79	628.00	3
16	205.79	628.00	387.79	675.00	2
17	387.79	675.00	451.02	675.80	2
18	451.02	675.80	639.94	670.50	2
19	639.94	670.50	674.77	670.50	2
20	674.77	670.50	700.00	670.50	2
21	205.79	628.00	217.96	620.00	3
22	217.96	620.00	307.96	620.34	3
23	307.96	620.34	700.00	618.85	3
24	199.80	628.00	211.96	620.00	5
25	0.00	622.00	90.00	621.00	4
26	90.00	621.00	211.96	620.00	4
27	211.96	620.00	217.96	617.50	4
28	217.96	617.50	307.96	617.84	4
29	307.96	617.84	700.00	616.35	4

Soil Parameters

Number of Soil Types : 5

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.

1	122.0	122.0	1000.0	0.0	0.00	0.0	0
2	60.0	60.0	0.0	35.0	0.00	0.0	0
3	138.0	138.0	1000.0	0.0	0.00	0.0	0
4	138.0	138.0	1000.0	0.0	0.00	0.0	0
5	128.0	128.0	0.0	29.0	0.00	0.0	0

Piezometric Surfaces

Number of Surfaces : 1
Unit Weight of Water : 62.40 pcf

Piezometric Surface No. : 1
Number of Coordinate Points : 6

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	625.00
2	204.35	625.00
3	211.96	620.00
4	217.96	617.50
5	307.96	617.84
6	700.00	616.35

****
*****   TRIAL SURFACE GENERATION   *****
****

Data for Generating Circular Surfaces

Number of Initiation Points : 100
Number of Surfaces From Each Point : 100
Left Initiation Point : 80.00 ft
Right Initiation Point : 200.00 ft
Left Termination Point : 300.00 ft
Right Termination Point : 590.00 ft
Minimum Elevation : 595.00 ft
Segment Length : 5.00 ft
Positive Angle Limit : 0.00 deg
Negative Angle Limit : 0.00 deg

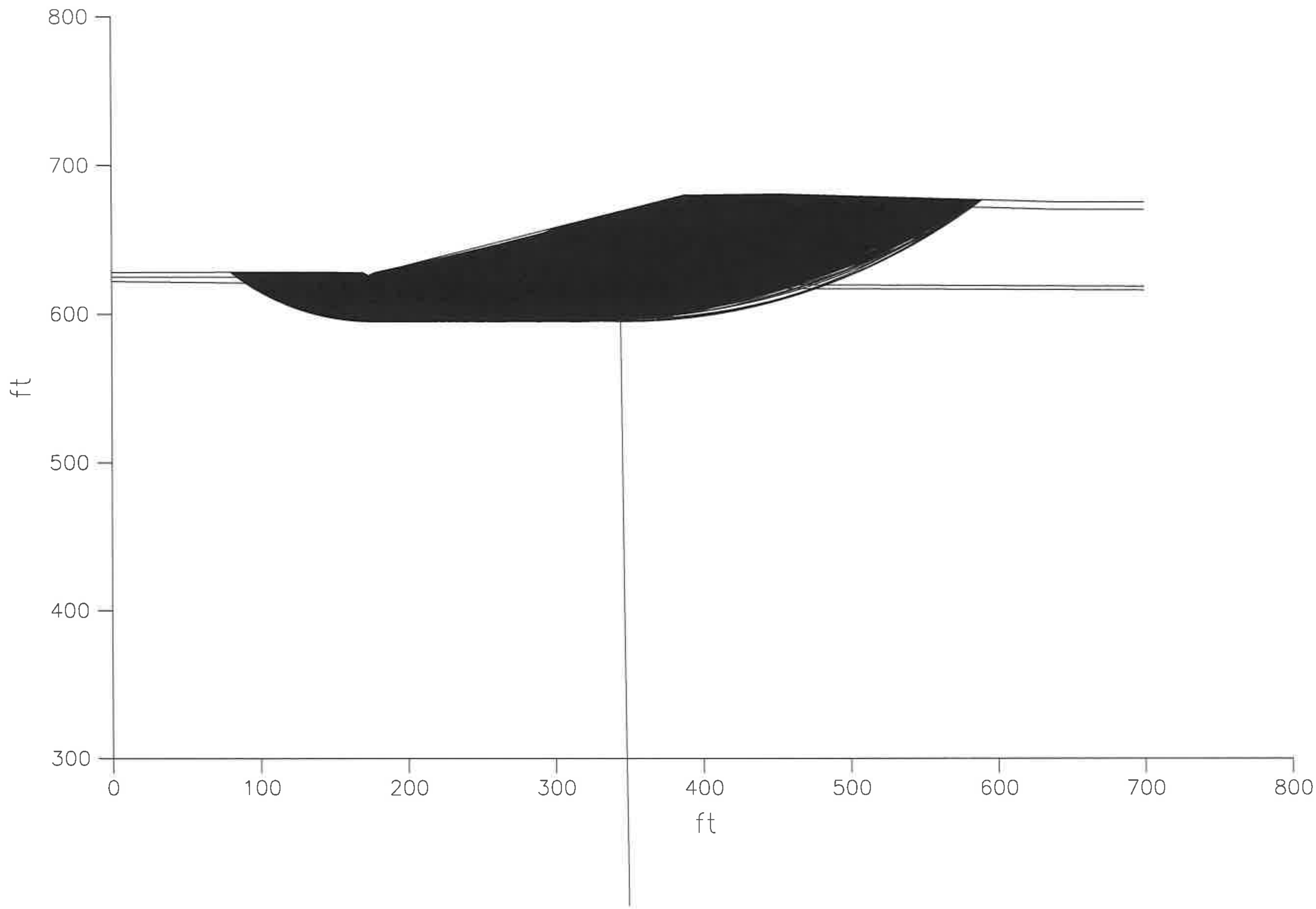
****
*****   RESULTS   *****
****

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	2.471	273.01	781.71	186.54
2	2.474	278.15	795.20	199.94
3	2.476	276.29	783.83	188.33
4	2.480	272.42	789.15	193.70
5	2.482	283.43	808.28	213.20
6	2.484	269.49	783.33	187.90
7	2.486	270.98	786.37	190.59
8	2.487	272.60	785.28	189.26

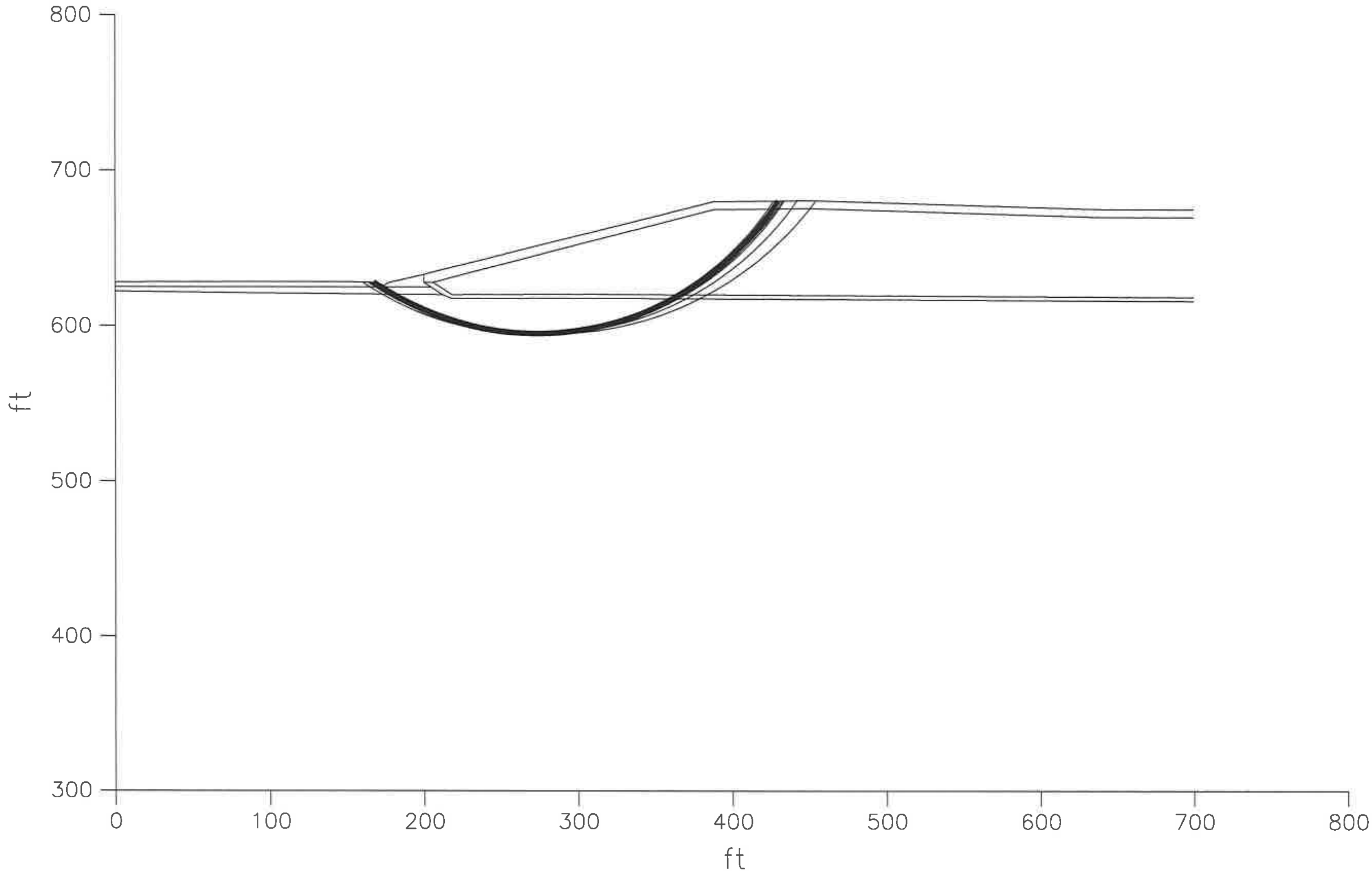
9	2.488	274.68	783.56	187.38
10	2.491	267.94	788.06	192.94

Bishop Circular Surfaces – Search for Critical Surfaces



Bishop Circular Surfaces — Most Critical Surfaces

Minimum Factor of Safety : 2.471



CROSS-SECTION A-A
STATIC CIRCULAR ANALYSIS
γ_{waste} = 100 pcf
Φ_{waste} = 25°

```
*******************************************************************************
*****                              GeoSlope                              *****
*****                            Version 5.10                            *****
*****                                                                    *****
*****             (c)1992 by GEOCOMP Corp, Concord, MA                   *****
*****                         Licensed to RUST                           *****
*******************************************************************************
```

Problem Title : Dow Corning Midland Facility
Description : Slope Stability Cross-Section A-A'
Remarks : Waste unit weight = 100 pcf, Waste phi = 25

```
*******************************************************************************
*****                              INPUT DATA                            *****
*******************************************************************************
```

Profile Boundaries

Number of Boundaries : 29
Number of Top Boundaries : 13

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	628.00	119.79	628.38	5
2	119.79	628.38	141.79	628.38	5
3	141.79	628.38	169.60	628.00	5
4	169.60	628.00	173.60	626.00	5
5	173.60	626.00	177.60	628.00	5
6	177.60	628.00	195.79	632.00	5
7	195.79	632.00	199.79	633.00	5
8	199.79	633.00	207.98	635.05	1
9	207.98	635.05	387.79	680.00	1
10	387.79	680.00	451.02	680.80	1
11	451.02	680.80	639.94	675.50	1
12	639.94	675.50	674.77	675.50	1
13	674.77	675.50	700.00	675.50	1
14	199.79	633.00	199.80	628.00	5
15	199.80	628.00	205.79	628.00	3
16	205.79	628.00	387.79	675.00	2
17	387.79	675.00	451.02	675.80	2
18	451.02	675.80	639.94	670.50	2
19	639.94	670.50	674.77	670.50	2
20	674.77	670.50	700.00	670.50	2
21	205.79	628.00	217.96	620.00	3
22	217.96	620.00	307.96	620.34	3
23	307.96	620.34	700.00	618.85	3
24	199.80	628.00	211.96	620.00	5
25	0.00	622.00	90.00	621.00	4
26	90.00	621.00	211.96	620.00	4
27	211.96	620.00	217.96	617.50	4
28	217.96	617.50	307.96	617.84	4
29	307.96	617.84	700.00	616.35	4

Soil Parameters

Number of Soil Types : 5

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.

1	122.0	122.0	1000.0	0.0	0.00	0.0	0
2	100.0	100.0	0.0	25.0	0.00	0.0	0
3	138.0	138.0	1000.0	0.0	0.00	0.0	0
4	138.0	138.0	1000.0	0.0	0.00	0.0	0
5	128.0	128.0	0.0	29.0	0.00	0.0	0

Piezometric Surfaces

Number of Surfaces : 1
Unit Weight of Water : 62.40 pcf

Piezometric Surface No. : 1
Number of Coordinate Points : 6

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	625.00
2	204.35	625.00
3	211.96	620.00
4	217.96	617.50
5	307.96	617.84
6	700.00	616.35

```
*****************************************************************************
*****                    TRIAL SURFACE GENERATION                       *****
*****************************************************************************
```

Data for Generating Circular Surfaces

Number of Initiation Points : 100
Number of Surfaces From Each Point : 100
Left Initiation Point : 80.00 ft
Right Initiation Point : 200.00 ft
Left Termination Point : 300.00 ft
Right Termination Point : 590.00 ft
Minimum Elevation : 595.00 ft
Segment Length : 5.00 ft
Positive Angle Limit : 0.00 deg
Negative Angle Limit : 0.00 deg

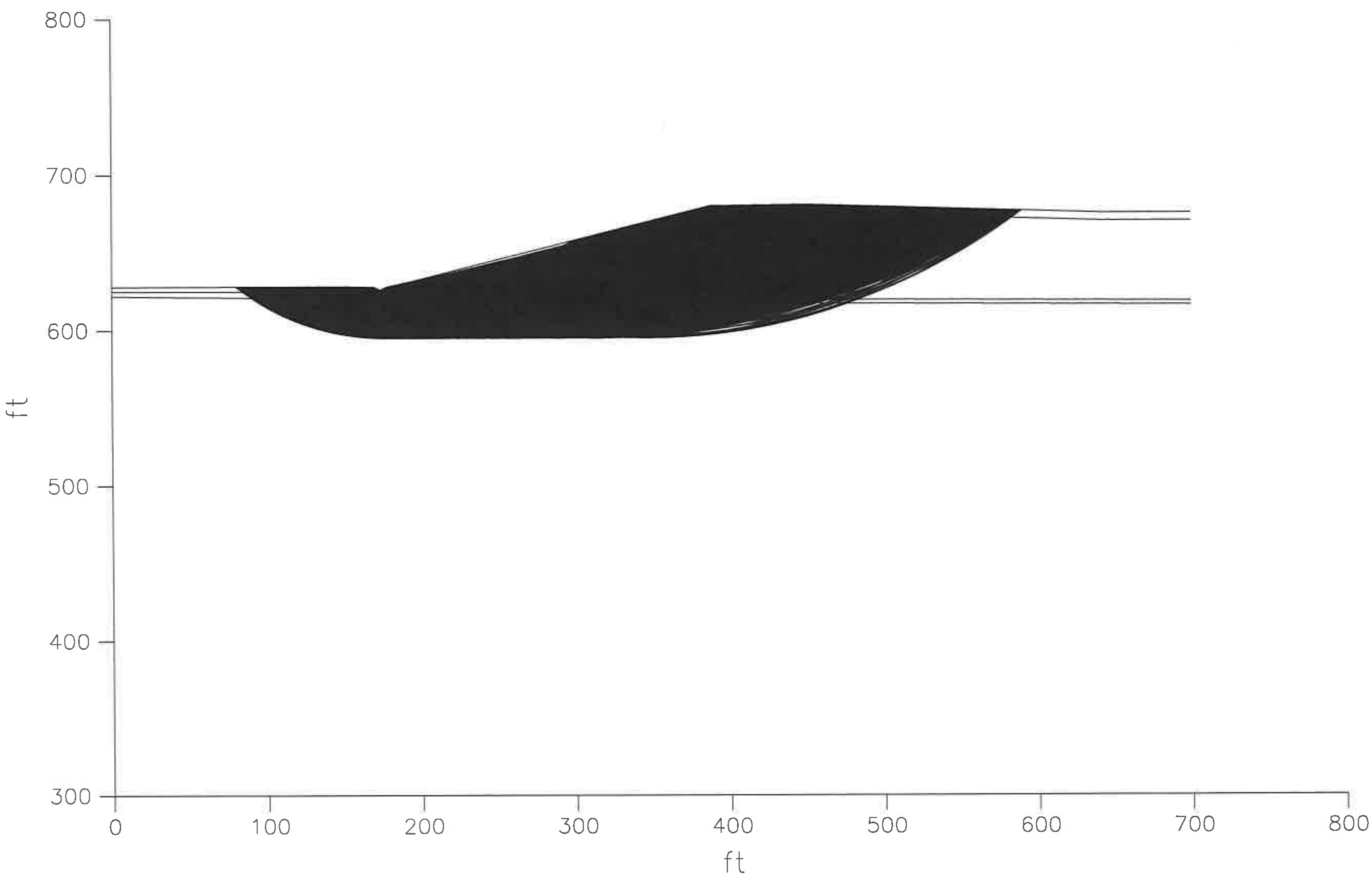
```
*****************************************************************************
*****                           RESULTS                                 *****
*****************************************************************************
```

