DAPPOLONIA
WASTE MANAGEMENT SE VICES

USA-EPA

By WTC Date ______ Subject DESIGN CALCULATIONS Sheet No. 1 of 1
Chkd. By ____ Date ______ VERTAC CHEMICAL PLANT, JACKSONVILLE, AK Proj. No. 846012

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0014622

80372

80372

DAM OUTLET PIPE DISCHARGE CAPACITY

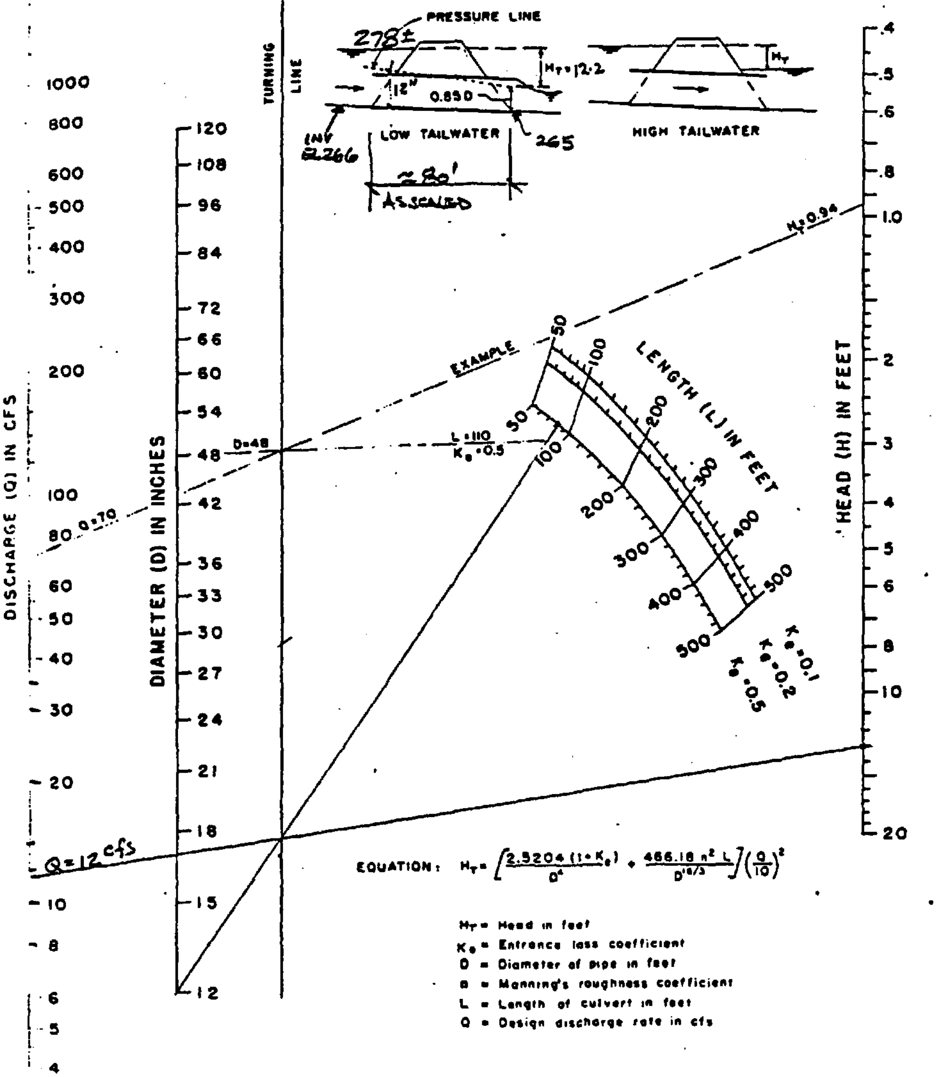


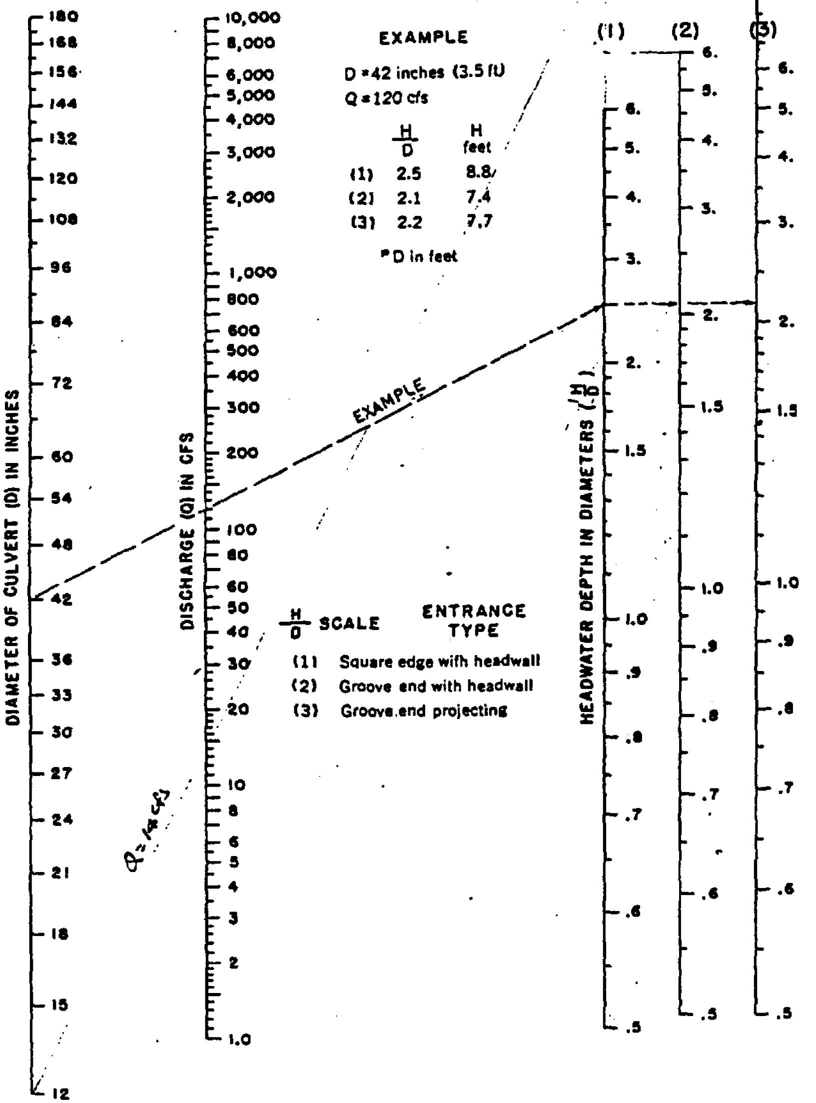
Figure 8-10. Head for concrete pipe culverts flowing full, $n=0.012$. (U.S. Bureau of Public Roads.) 288-D-2910.

CONSULTING ENGINEERS, INC.

By WTC Date 12/4/83 Subje VERTAC CHEMICAL CORP

Chkd. By JM Date 4/30/84 JACKSONVILLE, AK Proj. No. 846012

To use scale (2) or (3), project horizontally to scale (1), then use straight inclined line through D and Q scales, or reverse as illustrated.



ENTRANCE CONTROL CONDITION Q = 14 cfs > i.e. FLOW FULL CONTROL

FLOW FULL CONDITION Q = 12 cfs

12" RCP OUTLET PIPE CAPACITY = 12 cfs

Figure 8-8. Headwater depth for concrete pipe culverts with entrance control. (U.S. Bureau of Public Roads.) 288-D-2901

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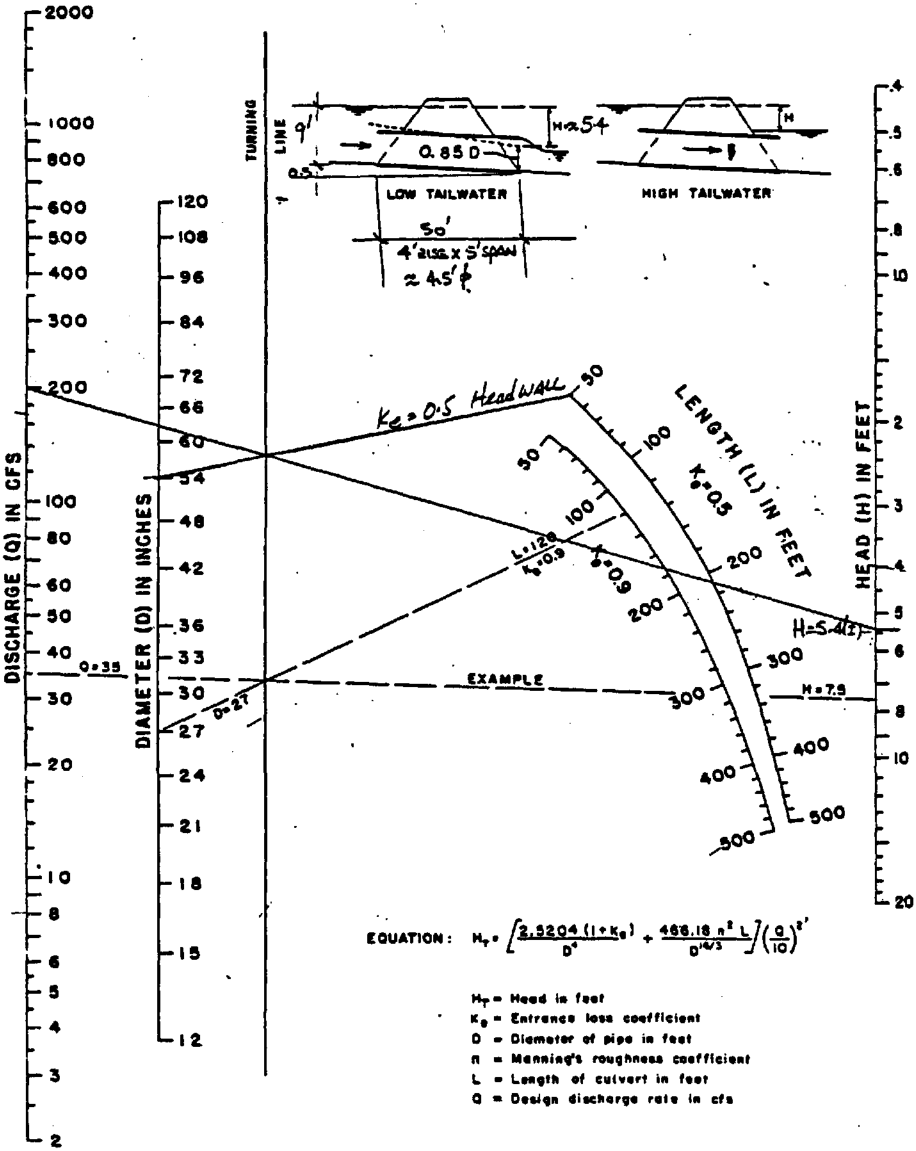
(3)

By WTC Date 12/6/83 Subject VERTAC CHEMICAL CORP Sheet No. 1 of 2
Chkd. By UM Date 4/30/84 JACKSONVILLE AK Proj. No. 846012
DISCHARGE CAPACITY OF EXISTING CMP 0.5cm. X 0.5cm.



EQUATION: $H_T = \left[\frac{2.5204(1+K_e)}{D^4} + \frac{466.18\, n^2 L}{D^{16/3}}\right]\left(\frac{Q}{10}\right)^2$

H_T = Head in feet
K_e = Entrance loss coefficient
D = Diameter of pipe in feet
n = Manning's roughness coefficient
L = Length of culvert in feet
Q = Design discharge rate in cfs

Figure B-11. Head for corrugated-metal pipe culverts flowing full, n=0.024. (U.S. Bureau of Public Roads.) 288-D-2911.

007465

(4)

).5cm.

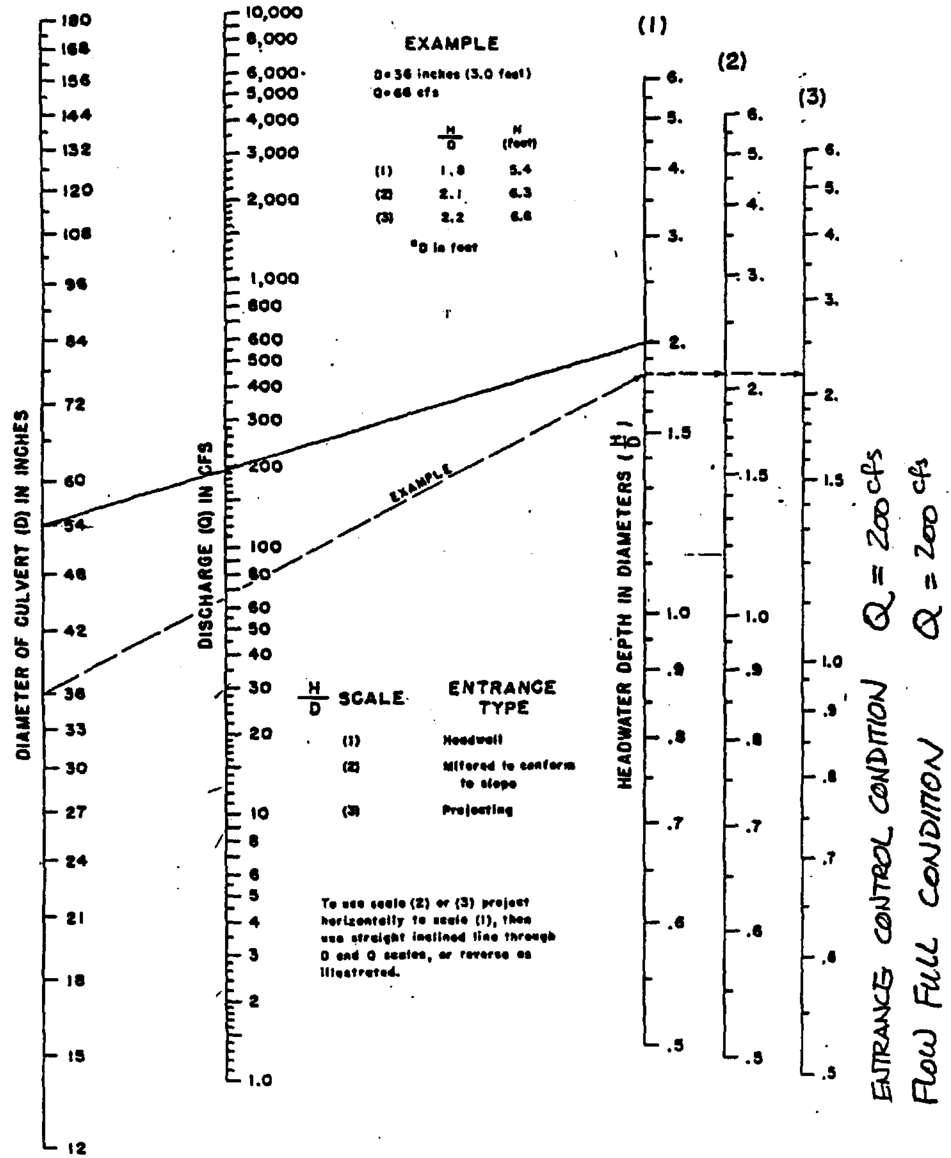


Figure 8-9. Headwater depth for corrugated-metal pipe culverts with entrance control. (U.S. Bureau of Public Roads.) 288-D-2K

COOLING POND STORAGE CAPACITY & DRAINTIME

FROM GL 265 to 274 (SEE WTC CALC. 11/16/83) VOL = 869 650 CF = 6,505,000 gal

APPROXIMATE TIME REQ'D to DRAIN POND (ASSUME NO INFLOW)

$$T_1 = \frac{869\ 650}{12} = 72{,}471\ sec = 20.1^{hr} = 0.8\ day.$$

ASSUME BASED FLOW = 1 cfs = 448 gpm. (See Weir data)

$$T_2 = \frac{869\ 650}{(12-1)} = 79{,}059\ sec = 22^{hr} = 1\ days$$

IN GENERAL IT WILL TAKE 1 to 2 day to drain down COOLING POND.

WATERSHED = 700 acre ABOVE NORTH ENTRANCE OF POND
= 110 acre WITHIN PLANT AREA

total = 810 acre.

$$RUNOFF = \frac{869\ 650}{810 \times 43560} \times 12 = 0.30'' \text{ WILL FILL UP POND.}$$

EXCESS RUNOFF WILL BE DISCHARGED THROUGH FOUR 5' SPAN 4' RISE CMP., WHICH HAS A COMBINED CAPACITY Q = 4x200 = 800 cfs WHICH IS SLIGHTLY LESS THAN 846 cfs of 100 YR Peak INFLOW OK.

0014467

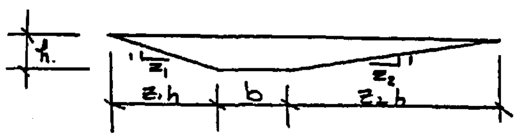
ROCKY BRANCH CREEK (COOLING POND SECTION)

SINCE THE HYDRAULIC PERFORMANCE IS LIMITED PHYSICALLY BY THE EXISTING 12"ϕ CMP OUTLET PIPE., IT IS NO NEED TO PROVIDE A LINED CHANNEL FOR MAJOR STORM EVENT. THE COOLING POND IS LIKELY TO BE FULL WITH STORM WATER RUNOFF AND SPILL OVER THROUGH FOUR 4' RISE X 5' SPAN CMP. THE MAXIMUM FLOOD STAGE IN COOLING POND HAS BEEN DETERMINED IN "100 YEAR COOLING POND ROUTING ANALYSIS" (

TO DETERMINE WATER DEPTH AND VELOCITY OF ROCKY BRANCH ASSUMING IF RAILROAD EMBANKMENT REMOVED, USING MANNING FORMULA.

FLOW AREA = A

$= b + \left(\frac{Z_1 + Z_2}{2}\right) h$



WETTED PERIMETER = P = $b + h\left(\sqrt{1+Z_1^2} + \sqrt{1+Z_2^2}\right)$

HYDRAULIC RADIUS = R = $\frac{A}{P}$

$V = \frac{1.486}{n} (R)^{2/3} (S)^{1/2}$

Q = VA.

n = 0.045 FOR ROCK SURFACE

$S = \frac{274 - 264}{1100} = 0.0091$

$Z_1 \doteq 10\% \approx 10$

$Z_2 \doteq 2\% \approx 50$

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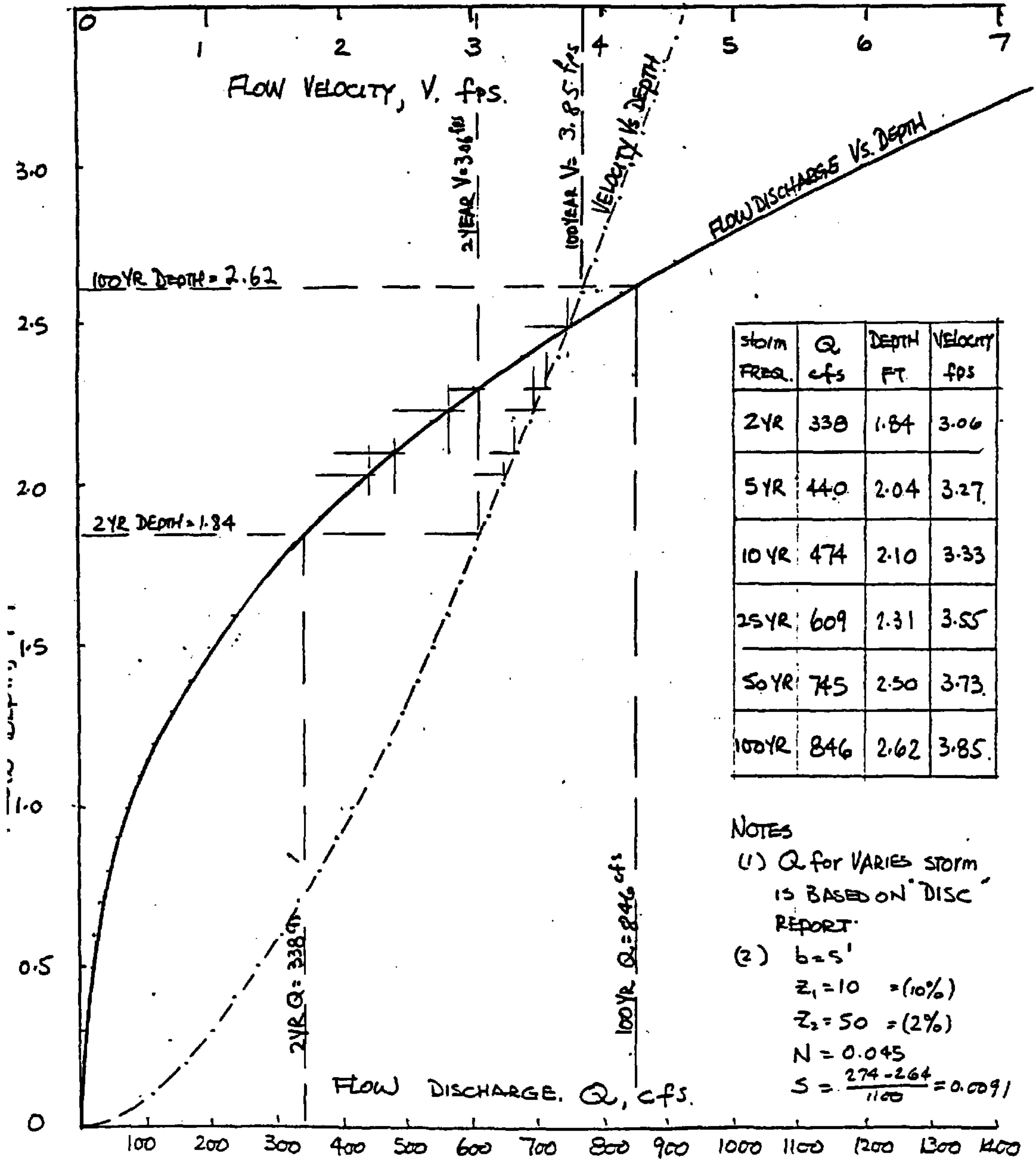
By WTC Date 1/20/84 Subject ROCKY BRANCH CREEK Sheet No. 2 of 6
Chkd. By JM Date 5/17/84 VERTAC CHEMICAL JACKSONVILLE AK Proj. No. 846012



Storm FREQ.	Q cfs	DEPTH FT	VELOCITY fps
2 YR	338	1.84	3.06
5 YR	440	2.04	3.27
10 YR	474	2.10	3.33
25 YR	609	2.31	3.55
50 YR	745	2.50	3.73
100 YR	846	2.62	3.85

NOTES
(1) Q for VARIES storm IS BASED ON "DISC" REPORT
(2) b = 5'
$Z_1 = 10$ = (10%)
$Z_2 = 50$ = (2%)
N = 0.045
$S = \frac{274 - 264}{1100} = 0.0091$

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WASTE MANAGEMENT SERVICES

By WTC Date 1/20/84 Subject ROCKY BRANCH CREEK Sheet No. 3 of 6
Chkd. By JM Date 5/1?/84 VERTAC CHEMICAL JACKSONVILLE AK Proj. No. 846012

```
LBL "MF"
CF 22
CF 00
"STONE ?"
PROMPT
FS?C 22
SF 00
2
ENTER↑
3
/
STO 11
"b=?"
PROMPT
FS?C 22
STO 01
"Z1=?"
PROMPT
FS?C 22
STO 02
"Z2=?"
PROMPT
FS?C 22
STO 03
"N=?"
PROMPT
FS?C 22
STO 04
"S=?"
PROMPT
FS?C 22
STO 05
"START d=?"
PROMPT
STO 06
"INCREMENT=?"
PROMPT
STO 12
"INC. NO.=?"
PROMPT
LBL 02
STO 13
LBL 01
"d="
ARCL 06
"⊢FT"
AVIEW
XEQ G
FS? 00
XEQ 03
RCL 12
ST+ 06
ADV
DSE 13
GTO 01
CF 22
"MORE d ?"
PROMPT
FS?C 22
GTO 02
"CHANGED ?"
PROMPT
FS?C 22
GTO "MF"
"FINISH"
AVIEW
STOP
LBL G
XEQ H
XEQ I
*
STO 07
"Q="
ARCL X
"⊢CFS"
AVIEW
RTN
LBL H
XEQ I
XEQ J
/
RCL 11
Y↑X
RCL 05
SQRT
*
1.486
*
RCL 04
/
STO 08
"V="
ARCL X
"⊢FPS"
AVIEW
RTN
LBL I
RCL 02
RCL 03
+
RCL 06
*
2
/
RCL 01
+
RCL 06
*
RTN
LBL J
RCL 02
X↑2
1
+
SQRT
RCL 03
X↑2
1
+
SQRT
+
RCL 06
*
RCL 01
+
RTN
LBL 03
RCL 06
32.2
*
SQRT
1/X
RCL 08
*
"F="
ARCL X
AVIEW
3
Y↑X
RCL 06
*
.28
*
"D50="
ARCL X
"⊢FT"
AVIEW
3
Y↑X
86.39
*
"W50="
ARCL X
"⊢LBS"
AVIEW
END
```

XEQ "MF"

STONE ?

RUN

B=?

5.00 RUN

Z1=?

10.00 RUN

Z2=?

50.00 RUN

N=?

.045 RUN

S=?

.0091 RUN

START d=?

.10 RUN

INCREMENT=?

.10 RUN

INC. NO.=?

30.00 RUN

d=0.10FT
V=0.55FPS
Q=0.44CFS

d=0.20FT
V=0.81FPS
Q=1.77CFS

d=0.30FT
V=1.01FPS
Q=4.26CFS

d=0.40FT
V=1.20FPS
Q=8.14CFS

d=0.50FT
V=1.37FPS
Q=13.66CFS

d=0.60FT
V=1.52FPS
Q=21.02CFS

d=0.70FT
V=1.67FPS
Q=30.44CFS

d=0.80FT
V=1.81FPS
Q=42.11CFS

d=0.90FT
V=1.95FPS
Q=56.21CFS

d=1.00FT
V=2.08FPS
Q=72.93CFS

d=1.10FT
V=2.21FPS
Q=92.44CFS

d=1.20FT
V=2.34FPS
Q=114.90CFS

d=1.30FT
V=2.46FPS
Q=140.50CFS

d=1.40FT
V=2.57FPS
Q=169.37CFS

d=1.50FT
V=2.69FPS
Q=201.68CFS

d=1.60FT
V=2.80FPS
Q=237.59CFS

d=1.70FT
V=2.91FPS
Q=277.24CFS

d=1.80FT
V=3.02FPS
Q=320.78CFS

d=1.90FT
V=3.13FPS
Q=368.35CFS

d=2.00FT
V=3.23FPS
Q=420.10CFS

d=2.10FT
V=3.33FPS
Q=476.16CFS

d=2.20FT
V=3.44FPS
Q=536.67CFS

d=2.30FT
V=3.54FPS
Q=601.72CFS

d=2.40FT
V=3.63FPS
Q=671.57CFS

d=2.50FT
V=3.73FPS
Q=746.24CFS

d=2.60FT
V=3.83FPS
Q=825.88CFS

d=2.70FT
V=3.92FPS
Q=910.62CFS

d=2.80FT
V=4.02FPS
Q=1,000.60CFS

d=2.90FT
V=4.11FPS
Q=1,095.94CFS

d=3.00FT
V=4.20FPS
Q=1,196.76CFS

MORE d ?

5.00 RUN

d=3.10FT
V=4.29FPS
Q=1,303.18CFS

d=3.20FT
V=4.38FPS
Q=1,415.32CFS

d=3.30FT
V=4.47FPS
Q=1,533.30CFS

d=3.40FT
V=4.56FPS
Q=1,657.24CFS

d=3.50FT
V=4.64FPS
Q=1,787.26CFS

MORE d ?

RUN

CHANGED ?

RUN

STITCH

0014771

(10)

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WASTE MANAGEMENT SERVICES

By WTC Date 1/20/84 Subject ROCKY BRANCH CREEK Sheet No. 5 of 6
Chkd. By JM Date 5/17/84 VERTAC CHEMICAL JACKSONVILLE AK Proj No 846012

```
          XEQ "MF"
STONE ?
          5.00    RUN
b=?
         10.00    RUN
Z1=?
          XEQ "MF"
STONE ?
                  RUN
b=?
          5.00    RUN
Z1=?
         10.00    RUN
Z2=?
         50.00    RUN
N=?
          .045    RUN
S=?
         .0091    RUN
START d=?
          1.80    RUN
INCREMENT=?
           .01    RUN
INC. NO.=?
         85.00    RUN
```

d=1.80FT
V=3.02FPS
Q=320.78CFS

d=1.81FT
V=3.03FPS
Q=325.35CFS

d=1.82FT
V=3.04FPS
Q=329.97CFS

d=1.83FT
V=3.05FPS
Q=334.62CFS

d=1.84FT
V=3.06FPS 2YR
Q=339.32CFS

d=1.85FT
V=3.07FPS
Q=344.05CFS

d=1.86FT
V=3.08FPS
Q=348.83CFS

d=1.87FT
V=3.10FPS
Q=353.65CFS

d=1.88FT
V=3.11FPS
Q=358.51CFS

d=1.89FT
V=3.12FPS
Q=363.41CFS

d=1.90FT
V=3.13FPS
Q=368.35CFS

d=1.91FT
V=3.14FPS
Q=373.33CFS

d=1.92FT
V=3.15FPS
Q=378.36CFS

d=1.93FT
V=3.16FPS
Q=383.43CFS

d=1.94FT
V=3.17FPS
Q=388.54CFS

d=1.95FT
V=3.18FPS
Q=393.69CFS

d=1.96FT
V=3.19FPS
Q=398.89CFS

d=1.97FT
V=3.20FPS
Q=404.13CFS

d=1.98FT
V=3.21FPS
Q=409.41CFS

d=1.99FT
V=3.22FPS
Q=414.73CFS

d=2.00FT
V=3.23FPS
Q=420.10CFS

d=2.01FT
V=3.24FPS
Q=425.51CFS

d=2.02FT
V=3.25FPS
Q=430.96CFS

d=2.03FT
V=3.26FPS
Q=436.45CFS

d=2.04FT
V=3.27FPS 5YR
Q=441.99CFS

d=2.05FT
V=3.28FPS
Q=447.58CFS

d=2.06FT
V=3.29FPS
Q=453.21CFS

d=2.07FT
V=3.30FPS
Q=458.88CFS

d=2.08FT
V=3.31FPS
Q=464.59CFS

d=2.09FT
V=3.32FPS
Q=470.35CFS

d=2.10FT
V=3.33FPS 10-YR
Q=476.16CFS

d=2.11FT
V=3.34FPS
Q=482.00CFS

d=2.12FT
V=3.35FPS
Q=487.90CFS

d=2.13FT
V=3.36FPS
Q=493.83CFS

d=2.14FT
V=3.38FPS
Q=499.82CFS

d=2.15FT
V=3.39FPS
Q=505.85CFS

d=2.16FT
V=3.40FPS
Q=511.92CFS

d=2.17FT
V=3.41FPS
Q=518.04CFS

d=2.18FT
V=3.42FPS
Q=524.20CFS

d=2.19FT
V=3.43FPS
Q=530.41CFS

d=2.20FT
V=3.44FPS
Q=536.67CFS

d=2.21FT
V=3.45FPS
Q=542.97CFS

d=2.22FT
V=3.46FPS
Q=549.31CFS

d=2.23FT
V=3.47FPS
Q=555.71CFS

d=2.24FT
V=3.48FPS
Q=562.15CFS

d=2.25FT
V=3.49FPS
Q=568.63CFS

d=2.26FT
V=3.50FPS
Q=575.16CFS

d=2.27FT
V=3.51FPS
Q=581.74CFS

d=2.28FT
V=3.52FPS
Q=588.37CFS

d=2.29FT
V=3.53FPS
Q=595.04CFS

d=2.30FT
V=3.54FPS
Q=601.76CFS

d=2.31FT
V=3.55FPS 25YR
Q=608.53CFS

d=2.32FT
V=3.56FPS
Q=615.34CFS

d=2.33FT
V=3.57FPS
Q=622.20CFS

d=2.34FT
V=3.58FPS
Q=629.11CFS

d=2.35FT
V=3.59FPS
Q=636.07CFS

d=2.36FT
V=3.59FPS
Q=643.07CFS

d=2.37FT
V=3.60FPS
Q=650.13CFS

d=2.38FT
V=3.61FPS
Q=657.23CFS

d=2.39FT
V=3.62FPS
Q=664.38CFS

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d=2.41FT
V=3.64FPS
Q=678.82CFS

d=2.42FT
V=3.65FPS
Q=686.11CFS

d=2.43FT
V=3.66FPS
Q=693.46CFS

00[illegible]72

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WASTE MANAGEMENT SERVICES

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By WTC Date 1/20/84 Subject ROCKYBRANCH CREEK Sheet No. 6 of 6
Chkd. By JM Date [illegible] VERTAC CHEMICAL, JACKSONVILLE AR Proj. No. 846012

d=2.44FT
V=3.67FPS
Q=700.85CFS

d=2.45FT
V=3.68FPS
Q=708.29CFS

d=2.46FT
V=3.69FPS
Q=715.78CFS

d=2.47FT
V=3.70FPS
Q=723.32CFS

d=2.48FT
V=3.71FPS
Q=730.91CFS

d=2.49FT
V=3.72FPS
Q=738.55CFS

d=2.50FT
V=3.73FPS 50YR
Q=746.24CFS

d=2.51FT
V=3.74FPS
Q=753.97CFS

d=2.52FT
V=3.75FPS
Q=761.76CFS

d=2.53FT
V=3.76FPS
Q=769.60CFS

d=2.54FT
V=3.77FPS
Q=777.49CFS

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V=3.79FPS
Q=793.42CFS

d=2.57FT
V=3.80FPS
Q=801.45CFS

d=2.58FT
V=3.81FPS
Q=809.54CFS

d=2.59FT
V=3.82FPS
Q=817.69CFS

d=2.60FT
V=3.83FPS
Q=825.88CFS

d=2.61FT
V=3.84FPS
Q=834.12CFS

d=2.62FT
V=3.85FPS 100YR.
Q=842.41CFS

d=2.63FT
V=3.86FPS
Q=850.76CFS

d=2.64FT
V=3.87FPS
Q=859.16CFS

MORE d ?
RUN
CHANGED ?
RUN
FINISH

001473

PURPOSE:

FIND 100 YEAR FLOOD ELEVATION ON ROCKY BRANCH CREEK AT THE DISCHARGE STRUCTURE ONCE THE POND HAS BEEN CLOSED AND THE WEIR UPGRADED ACCORDING TO CURRENT DESIGN PLANS.

METHODOLOGY:

1) ESTIMATE SOIL GROUP HYDROLOGIC CLASSIFICATION TO DETERMINE "CN" (SOIL CONSERVATION SERVICE, REF. 7)

2) DETERMINE Q AND ∀ BY SCS TRIANGULAR INFLOW HYDROGRAPH.

3) DETERMINE DISCHARGE CAPACITY USING PIPE FLOWS AND THE BROAD-CRESTED WEIR FORMULA.

4) ROUTING ANALYSIS

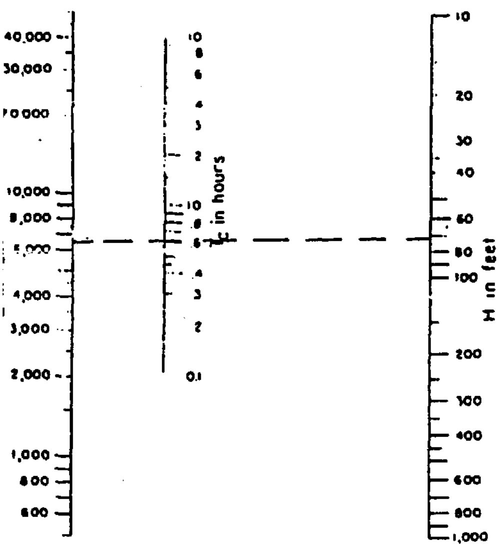
001474

1. FIND 100 YEAR / 6 HOUR STORM INFLOW:

100 YEAR / 6 HOUR RAINFALL = 6 IN. (REF. 1)

WATERSHED AREA = AREA 1 + AREA 2 = 700 + 110 = 810 ACRES (REF. 2)
(SEE FIGURE 1)

C ESTIMATING T_c FROM LENGTHS AND SLOPES:



(a) Nomograph (SCS Guide)

L = length of longest watercourse in feet
H = difference in elevation in feet between outlet point and divide

(b) Solution may be made by equation from California Culverts Practice, California Highways and Public Works, September 1942

$$T = \left(\frac{11.9\,L^3}{H}\right)^{0.385}$$

T = T_c in hours
L = length of longest watercourse in miles
H = elevation difference in feet

Figure III.2.4
Time of Channel Flow

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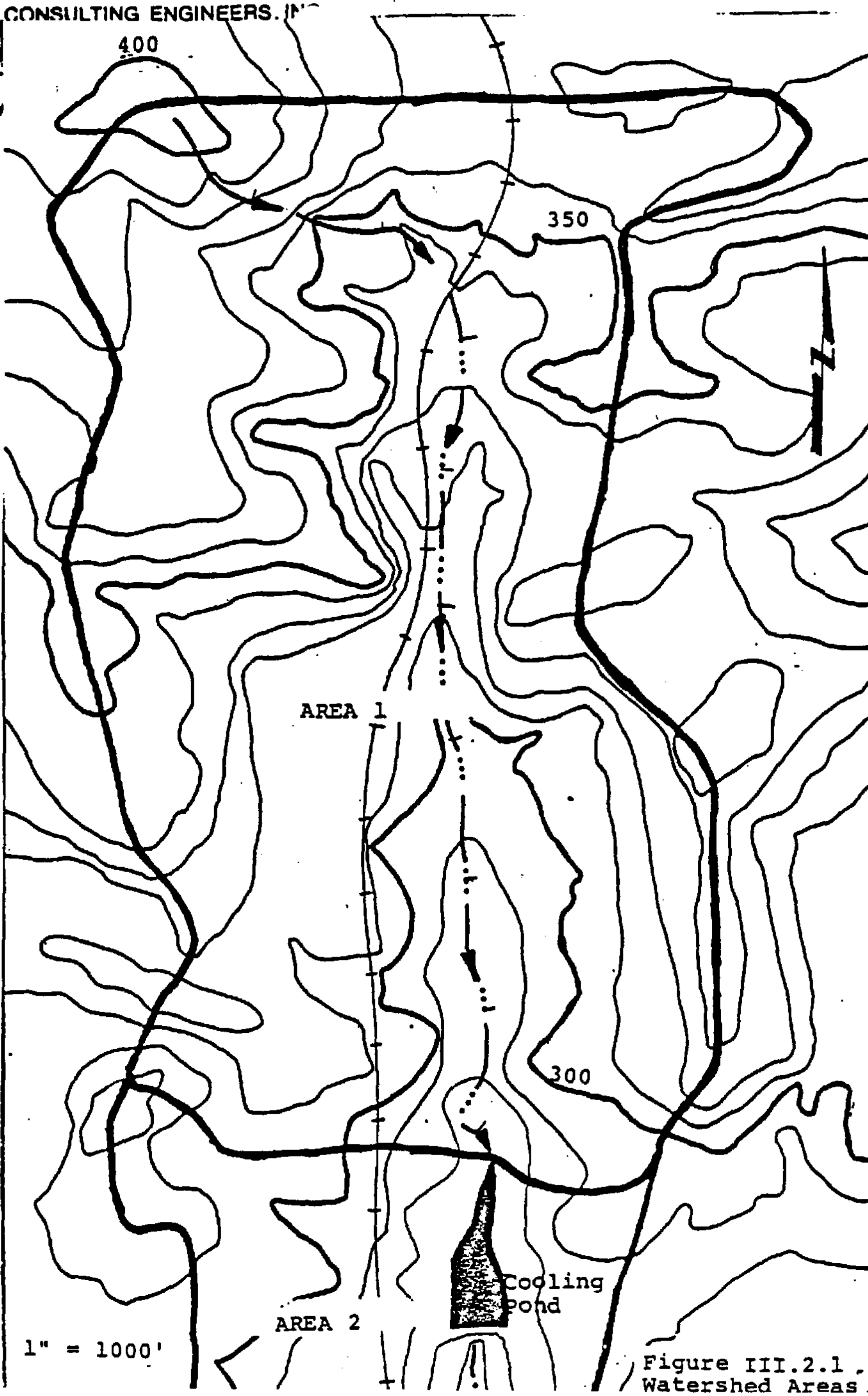
By 03/07/84
Chkd. By



(TAKEN FROM REF. 2.)

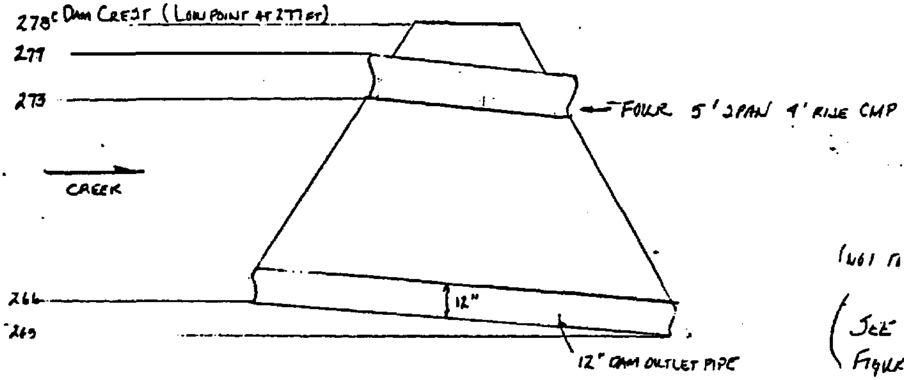
Figure III.2.1
Watershed Areas

001476

DETERMINE TIME OF CONCENTRATION

$L = 10{,}500$ FT = 1.989 MI (SEE FIGURE 1)

$H = 400^{(Fig. 1)} - 266 = 134.0$ FT



(NOT TO SCALE)

(SEE D'APP FIGURE 2)

$$T_c = \left(\frac{11.9 L^3}{H}\right)^{0.385} = \left[\frac{11.9\,(1.989\,mi)^3}{134.0\,ft}\right]^{0.385}$$

$= 0.871$ HR

$= 52$ MIN

0014777

ESTIMATION OF HYDROLOGIC CURVE NUMBER (SEE FIGURE 2)

SOIL GROUP (REF. 2)	HYDROLOGIC CLASSIFICATION (REF 7; CHAPTER 7)	LAND USE
AMY	D	—
LEADVALE	C	SLIGHTLY PERVIOUS SOIL WITH TURF
LINKER	(C) (REF 2)	IMPERVIOUS SOIL
MOUNTAINBURG	D	IMPERVIOUS SOIL
—	ASSUME C	WOODED AREAS
URBAN LAND	ASSUME C	URBAN LAND

PERCENT OF WATERSHED AREA (REF 2)	EST. CURVE NO.		WEIGHTED CURVE NO.	
(AREA I = 700 ACRES)				
15% URBAN LAND	91	(91)(0.15) =	13.65	
35% WOODED AREA	70	(70)(0.35) =	24.50	
20% SLIGHTLY PERVIOUS SOIL WITH TURF	79	(79)(0.20) =	15.80	
30% IMPERVIOUS SOIL WITH TURF	90	(90)(0.30) =	27.00	
			80.95	(AREA I) (86.42% of TOTAL AREA)
(AREA II = 110 ACRES)				
100% SLIGHTLY PERVIOUS SOIL WITH TURF	79		79	(AREA II) (13.58%)

AREA I	(80.95)(0.8642) =	69.96
AREA II	(79)(0.1358) =	10.73
TOTAL WATERSHED		80.69 = 80.7

001479

TABLE III.2.1

SOIL DESCRIPTIONS

Au	Amy-Urban land complex	Unified ML
LdC	Leadvale-Urban land complex	Unified ML
LkC	Linku gravelly fine sandy loam	Unified ML
LnC	Linku-Urban land complex	Unified ML
MoD	Mountainburg stony fine sandy loam	Unified ML
Ut	Urban land - properties too variable to estimate-onsite investigations required	

* From Soil Survey of Pulaski County, Arkansas
Compiled by United Stated Department of Agriculture
Soil Conservation Service

TAKEN FROM REF. 2

001479

D'APPOLONIA
CONSULTING ENGINEERS, INC.

(19)

By RPC Date 05/11/84 Subject VERTAC Sheet No. 8 of 20
Chkd. By WTC Date 5/14/84 100 YEAR COOLING POND ROUTING ANALYSIS Proj. No. 846012

Table 2.20 Runoff Curve Numbers for Selected Agricultural, Suburban, and Urban Land Use. (Antecedent Moisture Condition II).

LAND USE DESCRIPTION	HYDROLOGIC SOIL GROUP A	B	C	D
Cultivated land[1]: without conservation treatment	72	81	88	91
: with conservation treatment	62	71	78	81
Pasture or range land: poor condition	68	79	86	89
good condition	39	61	74	80
Meadow: good condition	30	58	71	78
Wood or Forest land: thin stand, poor cover, no mulch	45	66	77	83
good cover[2]	25	55	70	77
Open Spaces, lawns, parks, golf courses, cemeteries, etc.				
good condition: grass cover on 75% or more of the area	39	61	74	80
fair condition: grass cover on 50% to 75% of the area	49	69	79	84
Commercial and business areas (85% impervious)	89	92	94	95
Industrial districts (72% impervious).	81	88	91	93
Residential:[3]				
Average lot size — Average % Impervious[4]				
1/8 acre or less — 65	77	85	90	92
1/4 acre — 38	61	75	83	87
1/3 acre — 30	57	72	81	86
1/2 acre — 25	54	70	80	85
1 acre — 20	51	68	79	84
Paved parking lots, roofs, driveways, etc.[5]	98	98	98	98
Streets and roads:				
paved with curbs and storm sewers[5]	98	98	98	98
gravel	76	85	89	91
dirt	72	82	87	89

1/ For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Section 4, Hydrology, Chapter 9, Aug. 1972.

2/ Good cover is protected from grazing and litter and brush cover soil.

3/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

4/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

5/ In some warmer climates of the country a curve number of 95 may be used.

TAKEN FROM REF. 6

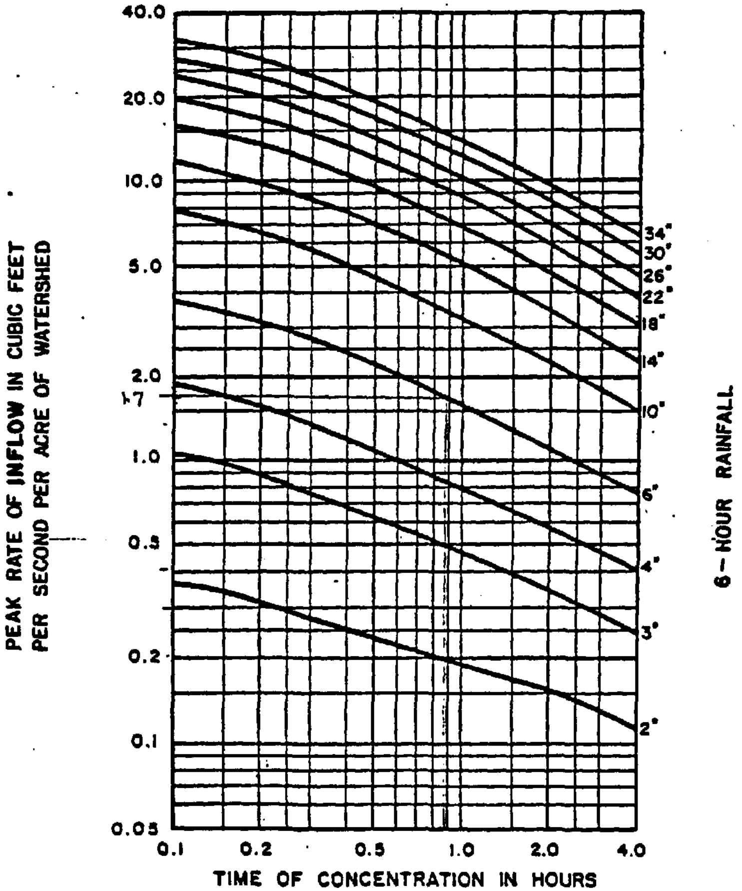


FIG. 6.34 ESTIMATES FOR PEAK INFLOW RATE FOR 6-HOUR DESIGN STORM AND CN=80

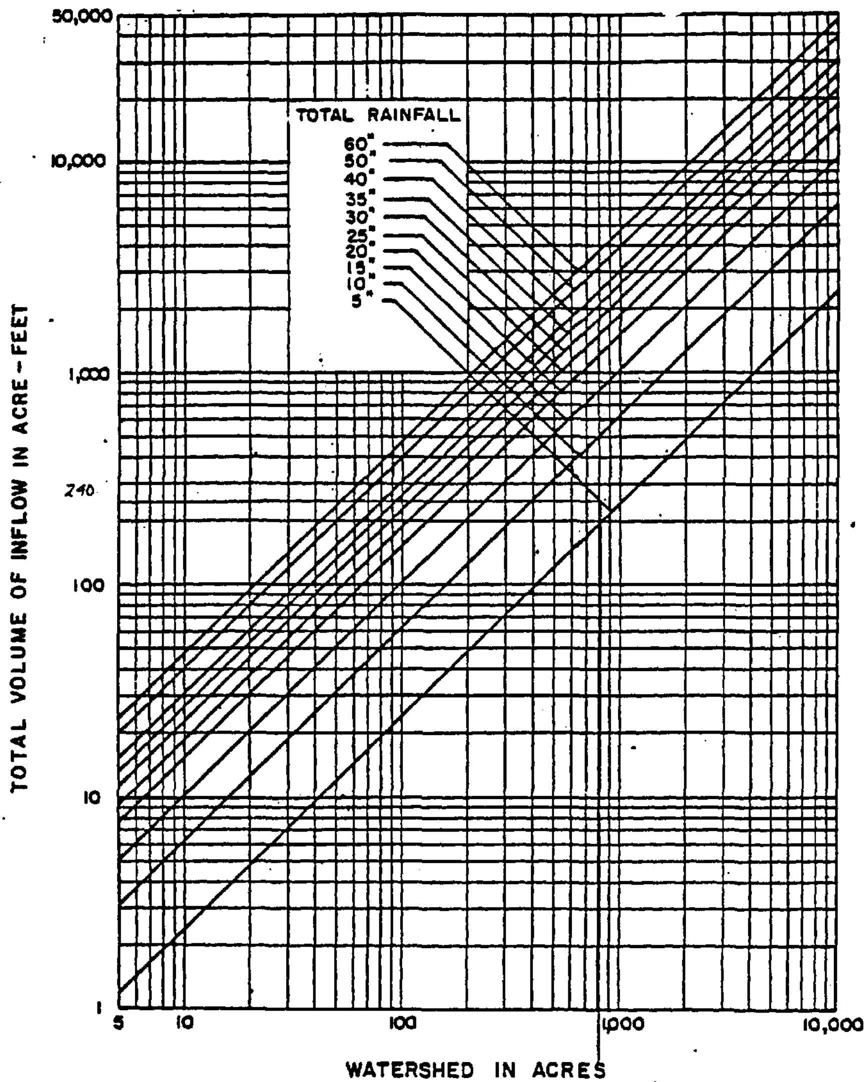


FIG. 6.31 ESTIMATES FOR TOTAL INFLOW VOLUME FOR CN=80

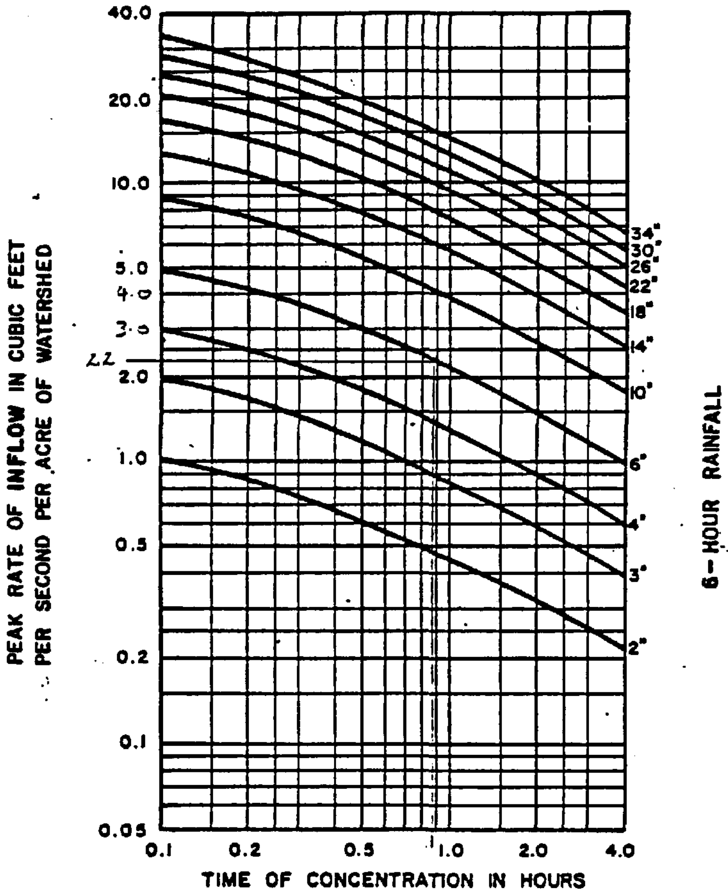


FIG. 6.35 ESTIMATES FOR PEAK INFLOW RATE FOR 6-HOUR DESIGN STORM AND CN=90

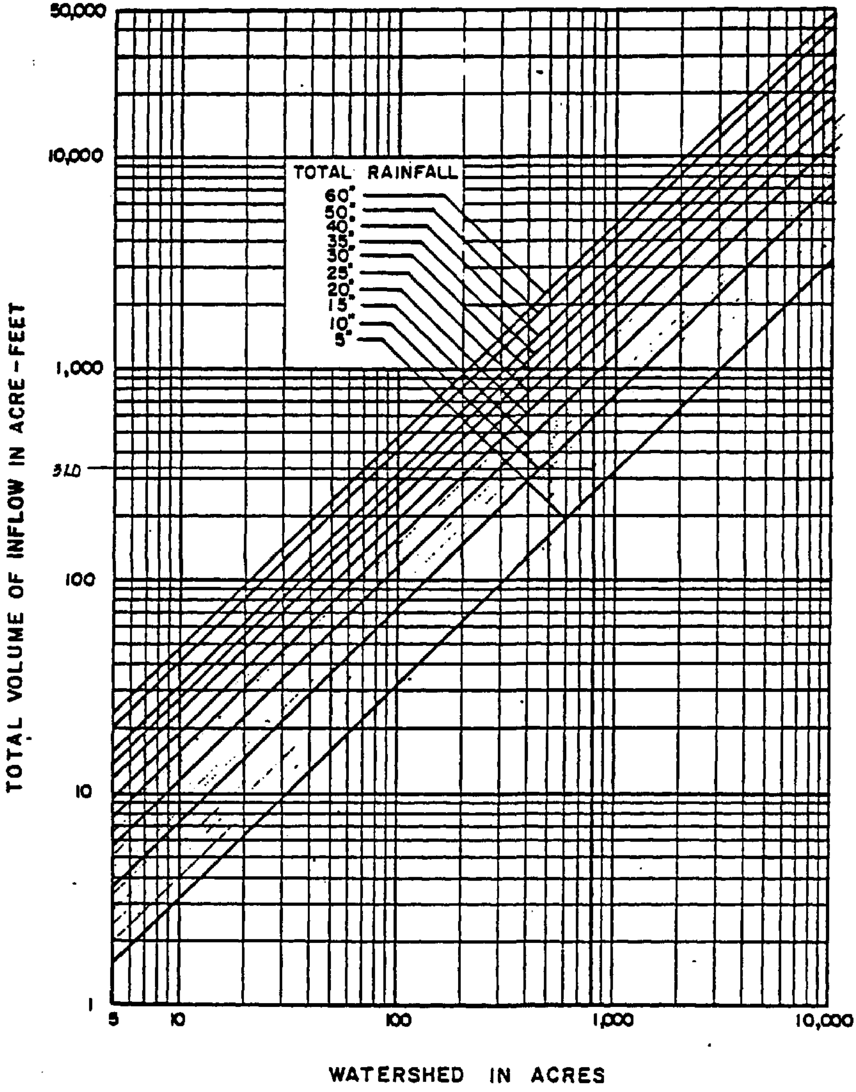


FIG. 6.32 ESTIMATES FOR TOTAL INFLOW VOLUME FOR CN=90

USING CN = 80:

PEAK INFLOW RATE (Q_{Imax}) = 1.7 CFS/ACRE (810 ACRES) = 1377.0 CFS

TOTAL INFLOW VOLUME (V_I) = 240 ACRE-FT

USING CN = 90

PEAK INFLOW RATE (Q_{Imax}) = 2.2 CFS/ACRE (810) = 1782.0 CFS.