Critical Surfaces

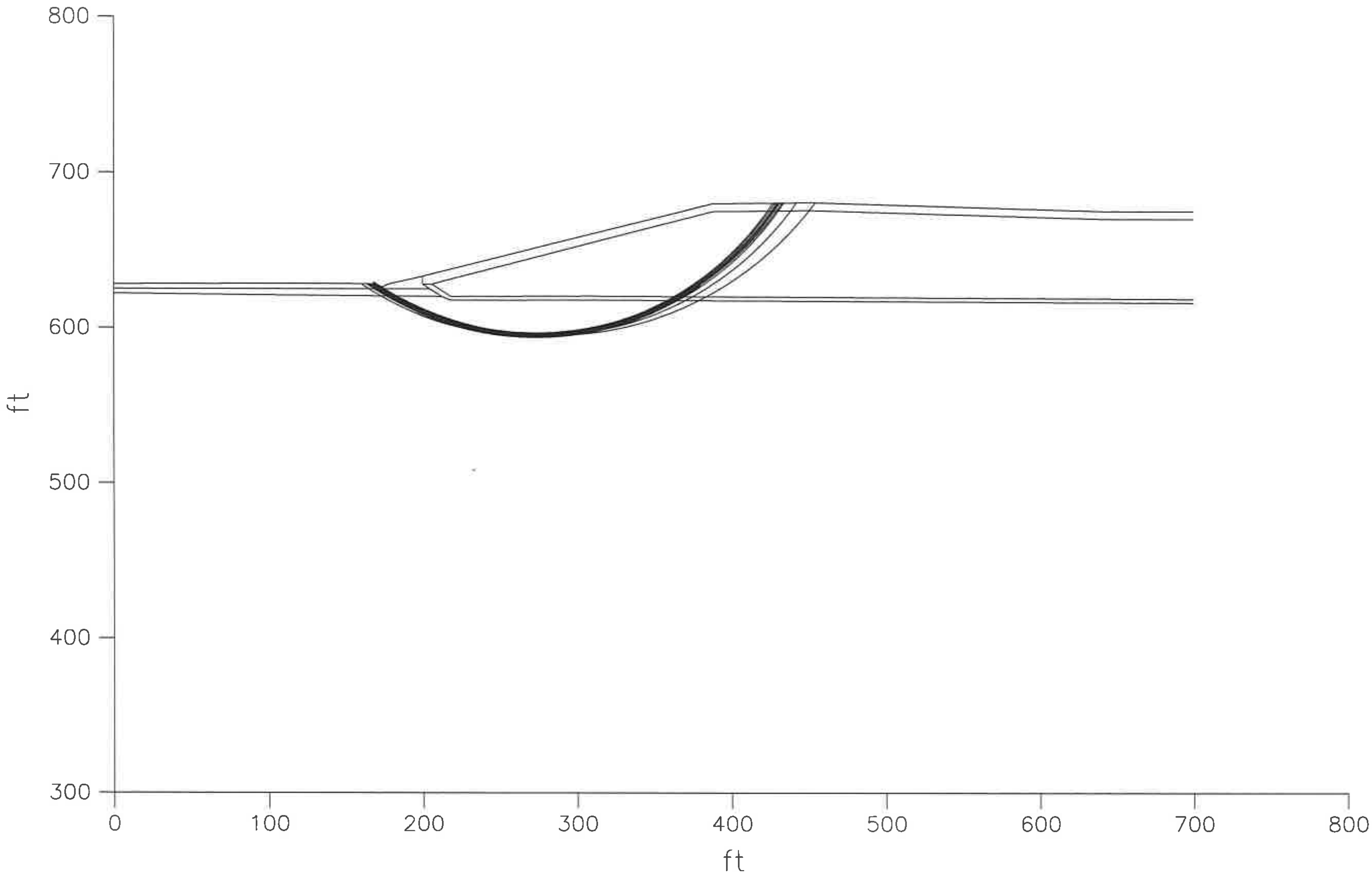
No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	1.527	273.01	781.71	186.54
2	1.531	276.29	783.83	188.33
3	1.531	278.15	795.20	199.94
4	1.535	272.42	789.15	193.70
5	1.536	269.49	783.33	187.90
6	1.537	283.43	808.28	213.20
7	1.539	270.98	786.37	190.59
8	1.540	272.60	785.28	189.26

9	1.541	274.68	783.56	187.38
10	1.541	267.94	788.06	192.94

Bishop Circular Surfaces – Search for Critical Surfaces



Bishop Circular Surfaces – Most Critical Surfaces



CROSS-SECTION A-A
STATIC CIRCULAR ANALYSIS

$\gamma_{waste} = 100$ pcf

$\Phi_{waste} = 30°$

```
********************************************************************************
*****                              GeoSlope                               *****
*****                            Version 5.10                             *****
*****                                                                     *****
*****             (c)1992 by GEOCOMP Corp, Concord, MA                    *****
*****                          Licensed to RUST                           *****
********************************************************************************
```

Problem Title : Dow Corning Midland Facility
Description : Slope Stability Cross-Section A-A'
Remarks : Waste unit weight = 100 pcf, Waste phi = 30

```
********************************************************************************
*****                             INPUT DATA                              *****
********************************************************************************
```

Profile Boundaries

Number of Boundaries : 29
Number of Top Boundaries : 13

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	628.00	119.79	628.38	5
2	119.79	628.38	141.79	628.38	5
3	141.79	628.38	169.60	628.00	5
4	169.60	628.00	173.60	626.00	5
5	173.60	626.00	177.60	628.00	5
6	177.60	628.00	195.79	632.00	5
7	195.79	632.00	199.79	633.00	5
8	199.79	633.00	207.98	635.05	1
9	207.98	635.05	387.79	680.00	1
10	387.79	680.00	451.02	680.80	1
11	451.02	680.80	639.94	675.50	1
12	639.94	675.50	674.77	675.50	1
13	674.77	675.50	700.00	675.50	1
14	199.79	633.00	199.80	628.00	5
15	199.80	628.00	205.79	628.00	3
16	205.79	628.00	387.79	675.00	2
17	387.79	675.00	451.02	675.80	2
18	451.02	675.80	639.94	670.50	2
19	639.94	670.50	674.77	670.50	2
20	674.77	670.50	700.00	670.50	2
21	205.79	628.00	217.96	620.00	3
22	217.96	620.00	307.96	620.34	3
23	307.96	620.34	700.00	618.85	3
24	199.80	628.00	211.96	620.00	5
25	0.00	622.00	90.00	621.00	4
26	90.00	621.00	211.96	620.00	4
27	211.96	620.00	217.96	617.50	4
28	217.96	617.50	307.96	617.84	4
29	307.96	617.84	700.00	616.35	4

Soil Parameters

Number of Soil Types : 5

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.

1	122.0	122.0	1000.0	0.0	0.00	0.0	0
2	100.0	100.0	0.0	30.0	0.00	0.0	0
3	138.0	138.0	1000.0	0.0	0.00	0.0	0
4	138.0	138.0	1000.0	0.0	0.00	0.0	0
5	128.0	128.0	0.0	29.0	0.00	0.0	0

Piezometric Surfaces

Number of Surfaces : 1
Unit Weight of Water : 62.40 pcf

Piezometric Surface No. : 1
Number of Coordinate Points : 6

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	625.00
2	204.35	625.00
3	211.96	620.00
4	217.96	617.50
5	307.96	617.84
6	700.00	616.35

```
*******************************************************************************
*****                      TRIAL SURFACE GENERATION                      *****
*******************************************************************************
```

Data for Generating Circular Surfaces

Number of Initiation Points : 100
Number of Surfaces From Each Point : 100
Left Initiation Point : 80.00 ft
Right Initiation Point : 200.00 ft
Left Termination Point : 300.00 ft
Right Termination Point : 590.00 ft
Minimum Elevation : 595.00 ft
Segment Length : 5.00 ft
Positive Angle Limit : 0.00 deg
Negative Angle Limit : 0.00 deg

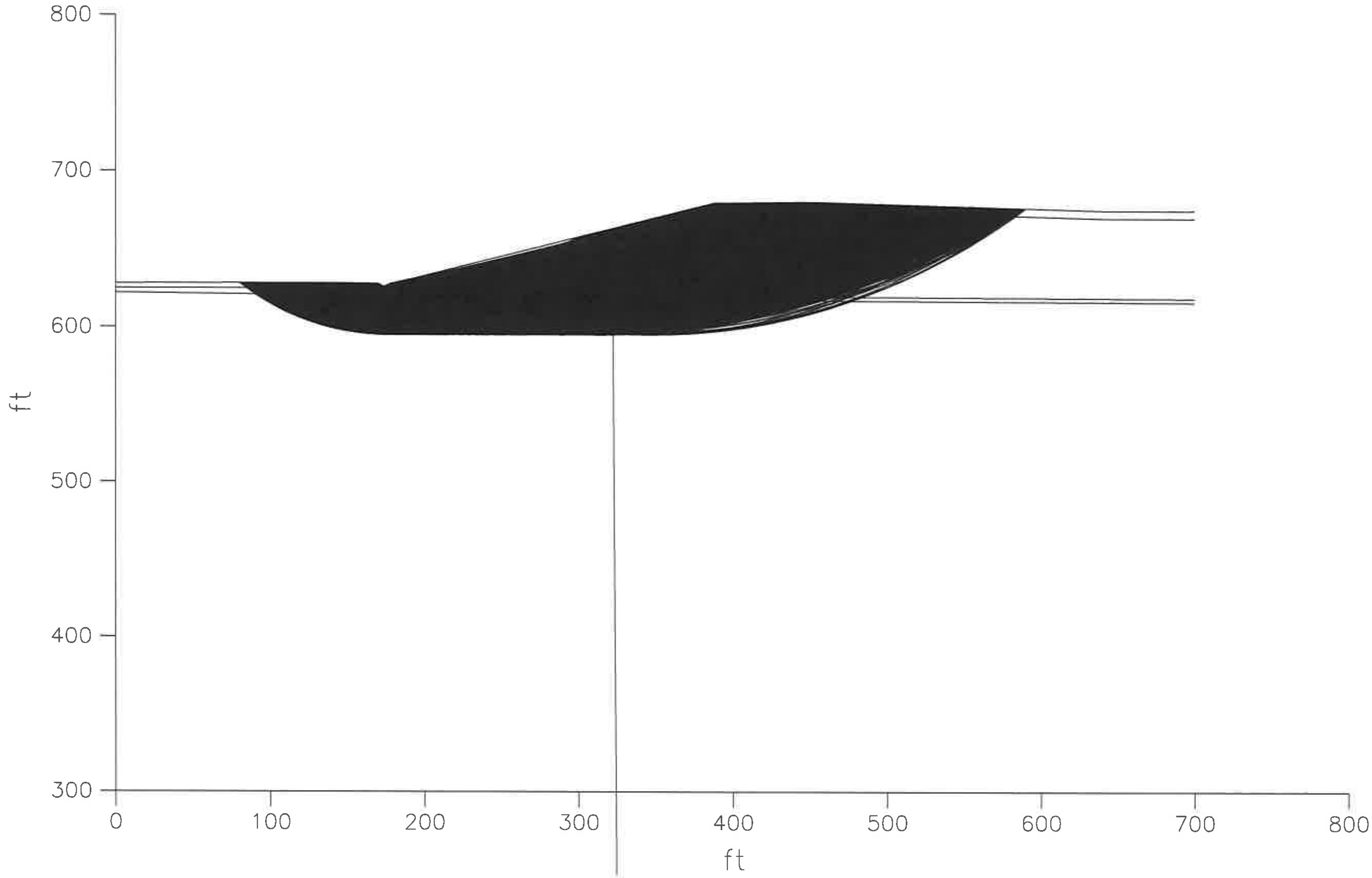
```
*******************************************************************************
*****                              RESULTS                               *****
*******************************************************************************
```

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	1.630	273.01	781.71	186.54
2	1.637	276.29	783.83	188.33
3	1.638	278.15	795.20	199.94
4	1.640	266.72	752.31	157.22
5	1.641	269.49	783.33	187.90
6	1.641	272.42	789.15	193.70
7	1.646	267.94	788.06	192.94
8	1.646	270.98	786.37	190.59

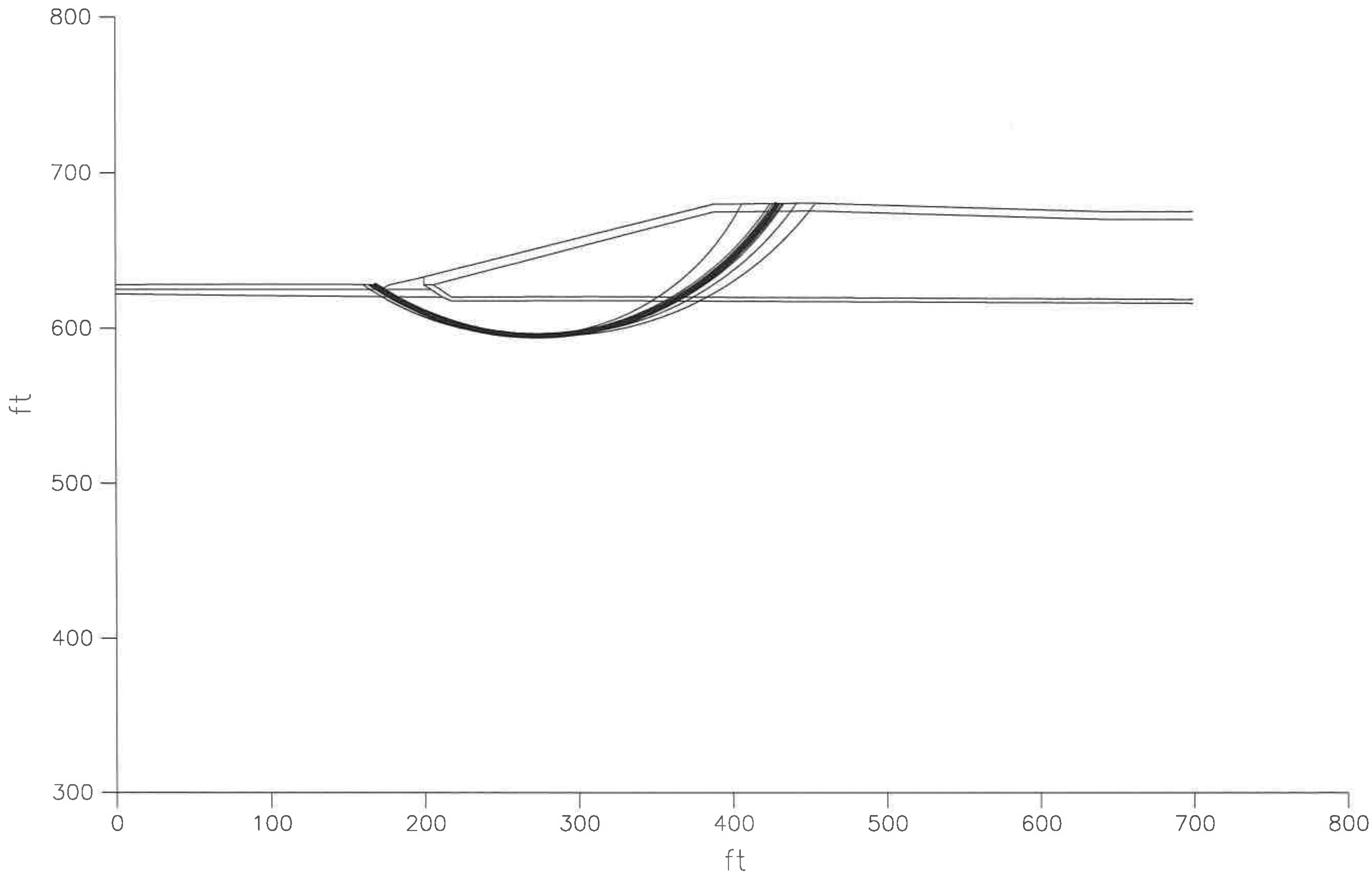
9	1.646	283.43	808.28	213.20
10	1.647	266.70	784.49	189.30