TOTAL INFLOW VOLUME (V_I) = 320 ACRE-FT

FOR A RAINFALL OF 6" AND A CN RANGE OF 70-90, CURVE NUMBERS CAN BE INTERPOLATED LINEARLY. (REF 7, p.70)

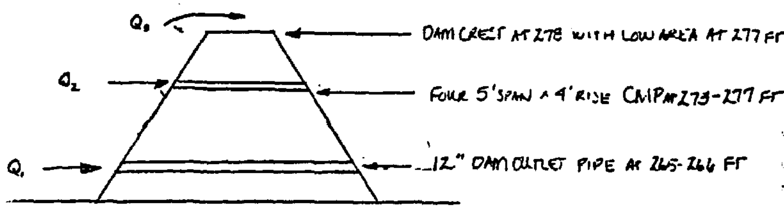
∴

FOR CN = 80.7 Q_{Imax} = 1405 CFS

V_I = 245.6 ACRE-FT

001485

2. FIND THE DISCHARGE CAPACITY OF THE OUTFLOW STRUCTURE:

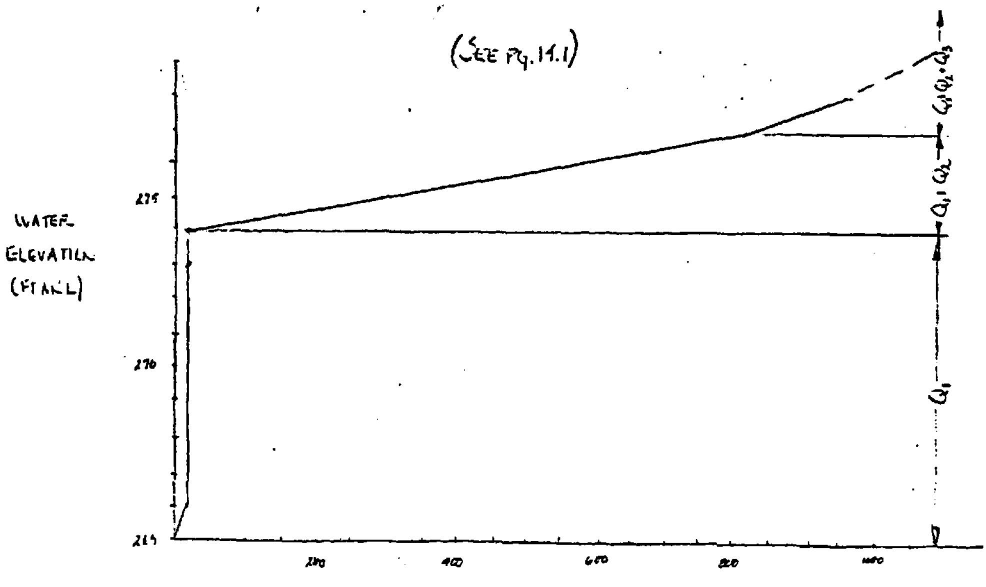


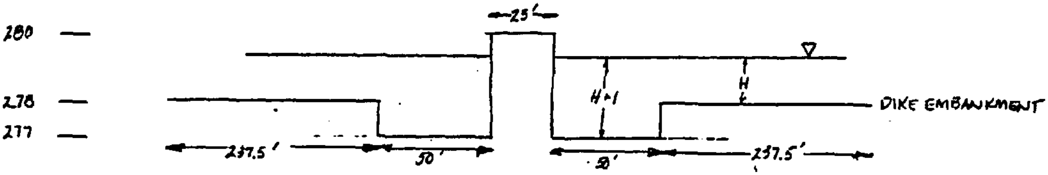
Q_1 = 12 CFS (REF 3)

Q_2 = 200 CFS (4 PIPES) = 800 CFS (REF. 3)

$Q_3 = CLH^{1.5}$ (OVERTOPPING DISCHARGE) (REF. 5)

(SEE FIG. 14.1)





$Q_s = CLH^{1.5}$ $C = 2.70$ (REF. 5)

$= 2.7\left[100(H+1)^{1.5} + (475)(H)^{1.5}\right]$

AT H=0 (277 FT) $Q_s = CL = 2.7(100)$
$= 270$ CFS

To use scale (2) or (3), project horizontally to scale (1), then use straight inclined line through D and Q scales, or reverse as illustrated.

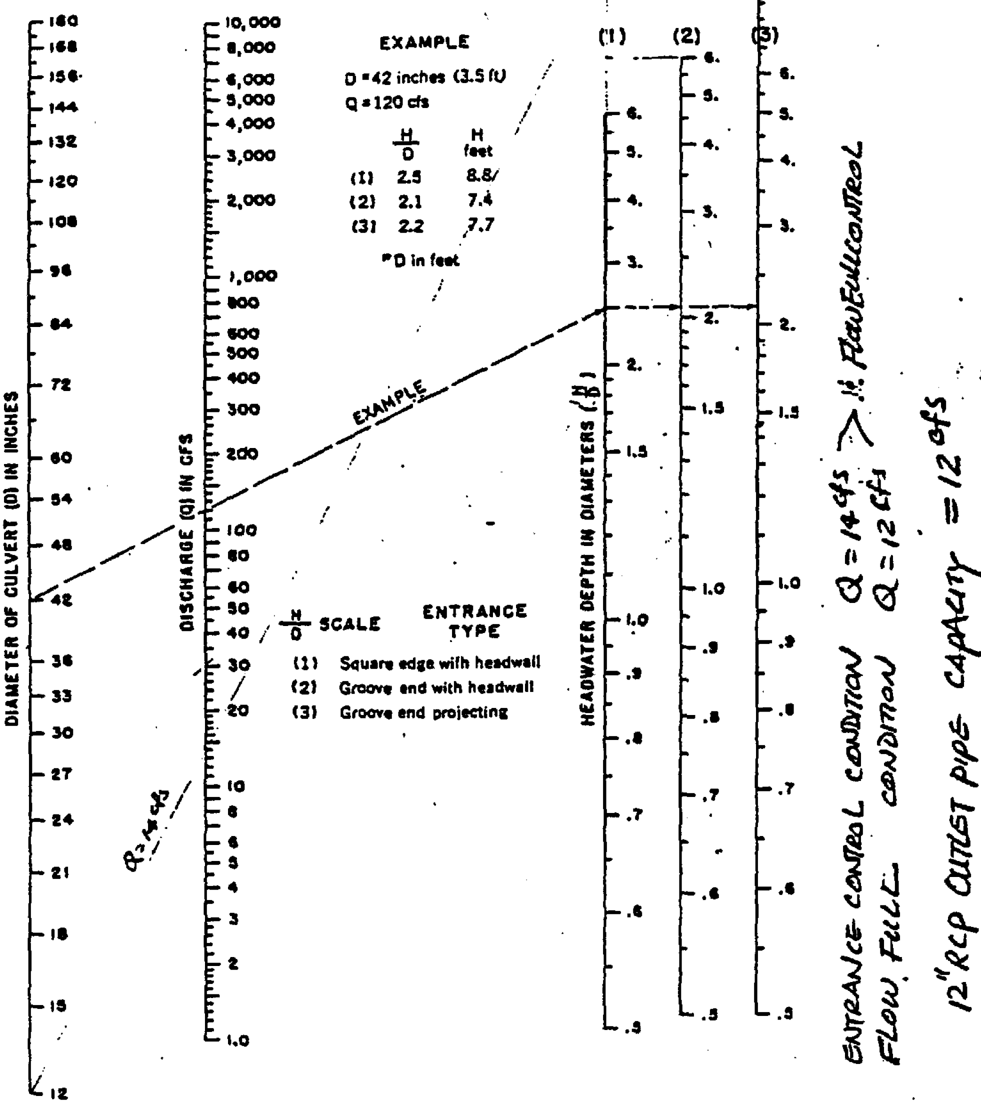
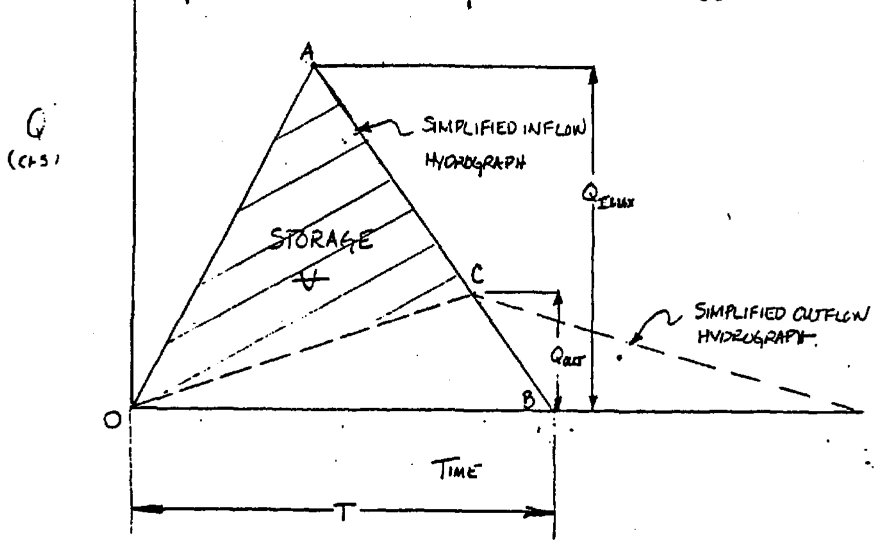


Figure 5-8. Headwater depth for concrete pipe culverts with entrance control. (U.S. Bureau of Public Roads.) 218—0—2908

3. ESTABLISH RELATIONSHIP BETWEEN MAX. SPILLWAY DISCHARGE AND STORAGE REQUIRED TO PASS FLOOD HYDROGRAPH WITHOUT EXCEEDING MAXIMUM POOL LEVEL.



$$\forall_{STORAGE} = \Delta AOB - \Delta COB$$

$$= \forall_{IMAX} - \tfrac{1}{2}T(Q_{OUT})$$

$$\frac{\forall_{ST}}{\forall_{IMAX}} = 1 - \frac{\tfrac{1}{2}T(Q_{OUT})}{\tfrac{1}{2}V_{IMAX}} = 1 - \frac{\tfrac{1}{2}T(Q_{OUT})}{\tfrac{1}{2}T(Q_{IN})}$$

$$= 1 - \frac{Q_{OUT}}{Q_{IMAX}}$$

$$\therefore \quad \frac{\forall_{ST}}{\forall_{IMAX}} + \frac{Q_{OUT}}{Q_{IMAX}} = 1$$

001489

FOR WATER ELEVATION 278 FT (DIKE CREST) ; $Q_0 = Q_1 + Q_2 = 812$ CFS

$\forall_s = 6,505,000$ GAL
$= 869,650\ FT^3$ (REF 4)

$$\frac{Q_0}{Q_I} + \frac{\forall_s}{\forall_I} = 1$$

AT ELEVATION 277:

$$\frac{812_{cfs}}{1405\ cfs} + \frac{869,650\ FT^3}{245.6\ \text{ACRE-FT}\left(\frac{43560\ FT^2}{1\ ACRE}\right)} = 0.5779 + 0.0813 = 0.6592 \quad N.G.$$

→ FIND H OVERTOPPING DIKE.

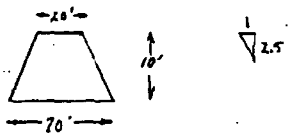
AT ELEVATION 278: $Q_{OUT} = 812 + 270 = 1082$ CFS

$$\frac{1082}{1405} + 0.0813 = 0.7701 + 0.0813 = 0.8514 \quad N.G. \rightarrow \text{FIND H}$$

NEGLECT STORAGE VOLUME ABOVE DAM CREST (278 FT)

L = 575 FT (DIST. BETWEEN 280 CONTOURS ON DIKE)

EQ. 1 $\frac{Q_{OUT}}{1405\ cfs} + 0.0813 = 1$



(REF. 5, p.5-40)

EQ. 2 $Q_{OUT} = 812 + Q_3$

FROM EQ. 1 AND 2:
$\therefore Q_3 = 478.8$ CFS

H	C
0.2	2.68
0.4	2.70

$478.8\,cfs = 2.68\left[(100)(H+1)^{1.5} + 475(H)^{1.5}\right]$

$H = 0.2095$ FT

CHECK:

$$Q_3 = 2.68\left[100(0.2095+1)^{1.5} + 475(0.2095)^{1.5}\right] =$$

$$= 478.5 \checkmark$$

$$\frac{612+478.5}{1405} + 0.0813 = 1.00 \checkmark$$

CONCLUSION:

THE 100 YEAR FLOOD ELEVATION AT THE COOLING POND DIKE IS APPROXIMATELY 278.2 FT MSL. FOR DESIGN PURPOSES, USE ELEVATION 278 AS THE 100 YEAR FLOOD LEVEL.

001491

REFERENCES

1. HERSHFIELD, D.M., 1963, RAINFALL FREQUENCY ATLAS OF THE UNITED STATES, FOR DURATIONS FROM 30 MINUTES TO 24 HOURS AND RETURN PERIODS FROM 1 TO 100 YEARS, TECHNICAL PAPER NO. 40, SOIL CONSERVATION SERVICE, WASHINGTON, D.C., CHART 35, p. 42.

2. DEVELOPERS, INTERNATIONAL SERVICES CORP. (DISC), 1982, "FINAL REPORT FOR ENVIRONMENTAL ASSESSMENT STUDY, VERTAC CHEMICAL CORP. SITE, JACKSONVILLE, ARKANSAS", REPORT SERIAL NO. B-041.

3. CHAN, WT, 1983, "CALCULATION OF DAM OUTLET PIPE DISCHARGE CAPACITY, AND COOLING POND STORAGE CAPACITY, DEC. 4.

4. CHAN, W.T., 1983, VOLUME CALCULATIONS, NOV. 16.

5. BRATER AND KING, 1976, HANDBOOK OF HYDRAULICS, 6TH EDITION, McGRAW HILL.

6. HAAN, C.T, AND B.J. BARFIELD, 1978, HYDROLOGY AND SEDIMENTOLOGY OF SURFACE MINED LANDS, UNIVERSITY OF KENTUCKY.

7. SOIL CONSERVATION SERVICE, 1972, HYDROLOGY; SECTION 4, SCS NATIONAL ENGINEERING HANDBOOK.

0014492

By WTC Date 12/5/83 Subject VERTAC CHEMICAL CORP Sheet No. 1 of 1
Chkd. By JM Date 4/30/84 JACKSONVILLE AK Proj. No. 846012
0.5cm. X 0.5cm.

RESEEDED AREA SCALE 1" = 200'
$(1")^2 = (200')^2$ = 40000 SF

1. REASOR-HILL LANDFILL

AREA = .287 IN² = 114,800 FT² = 2.64 Ac.

2. OLD EQUALIZATION POND

AREA = 2.12 IN² = 84,800 FT² = 1.95 ac

3. D/S DAM slope

AREA = 0.5 IN² = 20,000 FT² = 0.46 ac

4. NORTH BURIAL AREA

AREA = 11.05 IN² = 442,000 FT² = 10.15 ac

5. Borrow Pit Area

AREA = 4.79 IN² = 191,600 FT² = 4.40 ac

6. MISC. ....

SMALL AREA NOT INCLUDED IN ESTIMATED

TOTAL 853,200 SF = 19.6 ac

0014905

By KTM Date 2/5/83 Subj VERTAC Sheet No.___ of ___
Chkd. By JW Date 4/3/84 JACKSONVILLE ARKANSAS Proj. No. 846012

GEOLOGICAL SYNOPSIS OF DISC VERTAC REPORT B-041 AND SUPPLEMENTAL E-016

1. THE VERTAC SITE IS BISSECTED BY THE "FALL LINE," WHICH IS THE CONTACT BETWEEN THE PALEOZOIC AGE ATOKA FORMATION AND THE TERTIARY AGE MIDWAY GROUP.

2. ATOKA FM. IS CHARACTERIZED BY ALTERNATING BEDS OF SANDSTONE AND SHALE.
MIDWAY GROUP IS CHARACTERIZED BY SILTY, SANDY, GLAUCONITIC, CARBONACEOUS, AND CALCAREOUS CLAYS.

3. THE SOIL HORIZONS DEVELOPED AT THE SITE RANGE FROM 0FT TO 20FT IN THICKNESS AND RANGE IN PERMEABILITY FROM 10^{-6} CM/SEC TO 10^{-7} CM/SEC. BOTH SOIL HORIZONS, ATOKA-MIDWAY, HAVE SIMILAR PHYSICAL CHARACTERISTICS.

NOTE: GEOLOGIC DATA AVAILABLE TO D'APPOLONIA FOR REVIEW

A. GEOLOGIC MAP OF ARKANSAS 1:500,000

B. JACKSONVILLE
McALMONT
CABOT
OLMSTEAD
} 7½ MIN TOPOGRAPHIC MAPS (XEROXED) WITH SURFICIAL GEOLOGY SUPERIMPOSED

0014494

GEOLOGICAL SYNOPSIS OF DISC VERTAC REPORT B-041 AND SUPPLEMENTAL E-016

1. THE VERTAC SITE IS BISSECTED BY THE "FALL LINE," WHICH IS THE CONTACT BETWEEN THE PALEOZOIC AGE ATOKA FORMATION AND THE TERTIARY AGE MIDWAY GROUP.

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MIDWAY GROUP IS CHARACTERIZED BY SILTY, SANDY, GLAUCONITIC, CARBONACEOUS, AND CALCAREOUS CLAYS.

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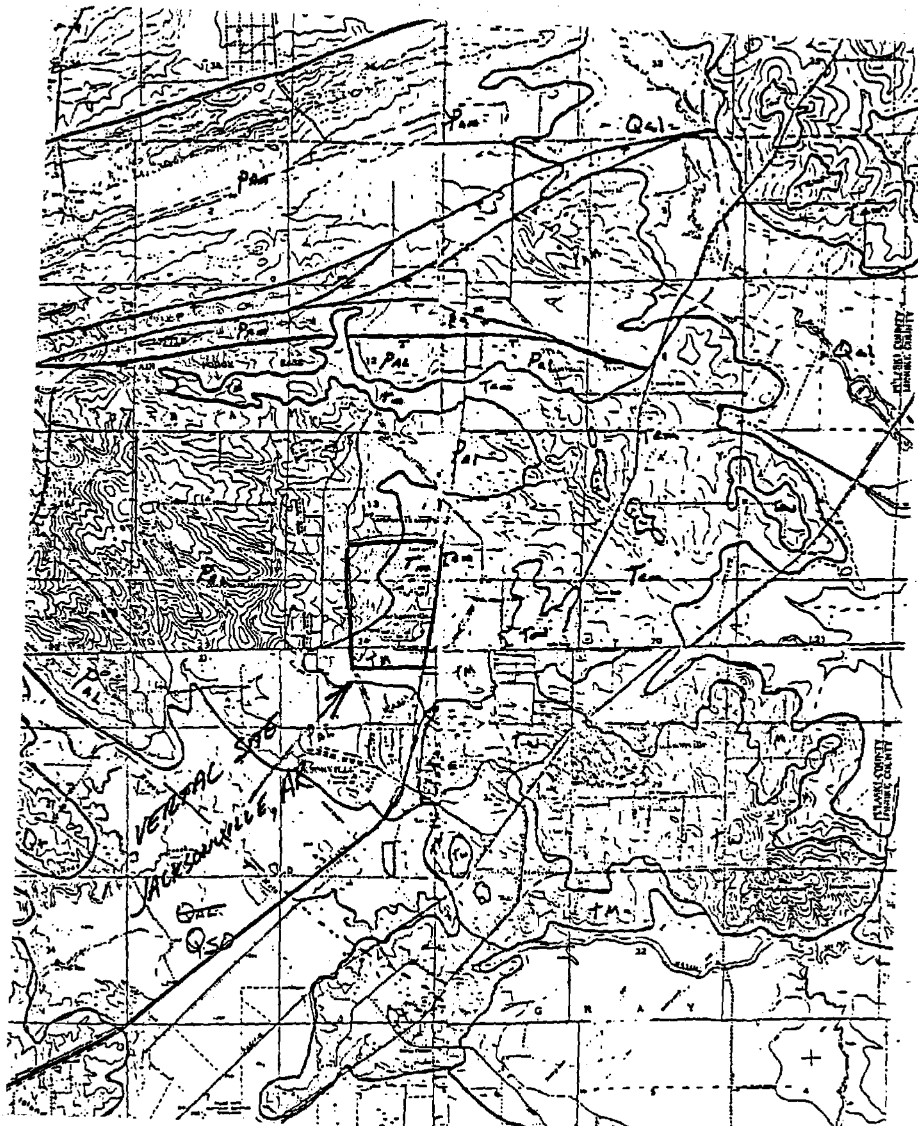
} 7½ MIN TOPOGRAPHIC MAPS (XEROXED) WITH SURFICIAL GEOLOGY SUPERIMPOSED



001496

SECONDARY SPILL CONTAINMENT (Assume 200 gal/ac drainage watershed)

A. CENTRAL DITCH

DITCH SLOPE ≈ 0.005

DITCH STA	AREA			ΔV, CF.
0	[4+(1.5)(1)](1)	=	5.5	
				232.4
50	[4+(1.5)(0.75)](0.75)	=	3.34	
				154.0
100	[4+(1.5)(0.5)](0.5)	=	2.38	
				84.7
150	[4+(1.5)(0.25)](0.25)	=	1.09	
				18.2
200	0	=	0	

$\Sigma V = 489.3^{CF} = 3660$ gal.

BASIN STORAGE = 7256 gal (SEE WTC CAL 1/5/84)

TOTAL STORAGE VOLUME = 3660 + 7256 = 10916 gal.

B EAST DITCH

BASIN STORAGE = 7256 gal.

DITCH AREA = @ EL 89 A = 1000 SF
@ EL 88 A = 450 SF > ΔV = 725 CF = 5423 gal

TOTAL STORAGE VOLUME = 5423 + 7256 = 12,679 gal.

001497

DRAINAGE AREA

EAST DITCH, 5 X 500 X 500 = 1,250,000 SF = 29 ac.

CENTRAL DITCH 3 X 500 X 500 = 750,000 SF = 17 ac

Rocky BRANCH = 693 ac + 109 ac = 802 ac.