Bishop Circular Surfaces - Search for Critical Surfaces



Bishop Circular Surfaces — Most Critical Surfaces

Minimum Factor of Safety : 1.630



CROSS-SECTION A-A
STATIC CIRCULAR ANALYSIS

γ_{waste} = 100 pcf

Φ_{waste} = 35°

```
*******************************************************************************
*****                            GeoSlope                                 *****
*****                          Version 5.10                               *****
*****                                                                     *****
*****              (c)1992 by GEOCOMP Corp, Concord, MA                   *****
*****                       Licensed to RUST                              *****
*******************************************************************************
```

Problem Title : Dow Corning Midland Facility
Description : Slope Stability Cross-Section A-A'
Remarks : Waste unit weight = 100 pcf, Waste phi = 35

```
*******************************************************************************
*****                           INPUT DATA                                *****
*******************************************************************************
```

Profile Boundaries

Number of Boundaries : 29
Number of Top Boundaries : 13

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	628.00	119.79	628.38	5
2	119.79	628.38	141.79	628.38	5
3	141.79	628.38	169.60	628.00	5
4	169.60	628.00	173.60	626.00	5
5	173.60	626.00	177.60	628.00	5
6	177.60	628.00	195.79	632.00	5
7	195.79	632.00	199.79	633.00	5
8	199.79	633.00	207.98	635.05	1
9	207.98	635.05	387.79	680.00	1
10	387.79	680.00	451.02	680.80	1
11	451.02	680.80	639.94	675.50	1
12	639.94	675.50	674.77	675.50	1
13	674.77	675.50	700.00	675.50	1
14	199.79	633.00	199.80	628.00	5
15	199.80	628.00	205.79	628.00	3
16	205.79	628.00	387.79	675.00	2
17	387.79	675.00	451.02	675.80	2
18	451.02	675.80	639.94	670.50	2
19	639.94	670.50	674.77	670.50	2
20	674.77	670.50	700.00	670.50	2
21	205.79	628.00	217.96	620.00	3
22	217.96	620.00	307.96	620.34	3
23	307.96	620.34	700.00	618.85	3
24	199.80	628.00	211.96	620.00	5
25	0.00	622.00	90.00	621.00	4
26	90.00	621.00	211.96	620.00	4
27	211.96	620.00	217.96	617.50	4
28	217.96	617.50	307.96	617.84	4
29	307.96	617.84	700.00	616.35	4

Soil Parameters

Number of Soil Types : 5

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.

1	122.0	122.0	1000.0	0.0	0.00	0.0	0
2	100.0	100.0	0.0	35.0	0.00	0.0	0
3	138.0	138.0	1000.0	0.0	0.00	0.0	0
4	138.0	138.0	1000.0	0.0	0.00	0.0	0
5	128.0	128.0	0.0	29.0	0.00	0.0	0

Piezometric Surfaces

Number of Surfaces : 1
Unit Weight of Water : 62.40 pcf

Piezometric Surface No. : 1
Number of Coordinate Points : 6

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	625.00
2	204.35	625.00
3	211.96	620.00
4	217.96	617.50
5	307.96	617.84
6	700.00	616.35

```
*****************************************************************************
*****                   TRIAL SURFACE GENERATION                        *****
*****************************************************************************
```

Data for Generating Circular Surfaces

Number of Initiation Points : 100
Number of Surfaces From Each Point : 100
Left Initiation Point : 80.00 ft
Right Initiation Point : 200.00 ft
Left Termination Point : 300.00 ft
Right Termination Point : 590.00 ft
Minimum Elevation : 595.00 ft
Segment Length : 5.00 ft
Positive Angle Limit : 0.00 deg
Negative Angle Limit : 0.00 deg

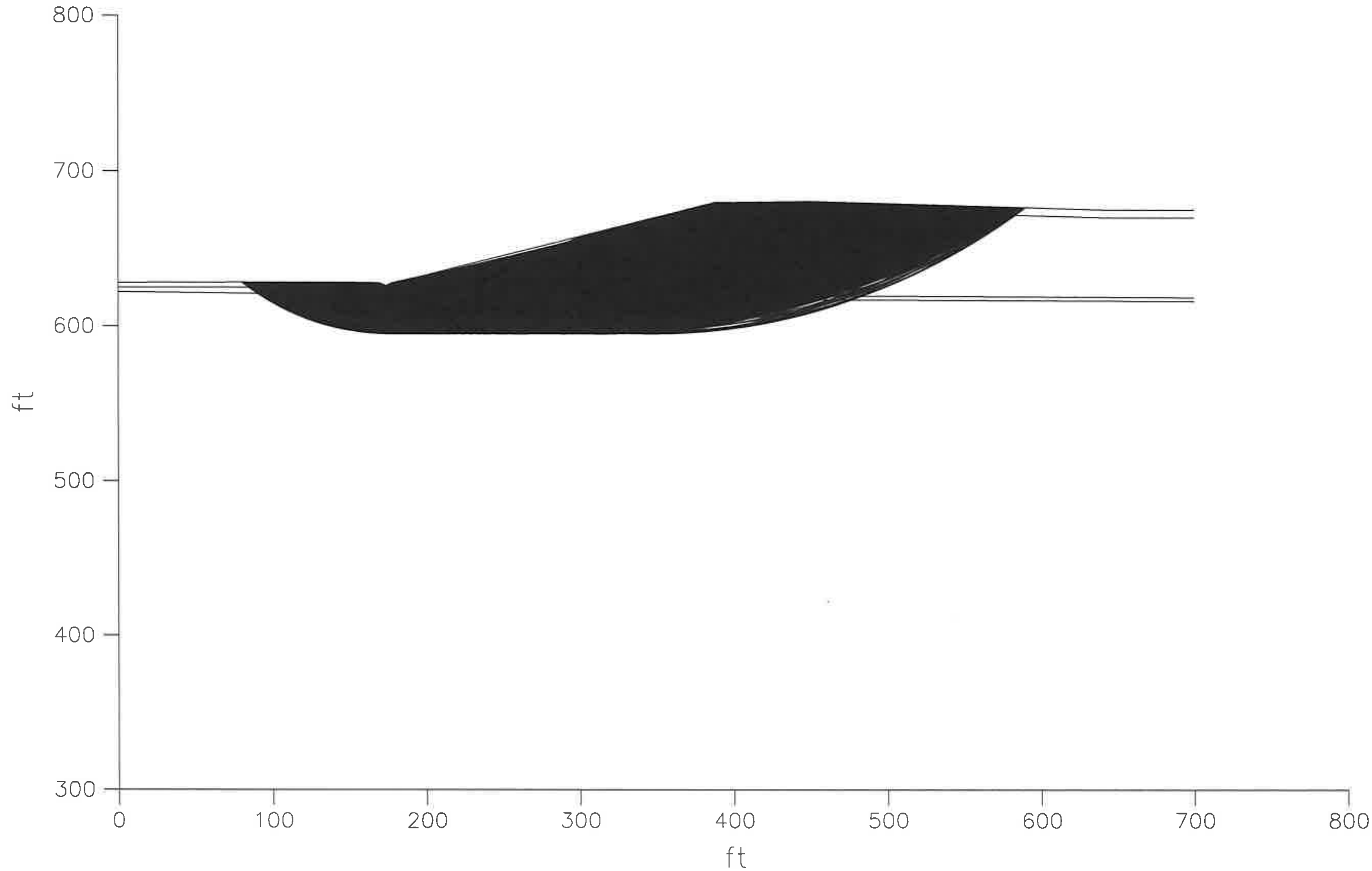
```
*****************************************************************************
*****                           RESULTS                                 *****
*****************************************************************************
```

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	1.740	273.01	781.71	186.54
2	1.741	266.72	752.31	157.22
3	1.749	276.29	783.83	188.33
4	1.752	269.49	783.33	187.90
5	1.753	278.15	795.20	199.94
6	1.754	272.42	789.15	193.70
7	1.754	262.62	761.06	165.77
8	1.757	267.94	788.06	192.94

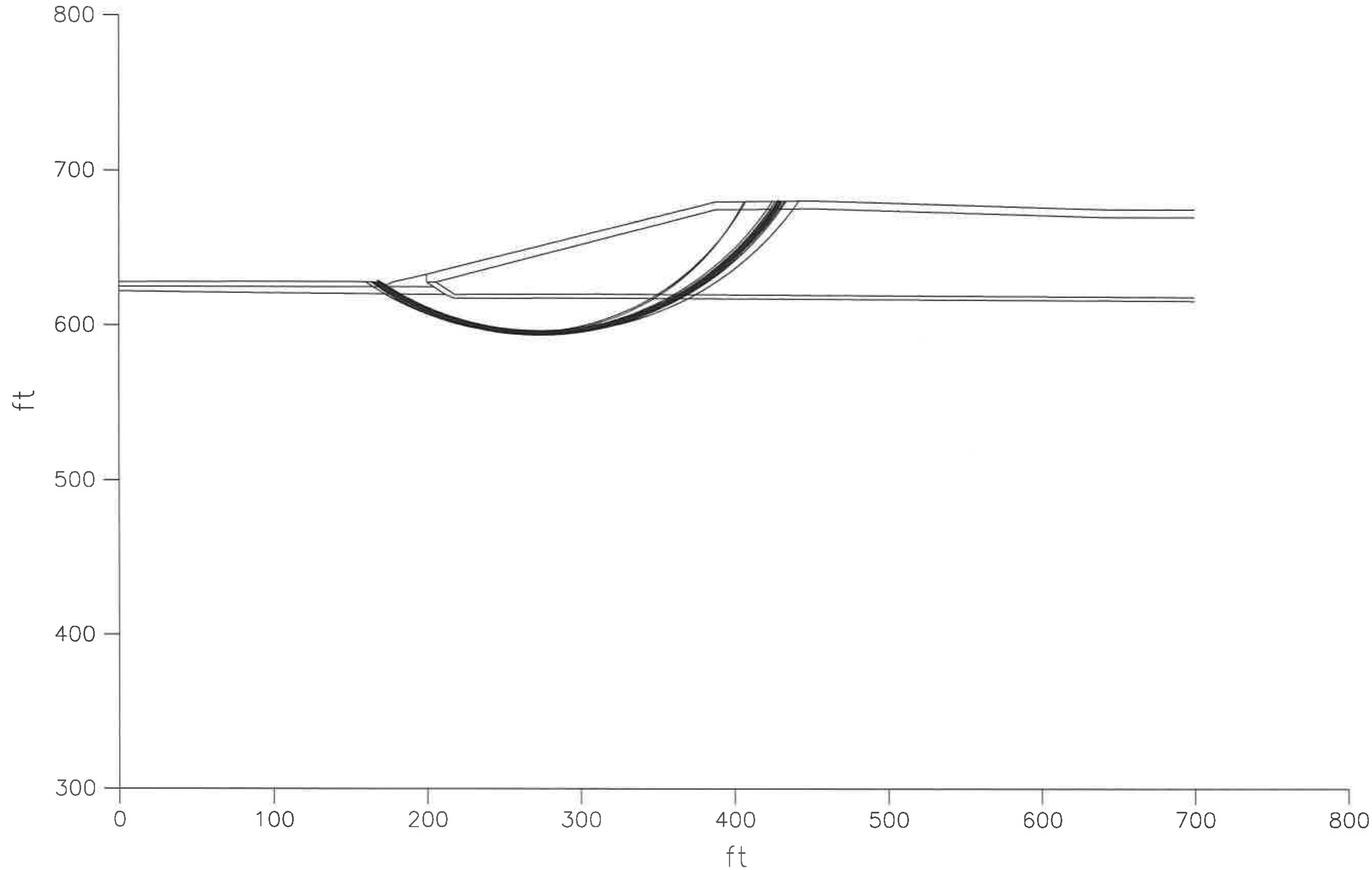
9	1.757	266.70	784.49	189.30
10	1.759	270.98	786.37	190.59

Bishop Circular Surfaces — Search for Critical Surfaces

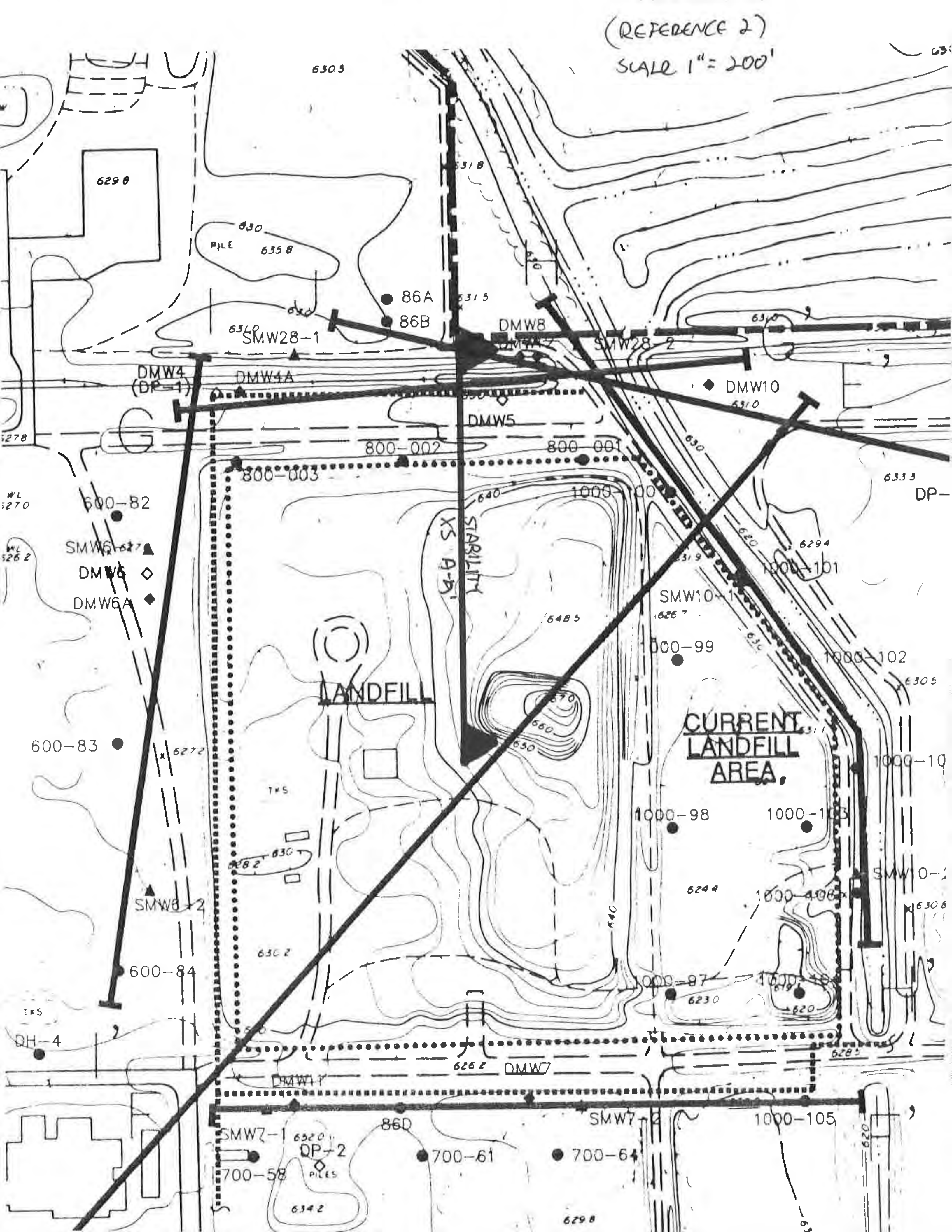


Bishop Circular Surfaces – Most Critical Surfaces

Minimum Factor of Safety : 1.740



REFERENCE INFORMATION


(REFERENCE 2)
SCALE 1" = 200'
LANDFILL
CURRENT LANDFILL AREA
XS STABILITY A-A'
PILE
86A
86B
DMW8
SMW28-1
SMW28-2
DMW4 (DP-1)
DMW4A
DMW10
DMW5
800-002
800-001
800-003
600-82
SMW6
DMW6
DMW6A
1000-100
1000-101
SMW10-1
1000-99
1000-102
600-83
1000-10
1000-98
1000-103
SMW10-2
1000-106
SMW6-2
600-84
1000-97
DH-4
DMW7
DMW11
SMW7-2
1000-105
SMW7-1
86D
DP-2
700-61
700-64
700-58
PILES
DP-

(REFERENCE 3)

EDI Engineering & Science
Environmental Engineering
Geology, Biology and Chemistry

Well / Boring Log Sheet

Page: 1 of 1
Well/Boring No.: 86-B
Client: Dow Corning
Project No.: 20600
Permit No.:
Date Started ______ Finished 9/17/86

County	Township	Fraction	Section	T	R
MIDLAND	MIDLAND	1/4 1/4 1/4	26	14N	2E

Contractor: Raymer
Address: Grand Rapids, MI
Equipment: Failing Rig #10
Supervisor: D. Pierce
Drilling Method(s): Rotary
Depth:

Grouting/Seal
Depth To Material

Development:

Water Level: ______ Ft. Below:
Measured On:

Screen:
Manufacturer:
Material:
Model:
Slot/Gauze: ______ Dia.:
Length:
Depth Set: ______ To:

Casing
Dia. Type Depth Set
______ To ______
______ To ______

Elevation
Casing:
Ground:
Ref. Pt.:

Remarks (include here, other data available)

Location Sketch

(FEET) Thickness	(FEET) Depth To Base	Description	Remarks
7.0	7.0	SAND - fine to medium, light brown	
31.0	38.0	CLAY - gray	
11.0	49.0	CLAY - gravelly, gray	
15.0	64.0	SAND - fine to medium, brown	
11.0	75.0	GRAVEL - medium, sandy	
21.0	96.0	GRAVEL - coarse, sandy	
		coarse gravel refusal @ 96'	

(REFERENCE 3)

EDI Engineering & Science
Environmental Engineering
Geology, Biology and Chemistry

Page: 1 of 1 — 028
Well/Boring No.: DMW-8
Client: Dow Corning
Project No.: 20600
Permit No.:
Date Started: Finished: 10/1/86

Well / Boring Log Sheet

County	Township	Fraction	Section	T	R
MIDLAND	MIDLAND	1/4 1/4 1/4	26	14N	2E

Contractor: Raymer
Address: Grand Rapids, MI
Equipment: Failing Rig #10
Supervisor: D. Pierce
Drilling Method(s): Rotary — Depth:

Grouting/Seal

Depth	To	Material
70	72'	Bentonite Pellets
0	70'	Bentonite/Cement

Development: Water Jet w/ Deionized Water

Water Level: Ft. Below:
Measured On:

Screen:
Manufacturer: Johnson
Material: stainless steel
Model: 960
Slot/Gauze: 10 slot Dia.: 2"
Length: 5'
Depth Set: 74.9' To: 79.9'

Casing

Dia.	Type	Depth Set
2"	S.S.	+2.1 To 74.9'
7"	Blk.	+0.5 To 12.8'

Elevation
Casing: 634.94'
Ground: 632.8'
Ref. Pt.:

Location Sketch
9283.78 N
3821.24 E

Remarks (include here, other data available)
Filter pack from 72' to 82' #7 grade.
Pea gravel from 82' to 244'.

(FEET) Thickness	(FEET) Depth To Base	Description	Remarks
9.0	9.0	CLAY - sandy, some small stones, dark brown	
33.0	42.0	CLAY - gray	
30.0	72.0	SAND - fine to medium, brown	
15.0	87.0	GRAVEL - medium to coarse	
3.0	90.0	GRAVEL - sandy, clayey, brown	
5.0	95.0	SHALE - black	
2.0	97.0	CLAY - gravelly, gray	
48.0	145.0	CLAY - gray	
7.0	152.0	CLAY - shale, dark brown to black	
92.0	244.0	SHALE - interbedded with coal seams	

(REFERENCE 3)

DMW5

LOG OF SOIL BORING NO. ______

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Observation Well

JOB NO. MW5 81-111

LOCATION Dow-Corning

SURFACE ELEV. ______ DATE 11-16-17-81 Midland, Michigan

Sample & Type	Depth	Legend		Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str %
	2	FILL	1'6"	Moist fine brown sand, fill						
	4		4'6"	Moist fine oxidized brown sand						
	6									
	8		8'6"	Moist to wet fine brown and discolored sand *Surface Sand*						
	10			*Lakebed clay*						
	12									
	14			Stiff moist silty blue clay						
	16									
	18									
	20									
	22									
	24		23'0"	Extremely stiff moist gravelly blue clay *Lakebed Clay*						
	26									
	28									
	30		29'6"	*Glacial Till*						
	32			Extremely stiff moist sandy blue claypan						
	34									
	36									
	38									
	40		39'6"	Extremely compact wet medium brown sand						
	42									
A	44				32					
					60					
	46		45'0"	Extremely stiff moist [illegible] blue clay [illegible]						
	48									
	50									
				(Cont'd.)						

TYPE OF SAMPLE
D - DISTURBED
UL - UNDIST. LINER
ST. - SHELBY TUBE
SS - SPLIT SPOON
RC - ROCK CORE

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 5 FT 6 INS
G.W. ENCOUNTERED AT 59 FT 0 INS
G.W. AFTER COMPLETION FT INS
G.W. AFTER HRS FT INS

(REFERENCE 3)

LOG OF SOIL BORING NO. DW#5

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT: Observation Wells

JOB NO.: 81-111

LOCATION: Dow-Corning, Midland, Michigan

SURFACE ELEV.:

DATE: 11-16-17-81

Sample & Type	Depth	Legend	Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp Strength PSF	Su %
	52		Extremely stiff moist gravelly blue clay, occasional stones						
	54								
	56								
	58								
	60		59'0" Extremely compact wet medium to coarse gray sand (9')	60					
B UL	62			60/3"					
	64								
	66								
	68		68'0"						
	70		Extremely stiff moist silty blue clay, hardpan, layers of sand and gravel						
	72								
	74								
	76								
	78		78'0"						
	80		2½' Stick-Up. Bottom of screen 68'0". 10' - .010 screen. Blew for 30 minutes at 10 gallons per minute ±						
	82								
	84								
	86								
	88								
	90								
	92								
	94								
	96								

TYPE OF SAMPLE
D - DISTURBED
U.L - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C - ROCK CORE
( ) - PENETROMETER

REMARKS.

Standard Penetration Test - Driving 2" OD Sampler 1' With 140 # Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 5 FT 6 INS
G.W. ENCOUNTERED AT 59 FT 0 INS
G.W. AFTER COMPLETION FT INS
G.W. AFTER HRS FT INS
G.W. VOLUMES Washed

(REFERENCE 3)

B1245-3

DC 6901-P

LOG OF BORING NO. 800-002-79

PROJECT	SITE
Site Evaluation - C & D Street	Dow Corning Corp., Midland, MI

BORING	PROJECT NO.	SAMPLE TYPE
STARTED 2-20-79 COMPLETED 2-20-79	B1245	S.S. X AUGER X SHELBY

SURFACE ELEVATION — 103.0'

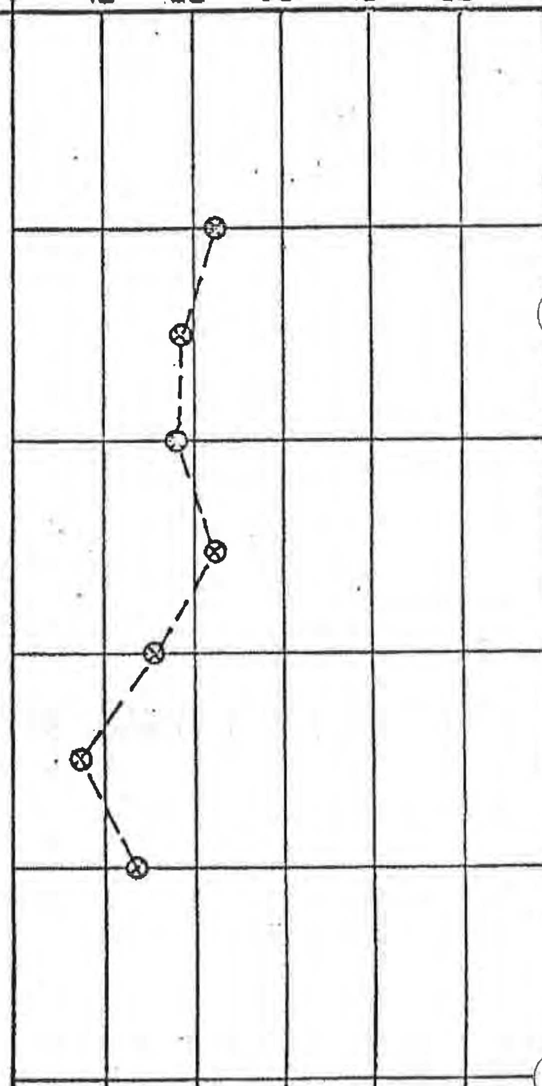
DEPTH IN FEET	DESCRIPTION OF MATERIAL	SAMPLE NO.	STD. PENETRATION "N" BLOWS PER FOOT	UNIT WET. WT. LB./FT.³
	Sand-yellow, graded med. fine SP		5	
	Sand-brown, med. fine SP		6 7	
	Clay-stiff, brown, silty, trace of sand & pebbles CL		6	
10		A	10 14	128
		B	6 10 10	133
20		C	5 10 12	134
	Clayey-silt-compact, gray, some sand ML	D	6 6 7	125
30	Sand-compact, brown SP	E	7 9 11	130
	Clay-extremely hard, gray some sand & pebbles	F	23 42 75	144
	Clayey-sand-very compact, brown, graded med. SC			
40	End of Boring at 40 ft.	G	40 70 79	134

Boring cement grouted to 35 ft.

Mineral Well permit #

UNCONFINED COMPRESSIVE STRENGTH TONS/FT² — 1 2 3 4 5

PLASTIC LIMIT % ✕ — WATER CONTENT % ⊗ — LIQUID LIMIT % △ — 10 20 30 40 50



WATER LEVEL OBSERVATIONS	
W.L.	Encountered initially at 3 ft.
W.L.	Final level at 3 ft.

SAMTEST, INC.
DRILLING & TESTING SERVICES

(REFERENCE 3)

MICHIGAN TESTING ENGINEERS, INC.
MICHIGAN DRILLING DIVISION
CONSULTING ENGINEERS IN SOILS & FOUNDATIONS
[illegible] WYOMING AVENUE • DETROIT, MICHIGAN [illegible]

JOB NO. 74-523 LOG OF SOIL BORING NO. 1000-99-(

PROJECT PROPOSED SOILS EXPLORATION

LOCATION DOW CORNING
MIDLAND, MICHIGAN

DATE 7-31-74 SURFACE ELEV. 111.80

Sample & Type	Depth	Legend	Soil Description	Penetration Blows Per 6"			Moisture %	Natural Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1	FILL	STIFF MOIST BROWN SANDY CLAY, FILL, LIGHT VEGETATION, SLIGHTLY ORGANIC							
A UL	2–3			5	5	6				
	4	3'9"								
B UL	5	FILL	COMPACT MOIST MEDIUM BROWN SAND, FILL, CINDERS, SLIGHT ORGANIC STREAKS	5	6	7				
	6									
C UL	7–8			4	6	7				
		8'6"								
D UL	9–10		VERY COMPACT MOIST MEDIUM BROWN SAND	6	8	12				
		10'0"								
	11–14		COMPACT WET MEDIUM BROWN SAND							
		14'0"								
E UL	15		VERY STIFF MOIST BLUE SILTY CLAY	5	7	11				
		15'0"								
	16									
	17									
	18									
	19									
	20									

TYPE OF SAMPLE
D. -DISTURBED
U.L.-UNDIST. LINER
S.T. -SHELBY TUBE
S.S. -SPLIT SPOON
R.C. -ROCK CORE

REMARKS:

Standard Penetration Test – Driving 2" OD Sampler 1' With [illegible]

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT 10 FT. 3 INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION 9 FT. 6 INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES HEAVY

(REFERENCE 4)

FIGURE #1

SAMTEST, INC.
DRILLING & TESTING SERVICES

P.O. Box 1444
Midland, Mich. 48640
1-517-496-3610

JOB NO 80-352

DATE 5-22-80

MOISTURE-DENSITY RELATIONSHIP
(PROCTOR)

CLIENT Dow Corning Corp.