	I	ROCKY BRANCH (See Ref.)	EAST DITCH! $Q = 0.34 \times 29 \times I$	CENTRAL DITCH $Q = 0.34 \times 17 \times I$
2 year	1"/hr	338	10	6
5 year	1.3	440.	13	8
10 year	1.4	474	14	8
25 year	1.8	609	17	10
50 year	2.2	745	21	13
100 year	2.5	846	24	14

2x24" RCP
$\frac{H}{D} = 1$ $q = 13 \times 2 = 26$ cfs
plus
1 x 18" CMP

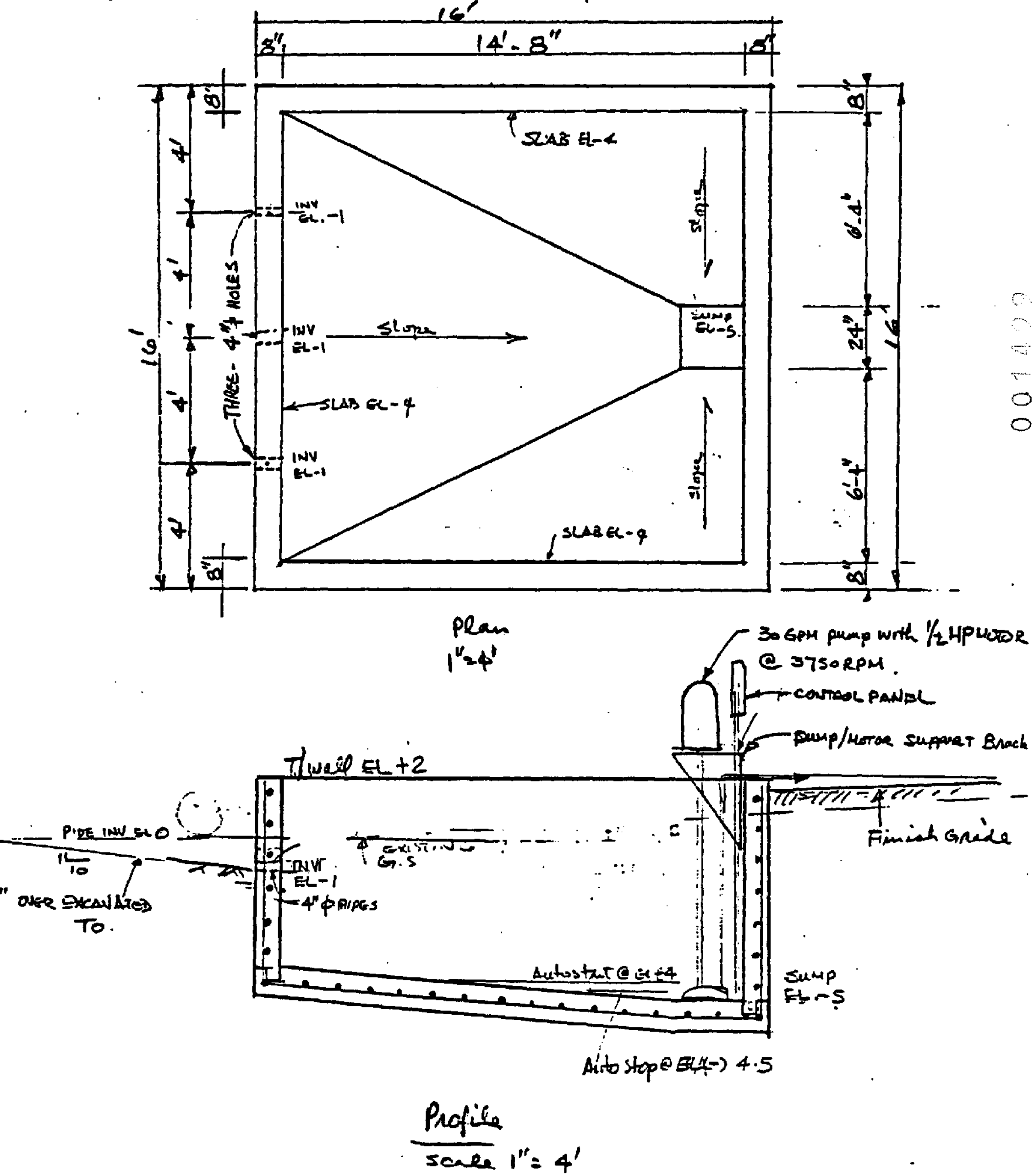
2x24 CMP
$\frac{H}{D} = 1$ $q = 13 \times 2 = 26$

001408

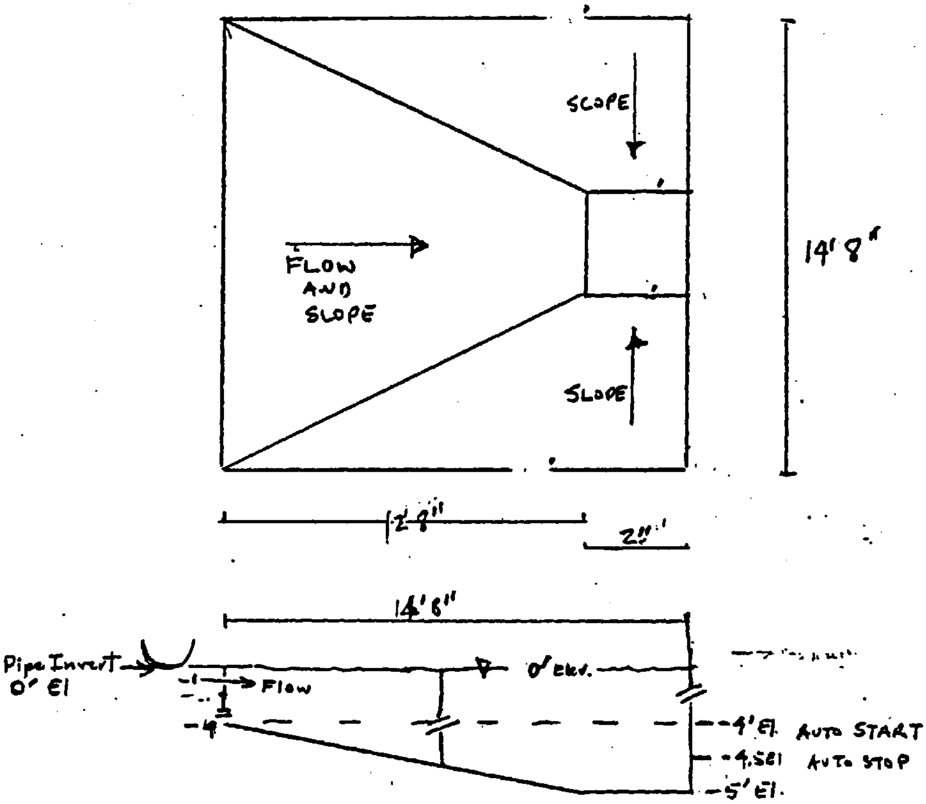
CONSULTING ENGINEERS, INC.

By WTC Date 1/5/84 Subject VERTAC CHEMICAL CORP. Sheet No. 3 of 4

Chkd. By JJM Date 4/30/84 Revision #1 SECONDARY SPILL CONTAINMENT Proj. No. 846012



Estimate Volume of Spill Containment Structure



NTS

Volume = width × Breadth × Depth + Pumpage (say for 1hr)

= 14'8" × 14'8" × 4' + 30 gpm × 60

= 860 ft3 + 1800 gal

= 6000 + 1800 gal = 7800 gallons in 1 hr.

001500

STORAGE VOLUME.

$[14'\text{-}8"]^2 (4') \times 7.48\ gal/cf = 6436\ gal.$

$\frac{[14'\text{-}8"]^2 + (2)^2}{2} (1) \times 7.48 = 820\ gal$

7256 gal. Say 7000 gal Design Capacity

ORIFICE FLOW CAPACITY

THREE 4" ϕ ORIFICE

$$q = C_d A_o \sqrt{2g \Delta H}$$
$$= (C_c C_v) A_o \sqrt{2g \Delta H}$$
$$= (1)(0.82) \frac{\pi (\frac{4}{12})^2}{4} \sqrt{(64.4)(1)}$$
$$= 0.5743 \text{ cfs}$$
$$= 258 \text{ gpm}$$

$Q = 3q = 3 \times 258 = 774$ gpm >> pump capacity = 20-30 gpm

0015 01

Revised

By RGM Date 5/2/84 Subject Est. First Flush Sheet No. 1 of 7
Chkd. By RCB Date 5/6/84 Capacity of Containment Structure Proj. No. 846012
(REV. 2)

Purpose: Estimate Amount of Rainfall Assoc. w/ Containment Capacity.

Given: Figure 5 dimensions (p. 2)
Drainage Areas per DISC dwg no. P-1 (p. 4)
as revised per planned construction

Storage Capacity: (from pipe invert to auto start level & pumped vol. in 1 hr.)
$V = 1040\ ft^3 \quad \left(\frac{6000 + 1800\ gal}{7.48\ gal/ft^3}\right)$ p. 2

East Ditch Drainage Area, $A_1 \sim 330{,}000\ ft^2$
Central Ditch Drainage Area, $A_2 \sim 315{,}000\ ft^2$ } see p. 4
Note: actual area drained is less since an estimated 25% of @ area is drained by storm sewers.
Depth of Runoff, $RO = \frac{V}{A}$

Volume of Eastern Ditch, $V_1 = 6200$ gal $\sim 830\ ft^3$
Volume of Central Ditch, $V_2 = 4400$ gal $\sim 590\ ft^3$ } see p. 5

$RO_1 = \frac{(1040 + 830)\ ft^3}{330{,}000\ ft^2} = 0.0057\ ft = 0.068\ in$

$RO_2 = \frac{(1040 + 590)\ ft^3}{315{,}000\ ft^2} = 0.0052\ ft = 0.062\ in$

if reduce area by 25% to 250,000 ft² & 236,250 then RO's = 0.075 & 0.069.

Work backwards through the table on page 6 to determine the rainfall quantity. Ref: SCS, Tech paper No. 55

$CN = 80$ from p. 6 $\Rightarrow S = \frac{1000}{80} - 10 = 2.5$ (p. 6) where S = potential extraction

$$RO = \frac{(P - 0.2S)^2}{P + 0.8S}$$ (Eqn 2-5, SCS, Tech Paper.

for $P = 1.0$ $\quad RO = \frac{(1 - 0.2 \cdot 2.5)^2}{1 + 0.8(2.5)} = 0.0833$ in

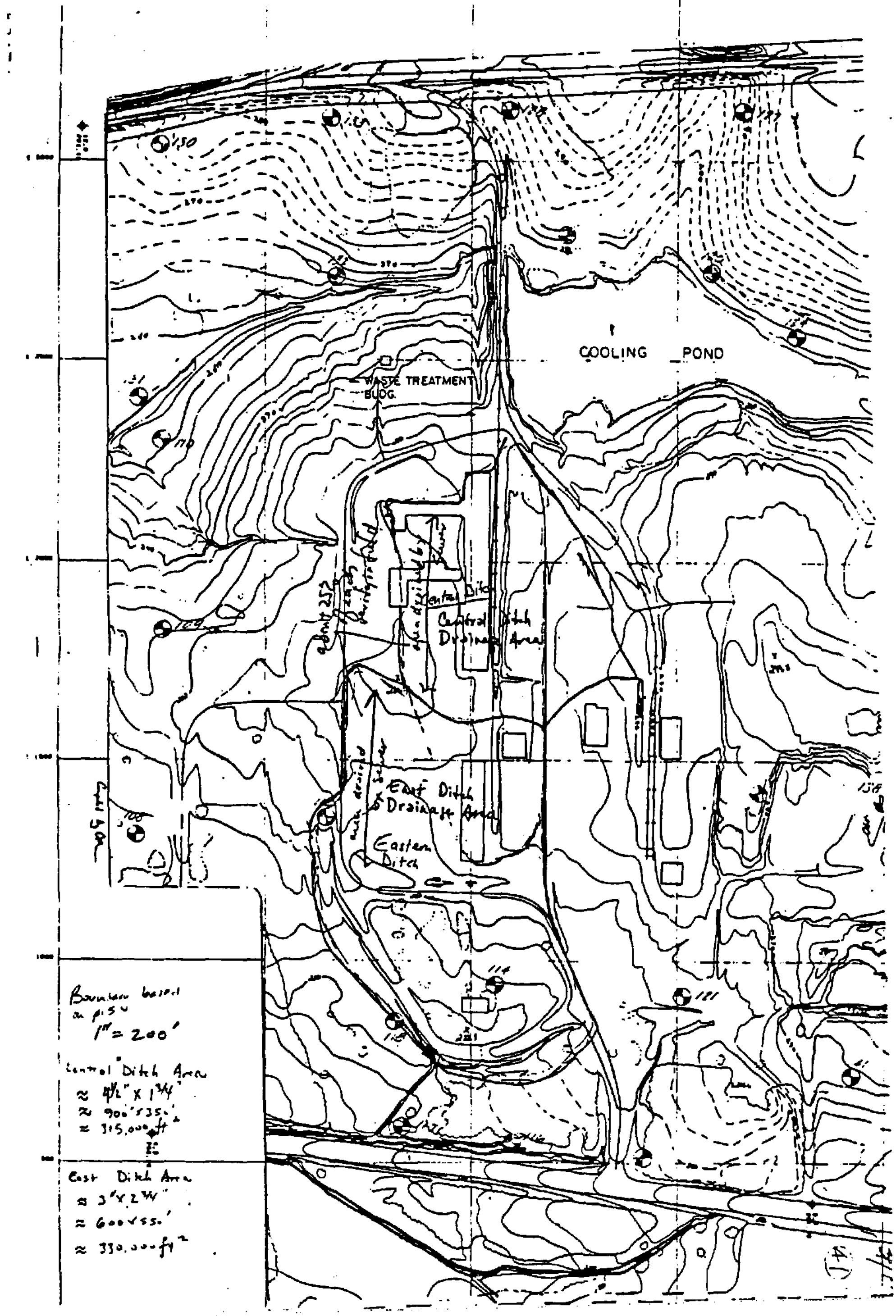
$P = 0.95 \Rightarrow RO = 0.69$ in

for $P = 0.8$ $\quad RO = \frac{(0.8 - 0.2 \cdot 2.5)^2}{0.8 + 0.8(2.5)} = 0.03$ in

for $P = 0.9$ $\quad RO = \frac{(0.9 - 0.2 \cdot 2.5)^2}{0.9 + 0.8(2.5)} = 0.055$ in

∴ Containment area of ditches can contain water from about 1" of rainfall.

0015002

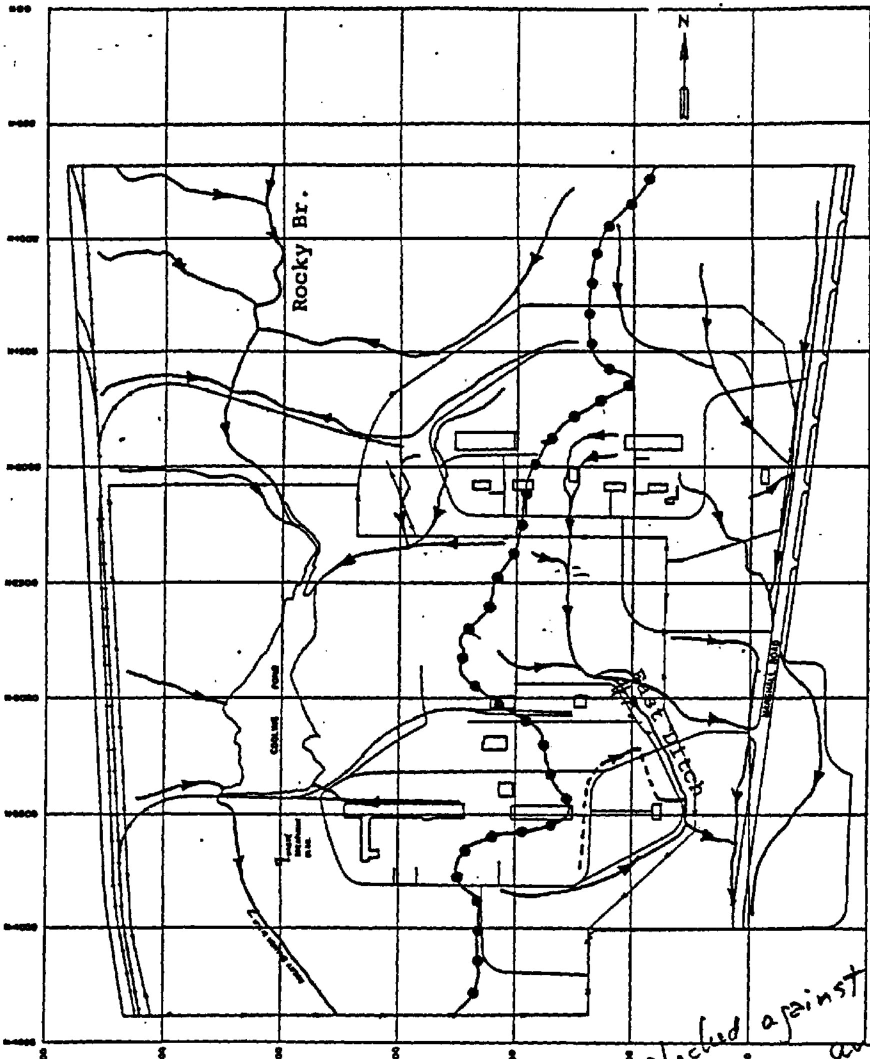


COOLING POND
WASTE TREATMENT BLDG.
Central Ditch Drainage Area
East Ditch Drainage Area
Eastern Ditch
1" = 200'
Central Ditch Area
≈ 4½" x 1¾"
≈ 900' x 350'
≈ 315,000 ft²
East Ditch Area
≈ 3" x 2¾"
≈ 600 x 550'
≈ 330,000 ft²

DISC Final Report, Oct

4/8

(42)



DRAINAGE DIVIDE

DRAINAGE & DIRECTION

Checked against topo map and aerial photo and site visit

Figure II.1.1
Surface Drainage

001504

Thus

$$P_e = P - I_a = P - 0.2S \qquad \text{(Eq. 2-4)}$$

where P is the total storm rainfall in inches. Substituting equation 2-4 in equation 2-2,

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad \text{(Eq. 2-5)}$$

Q = Actual Runoff
P = Rainfall
S = Potential Abstraction

Potential abstraction S is related to the soil and cover conditions of a watershed. The runoff curve number, which is also related to soil and cover conditions, is related to potential abstraction S by

$$CN = \frac{1{,}000}{S + 10} \qquad \text{(Eq. 2-6)}$$

from which

$$S = \frac{1{,}000}{CN} - 10 = \frac{1000}{80} - 10 = 2.5 \qquad \text{(Eq. 2-7)}$$

The solution to equation 2-5 is shown in table 2-1 for a range of CN's and total rainfall amounts.

Table 2-1.--Runoff depth in inches for selected CN's and rainfall amounts

from p. 7

Rainfall (inches)	Curve Number (CN)[1]							S=.52	S=0.20
	60	65	70	75	80 (S=2.5)	85	90	95	98
0.5								.17	.32
0.8								.40	.60
1.0	0	0	0	0.03	0.08	0.17	0.32	.56	.79
1.2	0	0	0.03	0.07	0.15	0.28	0.46	.74	.99
1.4	0	0.02	0.06	0.13	0.24	0.39	0.61	.92	1.18
1.6	0.01	0.05	0.11	0.20	0.34	0.52	0.76	1.11	1.38
1.8	0.03	0.09	0.17	0.29	0.44	0.65	0.93	1.29	1.58
2.0	0.06	0.14	0.24	0.38	0.56	0.80	1.09	1.48	1.77
2.5	0.17	0.30	0.46	0.65	0.89	1.18	1.53	1.96	2.27
3.0	0.33	0.51	0.72	0.96	1.25	1.59	1.98	2.45	2.78
4.0	0.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
5.0	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	1.92	2.35	2.80	3.28	3.78	4.31	4.85	5.41	5.76
7.0	2.60	3.10	3.62	4.15	4.69	5.26	5.82	6.41	6.76
8.0	3.33	3.90	4.47	5.04	5.62	6.22	6.81	7.40	7.76
9.0	4.10	4.72	5.34	5.95	6.57	7.19	7.79	8.40	8.76
10.0	4.90	5.57	6.23	6.88	7.52	8.16	8.78	9.40	9.76
11.0	5.72	6.44	7.13	7.82	8.48	9.14	9.77	10.39	10.76
12.0	6.56	7.32	8.05	8.76	9.45	10.12	10.76	11.39	11.76

1/ To obtain runoff depths for CN's and other rainfall amounts not shown in this table, use an arithmetic interpolation.

6/8

(44)

Table 2-2.--Runoff curve numbers for selected agricultural, suburban, and urban land use. (Antecedent moisture condition II, and $I_a = 0.2S$)

LAND USE DESCRIPTION	HYDROLOGIC SOIL GROUP A	B	C	D
Cultivated land[1/]: without conservation treatment	72	81	88	91
: with conservation treatment	62	71	78	81
Pasture or range land: poor condition	68	79	86	89
good condition	39	61	74	80
Meadow: good condition	30	58	71	78
Wood or Forest land: thin stand, poor cover, no mulch	45	66	77	83
good cover[2/]	25	55	70	77
Open Spaces, lawns, parks, golf courses, cemeteries, etc.				
good condition: grass cover on 75% or more of the area	39	61	74	80
fair condition: grass cover on 50% to 75% of the area	49	69	79	84
Commercial and business areas (85% impervious)	89	92	94	95
Industrial districts (72% impervious)	81	88	91	93
Residential:[3/]				
Average lot size — Average % Impervious[4/]				
1/8 acre or less — 65	77	85	90	92
1/4 acre — 38	61	75	83	87
1/3 acre — 30	57	72	81	86
1/2 acre — 25	54	70	80	85
1 acre — 20	51	68	79	84
Paved parking lots, roofs, driveways, etc.[5/]	98	98	98	98
Streets and roads:				
paved with curbs and storm sewers[5/]	98	98	98	98
gravel	76	85	89	91
dirt	72	82	87	89

used C for Leadvale soils, see p. 1

use 80

1/ For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Section 4, Hydrology, Chapter 9, Aug. 1972.

2/ Good cover is protected from grazing and litter and brush cover soil.

3/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

4/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

5/ In some warmer climates of the country a curve number of 95 may be used.

0015096

From Urban hydrology for small Watersheds. Tech. Release No. 55, B-11

Table B.1—Continued

KUKAIAU	A	LANE	C	LEADVILLE	B	LICKDALE	D	LOLAK	D
KULA	B	LANEY	B	LEAF	D	LICKING	C	LOLALITA	B
KULAKALA	B/C	LANG	B/D	LEAHY	B	LICKSKILLET	D	LOLEKAA	B
KULLIT	D	LANGFORD	C	LEAL	B	LIDDELL	D	LOLETA	C/D
KUNA	B	LANGHEI	B	LEAPS	C	LIEBERMAN	C	LOLO	A
KUNIA	B	LANGLEY	C	LEATHAM	C	LIEN	D	LOLON	A
KUNUWEIA	C	LANGLOIS	D	LEAVENWORTH	B	LIGGET	B	LOMA	C
KUNO	D	LANG LA	B	LEAVITT	B	LIGHTNING	D	LOMALTA	D
KUSKOKWIM	D	LANGRELL	B	LEAVITTVILLE	B	LIGNUM	C	LOMAX	B
KUSLINA	D	LANGSTON	C	LEBANON	C	LIGON	D	LOMIRA	B
KUTCH	D	LANIER	B	LEBAR	B	LIHEN	A	LONDO	C
KUTZTOWN	B	LANIGER	B	LEBEC	B	LIHUE	B	LONEPINE	C
KVICHAK	B	LANKBUSH	B	LEBO	C	LIKES	A	LONERIDGE	B
KYLE	D	LANKIN	C	LEBSACK	C	LILAH	A	LONE ROCK	A
KYLER	D	LANKTREE	C	LECK KILL	B	LILLIWAUP	A	LONETREE	B
		LANOAK	B	LECRADER	B	LIMA	B	LONGFORD	C
LA BARGE	B	LANSDALE	B	LEDGEFORK	A	LIMANI	B	LONGLOIS	B
LABETTE	C	LANSDOWNE		LEDGER	C	LIMBAR	B	LONGMARE	B
LABISH	D	LANSING	B	LEDRU	D	LIMERICK	C	LONGMONT	C
LA BOUNTY	C	LANTIS	B	LEDY		LIMON	C	LONGRIE	C
LA BRIER	C	LANTON	C	LEE	D	LIMONES	B	LONGVAL	B
LACAMAS	C/D	LANTONIA	B	LEEDS	C	LINCOLN	A	LONG VALLEY	B
LA CASA	C	LANTZ	D	LEEFIELD	C	LINCROFT	A	LONGVIEW	C
LACITA	C	LAP	D	LEELANAU	A	LINDLEY	C	LONOKE	B
LACKAWANNA	C	LAPALMA	C	LEEPER	D	LINDSEY	D	LONTI	C
LACONA	C	LAPEER	B	LEESVILLE	B/C	LINDSIDE	C	LOOKOUT	C
LACOTA	D	LAPINE	A	LEETCH	C	LINDSTROM	B	LOON	B
LACY	D	LAPLATTA	C	LEETONIA	C	LINDY	C	LOPER	B
LADD	B	LAPORTE	C	LEFOR	B	LINEVILLE	C	LOPEZ	D
LADDER	D	LA POSTA	A	LEGLER	B	LINGANORE	B	LORADALE	C
LADELLE	B	LA PRAIRIE	B	LEGORE	B	LINKER	B	LORAIN	C/D
LADOGA	C	LARABEE	B	LEHEW	C	LINKVILLE	B	LORDSTOWN	C
LADUE	C	LARCHMOUNT	B	LEHIGH	C	LINNE	C	LORELLA	D
LADYSMITH	D	LARDELL	C	LEHMANS	D	LINNET	B	LORENZO	A
LA FARGE	B	LAREDO	B	LEHR	B	LINNEUS	B	LORETTO	B
LAFE	D	LARES	C	LEICESTER	C	LINO	C	LORING	C
LA FONDA	C	LARGENT	D	LEILEHUA	B	LINSLAW	B	LOS ALAMOS	C
LAFONT	B	LARGO	C	LELA	D	LINT	B	LOS BANOS	C
LAGLORIA	B	LARIMER	B	LELAND	D	LINTON	B	LOSEE	B
LAGONDA	C	LARKIN	B	LEMETA	D	LINVILLE	B	LOS GATOS	B
LA GRANDE	C	LARKSON	C	LEMPSTER	C/D	LINWOOD	A/D	LOS GUINEOS	C
LAHAINA	B	LA ROSE	B	LEN	C	LIPAN	D	LOS OSOS	C
LA HOGUE	B	LARRY	D	LENA	A	LIPPINCOTT	B/D	LOS ROBLES	B
LAHONTAN	D	LARSON	D	LENAPAH	D	LIRIOS	B	LOS TANOS	B
LAIDIG	C	LARUE	A	LENAWEE	B/D	LIRRET	D	LOST CREEK	B
LAIDLAW	B	LARVIE	D	LENNEP	D	LISADE	B	LOST HILLS	C
LAIRDSVILLE	D	LAS	C	LENOIR	D	LISAM	D	LOS TRANCOS	D
LAIREP	D	LAS ANIMAS	C	LENOX	B	LISBON	B	LOSTWELLS	B
LA JARA	C	LASAUSES	C	LENZ	B	LISMAS	D	LOTHAIR	C
LAKE	A	LAS FLORES	D	LEO	B	LISMORE	B	LOTUS	B
LAKE CHARLES	D	LASHLEY		LEON	A/D	LITCHFIELD	A	LOUDON	C
LAKE CREEK	B	LASIL	D	LEONARD	C	LITHGOW	C	LOUDONVILLE	C
LAKEHELEN	B	LAS LUCAS	C	LEONARDO	B	LITHIA	C	LOUIE	C
LAKEHURST	A	LAS POSAS	C	LEONARDTOWN	D	LITIMBER	C	LOUISA	B
LAKE JANEE	A	LASSEN	D	LEONIDAS	B	LITLE	D	LOUISBURG	B
LAKELAND	A	LASTANCE	B	LEOTA	C	LITTLEBEAR	A	LOUP	D
LAKEMONT	D	LAS VEGAS	B	LEPLEY	D	LITTLEFIELD	D	LOURDES	C
LAKEPORT	B	LATAH	C	LERDAL	C	LITTLE POLE	D	LOUVIERS	B
LAKESHORE	D	LATANCU	C	LEROY	B	LITTLETON	B	LOVEJOY	C
LAKESOL	B	LATANIER	D	LESHARA	B	LITTLE WOOD	B	LOVELAND	C
LAKETON	B	LATHAM	D	LESHO	C	LITZ	C	LOVELL	C
LAKEVIEW	C	LATINA	D	LESLIE	D	LIVERMORE	A	LOVELOCK	C/D
LAKEWIN	A	LATON	D	LESTER	B	LIVINGSTON	D	LOWELL	C
LAKEWOOD	A	LATONIA	B	LE SUEUR	B	LIVONA	A	LOWRY	B
LAKI	B	LATTY	C	LETA	C	LIZE	C	LOWVILLE	B
LALIN	A	LAUDERDALE	B	LETCHER	D	LIZZANT	B	LOYAL	B
LAKOMA	D	LAUGENOUR	B/D	LETHA	D	LOBDELL	C	LOYALTON	D
LALAAU	A	LAUGHLIN	C	LETHENT	C	LOBELVILLE	C	LOYSVILLE	D
LA LANDE	C	LAUMAIA	B	LETORT		LOBENG	B	LOZANO	B
LALLIE	D	LAUREL	C	LETTERBOX	B	LOBERT	B	LOZIER	D
LAM	B/D	LAURELHURST	C	LEVAN	A	LOBITOS	C	LUALUALEI	D
LAMAR	B	LAURELWOOD	B	LEVASY	C	LOCEY	C	LUBBOCK	C
LAMARTINE	B	LAUREN	B	LEVERETT	C	LOCHSA	B	LUBRECHT	C
LAMBERT	B	LAVALLEE	B	LEVIATHAN	B	LOCKE	B	LUCAS	C
LAMBETH	C	LAVEEN	B	LEVIS	C	LOCKERBY	C	LUCE	C
LAMINGTON	D	LAVELDO	D	LEWIS	D	LOCKHARD	B	LUCEDALE	B
LAMO	B	LAVERKIN	C	LEWISBERRY	B	LOCKHART	B	LUCERNE	B
LAMONI	D	LAVINA	C	LEWISBURG	C	LOCKPORT	D	LUCIEN	C
LAMONT	A	LAWAI	B	LEWISTON	C	LOCKWOOD	B	LUCILE	B
LAMONTA	D	LAWLER	B	LEWISVILLE	C	LOCUST	C	LUCILETON	B
LAMOURE	C	LAWRENCE	C	LEX	B	LODAR	D	LUCKY	B
LAMPHIER	B	LAWRENCEVILLE	C	LEXINGTON	B	LODPA	A	LUCKY STAR	B
LAMPSHIRE	D	LAWSON	B	LIBEIAGS	D	LODI	C	LUCY	A
LAMSON	D	LAWTHER	D	LIBBY	B	LODO	D	LUDDEN	D
LANARK	B	LAWTON	C	LIBEG	A	LOFFTUS	C	LUDLOW	C
LANCASTER	B	LAX	C	LIBERAL	D	LOFTON	D	LUPKIN	D
LANCE	B	LAYCOCK	B	LIBERTY	C	LOGAN	C	LUNCH	B
LAND	D	LAYTON	A	LIBORY	A	LOGGERT	A	LUJANE	C
LANDES	B	LEA	C	LIBRARY	D	LOGY	B	LUKIN	C
LANDISBURG	C	LEADER	B	LIBUTTE	D	LOHLER	C	LULA	B
LANDLOW	C	LEADPOINT	B	LICK	B	LOHMILLER	C	LUMBEE	D
LANDUSKY	D	LEADVALE	C	LICK CREEK	D	LOHNES	A	LUMMI	B/C