PROJECT Waste Disposal Site

LOCATION Midland Plant

TEST X T180 MODIFIED (ASTM-D1557) ________ T99 STANDARD (ASTM-D698)

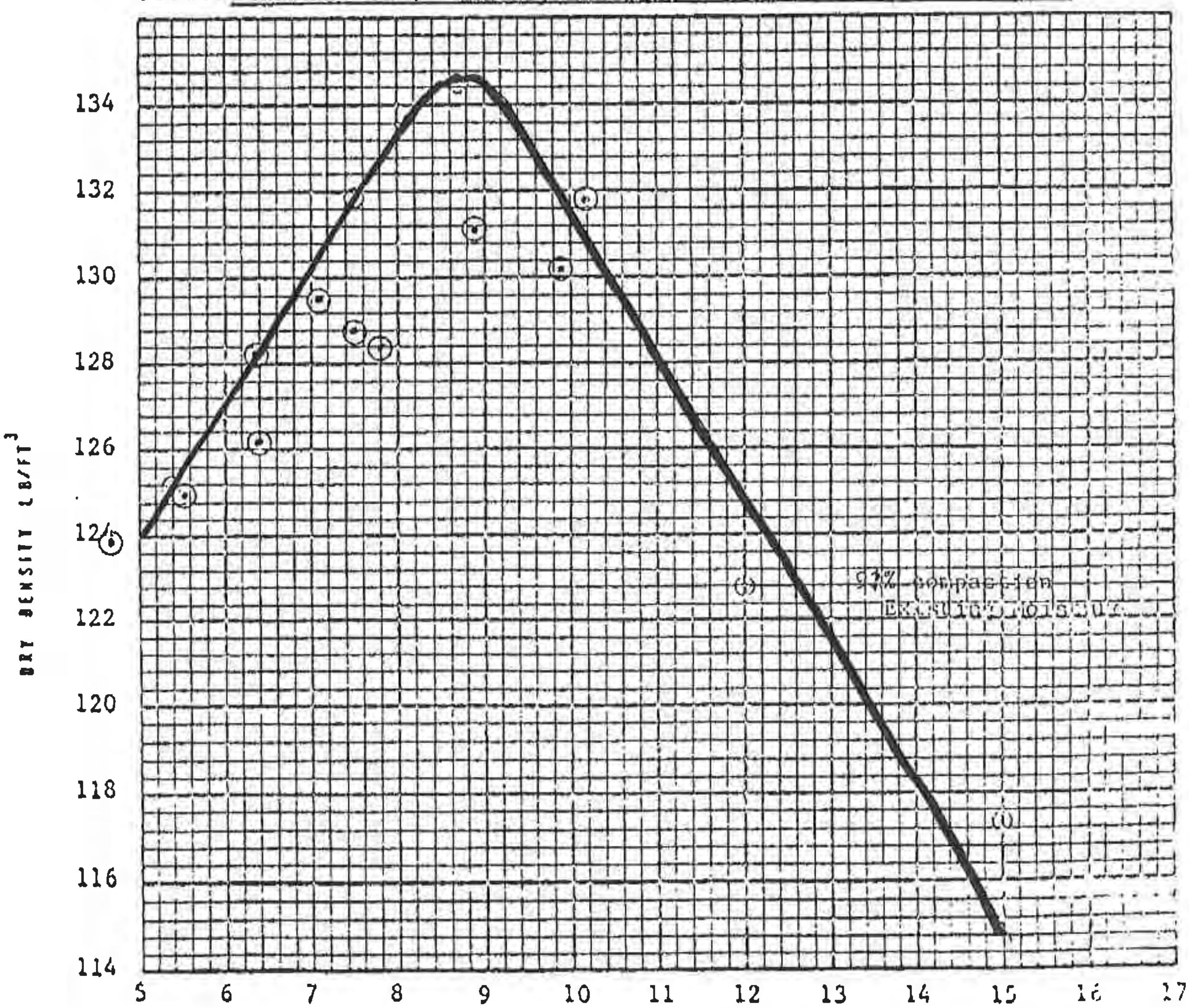
________ MICHIGAN CONE

RESULTS MAXIMUM DRY DENSITY 134.2 LB/FT³

OPTIMUM MOISTURE 8.7 %

MATERIAL Clay, brown, silty CLASSIFICATION CL

SOURCE Midland City Sanitary Landfill - Ashman St.



(REFERENCE 5)

Native Clay Test Results

Test	Method	Sample 1 Results	Sample 2 Results	Specification	Meets/Exceeds Specification?
1. Hydraulic Conductivity (@ compaction > 90%)	Falling Head	3.5×10^{-8} to 4.4×10^{-8} cm/sec.	1.7×10^{-8} to 5.8×10^{-8} cm/sec.	< 1.0×10^{-7} cm/sec.	Yes
2. Particle Size Distribution	ASTM C-136	82% < 5 µm	77% < 5 µm	Minimum 25% < 5 µm	Yes
3. Unified Soil Classification (Atterberg limits)	ASTM D-423, D-424	CL	CL	Must be type CL or CH	Yes
4. Soil density/moisture relationships: (No regulatory specification, but data will be used during cover construction to ensure required moisture content range after compaction is met.)					
a. Maximum density	ASTM D-1557	119.2 lb/ft^3	118.5 lb/ft^3	none	n/a
b. Optimum moisture	ASTM D-1557	13.9	14.5	none	n/a
c. Natural moisture	ASTM D-2216	15.0	16.1	none	n/a

(REFERENCE 6)

Table 13.2 Approximate Correlation of Standard Penetration Number and Consistency of Clay

Standard penetration number, N	Consistency	Unconfined compression strength, q_u (ton/ft^2)
0		0
	Very soft	
2		0.25
	Soft	
4		0.5
	Medium stiff	
8		1
	Stiff	
16		2
	Very stiff	
32		4
>32	Hard	>4

Note: 1 ton/ft^2 = 95.76 kN/m^2

(REFERENCE 6)

Table 13.3 Approximate Relation Between Corrected Standard Penetration Number, Angle of Friction, and Relative Density of Sand

Corrected standard penetration number, N	Relative density, D_r (%)	Angle of friction, ϕ (degrees)
0–5	0–5	26–30
5–10	5–30	28–35
10–30	30–60	35–42
30–50	60–95	38–46

(REFERENCE 7)

Table 1.3 Typical Void Ratio, Moisture Content, and Dry Unit Weight for Some Soils

Type of soil	Void ratio e	Natural moisture content in saturated condition (%)	Dry unit weight, γ_d (kN/m^3)	(lb/ft^3)
Loose uniform sand	0.8	30	14.5	92
Dense uniform sand	0.45	16	18	115
Loose angular-grained silty sand	0.65	25	16	102
Dense angular-grained silty sand	0.4	15	19	120
Stiff clay	0.6	21	17	108
Soft clay	0.9–1.4	30–50	11.5–14.5	73–92
Loess	0.9	25	13.5	86
Soft organic clay	2.5–3.2	90–120	6–8	38–51
Glacial till	0.3	10	21	134

Client Dow Corning	**Subject** Surface Water	**Prepared By** TCR	**Date** 5/5/11
Project Midland Facility	Diversion Berm Analysis	**Reviewed By** NKW	**Date** 5/5/11
		Approved By DFP	**Date** 5/6/11

SURFACE WATER DIVERSION BERM ANALYSIS

Objective

Design diversion berms to intercept surface water runoff from the top area of the final cover and divert surface water runoff to the downslope pipes.

Design Criteria and Assumptions

1. The Channel Design Utility of SEDCAD+, a computer program, was used to design the diversion berms. SEDCAD+ is a program developed at the University of Kentucky to assist in the design and evaluation of surface water management system components.

2. Diversion berms should be able to convey runoff from a 25-year, 24-hour storm event, with 6 inches of freeboard.

3. Diversion berm design will be based on maximum flow conditions. As discussed in the Surface Water Run-off Estimates, the design peak run-off flow is 3.94 cfs.

4. Diversion berms are located at the top of the 25 percent sideslopes around the perimeter of the top area. Diversion berms will slope toward the downslope pipes. Diversion berm slopes vary from a 0.5 percent minimum to a maximum of approximately 3.3 percent. To be conservative, the analysis considers a maximum diversion berm slope of 4 percent to evaluate riprap size and a minimum slope of 0.5 percent for depth.

5. Diversion berm channels will be triangular in shape with 3:1 (horizontal:vertical) channel sideslopes.

6. Diversion berm channels will be lined with riprap.

7. Flow from the cover drainage layer on the landfill top slope will be discharged to the diversion berms. The flow from the drainage layer will be low and will not coincide with peak surface water run-off flows. The surface water run-off peak flow is conservative and therefore used in this analysis.

Calculations

One analysis was performed to design the diversion berms for the landfill. For the analysis the largest area, which results in the largest peak flow, draining to a diversion berm is considered. The maximum and minimum berm slopes are included in the analysis so that a single final design can be chosen to function properly in all diversion berm locations. The maximum slope is considered to evaluate the riprap size and limiting velocity, while the minimum slope is considered to evaluate the required flow depth.

SEDCAD+ results for the maximum slope and minimum slope diversion berms is attached and summarized in Table 1 below.

Subwatersheds are labeled with the structure number and the subwatershed number. The subwatersheds that drain to a diversion berm are 6-2, 6-3, 6-5, and 7-1. The largest SWS, 6-3, is considered in this analysis.

Based on experience, to be conservative, and to limit the opportunity for riprap to enter downslope pipes, a design riprap D_{50} = 6 inches.

Table 1: Maximum Flow Summary

Component	Slope (%)	Max. Flow (cfs)	SEDCAD+ Flow Depth (ft)	Design Channel Depth (ft)	Maximum Velocity (fps)	SEDCAD+ Riprap D_{50} (in)	Design Riprap D_{50} (in)
Diversion Berm - maximum slope	4	3.94	0.58	1.5	3.84	1.50	6.0
Diversion Berm - minimum slope	0.5	3.94	0.79	1.5	2.11	0.50	

Conclusions

One typical cross-section of a diversion berm was developed for the triangular channel to meet the requirements of the SEDCAD+ analysis (attached). The typical cross-section for diversion berms is a 1.5 foot deep triangular channel with 3:1 (horizontal:vertical) sideslopes and a minimum slope of 0.5 percent and a maximum slope of 4 percent. The diversion berms will be lined with riprap or stone with a minimum D_{50} of 6 inches.

Diversion Berm, Minimum Slope

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
0.00	3.0:1	3.0:1	0.5			

PADER Method - Mild Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	3.94 cfs	
Depth:	0.79 ft	
Top Width:	4.74 ft	
Velocity:	2.11 fps	
X-Section Area:	1.87 sq ft	
Hydraulic Radius:	0.375	
Froude Number:	0.59	
Manning's n:	0.0260	
Dmin:	0.50 in	
D50:	0.75 in	
Dmax:	1.50 in	

Diversion Berm, Maximum Slope

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
0.00	3.0:1	3.0:1	4.0			

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	3.94 cfs	
Depth:	0.58 ft	
Top Width:	3.51 ft	
Velocity:	3.84 fps	
X-Section Area:	1.03 sq ft	
Hydraulic Radius:	0.277	
Froude Number:	1.25	
Manning's n:	0.0330	
Dmin:	1.00 in	
D50:	1.50 in	
Dmax:	3.00 in	

Client Dow Corning	**Subject** Downslope Pipe	**Project No.** 60134827	
Project Midland Facility	Analysis	**Prepared By** TCR	**Date** 5/5/11
		Reviewed By NKW	**Date** 5/5/11
		Approved By DFP	**Date** 5/6/11

DOWNSLOPE PIPE ANALYSIS

Objective

Design downslope pipes to convey surface water runoff from the diversion berms to the perimeter ditches.

Design Criteria and Assumptions

1. The Channel Design Utility of SEDCAD+, a computer program, was used to design the downslope pipes. SEDCAD+ is a program developed at the University of Kentucky to assist in the design and evaluation of surface water management system components.

2. Downslope pipes should be able to convey runoff from the 25-year, 24-hour storm from the top area diversion berms to the perimeter ditches.

3. Downslope pipe design will be based on maximum flow conditions. As discussed in the Surface Water Run-off Estimates, the design peak run-off flow is 3.94 cfs.

4. Downslope pipes are located on the 25 percent sideslopes.

5. Downslope pipes will consist of 8-inch HDPE pipes.

6. Downslope pipes will outlet to energy dissipators through a 3 foot section of 8-inch HDPE pipe at a slope of 1 percent. Riprap or alternative materials will be used to provide erosion protection.

Calculations

One analysis was performed to design the downslope pipes for the landfill. For the analysis the largest area, which results in the largest peak flow, draining to a downslope pipe is considered. Downslope pipe locations are shown on the Surface Water Run-off Estimates Attachment 5 figure.

The SEDCAD+ Channel Design Utility was used to evaluate the downslope pipes. The results of this analysis is attached. For an 8 inch diameter HDPE pipe, the maximum design flow velocity is approximately 18.5 fps and the flow depth is approximately 0.4 feet (4.8 inches).

Conclusions

Based on the analysis, a downslope pipe with a minimum diameter of 8 inches is sufficient to handle the design flow. Erosion protection at downslope pipe inlets and outlets will be required.

8" HDPE Downslope Pipe

Material: Plastic

Circular Channel

Pipe Diameter (in)	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
8.00	25.0	0.0130			

	w/o Freeboard	w/ Freeboard
Design Discharge:	3.94 cfs	
Depth:	0.39 ft	
Top Width:	0.66 ft	
Velocity:	18.48 fps	
X-Section Area:	0.21 sq ft	
Hydraulic Radius:	0.183	
Froude Number:	5.71	

Client	Dow Corning	Subject	Surface Water	Prepared By TCR	Date 5/5/11
Project	Midland Facility		Energy Dissipator Analysis	Reviewed By NKW	Date 5/5/11
				Approved By DFP	Date 5/6/11

SURFACE WATER ENERGY DISSIPATOR ANALYSIS

Objective

Size energy dissipator structures to limit erosion at the point where downslope pipes discharge into perimeter ditches.

Design Criteria and Assumptions

1. Use impact-type energy dissipator, U.S. Bureau of Reclamation (USBR) Type VI Baffle Wall Energy Dissipator.

2. Use energy dissipator design procedure presented in Section 9 and riprap sizing from Appendix D of "Hydraulic Design of Energy Dissipators for Culverts and Channels," (HEC-14, 3rd Edition),U.S. Federal Highway Administration, Washington, D.C., July 2006.

3. Size energy dissipator for the maximum downslope pipe flow for the 25-year, 24-hour storm event using data from Downslope Pipe Analysis calculation.

4. Energy dissipators will be located at the outlet of each downslope pipe.

5. The downslope pipe will be connected the energy dissipator by a minimum 3 foot section of pipe at a 1% slope.

Calculations

One analysis was performed to design the energy dissipators for the landfill.

The following data is from the Downslope Pipe Analysis calculation:

Discharge	= 3.94 ft^3/sec
Velocity	= 18.48 ft/sec
Cross-sectional area	= 0.21 ft^2
Froude number	= 5.71

Calculate the equivalent flow depth, y_e

$$y_e = (A/2)^{1/2} = (0.21\ ft^2/2)^{1/2}$$
$$= 0.324\ ft$$

Calculate the flow energy, H_0:

$$H_0 = y_e + (V_0)^2/2g$$

Where H_0 = flow energy, ft. of water
y_e = equivalent flow depth, ft
V_0 = channel velocity, ft/sec
g = 32.2 ft/sec^2:

$H_0 = (0.324) + (18.48)^2/(2 * 32.2)$
$H_0 = 5.627$ ft

From the attached Figure 9.14, determine H_0/W, based on the Froude number of 5.71 (W is the width of the energy dissipator).

$H_0/W = 1.97$
$W = 5.71$ ft/1.97 = 2.90 ft
Round up to 4.0 feet to match the smallest available energy dissipator.

Calculate the exit velocity from the dissipator by trial and error using an energy balance between the culvert exit and the basin exit. A spreadsheet is used for the iterative trial and error process.

$H_B = Q/(W_B V_B) + V_B^2/(2g) = H_o(1- H_L/H_o)$

Where
Q = flow, cfs
W_B = width of dissipator, ft
V_B = exit velocity from dissipator, fps
g = 32.2 ft/sec^2
H_L/H_0 = Loss of energy (from attached Figure 9.15)
H_L = dissipater discharge flow energy, ft. of water

Exit Velocity Calculation					
Q	W_B	**V_B**	g	H_o	H_L/H_o
(cfs)	(ft)	**(fps)**	(ft/sec^2)	(ft of water)	(ft of water)
3.94	4	**10.12**	32.2	5.627	0.7
		$Q/(W_B V_B) + V_B^2/(2g)$	=	$H_o(1- H_L/H_o)$	
		1.6876	=	1.6881	

Use equation D.2 from Appendix D of HEC 14 to size riprap at the energy dissipator outlet:
$D_{50} = \alpha V^2$
Where: V = culvert exit velocity, ft/s
α = unit conversion constant, 0.0126 for customary units
$D_{50} = 0.0126 * 10.12^2 = 1.29$ ft.

For design purposes, use a minimum D_{50} = 1.3 ft. = 16 in.
Per recommendations in HEC 14, riprap will extend a minimum of 4 pipe diameters, or 3 feet, from the energy dissipator. For design purposes use 4 feet.

Conclusions

At the discharge of Downslope Pipes, a 3 foot section of pipe with a slope of 1 percent and a 4-foot wide energy dissipator is required. The remaining dimensions of the energy dissipator, summarized in Table 1 below, can be found on the attached Table 9.2 and are shown graphically on attached Figure 9.13. Energy dissipators that have similar hydraulic performance may be substituted for this design.

Table 1: Energy Dissipator Dimensions (in feet-inches)

W	h_1	L	H_2	H_3	L_1	L_2	H_4	W_1	W_2	t_3	t_2	t_1	t_4	t_5
4-0	3-1	5-5	1-6	0-8	2-4	3-1	1-8	0-4	1-1	0-6	0-6	0-6	0-6	0-3

The estimated surface water exit velocity from the dissipator is approximately 10.12 fps. A minimum D_{50} = 1.3 foot riprap should be placed a minimum of 2.0 feet thick (D_{50} * 1.5), on the perimeter channel bottom and sideslopes extending downstream 4 feet from the energy dissipator.

9.4 USBR TYPE VI IMPACT BASIN

The U.S. Bureau of Reclamation (USBR) Type VI impact basin was developed at the USBR Laboratory (ASCE, 1957). The dissipator is contained in a relatively small box-like structure that requires no tailwater for successful performance. Although the emphasis in this manual is on its use at culvert outlets, the structure may also be used in open channels.

The shape of the basin has evolved from extensive tests, but these were limited in range by the practical size of field structures required. With the many combinations of discharge, velocity, and depth possible for the incoming flow, it became apparent that some device was needed which would be equally effective over the entire range. The vertical hanging baffle, shown in Figure 9.13, proved to be this device. Energy dissipation is initiated by flow striking the vertical hanging baffle and being deflected upstream by the horizontal portion of the baffle and by the floor, creating horizontal eddies.

Notches in the baffle are provided to aid in cleaning the basin after prolonged periods of low or no flow. If the basin is full of sediment, the notches provide concentrated jets of water for cleaning. The basin is designed to carry the full discharge over the top of the baffle if the space beneath the baffle becomes completely clogged. Although this performance is not good, it is acceptable for short periods of time.

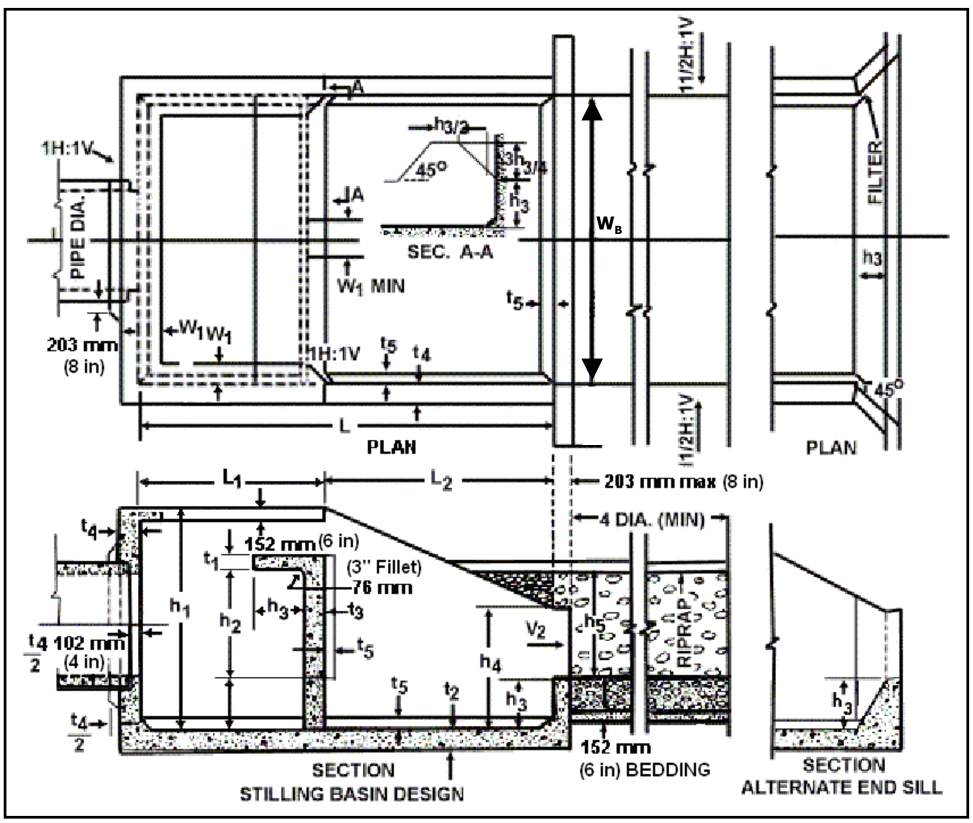


Figure 9.13. USBR Type VI Impact Basin

The design information is presented as a dimensionless curve in Figure 9.14. This curve incorporates the original information contained in ASCE (1957) and the results of additional experimentation performed by the Department of Public Works, City of Los Angeles. The curve shows the relationship of the Froude number to the ratio of the energy entering the dissipator to the width of dissipator required. The Los Angeles tests indicate that limited extrapolation of this curve is permissible.

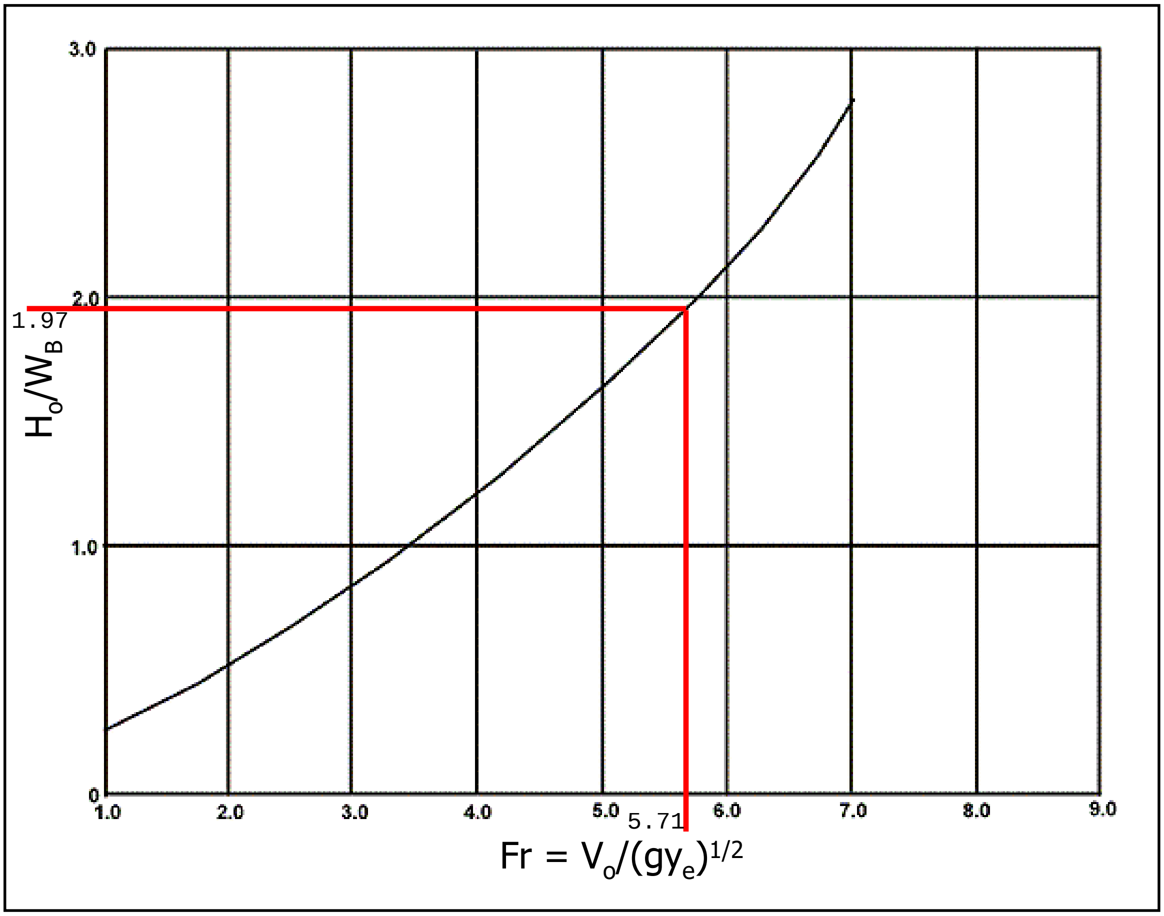


Figure 9.14. Design Curve for USBR Type VI Impact Basin

Once the basin width, W_B, has been determined, many of the other dimensions shown in Figure 9.13 follow according to Table 9.2. To use Table 9.2, round the value of W_B to the nearest entry in the table to determine the other dimensions. Interpolation is not necessary.

In calculating the energy and the Froude number, the equivalent depth of flow, $y_e = (A/2)^{1/2}$, entering the dissipator from a pipe or irregular-shaped conduit must be computed. In other words, the cross section flow area in the pipe is converted into an equivalent rectangular cross section in which the width is twice the depth of flow. The conduit preceding the dissipator can be open, closed, or of any cross section.

The effectiveness of the basin is best illustrated by comparing the energy losses within the structure to those in a natural hydraulic jump, Figure 9.15. The energy loss was computed based on depth and velocity measurements made in the approach pipe and also in the downstream channel with no tailwater. Compared with the natural hydraulic jump, the USBR Type VI impact basin shows a greater capacity for dissipating energy.

Table 9.2 (CU). USBR Type VI Impact Basin Dimensions (ft) (AASHTO, 2005)

W_B	h_1	h_2	h_3	h_4	L	L_1	L_2
4.	3.08	1.50	0.67	1.67	5.42	2.33	3.08
5.	3.83	1.92	0.83	2.08	6.67	2.92	3.83
6.	4.58	2.25	1.00	2.50	8.00	3.42	4.58
7.	5.42	2.58	1.17	2.92	9.42	4.00	5.42
8.	6.17	3.00	1.33	3.33	10.67	4.58	6.17
9.	6.92	3.42	1.50	3.75	12.00	5.17	6.92
10.	7.58	3.75	1.67	4.17	13.42	5.75	7.67
11.	8.42	4.17	1.83	4.58	14.58	6.33	8.42
12.	9.17	4.50	2.00	5.00	16.00	6.83	9.17
13.	10.17	4.92	2.17	5.42	17.33	7.42	10.00
14.	10.75	5.25	2.33	5.83	18.67	8.00	10.75
15.	11.50	5.58	2.50	6.25	20.00	8.50	11.50
16.	12.25	6.00	2.67	6.67	21.33	9.08	12.25
17.	13.00	6.33	2.83	7.08	21.50	9.67	13.00
18.	13.75	6.67	3.00	7.50	23.92	10.25	13.75
19.	14.58	7.08	3.17	7.92	25.33	10.83	14.58
20.	15.33	7.50	3.33	8.33	26.58	11.42	15.33

W_B	W_1	W_2	t_1	t_2	t_3	t_4	t_5
4.	0.33	1.08	0.50	0.50	0.50	0.50	0.25
5.	0.42	1.42	0.50	0.50	0.50	0.50	0.25
6.	0.50	1.67	0.50	0.50	0.50	0.50	0.25
7.	0.50	1.92	0.50	0.50	0.50	0.50	0.25
8.	0.58	2.17	0.50	0.58	0.58	0.50	0.25
9.	0.67	2.50	0.58	0.58	0.67	0.58	0.25
10.	0.75	2.75	0.67	0.67	0.75	0.67	0.25
11.	0.83	3.00	0.67	0.75	0.75	0.67	0.33
12.	0.92	3.00	0.67	0.83	0.83	0.75	0.33
13.	1.00	3.00	0.67	0.92	0.83	0.83	0.33
14.	1.08	3.00	0.67	1.00	0.92	0.92	0.42
15.	1.17	3.00	0.67	1.00	1.00	1.00	0.42
16.	1.25	3.00	0.75	1.00	1.00	1.00	0.50
17.	1.33	3.00	0.75	1.08	1.00	1.00	0.50
18.	1.33	3.00	0.75	1.08	1.08	1.08	0.58
19.	1.42	3.00	0.83	1.17	1.08	1.08	0.58
20.	1.50	3.00	0.83	1.17	1.17	1.17	0.67

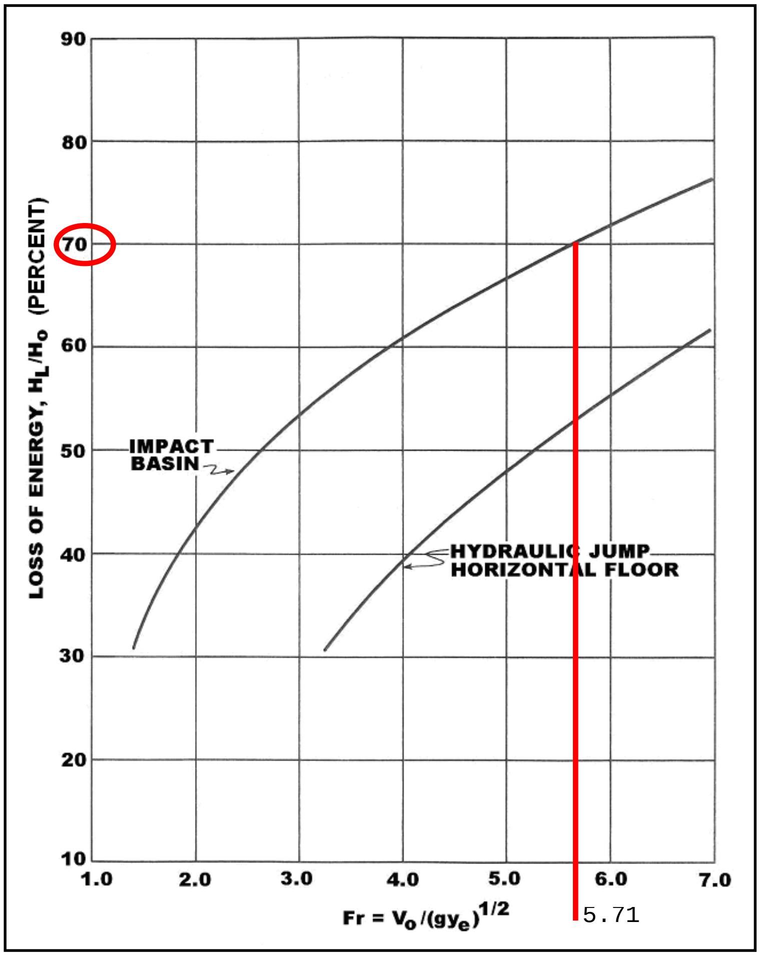


Figure 9.15. Energy Loss of USBR Type VI Impact Basin versus Hydraulic Jump

For erosion reduction and better basin operation, use the alternative end sill and 45° wingwall design as shown in Figure 9.13. The sill should be set as low as possible to prevent degradation downstream. For best performance, the downstream channel should be at the same elevation as the top of the sill. A slot should be placed in the end sill to provide for drainage during periods of low flow. Although the basin is depressed, the slot allows water to drain into the surrounding soil.

For protection against undermining, a cutoff wall should be added at the end of the basin. Its depth will depend on the type of soil present. Riprap should be placed downstream of the basin for a length of at least four conduit widths. For riprap size recommendations see Chapter 10.

The Los Angeles experiments simulated discharges up to 11.3 m^3/s (400 ft^3/s) and entrance velocities as high as 15.2 m/s (50 ft/s). Therefore, use of the basin is limited to installations within these parameters. Velocities up to 15.2 m/s (50 ft/s) can be used without subjecting the structure to damage from cavitation forces. Some structures already constructed have exceeded these thresholds suggesting there may be some design flexibility. For larger installations where discharge is separable, two or more structures may be placed side by side. The USBR Type VI is not recommended where debris or ice buildup may cause substantial clogging.