NOTES A BLANK HYDROLOGIC SOIL GROUP INDICATES THE SOIL GROUP HAS NOT BEEN DETERMINED
TWO SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION

By WTC Date 4/26/84 Subject QUANTITIES / LANDFILL (REV. 2) Sheet No. 1 of 10
Chkd. By RGM Date 5/1/84 VERTAC CHEMICAL PLANT, JACKSONVILLE, AK Proj. No. 846012

LANDFILL DESIGN (REV. 2)
QUANTITIES (ALTERNATIVE 3, WASTE CONTAINMENT)

RELOCATE WASTE CONTAINMENT TOWARD PLANT / NORTH BURIAL AREA AND RAISE THE BOTTOM TO EL 278, (ABOVE 100 YEAR FLOOD LEVEL). IT REQUIRES

- CUT / FILL THE EAST SIDE OF POND TO BUILD PLATFORM
- PROVIDE MINIMUM 1% LECHATE COLLECTION SLOPE
- PROVIDE 2 – 5% TOP SLOPE (FINISH GRADE) FOR SURFACE DRAINAGE.
- COVER SYSTEM. 12" TOPSOIL & 18" CLAY FOR SLOPE LESS THAN 5%
  12" TOPSOIL & 36" CLAY FOR SLOPE GREATER THAN 5%

TOTAL WASTE CONTAINMENT AREA = 8.58 IN^2

SCALE 1" = 100 FT

$(1")^2 = 10{,}000$ SF

= 85,800 SF

= 1.97 acres

000150

By WTC Date 4/26/84 Subject QUANTITIES / LANDFILL (REV2) Sheet No. 2 of 10
Chkd. By RGM Date 5/1/84 VERTAC CHEMICAL PLANT JACKSONVILLE AK Proj. No. 846012

PLAT FORM. CUT VOLUME.

ELEVATION FT	AREA IN^2	AREA FT^2	ΔH FT	ΔV
286.5	0	0		
			0.5	?
286.0	0.03	300		
			2.0	
284.0	0.30	3000		
			2.0	
282.0	0.65	6500		
			1.0	
281.0	0.97	9700		
			1.0	
280.0	0.29+0.29	5800		
			1.0	
279.0	0.09+0.01	1000		
			0.5	
278.5	0	0		

TOTAL CUT VOLUME = 1152 CY

NOTE. $Volume = \frac{\Delta H}{3}\left(A_{Top} + A_{Bot} + \sqrt{A_{Top} \cdot A_{Bot}}\right)\left(\frac{1}{27}\right)$

```
                XEQ "VOL"
H=?
            .5        RUN
AREA 1=? S.F.
            0.        RUN
NEXT AREA=?
          300.        RUN
VOL= 2. CY
ΣVOL= 2. CY
H=?
            2.        RUN
NEXT AREA=?
        3,000.        RUN
VOL= 105. CY
ΣVOL= 107. CY
H=?
            2.        RUN
NEXT AREA=?
        6,500.        RUN
VOL= 344. CY
ΣVOL= 450. CY
H=?
            1.        RUN
NEXT AREA=?
        9,700.        RUN
VOL= 298. CY
ΣVOL= 748. CY
H=?
            1.        RUN
NEXT AREA=?
        5,800.        RUN
VOL= 284. CY
ΣVOL= 1,032. CY
H=?
            1.        RUN
NEXT AREA=?
        1,000.        RUN
VOL= 114. CY
ΣVOL= 1,146. CY
H=?
            .5        RUN
NEXT AREA=?
            0.        RUN
VOL= 6. CY
ΣVOL= 1,152. CY
```

0001509

PLAT FORM FILL VOLUME

ELEVATION FT	AREA IN²	AREA FT²	ΔH FT
280.0	0.03	300	
			1.0
279.0	1.20	12,000	
			1.0
278.0	3.20	32,000	
			—
278.0	3.61	36,100	
			2.0
276.0	2.20	22,000	
			2.0
274.0	1.91	19 100	
			1.0
273.0	0.75	7500	
			1.0
272.0	0.20 + 0.06	2600	
			1.0
271.0	0.02	200	
			1.0
270.0	0	0	

TOTAL FILL VOL = 960 + 4353
= 5313 CY

```
XEQ "VOL"
H=?
1.       RUN
AREA 1=? S.F.
300.     RUN
NEXT AREA=?
12,000.  RUN
VOL= 175. CY
ΣVOL= 175. CY
H=?
1.       RUN
NEXT AREA=?
32,000.  RUN
VOL= 785. CY
ΣVOL= 960. CY

XEQ "VOL"
H=?
2.       RUN
AREA 1=? S.F.
36,100.  RUN
NEXT AREA=?
22,000.  RUN
VOL= 2,130. CY
ΣVOL= 2,130. CY
H=?
2.       RUN
NEXT AREA=?
19,100.  RUN
VOL= 1,521. CY
ΣVOL= 3,651. CY
H=?
1.       RUN
NEXT AREA=?
7,500.   RUN
VOL= 476. CY
ΣVOL= 4,128. CY
H=?
1.       RUN
NEXT AREA=?
2,600.   RUN
VOL= 179. CY
ΣVOL= 4,307. CY
H=?
1.       RUN
NEXT AREA=?
200.     RUN
VOL= 43. CY
ΣVOL= 4,350. CY
H=?
1.       RUN
NEXT AREA=?
0.       RUN
VOL= 2. CY
ΣVOL= 4,353. CY
```

D'APPOLONIA
WASTE MANAGEMENT SERVICES

SHEET 4 OF 10

By WTC Date 4/26/84 Subject QUANTITIES / LANDFILL (REV. 2)
Chkd. By LGM Date 5/1/84 VERTAC CHEMICAL PLANT, JACKSONVILLE AK

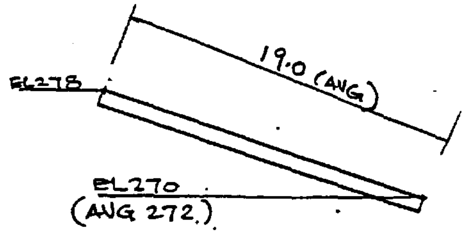
WASTE VOLUME

ELEVATION FT	AREA IN^2	AREA FT^2	ΔH FT
278.0	0	0	
			1.0
279.0	0.61+0.73	13,400	
			1.0
280.0	3.60	36,000	
			1.0
281.0	4.30	43,000	
			3.0
284.0	4.38	43,800	
			1.0
285.0	3.89	38,900	
			1.0
286.0	3.55	35,500	
			1.0
287.0	2.84	28400	
			1.0
288.0	1.97	19,700	
			1.0
289.0	0.90	9000	
			0.6
289.6	0	0	

TOTAL WASTE VOLUME = 12,890 CY

```
H=?
            1.     RUN
AREA 1=? S.F.
            0.     RUN
NEXT AREA=?
       13,400.     RUN
VOL= 165. CY
ΣVOL= 165. CY
H=?
                   RUN
NEXT AREA=?
       36,000.     RUN
VOL= 881. CY
ΣVOL= 1,046. CY
H=?
                   RUN
NEXT AREA=?
       43,000.     RUN
VOL= 1,461. CY
ΣVOL= 2,508. CY
H=?
            3.     RUN
NEXT AREA=?
       43,800.     RUN
VOL= 4,822. CY
ΣVOL= 7,330. CY
H=?
            1.     RUN
NEXT AREA=?
       38,900.     RUN
VOL= 1,531. CY
ΣVOL= 8,860. CY
H=?
                   RUN
NEXT AREA=?
       35,500.     RUN
VOL= 1,377. CY
ΣVOL= 10,238. CY
H=?
                   RUN
NEXT AREA=?
       28,400.     RUN
VOL= 1,181. CY
ΣVOL= 11,418. CY
H=?
                   RUN
NEXT AREA=?
       19,700.     RUN
VOL= 886. CY
ΣVOL= 12,304. CY
H=?
                   RUN
NEXT AREA=?
        9,000.     RUN
VOL= 519. CY
ΣVOL= 12,823. CY
H=?
           .6      RUN
NEXT AREA=?
            0.     RUN
VOL= 67. CY
ΣVOL= 12,890. CY
```

RIPRAP VOLUME. BELOW EL 278



LENGTH = $\sqrt{6^2+18^2} = 19'$

WIDTH = 450'

THICKNESS = 12"

VOLUME = $\frac{1 \times 450 \times 19'}{27} = 317^{CY}$ Say 320^{CY} RIPRAP

0015412

TOPSOIL

12" Topsoil ON 2^{ac} area.

(From R1)

Vol = $\frac{1 \times 85800}{27} = 3178^{CY}$ Say 3200^{CY}

CLAY COVER (NOT INCLUDING PLATFORM)

18" CLAY ON TOP & 36" ON SIDE WALL

Top Volume = $39200^{SF} \times \frac{1.5}{27} = 2178^{CY}$

Horizon Width of 3' thick = $\frac{3}{\sin \tan^{-1}(1/3)} = 9.5$ FT.

Side Wall Volume (See P. 10 of this Calc) = $\left[\frac{9.5}{27}\right]\left[(320)(11^{\text{Height}}) + (400)(10') + (350')(7)\right]$

$= 3508^{CY}$

total Clay = 3508 + 2178 = 5686 Say 5700^{CY}

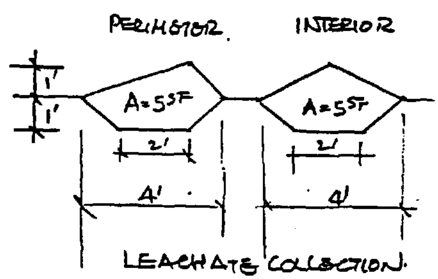
51

By WTC Date 4/26/84 Subject QUANTITIES/LANDFILL (REV. 2) Sheet No. 6 of 10
Chkd. By RGM Date 5/11/84 VERTAC CHEMICAL PLANT, JACKSONVILLE, AK Proj. No. 846012

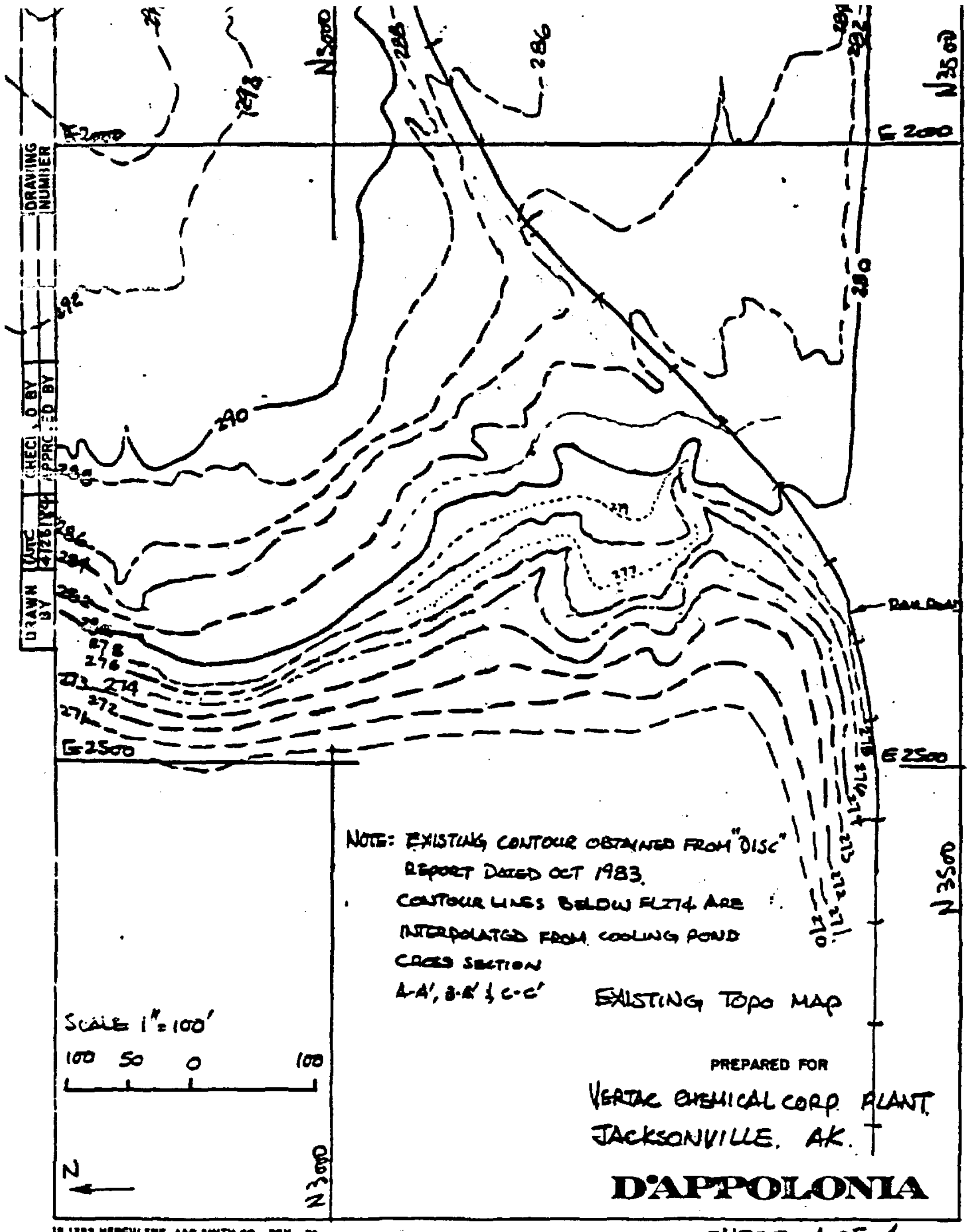
SUMMARY OF QUANTITIES

	ITEMS	QUANTITY	UNIT COST	SUBTOTAL
A	RAISED PLATFORM.			
	— CUT	1150 CY		
	— FILL	5320 CY		
	— BORROW	4170 CY		
	— RIPRAP	320 CY		
B	WASTE PLACMENT/SOLIDA-	13000 CY		
C.	CLAY COVER	5700 CY		
D	TOP SOIL	3200 CY		
E.	SEEDING	2 AC		
F	LEACHATE COLLECTION			
	• 4"Φ PERFORATED PVC PIPE.	1540 FT		
	• GRAVEL	285 CY		
	• MANHOLE (6' DEPTH X	2 UNIT		

001513



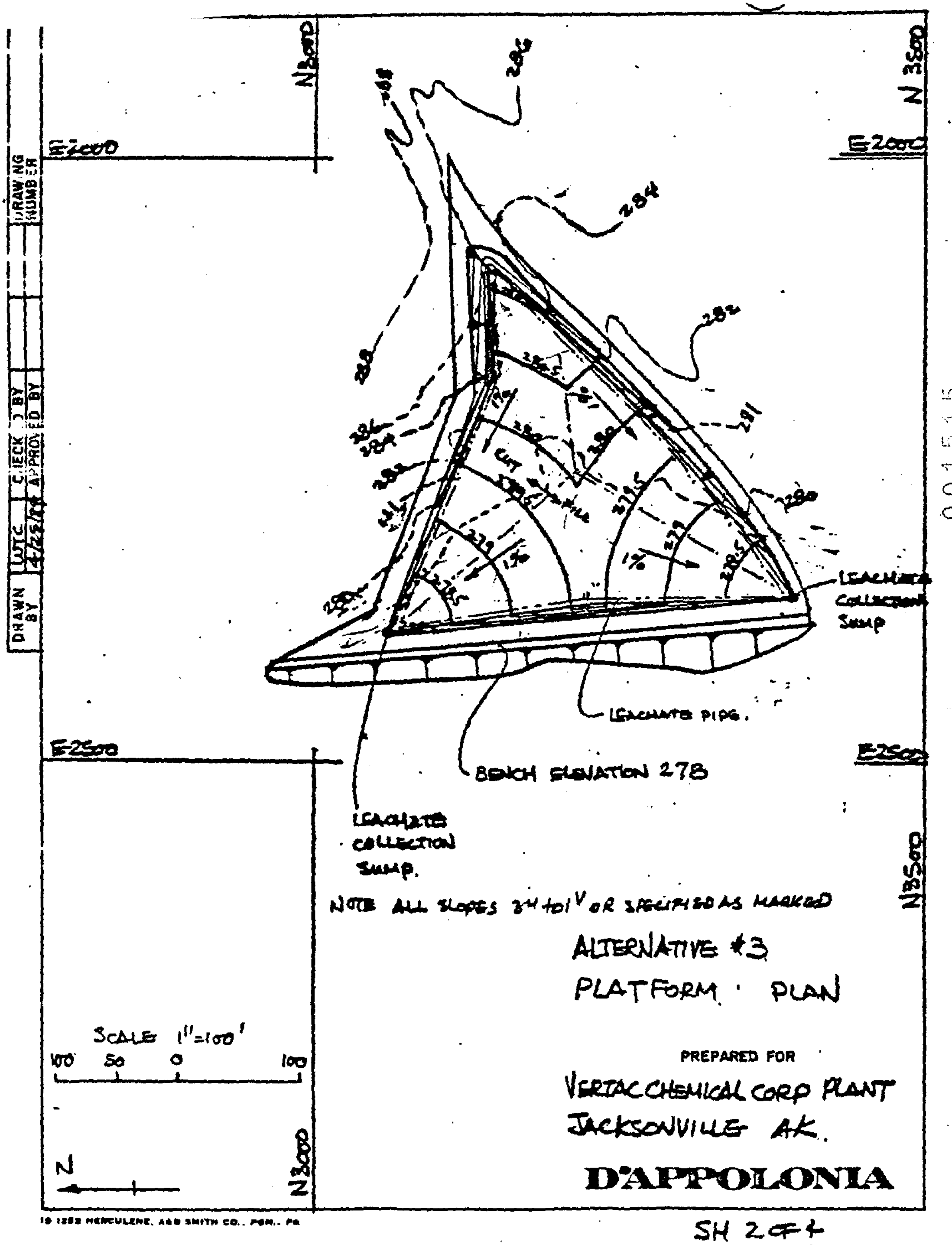
LEACHATE COLLECTION.



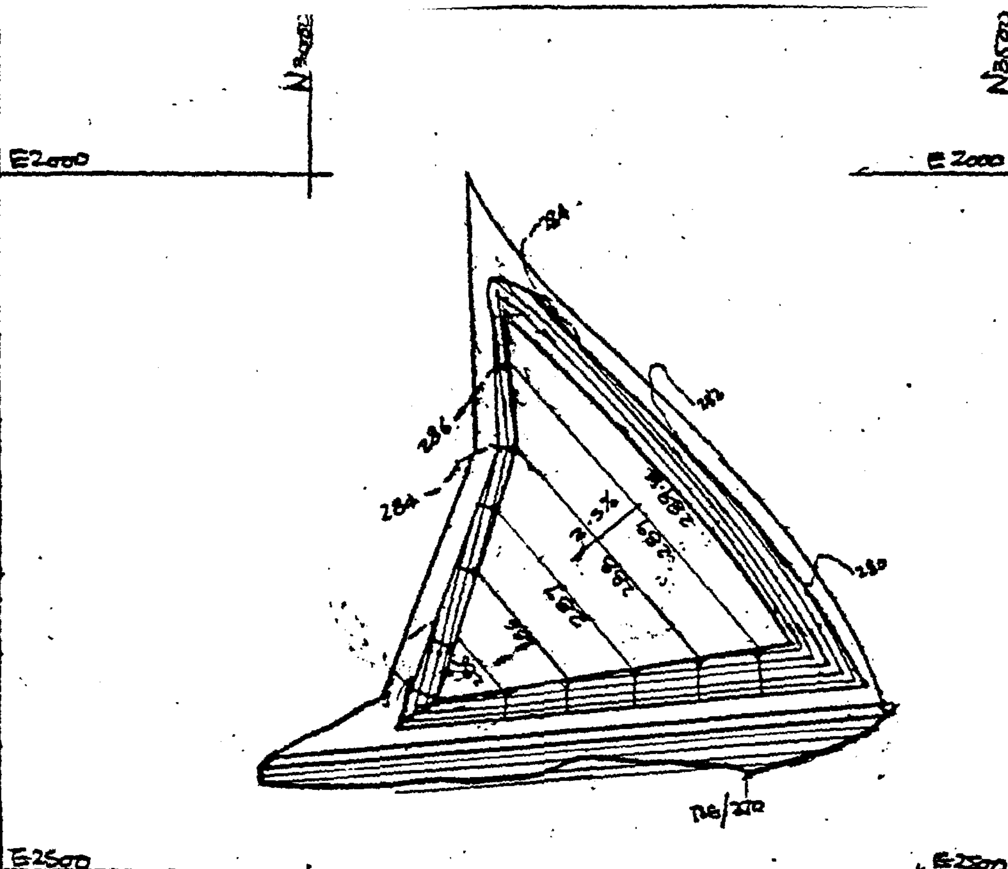
19 1283 HERCULENE, A&G SMITH CO., PGH., PA

SHEET 1 OF 4

001514


N3000
N3500
E2000
E2500
DRAWING NUMBER
DRAWN BY
DATE
CHECKED BY
APPROVED BY
284
282
280
278.5
279
1%
CUT
FILL
LEACHATE COLLECTION SUMP
LEACHATE PIPE.
BENCH ELEVATION 278
LEACHATE COLLECTION SUMP.
NOTE ALL SLOPES 3H to 1V OR SPECIFIED AS MARKED
ALTERNATIVE #3
PLATFORM PLAN
SCALE 1"=100'
100 50 0 100
N
PREPARED FOR
VERTAC CHEMICAL CORP PLANT
JACKSONVILLE AK.
D'APPOLONIA
SH 2 OF 4
0015155

DRAWN BY | DATE | CHECKED BY | APPROVED BY | DRAWING NUMBER



001516

NOTE ALL SLOPES 3H to 1V OR SPECIFIED AS MARKED

ALTERNATIVE #3 -
TOP/WASTE PLAN

SCALE 1" = 100'

100 50 0 100

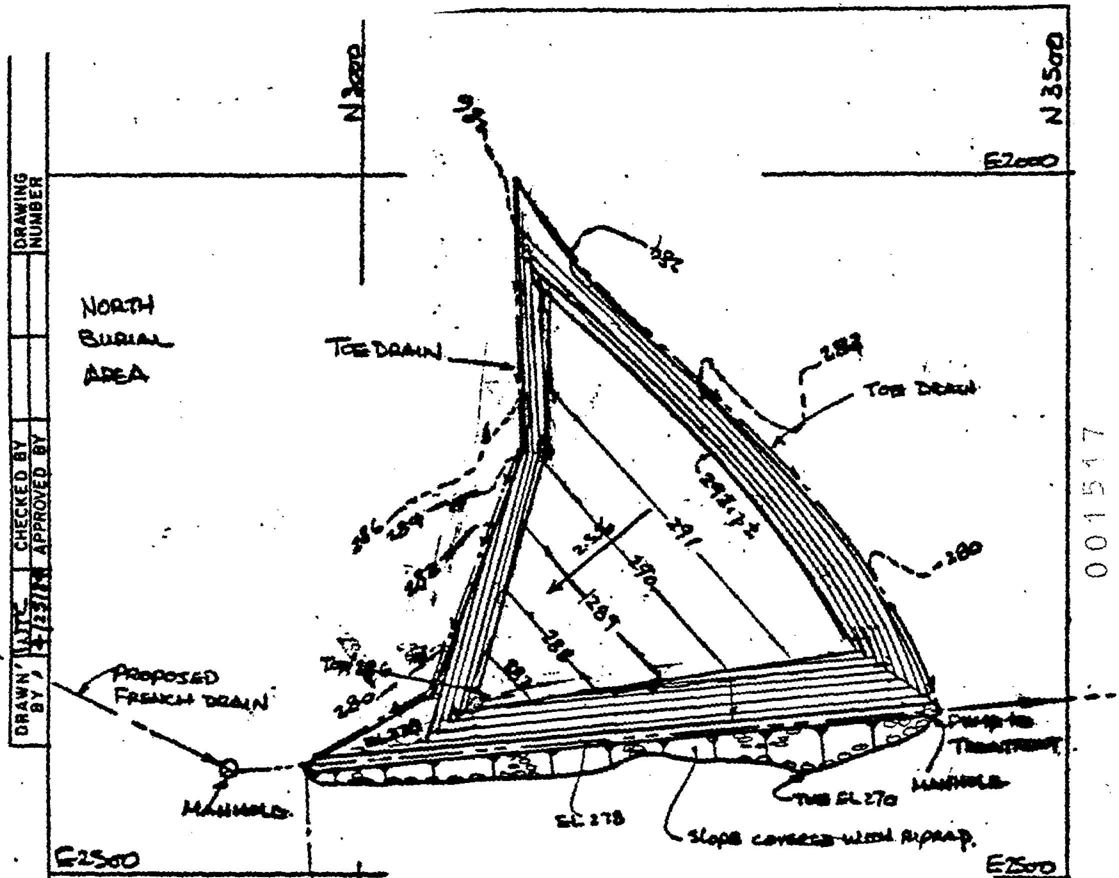
N

PREPARED FOR

VERTAC CHEMICAL CORP. PLANT
JACKSONVILLE, AK.

D'APPOLONIA

SH 3 OF 4



DRAIN TO COOLING POND

NOTE ALL SLOPES 2H to 1V OR SPECIFIED AS MARKED

SCALE 1" = 100'

100 50 0 100

N

ALTERNATIVE #3
FINISH GRADE PLAN

PREPARED FOR

VERTAC CHEMICAL CORP PLANT
JACKSONVILLE, AK

D'APPOLONIA

10 1255 HERCULENE, A&G SMITH CO., PGH., PA

SH 4 OF 4

D'APPOLONIA
WASTE MANAGEMENT SERVICES

(56)

By JM Date 4/25/84 Subject WATER BALANCE for Cases 1, 2, 3 Sheet No. 1 of 8
Chkd By WTC Date 05/14/84 VERTAC CHEMICAL CORP LITTLE ROCK AK Proj. No. 846012
RFC 05/14/84

0015100

PURPOSE: THIS CALCULATION IS DONE TO DETERMINE THE QUANTITY OF WATER WHICH MAY HAVE PERCOLATED THROUGH THE PROPOSED CLAY CAP AND VEGETATIVE GROWTH LAYERS.

METHODOLOGY: THIS CALCULATION IS BASED ON THE WATER BALANCE METHOD COMMONLY USED IN THE SOIL AND WATER CONSERVATION FIELDS. (REF 1) ... THE INFILTRATION FRACTION OF PRECIPITATION IS THE PRINCIPLE CONTRIBUTOR TO LEACHATE GENERATION FROM A LANDFILL CLOSURE. (REF. 2) THIS CALCULATION IS BASED UPON THE RELATIONSHIP AMONG PRECIPITATION, TEMPERATURE (REF 3), EVAPOTRANSPIRATION, SURFACE RUNOFF AND SOIL STORAGE AS SHOWN ON NEXT PAGE.

REFERENCES (1) C.W. THORNTHWAITE AND J.R. MATHER "INSTRUCTIONS AND TABLES FOR COMPUTING POTENTIAL EVAPOTRANSPIRATION AND THE WATER BALANCE" DREXEL INSTITUTE OF TECHNOLOGY LABORATORY OF CLIMATOLOGY, PUBLICATIONS IN CLIMATOLOGY, VOLUME X, NUMBER 3, 1957.

(2) D.G. FENN, K.J. HANLEY, and T.V. DeGEARE "USE OF THE WATER BALANCE METHOD FOR PREDICTING LEACHATE GENERATION FROM SOLID WATER DISPOSAL SITES" EPA REPORT /530/SW-168 OCTOBER 1975.

(3) "CLIMATOGRAPHY OF THE U.S. NO. 81 (By State), MONTHLY NORMALS OF TEMPERATURE, PRECIPITATION, AND HEATING AND COOLING DEGREE DAYS 1951 to 1980 ARKANSAS." NATIONAL CLIMATIC CENTER, ASHEVILLE N.C SEPT. 1982.

CASE 1: Vertac Design – 12" topsoil, 18" clay cap

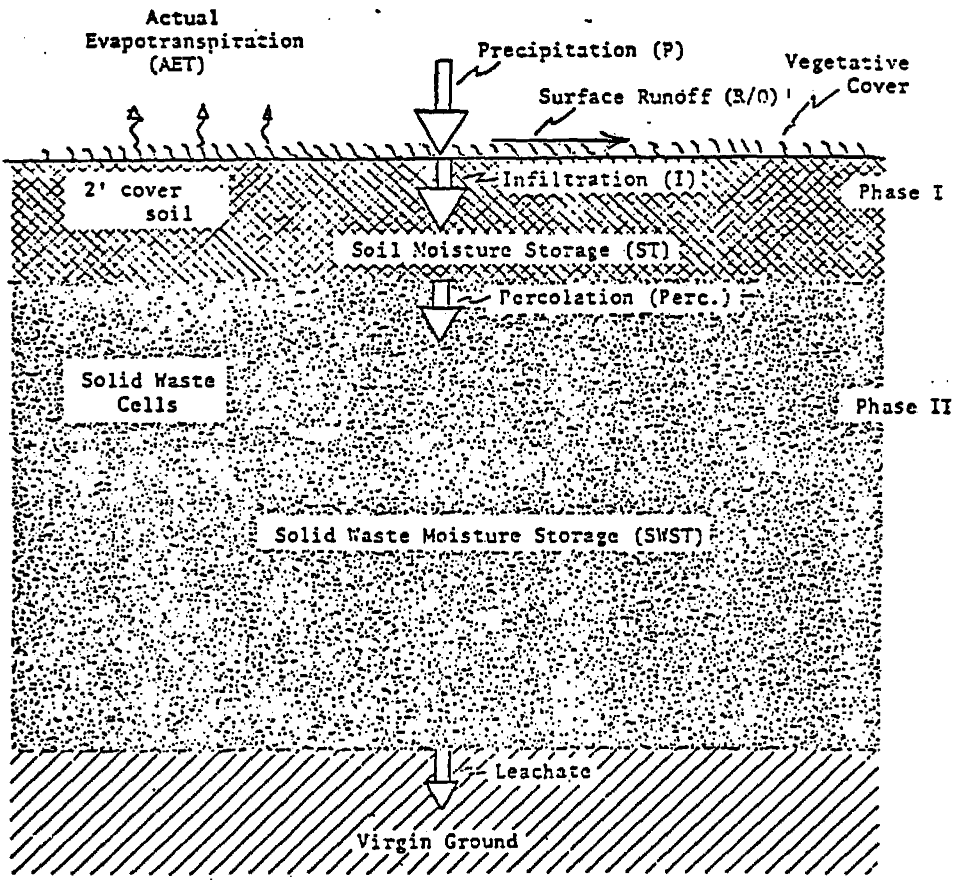
CASE 2: EPA Alternative III – 12" Topsoil, 24" drainage layer, 30 mill synthetic liner (aquiclude) and 24" Clay Cap

CASE 3: Existing Cap – 6" Topsoil, and 12" clay cap

REPAIRED EXISTING CAP – 12" TOPSOIL ...

By JM Date 4/25/84 Subject Water Balance for cases 1,2,3 Sheet No. 2 of 8
Chkd. By WTK Date 5/14/84 Vertac Chem Corp Little Rock Ark. Proj. No. 846012

Model Predicting Percolation & Leachate Using Water Balance Method



001519

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WASTE MANAGEMENT SERVICES

By JM Date 5/1/84 Subject WATER BALANCE for Cases 1+2 Sheet No. 3 of 8
Chkd. By WJC Date 5/14/84 Vertac Chem Corp Little Rock Ark. Proj. No. 846012

WATER BALANCE DATA FOR Little Rock Ark
CASES 1+2 (Vertac Design + EPA Alternative III)

	PARAMETERS	MONTHLY JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1	P, INCH	3.91	3.83	4.69	5.41	5.29	3.67	3.63	3.07	4.26	2.84	4.37	4.23	49.20
2	C R/O	.35	.35	.35	.34	.33	.32	.31	.31	.32	.33	.34	.35	—
3	RUNOFF R/O, INCH	1.37	1.34	1.64	1.84	1.75	1.17	1.13	.95	1.36	.94	1.49	1.48	16.46
4	INFILTRATION I, INCHES	2.54	2.49	3.05	3.57	3.54	2.5	2.5	2.12	2.9	1.9	2.88	2.75	32.74
5	TEMP. F°	39.9	44.1	52.2	62.4	70.5	78.5	82.1	81.0	74.3	63.1	51.2	43.2	61.9
6	HEAT INDEX I_{HEAT}	.82	1.56	3.4	6.31	9.03	12.01	13.45	13.01	10.41	6.53	3.16	1.39	81.08
7	UNADJ PE, IN	.01	.02	.04	.08	.12	.17	.19	.18	.15	.08	.04	.01	—
8	SOLAR Correction	26.1	25.5	30.9	32.7	36.3	36.3	36.9	34.8	30.9	29.1	25.8	25.5	—
9	PET, IN	.26	.51	1.24	2.62	4.36	6.17	7.01	6.26	4.64	2.33	1.03	.26	36.69
10	I − PET, IN	2.28	1.98	1.81	+.95	−.82	−3.67	−4.51	−4.14	−1.74	−.43	+1.85	2.49	−3.95
11	Σ_{NEG}(I−PET)				0	−.82	−4.49	−9.0	−13.14	−14.88	−15.31			—
12	ST, IN	7.79	8	8	8	7.22	4.55	2.59	1.55	1.24	1.17	3.02	5.51	—
13	Δ ST	2.28	.21	0	0	−.78	−2.67	−1.96	−1.04	−.31	−.07	+1.85	2.49	—
14	AET	.26	.51	1.24	2.62	4.32	5.17	4.46	3.16	3.21	1.97	1.03	.26	28.21
15	PERC	0	1.77	1.81	.95	0	0	0	0	0	0	0	0	4.53

Annual Precipitation ≈ 49.20 inches
Annual Runoff ≈ 16.46 inches
Annual Infiltration ≈ 32.74 inches
Annual Potential Evapotranspiration ≈ 36.69 inches
Annual Actual Evapotranspiration ≈ 28.21 inches

Annual Percolation ≈ 4.53 inches = 11.5 cm

By JM Date 5/2/84 Subject WATER BALANCE for Case 3 Sheet No. 4 of 8
Chkd. By WTC Date 5/14/84 Vertac Chem Corp Little Rock Ark. Proj. No. 840612

WATER BALANCE DATA FOR CASE 3 (Existing Cap)

	PARAMETERS	MONTHLY JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1	P, INCH	3.91	3.83	4.69	5.41	5.29	3.67	3.63	3.07	4.26	2.84	4.37	4.23	49.20
2	C R/O	.35	.35	.35	.34	.33	.32	.31	.31	.32	.33	.34	.35	—
3	RUNOFF R/O, INCH	1.37	1.34	1.64	1.84	1.75	1.17	1.13	.95	1.36	.94	1.49	1.48	16.46
4	INFILTRATION I, INCH	2.54	2.49	3.05	3.57	3.54	2.5	2.5	2.12	2.9	1.9	2.88	2.75	32.74
5	TEMP. F°	39.9	44.1	52.2	62.4	70.5	78.5	82.1	81.0	74.3	63.1	51.2	43.2	61.9
6	HEAT INDEX I_{HEAT}	.82	1.56	3.4	6.31	9.03	12.01	13.45	13.01	10.41	6.53	3.16	1.39	81.08
7	UNADJ PE, IN	.01	.02	.04	.08	.12	.17	.19	.18	.15	.08	.04	.01	—
8	SOLAR correction	26.1	25.5	30.9	32.7	36.3	36.3	36.9	34.8	30.9	29.1	25.8	25.5	—
9	PET, IN	.26	.51	1.24	2.62	4.36	6.17	7.01	6.26	4.64	2.33	1.03	.26	36.69
10	I − PET, IN	2.28	1.98	1.81	+.95	−.82	−3.67	−4.51	−4.14	−1.74	−.43	+1.85	2.49	−3.95
11	Σ_{NEG}(I-PET)				0	−.82	−4.49	−9.0	−13.14	−14.88	−15.31			—
12	ST, IN	5	5	5	5	4.23	2.00	.80	.35	*.23	*.20	2.05	4.54	—
13	Δ ST	.46	0	0	0	−.77	−2.23	−1.2	−.45	−.12	−.03	+1.85	2.49	—
14	AET	.26	.51	1.24	2.62	4.31	4.73	3.7	2.57	3.02	1.93	1.03	.26	26.18
15	PERC	1.82	1.98	1.81	.95	0	0	0	0	0	0	0	0	6.56

Annual Precipitation ≃ 49.20 inches
Annual Runoff ≃ 16.46 inches
Annual Infiltration ≃ 32.74 inches
Annual Potential Evapotranspiration ≃ 36.69 inches
Annual Actual Evapotranspiration ≃ 26.18 inches

Annual Percolation ≃ 6.56 inches = 16.7 cm

* Extrapolation

Water Balance Calculation Steps:

1. Precipitation Normals (Monthy) From Ref 3, Record 1951-1980
2. Runoff Coefficient for Grass Cover, Heavy Soil, Average slope (2%-7%). (.17 dry season to .21 wet season) from table 3 p. 8 of Ref 2.
   For Compacted clay assume higher runoff coefficient of .35 to .31.
3. Runoff = $P \times C_{R/O}$. ③ = ①×② (Ref. 2 p.31)
4. Infiltration (I) = P - Runoff ④=①-③ (Ref 2 p.31)
5. Mean Temperature (Monthly) From Ref. 3. Record 1951-1980
6. Heat Index From table 1 p. 206, 207 of Ref 1
7. Unadjusted Daily Potential Evapotranspiration from Table 3 p. 210-211 of Ref 1. and Table 5 p. 226 of Ref 1
8. Solar Correction from Table 6 p. 228 of Ref 1
   (With N 34°44' for Little Rock Ark. from Ref 3)
   use N 35°
9. PET = Potential Evapotranspiration, ⑨=⑦×⑧ (Ref. 2 p.31)
10. I - PET ⑩=④-⑨ (Ref 2 p.31)
11. Σ_{neg} (I-PET) 11 = Σ [-⑩] (Ref 2 p.32)

0015122

12. Holding Capacity

* ST = Available Water × Thickness of Root zone layer = Applicable Soil Moisture

TABLE 2

SOIL MOISTURE
MILLIMETER WATER PER METER SOIL

Type of soil	Field capacity* mm/m	Wilting point* mm/m	Available water mm/m	Available water in/ft
Fine sand	120	20	100	1.2
Sandy loam	200	50	150	1.8
→ Silty loam	300	100	200	2.4
→ Clay loam	375	125	250	3.0
→ Clay	450	150	300	3.6

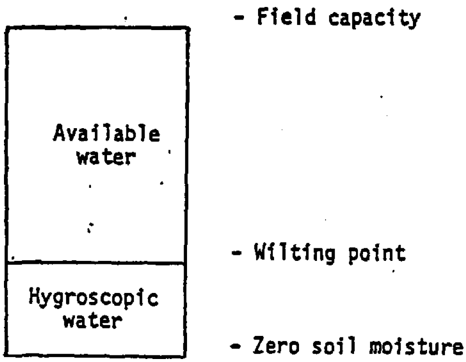


Figure 1. Soil Moisture Storage

Table 2 and Figure 1 from Ref 2 p. 5-6.

* ST equation from Ref. 2, p. 33.

001523

12. Holding Capacity (continued).

CASE 1: Vertac Design

$$ST = \left.\begin{array}{l} 3.0 \text{ in/ft} \times 1 \text{ ft} = 3'' \\ 3.6 \text{ in/ft} \times 1.5 \text{ ft} = 5.4'' \end{array}\right\} 8.4''$$

CASE 2: CH_2 M-Hill Design

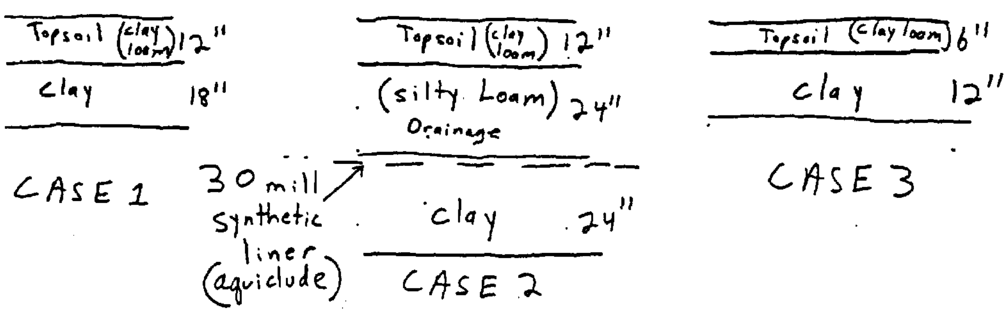
$$ST = \left.\begin{array}{l} 3.0 \text{ in/ft} \times 1 \text{ ft} = 3'' \\ 2.4 \text{ in/ft} \times 2 \text{ ft} = 4.8'' \end{array}\right\} 7.8''$$

for CASES 1 + 2 use Table 18 (p. 259-263 of Ref 1)
for Soil Moisture of approximately 8".

CASE 3: Existing Cap.

$$ST = \left.\begin{array}{l} 3.0 \text{ in/ft} \times 0.5 \text{ ft} = 1.5'' \\ 3.6 \text{ in/ft} \times 1 \text{ ft} = 3.6'' \end{array}\right\} 5.1''$$

for CASE 1 use Table 16 (p. 253-255 of Ref 1)
for Soil Moisture of approximately 5"



13. ΔST = change in Soil Moisture

e.g. $ST_{May} - ST_{April} = \Delta ST_{May}$

$7.22 - 8.0 = -.78$

14. Actual Evapotranspiration = AET

$AET = PET$ when $I > PET$

$AET = PET + [(I - PET) - \Delta ST]$ when $I < PET$

from Ref 2 p. 33

15. Percolation = Perc

$Perc = P - R/O - \Delta ST - AET$ from Ref 2 p. 31

0015525

D'APPOLONIA
WASTE MANAGEMENT SERVICES

(84)

By JM Date 4/30/84 Subject Cap Efficiency Sheet No. 1 of 10
Chkd. By RGM Date 5/17/84 Vertac Chem Corp Jacksonville Ark. Proj. No. 846012
For Cases 1, 2, 3

001526

Purpose: To determine Cap Efficiency (e.g. amount of infiltration which could percolate through the proposed/existing capping system.

Methodology: This calculation assumes all percolation calculated from the Water Balance method will reach the clay cap (approx. 11 to 17 cm) and determines the amount drained by the drainage layer and hence the amount available to percolate through the proposed capping system.

Ref 1 ⟨ This technique was used to determine the Cap Efficiency for the following 3 cases.

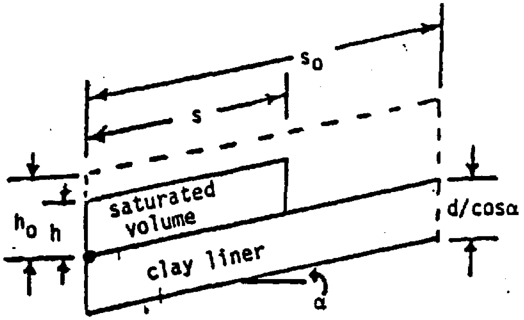
CASE 1: Vertac Plan - 12" Topsoil, 18" Clay Cap

*CASE 2: EPA Alternative III - 12" Topsoil, 24" drainage layer 30 mil synthetic liner (aquiclude) and 24" Clay Cap

CASE 3A: Existing Cap - 6" Topsoil, and 12" Clay Cap
CASE 3B: Repaired existing Cap, 12" Topsoil, and 12" clay Cap

Reference: (1) Charles A. Moore Ph.D., P.E. "Landfill and Surface Impoundment Performance Evaluation Manual" EPA Report SW-869, September 1980 p.34-46

*Note: CASE 2A assumes synthetic liner $K = 10^{-7}$ cm/s
CASE 2B assumes synthetic liner $K = 10^{-9}$ cm/s



from Ref. 1 p. 37

Figure 4.11 - Geometry for calculating effeciency of drain - liner systems. (after Wong, 1977)

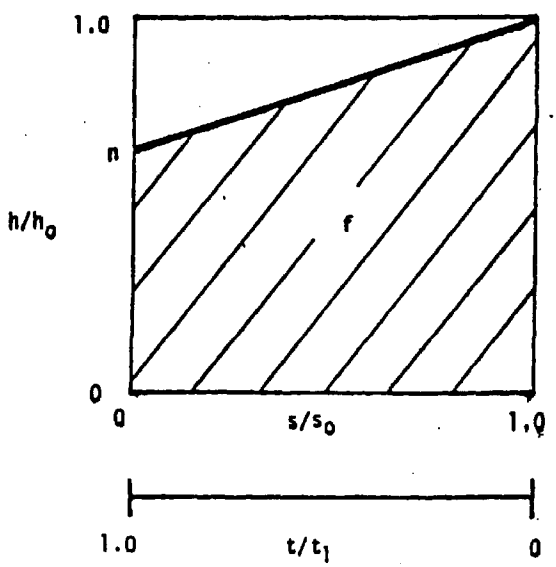


Figure 4.12 - Diagram for computing efficiency of drain - liner systems.(after Wong, 1977)

D'APPOLONIA
WASTE MANAGEMENT SERVICES

By JM Date 5/1/84 Subject Cap Efficiency Sheet No. 3 of 10
Chkd. By AGM Date 5/17/84 Vertac Chem Corp. Jacksonville Ark. Proj. No. 846012
For Cases 1, 2, 3

Variables and Equations from Ref 1 p. 36-38

* $h_o = 11.5\,cm$ (for CASES 1+2) $h_o = 16.7\,cm$ for CASE 3

$S_o = \frac{L}{2}\sec\alpha = 30.5\,cm$ = 1 ft. unit length for CASES 1,2,3

$\sec\alpha$ for $\alpha < 5\%$ (2.86°) ≈ 1

Therefore $S_o = \frac{L}{2}$ or $S_o = S_o$ for small unit length

$K_{s1} = 10^{-5}\,cm/s$ (Topsoil)

$K_{s2} = 10^{-7}\,cm/s$ (clay cap and 30mil synthetic liner)

$\alpha = 2$ to 5% $2\% = 1.15° = \alpha$

$3.5\% = 2° = \alpha$

$5\% = 2.86° = \alpha$

$t/t_1 = 1$

$d = \frac{d}{\cos\alpha} = 46\,cm$ = 18" $\cos\alpha$ for $\alpha < 5\% \approx 1$

Therefore $d = d = 46\,cm$ = thickness of clay cap for case 1

$$C = \left(\frac{S_o}{d}\right)\left(\frac{K_{s2}}{K_{s1}}\right)\cot\alpha$$

$$\frac{h}{h_o} = \left(1 + \frac{d}{h_o\cos\alpha}\right)e^{-Ct/t_1} - \left(\frac{d}{h_o\cos\alpha}\right)$$ assuming $t/t_1 = 1$ then

$$n = \left(1 + \frac{d}{h_o\cos\alpha}\right)e^{-C} - \left(\frac{d}{h_o\cos\alpha}\right)$$

$f = \frac{1+n}{2}$ when $n > 0$ $f = \frac{1}{2(1-n)}$ when $n \leq 0$

f = percent of liquid drained

$f \times h_o$ = amount of liquid drained.

$(1-f)\,h_o$ = amount of liquid percolating thru cap.

* Results from Water Balance Calculations for CASES 1, 2, 3

001528

CASE 1 Vertac Plan.

Using $\alpha = 1.15°$

$d = 46\,cm$ = thickness of clay cap for case 1

$\left\{ \begin{array}{l} S_o = 30.5\,cm \\ h_o = 11.5\,cm \end{array} \right\}$ for cases 1 and 2

$$c = \left(\frac{30.5}{46}\right)\left(\frac{10^{-7}}{10^{-5}}\right)\cot 1.15°$$

$$c = \underline{.33030}$$

$$n = \left(1 + \frac{46}{11.5\cos 1.15°}\right)e^{-.3303} - \left(\frac{46}{11.5\cos 1.15°}\right)$$

$$n = \underline{-.4067}$$

$f = \frac{1}{2(1-^{-}.4067)} = .36$ or 36% of liquid is drained.

$.36 \times 11.5_{cm} =$ 4.14 cm is amount of liquid drained.

$(1-.36)\,11.5\,cm =$ 7.36 cm is amount percolating thru cap.

using: $\alpha = 2°$

$$c = \left(\frac{30.5}{46}\right)\left(\frac{10^{-7}}{10^{-5}}\right)\cot 2°$$

$$c = \underline{.18987}$$

$$n = \left(1 + \frac{46}{11.5\cos 2°}\right)e^{-.18987} - \left(\frac{46}{11.5\cos 2°}\right)$$

$$n = \underline{.1349}$$

$f = \frac{1+.1349}{2} = .57$ or 57% of liquid is drained.