CALCULATION SHEET

Client	Dow Corning	**Subject**	Perimeter Ditch Analysis	**Project No.**	60134827
Project	Midland Facility			**Prepared By**	TCR — **Date** 5/5/11
				Reviewed By	NKW — **Date** 5/5/11
				Approved By	DFP — **Date** 5/6/11

PERIMETER DITCH ANALYSIS

Objective

Design perimeter ditches to convey surface water runoff from the downslope pipes to catch basins and manholes.

Design Criteria and Assumptions

1. The Channel Design Utility of SEDCAD+, a computer program, was used to design the perimeter ditches. SEDCAD+ is a program developed at the University of Kentucky to assist in the design and evaluation of surface water management system components.

2. Perimeter ditch should be able to convey runoff from a 25-year, 24-hour storm event, with 6 inches of freeboard.

3. Perimeter ditch design will be based on maximum flow conditions as provided in the Surface Water Run-off Estimates calculation.

4. Perimeter ditches are located around the entire perimeter of the landfill.

5. The slope of the perimeter ditches will be either 0.5 or 0.25 percent depending on location.

6. Perimeter ditches will be trapezoidal in shape with 3:1 (horizontal:vertical) ditch sideslopes. The bottom width of the ditch will be 4 feet.

7. Perimeter ditches will be vegetated. Riprap or other alternative materials, such as a geotextile erosion control mat, will be provided on the perimeter ditch bottoms and sideslopes at energy dissipator outlets, and catch basin and manhole inlets.

8. Flow from the cover drainage layer on the landfill sidelsopes will be discharged to the perimeter ditches. The flow from the drainage layer will be low and will not coincide with peak surface water run-off flows. The surface water run-off peak flow is conservative and therefore used in this analysis.

Calculations

The worst case flow conditions for the perimeter ditches on each side of the landfill were analyzed. To reduce the number of design variations for the perimeter ditch and for ease of construction, the perimeter ditch design required for the worst case flow conditions on each side of the landfill will be used for the entire length of the perimeter ditch on that side.

SEDCAD+ Channel Design Utility results for the perimeter ditch analysis are attached and summarized in Table 1 below.

CALCULATION SHEET

Client Dow Corning	**Subject** Perimeter Ditch Analysis	**Project No.** 60134827	
Project Midland Facility		**Prepared By** TCR	**Date** 5/5/11
		Reviewed By NKW	**Date** 5/5/11
		Approved By DFP	**Date** 5/6/11

Table 1: Perimeter Ditch Analysis Summary

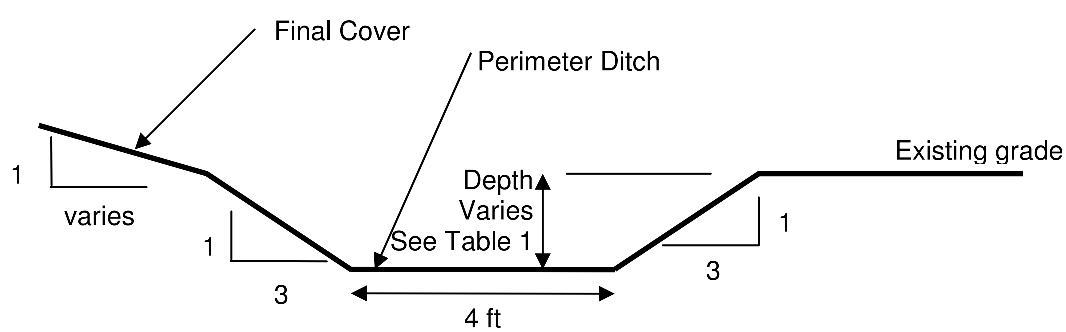
Description	SWS of max flow	Maximum Flow (cfs)	Ditch Slope (%)	Depth (ft)		Velocity (fps)
				SEDCAD+	Design	
West Side	5-1	4.04	0.5	1.40	2.0	0.92
East Side	6-1, 6-2, & 6-3	7.71	0.5	1.68	2.25	1.24
South Side	7-1 & 7-2	5.27	0.25	1.84	2.5	0.79

Notes:
1. SEDCAD+ depth is flow depth and does not include freeboard.
2. SEDCAD+ output rounds the ditch slope to the nearest tenth of a percent but uses the actual slope input in the analysis.

Conclusions

A typical cross section of a perimeter ditch was developed to convey the maximum-case flow rates. Dimensions identified by the SEDCAD+ analysis were rounded up to the nearest 0.25 foot to obtain the typical cross-section. The typical cross-section for perimeter ditches is:

Perimeter Ditch Typical Section



In general, grass vegetation will be stable with the low design velocities. Provide riprap or other erosion protection material at dissipator outlets and catch basin and manhole inlets.

Perimeter Channel - West

Material: Grass mixture

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.00	3.0:1	3.0:1	0.5	D, B				5.0

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	4.04 cfs		4.04 cfs	
Depth:	0.71 ft		1.40 ft	
Top Width:	8.28 ft		12.41 ft	
Velocity:	0.92 fps		0.35 fps	
X-Section Area:	4.38 sq ft		11.49 sq ft	
Hydraulic Radius:	0.514		0.894	
Froude Number:	0.22		0.06	
Roughness Coefficient:	0.0732		0.2781	

Perimeter Channel - East

Material: Grass mixture

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.00	3.0:1	3.0:1	0.5	D, B				5.0

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	7.71 cfs		7.71 cfs	
Depth:	0.92 ft		1.68 ft	
Top Width:	9.53 ft		14.06 ft	
Velocity:	1.24 fps		0.51 fps	
X-Section Area:	6.23 sq ft		15.13 sq ft	
Hydraulic Radius:	0.634		1.036	
Froude Number:	0.27		0.09	
Roughness Coefficient:	0.0628		0.2116	

Perimeter Channel - South

Material: Grass mixture

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.00	3.0:1	3.0:1	0.3	D, B				5.0

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	5.27 cfs		5.27 cfs	
Depth:	0.96 ft		1.84 ft	
Top Width:	9.79 ft		15.06 ft	
Velocity:	0.79 fps		0.30 fps	
X-Section Area:	6.65 sq ft		17.58 sq ft	
Hydraulic Radius:	0.659		1.122	
Froude Number:	0.17		0.05	
Roughness Coefficient:	0.0711		0.2682	

CALCULATION SHEET

AECOM

Client Dow Corning	**Subject** Surface Water	**Page** 1 **Of** 2	
Project Midland Facility	Run-off Estimates	**Project No.** 60134827	
		Prepared By TCR	**Date** 5/5/11
		Reviewed By NKW	**Date** 5/5/11
		Approved By DFP	**Date** 5/6/11

SURFACE WATER RUN-OFF ESTIMATES

Objective

Estimate surface water run-off flows for the landfill after final cover is in place.

Design Criteria and Assumptions

1. SEDCAD+, a computer program, was used to estimate run-off flows and design the surface water management system for the landfill. SEDCAD+ is a program developed at the University of Kentucky to assist in the design and evaluation of surface water management system components.

   The program is capable of computing peak flow, calculating runoff volume, sizing channels and culverts, and computing the hydraulic performance of sedimentation basins. SEDCAD+ utilizes the following methods within the program:

   - SCS Upland Curve Method for calculating time of concentration.
   - Muskingum's Method for routing between structures.
   - SCS Technical Release - 55 (TR-55) parameter for runoff volume.

2. In accordance with R299.9505(1)(f) the 25-year, 24-hour storm will be used in the analysis. The peak rainfall value of 3.90 inches is based on the figure provided in Attachment 1 obtained from the Illinois State Water Survey Bulletin, Rainfall Frequency Atlas of the Midwest, MCC Research Report 92-03, Bulletin 71, by Floyd A. Huff and James R. Angel.

3. Use SCS storm distribution Type II, per the figure from SCS TR-55 provided in Attachment 2.

4. The curve number is based on the cover soil characteristics and the condition of the vegetation. Based on soil information from the USDA, Natural Resources Conservation Service Web Soil Survey, http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm, soils in the vicinity of the landfill are classified as Hydrologic soil group B. It is assumed that locally available soils will be used for topsoil. Soils in the vicinity of the landfill include the following: Wixom Loamy Sand, Parkhill Loam, and Lenawee Silty Clay as shown in Attachment 3.

5. Determine the curve number from tables provided in SCS TR-55 and included in Attachment 4. A curve number of 69 is chosen based on hydrologic soil group B assuming final cover conditions are pasture, fair condition.

6. In the SEDCAD inputs to calculate time of concentration, paved areas are used to represent downslope pipes and riprap or stone lined channels.

7. Sub-watershed (SWS) areas and SEDCAD structure labels are shown on the figure provided in Attachment 5.

Project No. 60134827

Client Dow Corning	**Subject** Surface Water	**Prepared By** TCR	**Date** 5/5/11
Project Midland Facility	Run-off Estimates	**Reviewed By** NKW	**Date** 5/5/11
		Approved By DFP	**Date** 5/6/11

Calculations

SEDCAD output which includes input data is provided in Attachment 6. Table 1 summarizes the maximum flows for various conditions.

Table 1: Maximum Flow Summary

Component	SWS Considered [Structure #]-[SWS #]	SWS with Max. Flow	25-yr, 24-hr Storm Maximum Flow (cfs)
Diversion Berm	6-2, 6-3, 6-5, and 7-2	6-3	3.94
Downslope Pipe	6-2, 6-3, 6-5, and 7-2	6-3	3.94
Perimeter Ditch West	2-1, 3-1, 3-2, 4-1, and 5-1	5-1	4.04
Perimeter Ditch South	1-1 and (7-1 + 7-2)	(7-1 +7-2)	5.27 (3.06 + 2.21)
Perimeter Ditch East	(6-1 + 6-2 + 6-3) and (6-4 + 6-5)	(6-1 + 6-2 + 6-3)	7.71 (2.41 + 1.36 + 3.94)

Conclusions

The surface water run-off estimates for use in the design of the surface water management system components are summarized in Table 1.

Attachment 1

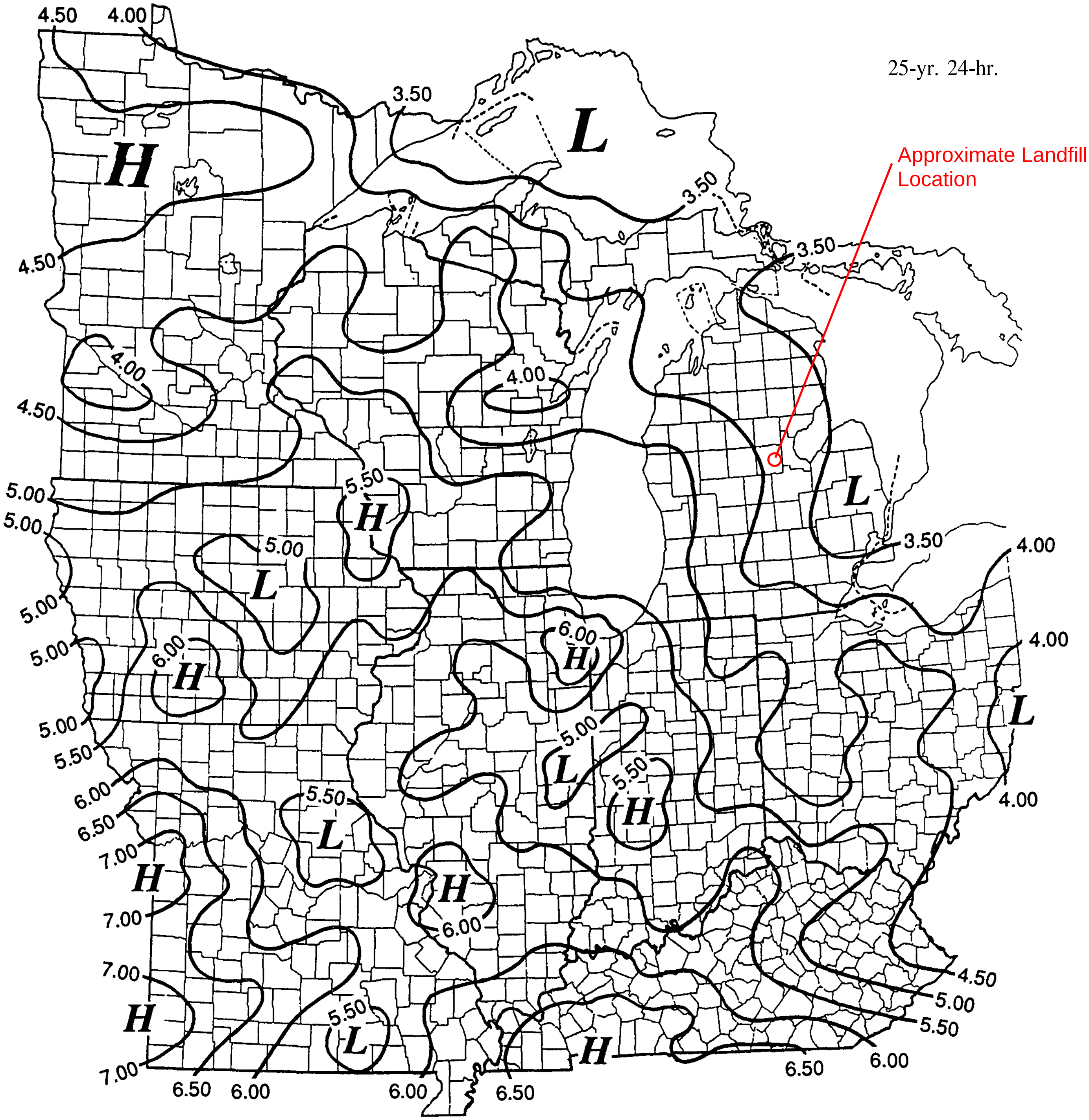
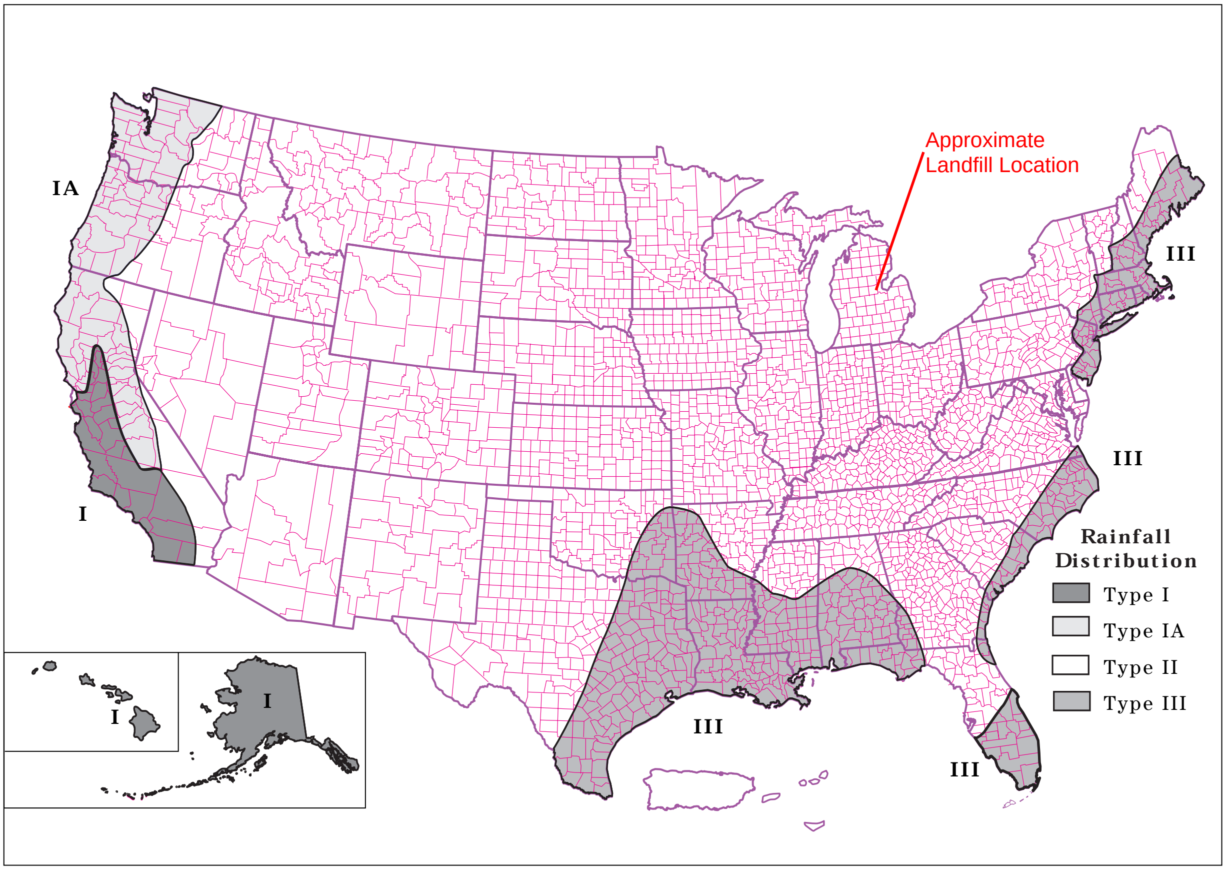


Figure 6. Continued

SOURCE: KOERNER, R.M "DESIGNING WITH GEOSYNTHETICS", 4TH ED., P.403 (1999)

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

Hawaii

Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.