$.57 \times 11.5\,cm =$ 6.55 cm is amount of liquid drained

$(1-.57)\,11.5\,cm =$ 4.95 cm is amount percolating thru cap

0015290

CASE 1 Vertac (Continued)

Using 2.86°

$$C = \left(\frac{30.5}{46}\right)\left(\frac{10^{-7}}{10^{-5}}\right)\cot 2.86°$$

$$C = \underline{.13272}$$

$$n = \left(1 + \frac{46}{11.5\cos 2.86°}\right) e^{-.13272} - \left(\frac{46}{11.5\cos 2.86°}\right)$$

$$n = \underline{.3779}$$

$$f = \frac{1 + .3779}{2} = .69$$ or 69% of liquid is drained

$.69 \times 11.5\text{cm} = \underline{7.9\text{ cm}}$ is amount of liquid drained

$(1 - .69)\,11.5\text{cm} = 3.6\text{ cm}$ is amount percolating thru cap

0001530

$K_{Liner} = 10^{-7}$ cm/s

Using $\alpha = 2°$ — $d = 61$ cm = thickness of clay cap and synthetic liner

$$C = \left(\frac{34.5}{61}\right)\left(\frac{10^{-7}}{10^{-5}}\right)\cot 2°$$

$\left\{ \begin{matrix} h_0 = 11.5\text{cm} \\ S_0 = 34.5\text{cm} \end{matrix} \right\}$ for Cases 1 and 2

$C = .14318$

$$n = \left(1 + \frac{61}{11.5\cos 2°}\right) e^{-.14318} - \left(\frac{61}{11.5\cos 2°}\right)$$

$n = .1586$

$f = \frac{1 + .1586}{2} = .58$ or 58% of liquid is drained.

$.58 \times 11.5\text{cm} =$ 6.67cm is amount of liquid drained

$(1 - .58)11.5\text{cm} =$ 4.83m is amount percolating thru clay cap

Using $\alpha = 2.86°$

$$C = \left(\frac{34.5}{61}\right)\left(\frac{10^{-7}}{10^{-5}}\right)\cot 2.86°$$

$C = .10008$

$$n = \left(1 + \frac{61}{11.5\cos 2.86°}\right) e^{-.10008} - \left(\frac{61}{11.5\cos 2.86°}\right)$$

$n = .3990$

$f = \frac{1 + .3990}{2} = .70$ or 70% of liquid is drained

$.70 \times 11.5\text{cm} =$ 8.05cm is amount of liquid drained

$(1 - .70)11.5\text{cm} =$ 3.45cm is amount percolating thru clay cap

001531

CASE 2B: EPA Alternative III

Percolation thru 30 mill synthetic liner.

using $\alpha = 2°$

$d = 30 \text{ mill} = .03'' = .0762 \text{ cm}$

$h_o = 11.5 \text{ cm}$

$S_o = 30.5 \text{ cm}$

$K_{liner} = 10^{-9} \text{ cm/s}$

$$c = \left(\frac{30.5}{.0762}\right)\left(\frac{10^{-9}}{10^{-5}}\right) \cot 2°$$

$$c = 1.14620$$

$$n = \left(1 + \frac{.0762}{11.5 \cos 2°}\right) e^{-1.14620} - \left(\frac{.0762}{11.5 \cos 2°}\right)$$

$$n = .3133$$

$f = \frac{1 + .3133}{2} = .66$ or 66% of liquid is drained.

$.66 \times 11.5 \text{ cm} = 7.59 \text{ cm}$ is amount of liquid drained,

$(1 - .66) 11.5 \text{ cm} = 3.91 \text{ cm}$ is amount percolating thru 30 mil liner and lower clay cap into the waste.

001532

CASE 3A Existing Cap.

Using $\alpha = 2°$

$d = 30.5\text{ cm}$ = thickness of clay cap for case 3

$S_o = 30.5\text{ cm}$, $h_o = 16.7\text{ cm}$ } for case 3A

$$c = \left(\frac{30.5}{30.5}\right)\left(\frac{10^{-7}}{10^{-5}}\right)\cot 2°$$

$$c = .28636$$

$$n = \left(1 + \frac{30.5}{16.7\cos 2°}\right)e^{-.28636} - \left(\frac{30.5}{16.7\cos 2°}\right)$$

$$n = .2960$$

$f = \frac{1 + .2960}{2} = .65$ or 65% of liquid is drained

$.65 \times 16.7\text{cm} =$ 10.86 cm is amount of liquid drained

$(1 - .65)\,16.7\text{cm} =$ 5.84 cm is amount percolating thru cap.

CASE 3B

Using $\alpha = 2°$

$d = 30.5\text{ cm}$ = thickness of clay cap.

$h_o = 11.5\text{ cm}$ = same as case 1

$S_o = 30.5\text{ cm}$

$$c = \left(\frac{30.5}{30.5}\right)\left(\frac{10^{-7}}{10^{-5}}\right)\cot 2.$$

$$c = .28636$$

$$n = \left(1 + \frac{30.5}{11.5\cos 2°}\right)e^{-.28636} - \left(\frac{30.5}{11.5\cos 2°}\right)$$

$$n = .0902$$

$f = \frac{1 + .0902}{2} = .55$ or 55% of liquid is drained

$.55 \times 11.5\text{cm} =$ 6.33 cm is amount of liquid drained

$(1 - .55)\,11.5\text{cm} =$ 5.17 cm is amount percolating thru cap

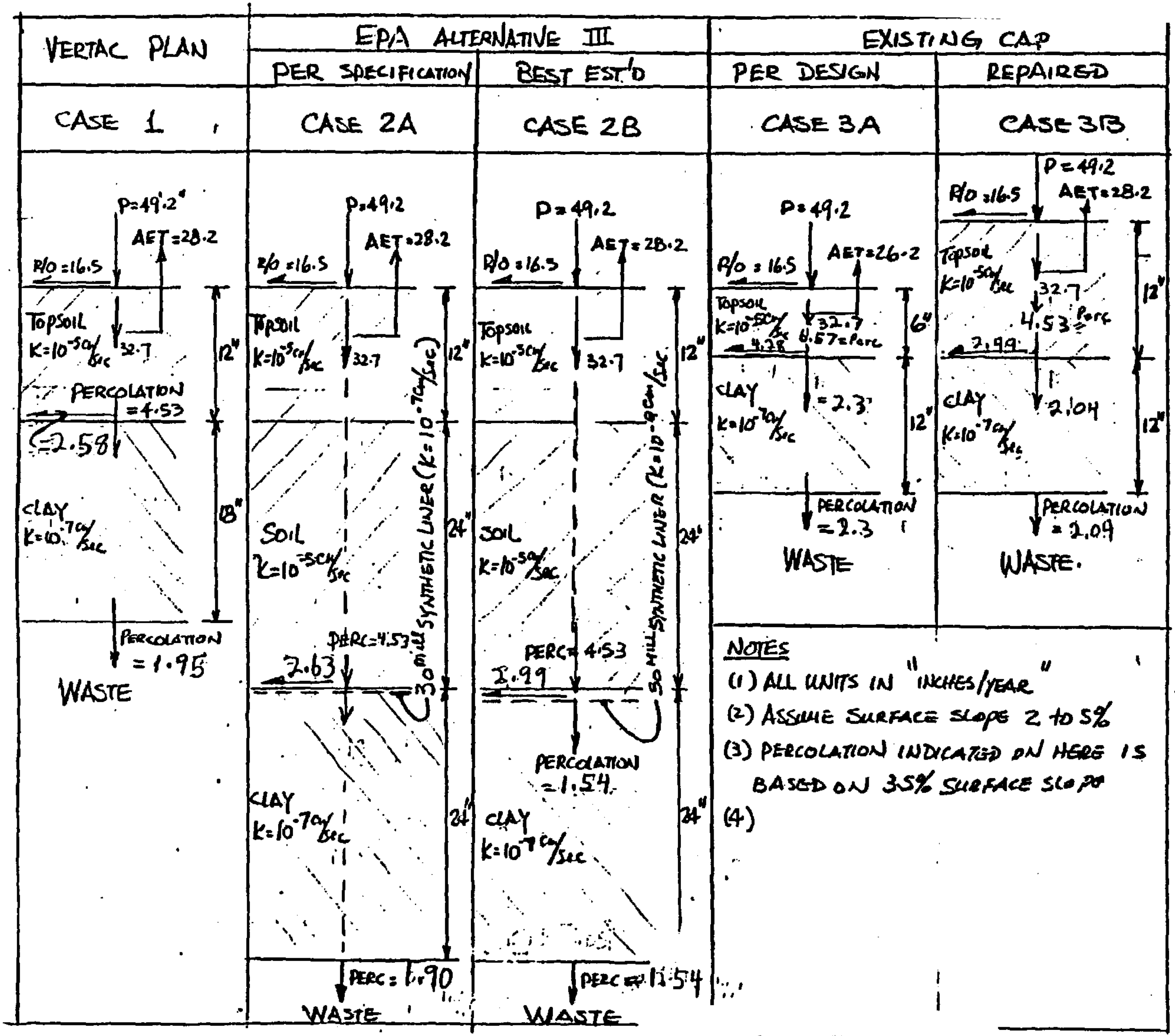
001533

SUMMARY

Amount of Percolation thru Clay Cap

α		CASE 1 Vertac Design	CASE 2 EPA Alternative III		CASE 3 Existing Cap	
			2A	2B	3A	3B
2%	1.15°	7.36 cm 2.9 in.	—	—	—	—
3.5%	2.0°	4.95 cm 1.95 in.	4.83 cm 1.9 in.	3.91 cm 1.54 in.	5.84 cm 2.3 in.	5.17 cm 2.04 in
5%	2.86°	3.6 cm 1.42 in	3.45 cm 1.36 in	—	—	—

001534



NOTES

(1) ALL UNITS IN "INCHES/YEAR"

(2) ASSUME SURFACE SLOPE 2 to 5%

(3) PERCOLATION INDICATED ON HERE IS BASED ON 3.5% SURFACE SLOPE

(4)

ESTIMATE GROUND WATER FLOW QUANTITIES

REF: 1. DWG NO A-1 "GROUND WATER GRADIENTS AND STREAMLINE DEVELOPED BY COMPUTER MODEL, ENVIRONMENTAL ASSESSMENT STUDY, VERTAC SITE IN JACKSONVILLE, ARKANSAS. BY DEVELOPERS INTERNATIONAL SERVICES CORP, NO DATE.

2. DWG NO A-2 " ROCK-SOIL INTERFACE CONTOURS "...... (SAME AS ABOVE DWG)....

1) FROM REF 2. THE TOP OF WEATHER ROCK ALONG THE EASTERN COOLING POND SHORELINE IS APPROX 6'-to 10' BELOW EXISTING GRADE AT ELEV. 270' to 274',

2) FROM REF 1. THE GROUND WATER SURFACE AS COMPUTED BY DISC'S COMPUTER MODEL VARIES FROM EL. 272 to 275.

3) GROUND WATER VELOCITIES AS INDICATED ON REF. 1 NEAR POND AREA ARE 0.145, 0.634 and 0.949 FT/YEAR.

4) FOR DESIGN PURPOSE, BE CONSERVATIVE IN COMPUTATION

$$A = (275-270) \times (1\text{FT width}) = 5 \text{ SF/FT}$$

$$V = \frac{0.145 + 0.634 + 0.949}{3} = 0.576 \text{ ft/YEAR} \quad \text{Say } 1 \text{ ft/YEAR}$$

$$q = AV = 5 \times 1 = 5 \text{ CF/FT/YEAR}$$

5) Total French Drainage LENGTH = 460 + 325 + 380

= 1165 FT.

001536

6) DESIGN FLOW WITHOUT SLURRY WALL OR INFILTRATION.

1165 x 5 = 5,825 CF/YEAR

= 43,571 gal/YEAR

= 119 gal/day

= 0.08 gpm

7) CONSIDER INFILTRATION = 1 IN/YEAR OVER 425,000 SF OF CAP AREA Vol = 35417 CF/YEAR

= 264,917 gal/YEAR

= 726 gal/day

= 0.50 gpm total = 0.58 gpm

001537

8) BE CONSERVATIVE USE 1 gpm for COOLING POND/NORTH BURIAL

9) REASOR-HILL FRENCH DRAIN = 260 + 350 = 610 FT

q_2 = 150,000 SF x 1"/YEAR q_1 = 610 x 5

= 12,500 CF/YEAR = 3050 CF/YEAR

= 93,500 gal/year = 22,814 gal/YEAR

= 256 gal/day = 62 gal/day

= 0.18 gpm = 0.04 GPM

$q_1 + q_2$ = total = 0.22 gpm

10) BE CONSERVATIVE USE 0.5 gpm for REASOR-HILL DRAIN.

By WTC Date 12/27/83 Subject ESTIMATE G.W. FLOW QUANTITIES Sheet No. 2 of 3
Chkd. By UM Date 4/30/84 VERTAC CHEMICAL JACKSONVILLE AK Proj. No. 846012

6) DESIGN FLOW WITHOUT SLURRY WALL OR INFILTRATION.

1165 x 5 = 5,825 CF/YEAR
= 43,571 gal/YEAR
= 119 gal/day
= 0.08 gpm.

7) CONSIDER INFILTRATION = 1 IN/YEAR OVER 425,000 SF OF CAP AREA Vol = 35417 CF/YEAR
= 264,917 gal/YEAR
= 726 gal/day
= 0.50 gpm total = 0.58 gpm

8) BE CONSERVATIVE USE 1 gpm for COOLING POND/NORTH BURIAL

9) REASOR-HILL FRENCH DRAIN = 260 + 350 = 610 FT

q_2 = 150,000 SF x 1"/YEAR
= 12,500 CF/YEAR
= 93,500 gal/year
= 256 gal/day
= 0.18 gpm

q_1 = 610 x 5
= 3050 CF/YEAR
= 22,814 gal/YEAR
= 62 gal/day
= 0.04 GPM

$q_1 + q_2$ = total = 0.22 gpm

10) BE CONSERVATIVE USE 0.5 gpm for REASOR-HILL DRAIN.

001538

(76)

By WTC Date 5/14/84 Subject ESTIMATE G.W. FLOW QUANTITIES Sheet No. 3 of 3
Chkd. By JM Date 5/16/84 VERTAC CHEMICAL JACKSONVILLE AK Proj. No. 846012

11) SOUTHERN FRENCH DRAIN.

AREA = AS DETERMINED USING GROUND WATER MAP

= 1,307,000 SF ≈ 30 ACRES

$$Vol = 1{,}307{,}000_{SF} \times \frac{1}{12} \frac{ft}{yr}$$

= 108917 CF/YEAR

= 814 697 gal/YR

= 2232 gal/day

= 1.55 gpm.

12) SUMMARY

AREA	GAL PER YEAR	GAL PER DAY	GPM
NORTH BURIAL	308,488	845	0.58
REASOR-HILL EQUALIZATION BASIN	116,314	319	0.22
SOUTHERN	814,697	2232	1.55
TOTAL	1,239,499	3396	2.35
DESIGN CAPACITY	1.3 million gal/YR	3600 gal/day	2.5 gpm

NOTE: SEE GEOFLOW OUTPUT/CALC FOR MORE DETAILED ESTIMATES OF GROUND WATER

0015390

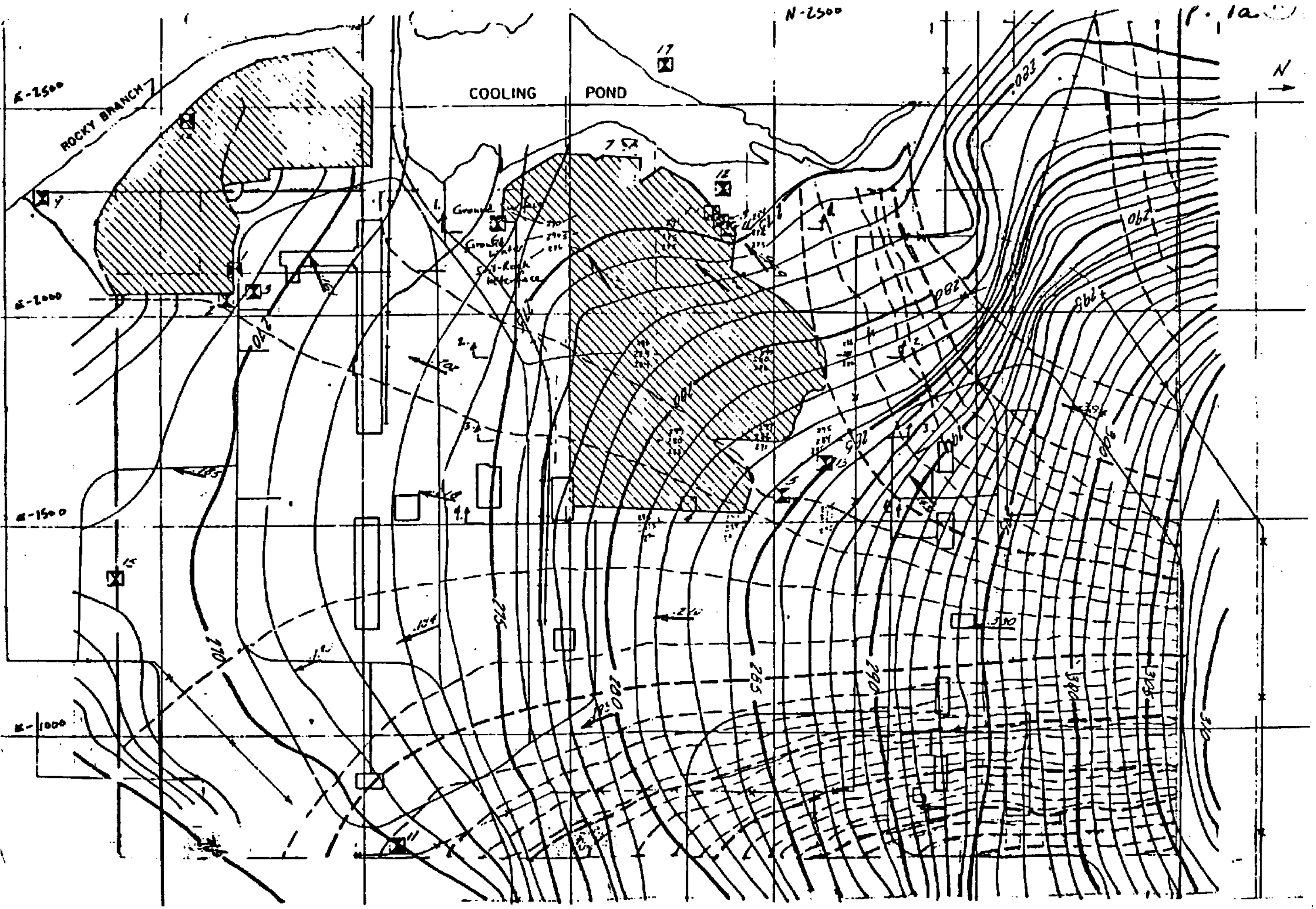
Purpose: At present water is seeping through the soil to the north of the plant, into the cooling pond. The pond is to be capped and so water subsequently will need to be diverted away. One alternative is with a French drain near the existing pond while the other is a slurry wall around the northern and eastern extents of the burial area.

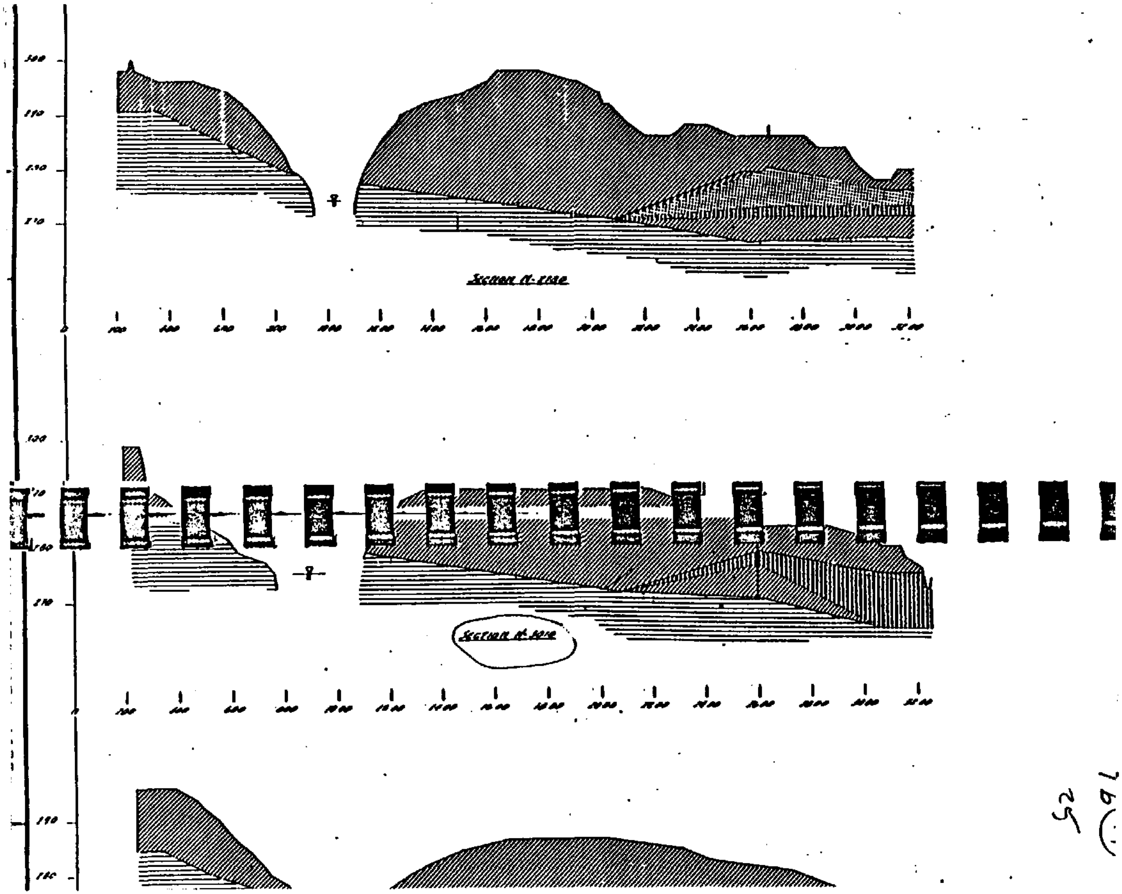
0015140

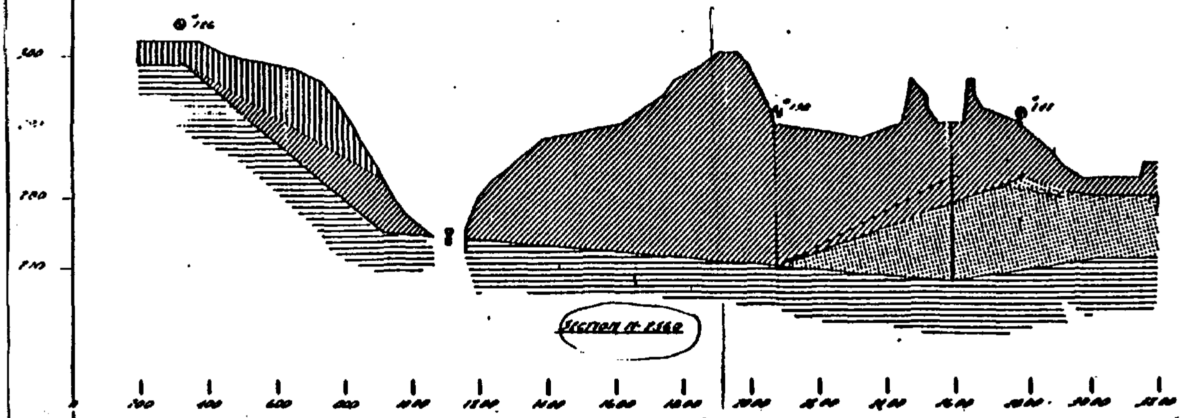
Three sections will be viewed to determine a rough value for the flow quantities.

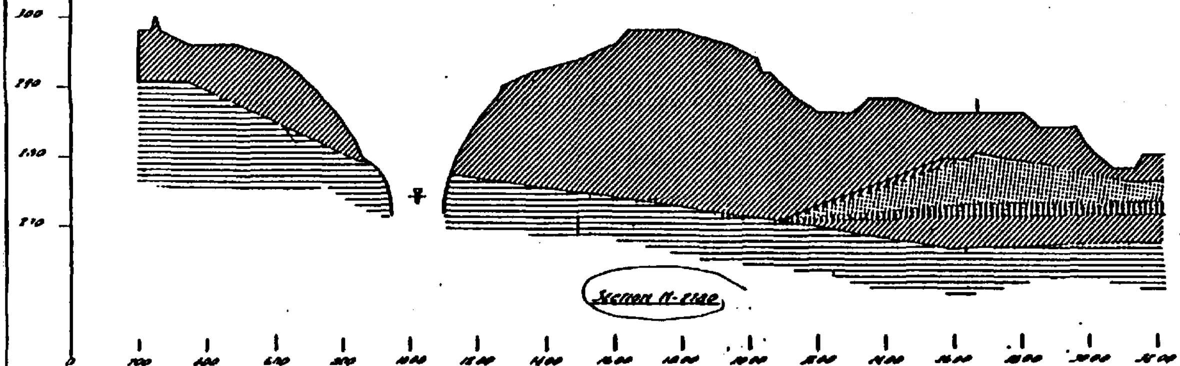
Alternatives: 1. A French drain placed along the edge of the pond. This would increase the gradient and so induce a greater flow.

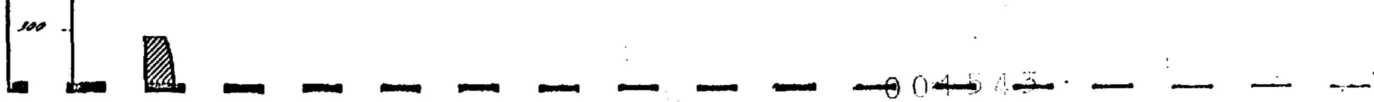
2. A slurry wall around the old Hercules-T drum landfill on the north and east sides would effectively cut-off the flow but the French drain would still be included.