Area of Interest (AOI) | **Soil Map** | Soil Data Explorer | Shopping Cart (Free)

Printable Version | Add to Shopping Cart

Search

Map Unit Legend

OaB	Oakville fine sand, 0 to 6 percent slopes	6,827.3	2.0%
Pa	Parkhill loam	20,441.4	6.0%
Pe	Pella silt loam	4,374.4	1.3%
PsB	Pipestone sand, 0 to 3 percent slopes	49,571.8	14.7%
PtB	Pipestone sand, loamy substratum, 0 to 3 percent slopes	18,065.2	5.3%
PuB	Pipestone-Oakville-Urban land complex, 0 to 6 percent slopes	4,014.6	1.2%
PwB	Plainfield sand, 0 to 6 percent slopes	3,204.6	0.9%
PxB	Poseyville-Londo complex, 0 to 4 percent slopes	5,428.3	1.6%
Sz	Sloan loam	3,079.4	0.9%
Ur	Urban land	3,796.1	1.1%
W	Water	4,516.3	1.3%
Wa	Wauseon sandy loam	1,960.0	0.6%
WxB	Wixom loamy sand	35,367.9	10.5%

Soil Map

Legend

Scale (not to scale)

SOURCE: KOERNER, R.M
"DESIGNING WITH

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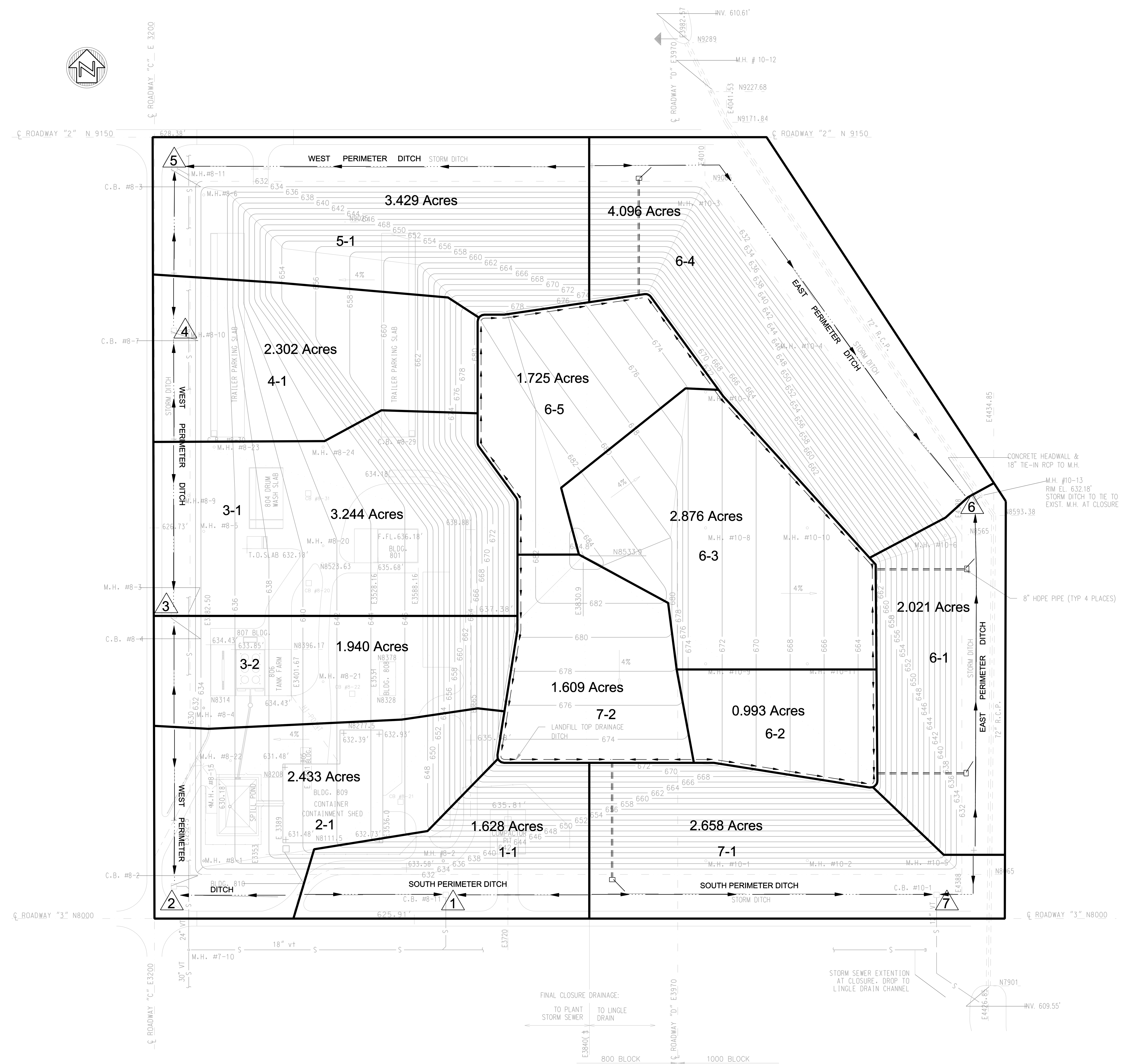
Attachment 4

Table 2-2c Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4]	48	65	73
Woods—grass combination (orchard or tree farm). [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.
2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.
3 *Poor*: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.
4 Actual curve number is less than 30; use CN = 30 for runoff computations.
5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.
6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.



NOTES:

1. FINAL CONTOURS ARE BASED ON:
   A. TOTAL FILL VOLUME AT OR VERY CLOSE TO MAXIMUM LANDFILL VOLUME AS SPECIFIED IN LANDFILL CLOSURE PLAN DATED 5 – 1988.
   B. SIDE SLOPE = 4:1
      PLATEAU SLOPE = 4% MINIMUM
2. CONTOURS REPRESENT ELEVATION OF A CLOSURE CAP. ACTUAL ELEVATION OF FILL MATERIAL WILL BE 5.0' LOWER.

△6	SEDCAD STRUCTURE LOCATION/LABEL
6-3	SUBWATERSHED LABEL (STRUCTURE # – SWS #)
·····►	PERIMETER DITCH AND FLOW DIRECTION
–►–►–►	DIVERSION BERM AND FLOW DIRECTION
= = = =□	DOWNSLOPE PIPE AND ENERGY DISSIPATOR

NO	REVISIONS	DRN	CHK	DATE

Sheboygan, Wisconsin

DRN
DES
CHK
APP

AECOM

MIDLAND LANDFILL CLOSURE
DOW CORNING CORPORATION

SEDCAD LAYOUT

DATE MAY 2011
PROJECT NO 60134827
FILENAME Drainage Figure.dwg
SHEET NO
DRAWING NO
ATTACHMENT 5

5/5/2011 11:25:29 AM
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Server = USSHB501
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Midland Landfill

25-year, 24-hour Storm Event

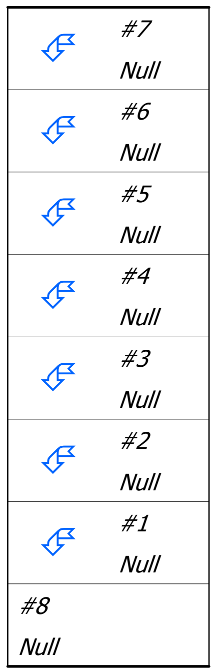
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	25 yr - 24 hr
Rainfall Depth:	3.900 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#8	0.000	0.000	CB #8-11
Null	#2	==>	#8	0.000	0.000	CB #8-2
Null	#3	==>	#8	0.000	0.000	CB #8-4
Null	#4	==>	#8	0.000	0.000	CB #8-7
Null	#5	==>	#8	0.000	0.000	CB #8-3
Null	#6	==>	#8	0.000	0.000	MH #10-13
Null	#7	==>	#8	0.000	0.000	CB #10-1
Null	#8	==>	End	0.000	0.000	Node for software setup purposes



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#7	4.270	4.270	5.00	0.43
#6	11.720	11.720	12.79	1.17
#5	3.430	3.430	4.04	0.34
#4	2.300	2.300	3.15	0.23
#3	5.180	5.180	6.14	0.52
#2	2.430	2.430	2.90	0.24
#1	1.630	1.630	2.23	0.16
#8	0.000	30.960	35.06	3.10

Structure Detail:

Structure #7 (Null)

CB #10-1

Structure #6 (Null)

MH #10-13

Structure #5 (Null)

CB #8-3

Structure #4 (Null)

CB #8-7

Structure #3 (Null)

CB #8-4

Structure #2 (Null)

CB #8-2

Structure #1 (Null)

CB #8-11

Structure #8 (Null)

Node for software setup purposes

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#7	1	2.660	0.201	0.000	0.000	69.000	TR55	3.06	0.266
	2	1.610	0.069	0.179	0.334	69.000	TR55	2.21	0.161
	Σ	**4.270**						**5.00**	**0.428**
#6	1	2.020	0.136	0.000	0.000	69.000	TR55	2.41	0.202
	2	0.990	0.079	0.106	0.338	69.000	TR55	1.36	0.099
	3	2.880	0.077	0.030	0.395	69.000	TR55	3.94	0.289
	4	4.100	0.223	0.000	0.000	69.000	TR55	4.50	0.411
	5	1.730	0.108	0.196	0.318	69.000	TR55	2.37	0.173
	Σ	**11.720**						**12.79**	**1.174**
#5	1	3.430	0.174	0.000	0.000	69.000	TR55	4.04	0.344
	Σ	**3.430**						**4.04**	**0.344**
#4	1	2.300	0.100	0.000	0.000	69.000	TR55	3.15	0.230
	Σ	**2.300**						**3.15**	**0.230**
#3	1	3.240	0.125	0.000	0.000	69.000	TR55	3.87	0.325
	2	1.940	0.050	0.000	0.000	69.000	TR55	2.66	0.194
	Σ	**5.180**						**6.14**	**0.519**
#2	1	2.430	0.129	0.000	0.000	69.000	TR55	2.90	0.243
	Σ	**2.430**						**2.90**	**0.243**
#1	1	1.630	0.090	0.000	0.000	69.000	TR55	2.23	0.163
	Σ	**1.630**						**2.23**	**0.163**
#8	Σ	**30.960**						**35.06**	**3.101**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	25.00	47.50	190.00	4.000	0.013
		6. Grassed waterway	0.25	0.52	208.00	0.750	0.077
#1	**1**	**Time of Concentration:**					**0.090**
#2	1	3. Short grass pasture	25.00	26.75	107.00	4.000	0.007
		3. Short grass pasture	4.00	14.92	373.00	1.600	0.064
		6. Grassed waterway	0.50	1.12	225.00	1.060	0.058
#2	**1**	**Time of Concentration:**					**0.129**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#3	1	3. Short grass pasture	20.00	39.60	198.00	3.570	0.015
		3. Short grass pasture	4.00	10.28	257.00	1.600	0.044
		6. Grassed waterway	0.50	1.27	255.00	1.060	0.066
#3	**1**	**Time of Concentration:**					**0.125**
#3	2	3. Short grass pasture	25.00	26.75	107.00	4.000	0.007
		6. Grassed waterway	0.50	0.82	165.00	1.060	0.043
#3	**2**	**Time of Concentration:**					**0.050**
#4	1	3. Short grass pasture	20.00	39.60	198.00	3.570	0.015
		3. Short grass pasture	4.00	10.28	257.00	1.600	0.044
		6. Grassed waterway	0.50	0.78	157.00	1.060	0.041
#4	**1**	**Time of Concentration:**					**0.100**
#5	1	3. Short grass pasture	25.00	49.50	198.00	4.000	0.013
		6. Grassed waterway	0.50	3.07	615.00	1.060	0.161
#5	**1**	**Time of Concentration:**					**0.174**
#6	1	3. Short grass pasture	25.00	15.50	62.00	4.000	0.004
		6. Grassed waterway	0.50	2.53	507.00	1.060	0.132
#6	**1**	**Time of Concentration:**					**0.136**
#6	2	3. Short grass pasture	4.00	11.52	288.00	1.600	0.050
		7. Paved area and small upland gullies	0.50	0.75	150.00	1.420	0.029
#6	**2**	**Time of Concentration:**					**0.079**
#6	3	3. Short grass pasture	4.00	11.08	277.00	1.600	0.048
		7. Paved area and small upland gullies	2.60	9.07	349.00	3.240	0.029
#6	**3**	**Time of Concentration:**					**0.077**
#6	4	3. Short grass pasture	25.00	49.50	198.00	4.000	0.013
		6. Grassed waterway	0.50	4.00	802.00	1.060	0.210
#6	**4**	**Time of Concentration:**					**0.223**
#6	5	3. Short grass pasture	4.00	3.52	88.00	1.600	0.015
		7. Paved area and small upland gullies	0.50	2.04	408.00	1.420	0.079
		7. Paved area and small upland gullies	3.30	6.43	195.00	3.650	0.014
#6	**5**	**Time of Concentration:**					**0.108**
#7	1	3. Short grass pasture	25.00	47.50	190.00	4.000	0.013
		6. Grassed waterway	0.25	1.27	510.00	0.750	0.188
#7	**1**	**Time of Concentration:**					**0.201**
#7	2	3. Short grass pasture	4.00	3.52	88.00	1.600	0.015
		7. Paved area and small upland gullies	2.70	8.04	298.00	3.300	0.025
		7. Paved area and small upland gullies	0.50	0.76	152.00	1.420	0.029
#7	**2**	**Time of Concentration:**					**0.069**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#6	2	7. Paved area and small upland gullies	25.00	37.00	148.00	10.060	0.004
		6. Grassed waterway	0.50	1.95	391.00	1.060	0.102
#6	**2**	**Muskingum K:**					**0.106**
#6	3	7. Paved area and small upland gullies	25.00	37.00	148.00	10.060	0.004
		6. Grassed waterway	0.50	0.50	101.00	1.060	0.026
#6	**3**	**Muskingum K:**					**0.030**
#6	5	7. Paved area and small upland gullies	25.00	49.50	198.00	10.060	0.005
		6. Grassed waterway	0.50	3.65	730.00	1.060	0.191
#6	**5**	**Muskingum K:**					**0.196**
#7	2	7. Paved area and small upland gullies	25.00	47.50	190.00	10.060	0.005
		6. Grassed waterway	0.25	1.17	470.00	0.750	0.174
#7	**2**	**Muskingum K:**					**0.179**