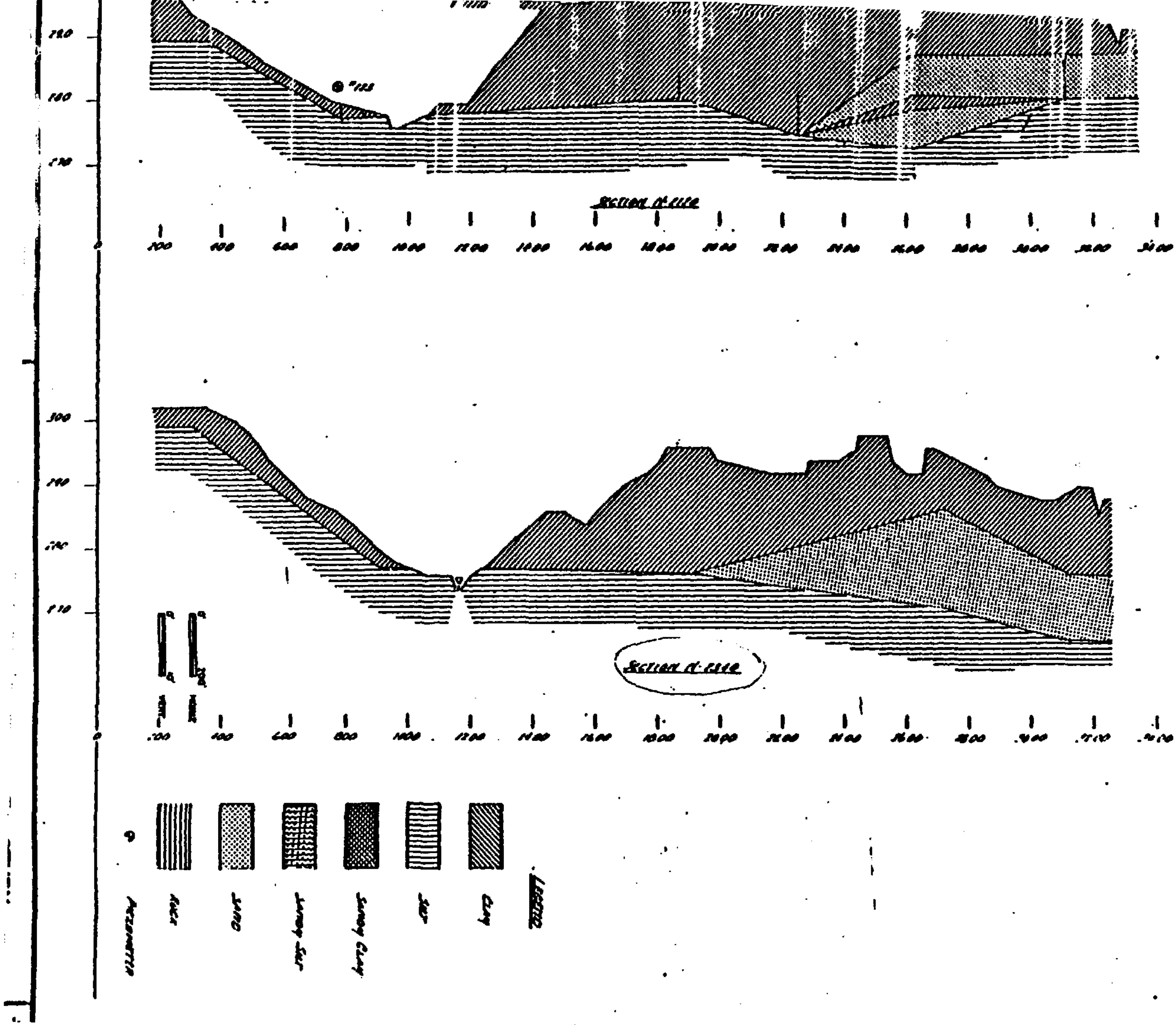

N-2500
COOLING
POND
N
E-2500
ROCKY BRANCH
E-2000
E-1500
E-1000
Ground Surface
Ground Water
Sap-Rock Interface
275
270
280
285
290
295
300
305
310
315











001544

P1

Cross-Section 1. Across E-2200 at N-2560, N-2780, N-3010

Using DISC's drawings "Ground Water Gradients and Streamline Developed by Computer model" (Drawing # A-1) and Cross-sections in their Environmental Assessment Study report to Vertac (Oct, 1982) in Appendix I-C.

$k = 10^{-4}$ cm/s is used because of the uncertainty with the drum landfill material.

$Q = k\,i\,A$

$k = 10^{-4}$ cm/sec $= 10^{-4}$ cm/sec $\times \frac{1 in}{2.54 cm} \times \frac{1 ft}{12 in} \times \frac{86400 s}{day} = 0.28$ ft

$i = 2'/80' = 0.025$ (near E 2200 & N-2560.) local gradient

$A = h \times w = (275-273) \times 1000' = 2000$ ft² (height of water above rock, @ 2560; 1000' = length of pond.)

- <u>Using a local gradient</u>

$Q = 0.28$ ft/day $\times 0.025 \times 2000$ ft² $= 14$ ft³/day. $\Rightarrow$ ~105 gal/day. for local gradient

- <u>Using an areal gradient prior to construction.</u>

$i = \frac{285-274}{1000} = 0.011$

$\therefore Q = 0.28$ ft/day $\times 0.011 \times 2000$ ft² $= 6$ ft³/day $\Rightarrow$ ~ 45 gal/day

- <u>Using an areal gradient with a French drain.</u>

The French drain will be down at elevation 265' $\therefore i = 20/1000 = 0.02$

$\therefore Q = 0.28$ ft/day $\times 0.02 \times 2000$ ft² $= 11$ ft³/day $\Rightarrow$ ~ 85 gal/day

Cross-Section 2 Across E-1900 at N-2340
N-2560
N-2780

use $k = 10^{-4}$ cm/s ⇒ 0.28 ft/day

l = 1000 ft (length of pond.)

- Using a local gradient. at N-2560

$i = \frac{2'}{170'} = 0.012$

A = 8' (height of flow @N-2560) x 1000' = 8000 ft²

⇒ Q = 0.28 ft/day x 0.012 x 8000 ft² = 27 ft³/day.

- Using an areal gradient prior to construction

$i = \frac{287-274}{1180} = 0.012$

Q = 0.28 ft/day x 0.012 x 8000 ft² = 27 ft³/day

- Using an areal gradient with a French drain

Q = 0.28 ft/day x $\frac{287-265}{1120}$ x 8000 ft² = 44 ft³/day ⇒ 220 gal/day

Cross-Section 3. Across E-1700 @ N-2340
2560
2780

- Using a local gradient @ N-2340

$i = \frac{2}{120} = 0.017$

$A = (282' - 271') @ 2560 \times 1000' = 11{,}000\ ft^2$

$Q = 0.28\ ft/day \times 0.017 \times 11{,}000\ ft^2 = 52\ ft^3/day$

- Using an areal gradient prior to construction

$i = \frac{287-274}{900} = 0.014$

$Q = 0.28\ ft/day \times 0.014 \times 11{,}000 = 43\ ft^3/day$

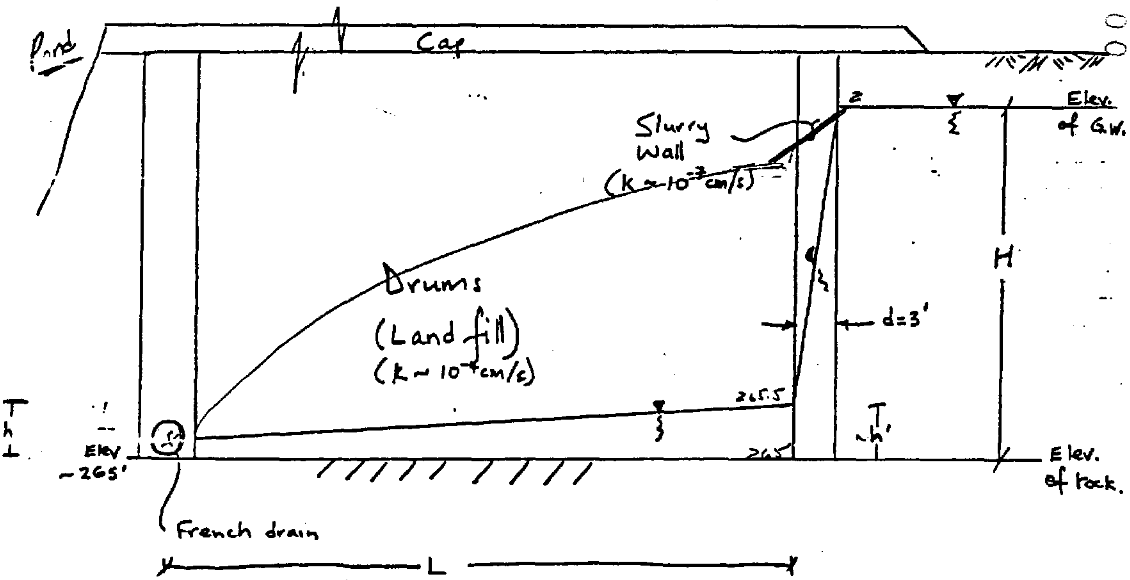
- Using an areal gradient with a French drain

$Q = 0.28\ ft/day \times \frac{287-265}{900} \times 11{,}000 = 75\ ft^3/day \Rightarrow 562\ gal/day$

0015477

Flow quantities with the slurry wall in place will be determined thru the slurry wall and thru the land fill to the drain.

Generalized figure



H = Elev of G.W. − Elev. of rock

h' = thickness of water as it exits the slurry wall.

h = Elev. of rock + h' − Elev. of French drain (~265') (275, +.5, −265)

$\therefore$ i (Slurry wall) = $\frac{H-h'}{d}$

i (Land fill) = $\frac{h}{L}$

Flow quantites at Cross-Section 1.

$H = 2'$ @ $N \approx 2560$

$h' = 6''$ (assumption)

$k_{s.w} = 10^{-7}\,cm/s \times \frac{1\,in}{2.54\,cm} \times \frac{1\,ft}{12\,in} \times \frac{86400\,s}{day} = 2.8\times10^{-4}\,ft/day$

Slurry wall, $i = \frac{275-273-0.5}{3} = 0.5$, $A = 2' \times 1'/l.f = 2\,ft^2/l.f$

Landfill, $i = \frac{273+0.5-265}{300'\,(\text{to drain})} = 0.028$, $A = 0.5' \times 1'/l.f = 0.5\,ft^2/l.f$

Slurry wall, $Q = 2.8\times10^{-4}\,ft/day \times 0.5 \times 2\,ft^2/l.f = \underline{3\times10^{-4}}\,ft^3/l.f/day$

Landfill, $Q = 0.28\,ft/day \times 0.028 \times 0.5\,ft^2/l.f = \underline{4\times10^{-3}}\,ft^3/l.f/day$

0015439

Flow quantities at Cross-Section 2.

$H = 280 - 272 = 8'$ @ N-2560

$h' = 1'$ (assumption) $h = 272 + 1 - 265 = 8'$

Slurry wall, $i = \frac{8-1}{3} = 2.3$ $A = 8\ ft^2/l.f$

Landfill, $i = 8/600 = 0.013$ $A = 1\ ft^2/l.f$

Slurry wall, $Q = 2.8 \times 10^{-4}\ ft/day \times 2.3 \times 8\ ft^2/l.f = 5. \times 10^{-3}\ ft^3/lf/day$

Landfill, $Q = 0.28\ ft/day \times 0.013 \times 1\ ft^2/l.f = 4 \times 10^{-3}\ ft^3/lf/day$

001550

Flow quantities at Cross-Section 3.

$H = 282 - 271 = 11'$ @ N-2560

$h' = 1'$ (assumption)

$h = 271 + 1 - 265 = 7'$

Slurry wall, $i = \frac{11-1}{3} = 3.3$ $A = H \times 1'/l.f = 11\ ft^2/l.f.$

Landfill, $i = 7/800' = 0.009$ $A = h' \times 1'/l.f = 1\ ft^2/l.f$

Slurry wall, $Q = 2.8\times10^{-4}\ ft/day \times 3.3 \times 11\ ft^2/l.f = 1\times10^{-2}\ ft^3/l.f/day$

Landfill, $Q = 0.28\ ft/day \times 0.009 \times 1\ ft^2/l.f. = 3\times10^{-3}\ ft^3/l.f./day$

001551

Flow quantities at Cross-section 4.

$H = 284 - 271 = 13'$ @ N2560

$h' = 1'$ (assumption)

$h = 271 + 1 - 265 = 7'$

Slurry wall

$i = \frac{13-1}{3} = 4$, $A = H \times 1'/l.f = 13\ ft^2/l.f$

$Q = 2.8 \times 10^{-4}\ ft/day \times 4 \times 13\ ft^2/l.f = \underline{2 \times 10^{-2}}\ ft^3/l.f/day$

.02 ft^3

Landfill

$i = 7/950' = 0.007$, $A = h' \times 1'/l.f = 1\ ft^2/l.f$

$Q = 0.28\ ft/day \times 0.007 \times 1\ ft^2/l.f = \underline{2 \times 10^{-3}}\ ft^3/l.f/day$

.002

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WASTE MANAGEMENT SERVICES

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By WTC Date 5/6/84 Subject K-Permeability Sheet No. 1 of 3
Chkd. By JM Date 5/17/84 VERTAC CHEMICAL JACKSONVILLE AK Proj. No. 846012

Table IV.2.1

MATERIAL TYPE	COEFFICIENT OF PERMEABLITY (cm/sec)
Silty Clay	5.85×10^{-6}
Clayey Silt	1.18×10^{-5}
Sandy Clay	1.16×10^{-5}
Sandy Silt	2.18×10^{-5}
Silty Sand	2.00×10^{-5}
Weathered Rock	4.00×10^{-6}
Unweathered Rock	1.71×10^{-7}

0015153

Table IV.2.2

MATERIAL TYPE	COEFFICIENT OF PERMEABILITY (cm/sec) HORIZONTAL	VERTICAL
Silty Clay	4.5×10^{-6}	6.1×10^{-8}
Sandy Silt	1.2×10^{-5}	2.3×10^{-6}
Shale	2.0×10^{-7}	6.4×10^{-9}

REFERENCE: "FINAL REPORT for ENVIRONMENTAL ASSESSMENT STUDY VERTAC CHEMICAL CORP. SITE, JACKSONVILLE, AK" By DEVELOPERS INTERNATIONAL SERVICES CORP. REPORT SERIAL NO B-041 Oct 1982

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WASTE MANAGEMENT SERVICES

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By WTC Date 5/6/84 Subject K- Permeability Sheet No. 2 of 3
Chkd. By SM Date 5/17/84 VERTAC CHEMICAL JACKSONVILLE AK Proj. No. 846012

Table 5
HYDRAULIC CONDUCTIVITIES (KS)[1]

Well Number	Interval (Ft. BGL)	Horizon Type (USC)	K (cm/sec)	Comments
Source:	a			
12	0.0-5.0	CL	1.15E-5	Horizontal K Value
	8.5-9.7	CL	5.51E-7	Horizontal K Value
	12.0-12.9	Shale	3.56E-6	Horizontal K Value
13	0.0-5.0	CL	2.80E-6	Horizontal K Value
	22.4-25.0	Shale	4.33E-6	Horizontal K Value
14	0.0-5.0	CL	8.72E-6	Horizontal K Value
15	0.0-5.0	CL	4.93E-6	Horizontal K Value
16	0.0-5.0	CL	2.00E-6	Horizontal K Value
	13.6-14.2	W.[2] SS[3] to	6.69E-6	Horizontal K Value
	19.5-23.3	W. SH[4] Shale	1.71E-7	Horizontal K Value
17	0.0-3.6	CL, W.Shale	1.66E-6	Horizontal K Value
	6.1-6.4	W.SH&W.SS	2.46E-6	Horizontal K Value
	7.0-	W.SH&W.SS	1.75E-6	Horizontal K Value
19	0.0-5.0	CL	1.55E-6	Horizontal K Value
	7.3-10.3	CL	5.05E-6	Horizontal K Value
	17.3-19.3	Shale	2.00E-6	Horizontal K Value
20	26.0-32.5	Sandstone	2.79E-5	Horizontal K Value
	26.0-102.8	SS&Shale	4.52E-6	Horizontal K Value
	26.0-102.8	SS&Shale	4.88E-6	Horizontal K Value
	75.0-102.8	Shale	3.25E-8	Horizontal K Value
20	3.0-4.0	CL	1.80E-6	Vertical K Value (lab)
	3.0-4.0	CL	2.20E-7	Vertical K Value (with leachate)
	37.9-42.5	Sandstone	6.70E-9	Vertical K Value (lab)
	37.9-42.5	Sandstone	9.30E-9	Vertical K Value (with leachate)
	80.3-81.1	Shale	6.60E-7	Vertical K Value (lab)
	80.3-81.1	Shale	2.40E-7	Vertical K Value (with leachate)
Source:	b			
EPA-2	1.0-2.5	ML	4.50E-9	Vertical K Value (lab)
	[illegible]	[illegible]	[illegible]	[illegible]

REFERENCE: "DRAFT" ONSITE FEASIBILITY STUDY APPENDICES" by CH2M HILL (CONTRACT 68-01-6692)

Table 5 (Continued)

Well Number	Interval (Ft. BGL)	Horizon Type (USC)	K (cm/sec)	Comments
EPA-3	3.0-4.1	ML/CL	3.80E-7	Vertical K Value (lab)
	6.5-7.0	ML	7.90E-8	Vertical K Value (lab)
	42.0-43.0	Sandstone	4.90E-8	Vertical K Value (lab)
	59.0-59.7	Sandstone	7.90E-9	Vertical K Value (lab)
	82.7-83.5	Sandstone	4.70E-10	Vertical K Value (lab)
EPA-4	0.5-2.0	CL	6.60E-9	Vertical K Value (lab)
EPA-5	3.0-4.6	ML/CL	8.70E-8	Vertical K Value (lab)
	6.0-7.3	ML	3.20E-8	Vertical K Value (lab)
	24.5-25.5	Shale	7.30E-9	Vertical K Value (lab)
	53.0-54.0	Shale	2.30E-6	Vertical K Value (lab)
	76.0-76.7	Shale	7.80E-6	Vertical K Value (lab)
EPA-6	1.5-3.0	ML/CL	5.50E-8	Vertical K Value (lab)
	4.5-5.0	CL	3.20E-9	Vertical K Value (lab)
EPA-7	3.0-4.5	CL/CH	5.30E-9	Vertical K Value (lab)
	6.0-6.3	CL	1.40E-7	Vertical K Value (lab)
EPA-8	0.5-2.0	CL	8.00E-9	Vertical K Value (lab)
	3.0-3.7	ML	9.60E-8	Vertical K Value (lab)
Source c:				
TP-7	0.5-1.0	CL	1.80E-6	Vertical K Value (lab)
TP-9	0.5-1.5	CL	1.10E-5	Vertical K Value (lab)
B-1	1.5-2.0	CL	3.50E-7	Vertical K Value (lab)
	7.0-7.5	W. Shale	4.40E-8	Vertical K Value (lab)
	>25.5	Sandstone	4.30E-4	Insitu?

DRAFT

[1] Hydraulic conductivities (K) have been estimated for various soil and bedrock horizons at the monitoring wells and piezometers installed by DISC and by previous consultants for both Vertac and EPA. The tests were primarily of the falling-head and constant-head type in which the rate of water flow into the horizon being tested is measured. These type tests yield order of magnitude results. Fortunately there have been many tests run which increase the confidence in the results.

[2] W. refers to weathered

[3] SS refers to sandstone

[4] SH refers to shale

001555

By WTC Date 4/27/84 Subject SUBSURFACE DRAINAGE Sheet No. 1 of 17
Chkd. By RGM Date 5/1/84 VERTAC CHEMICAL PLANT, JACKSONVILLE AK Proj. No. 846012

SUBSURFACE DRAINAGE

PURPOSE : TO DETERMINE THE PERFORMANCE OF GEOTEXTILE IN FRENCH DRAIN (SUBSURFACE DRAIN) AND LEACHATE COLLECTION SYSTEM

METHOLOGY : (1) FILTER DESIGN CRITERION TO PREVENT PIPING AND SEEPAGE BUILDUP (REF 1, 2)

(2) PORE VELOCITY (REF 1)

(3) DRAINAGE ELLIPSE. (REF 3)

REFERENCES

(1) HARRY R. CEDERGREN "SEEPAGE, DRAINAGE AND FLOW NETS" JOHN WILEY AND SONS, INC, 1968.

(2) J. Steward, R. Williamson & J Mohney "GUIDELINES FOR USE OF FABRICS IN CONSTRUCTION AND MAINTENANCE OF LOW-VOLUME ROADS" REPORT NO. FHWA-TS-78-205 by USDA FOREST SERVICE, JUNE 1977

(3) JAN VAN SCHILFGAARDE. "DRAINAGE FOR AGRICULTURE" NO. 17 AGRONOMY, AMERICAN SOCIETY OF AGRONOMY 1974. CHAPTER 10.

(4) DU PONT "TYPAR"

(5) "FIBRETEX." CROWN ZELLERBACK CORPORATION.

(6) "SUPAC" Technical Bulletin SD-1 PHILLIPS PETROLEUM COMPANY

(7) CH_2M-HILL REPORT

0015556

1) FILTER DESIGN CRITERION.

a) TO PREVENT PIPING, THE 15% SIZE (D_{15}) OF A FILTER MATERIAL / GEOTEXTILE OPENING MUST BE NOT MORE THAN FOUR TO FIVE TIMES THE 85% SIZE (D_{85}) OF A PROTECTED SOIL (Ref. 1 P. 175)

$$\text{PIPING RATIO} = \frac{D_{15\,(FILTER)}}{D_{85\,(SOIL)}} < 4 \text{ to } 5$$

EXAMPLE. "TYPAR" DU PONT MODEL 3421 HAS A OPEN. SIZE @ 15% (D_{15}) = 0.11 mm. THEN.

$$D_{85\,(SOIL)} > \frac{D_{15\,(FILTER)}}{4} = \frac{0.11}{4} = 0.0275 \text{ mm}$$

[SILT SIZE ≃ 0.074 mm or less] OK.

b) TO PREVENT SEEPAGE BUILDUP, THE 15% SIZE (D_{15}) OF A FILTER MATERIAL SHOULD BE AT LEAST FOUR OR FIVE TIMES THE 15% SIZE (D_{15}) OF PROTECTED SOIL

$$\frac{D_{15}\,(FILTER)}{D_{15}\,(SOIL)} > 4 \text{ to } 5$$

EXAMPLE $D_{15\,(SOIL)} < \frac{D_{15\,(FILTER)}}{5} = \frac{0.11}{5} = 0.022 \text{ mm}.$

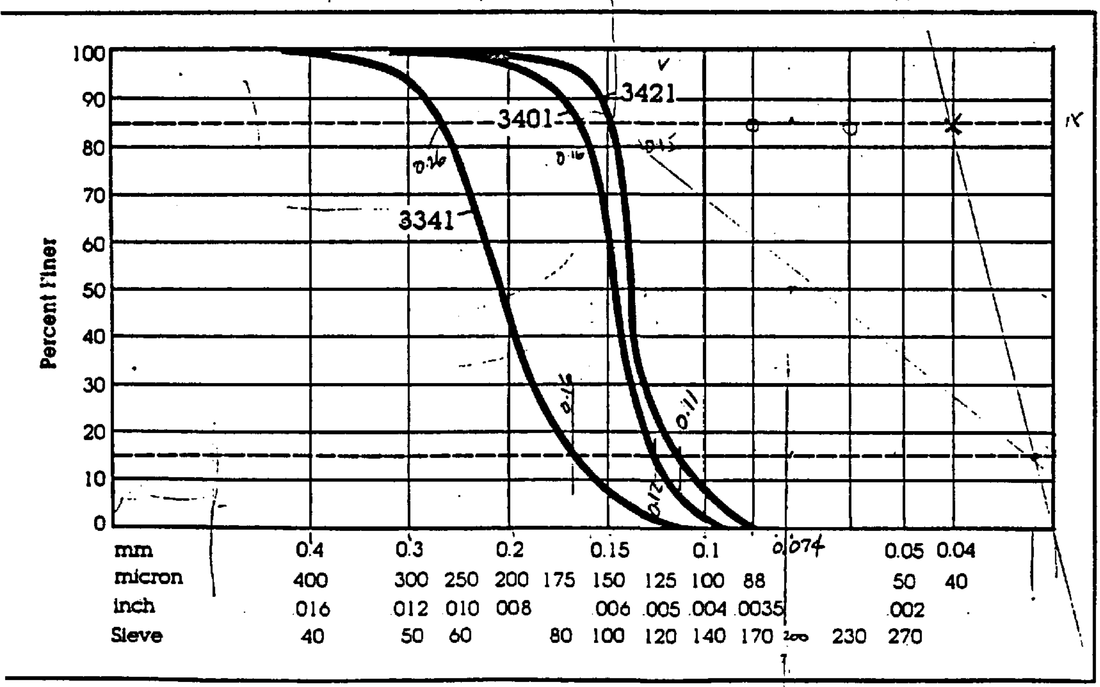
0015577

c) Du Pont Suggested Design criterion for Geotextile is

$$\frac{P_{85}\ (85\%\ \text{pore size of filter fabric})}{D_{85}\ (85\%\ \text{size of subgrade soil})} \leq 1$$

Review the above criterion, most of geotextile would be satisfied the site soil characteristics. However, soil sample should be tested for grain size analysis

Figure 6 (REF 4 P.5)
Typical Pore Size Distribution of Several Styles of TYPAR



Ref. 1) — H.R. Cedergren. "Seepage: Drainage. & Flow Nets." 2nd Ed.. John Wiley & Sons. 1977

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WASTE MANAGEMENT SERVICES

By WTC Date 4/27/84 Subject SUBSURFACE DRAINAGE Sheet No. 8 of 17
Chkd. By RGM Date 5/1/84 VERTAC CHEMICAL PLANT, JACKSONVILLE AK Proj. No. 846012

2) PORE VELOCITY

PORE VELOCITY OR SEEPAGE VELOCITY IS DEFINED AS

(REF 1 P.27)

" THE AVERAGE SEEPAGE VELOCITY, V_s, OF A MASS OF WATER PROGRESSING THROUGH THE PORE SPACES OF A SOIL IS EQUAL TO THE DISCHARGE VELOCITY ($V_d = ki$) MULTIPLIED BY $\frac{1+e}{e}$ OR THE DISCHARGE VELOCITY DIVIDED BY THE EFFECTIVE POROSITY n_e. "

$$V_s = (V_d)\left(\frac{1+e}{e}\right)$$

$$= (ki)\left(\frac{1+e}{e}\right)$$

$$= \frac{ki}{n_e}$$

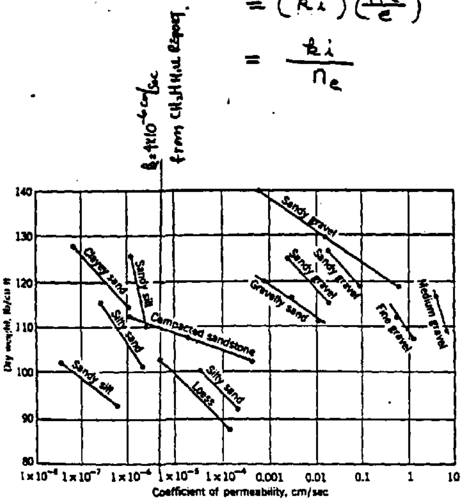


FIG. 2.7 Relation between coefficient of permeability and soil type and density (log scale) (REF 1 P 33)

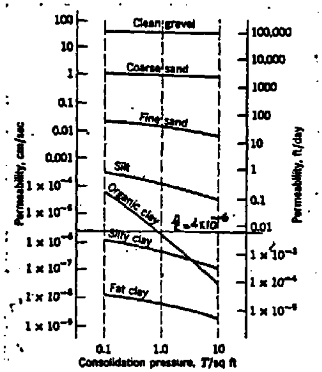


FIG. 2.11 Permeability versus consolidation pressure. REF 1 P.41

OBTAIN COEF. OF PERMEABILITY

$k = 4 \times 10^{-6}$ cm/sec.

FROM CH2M-HILL REPORT. (REF 7)

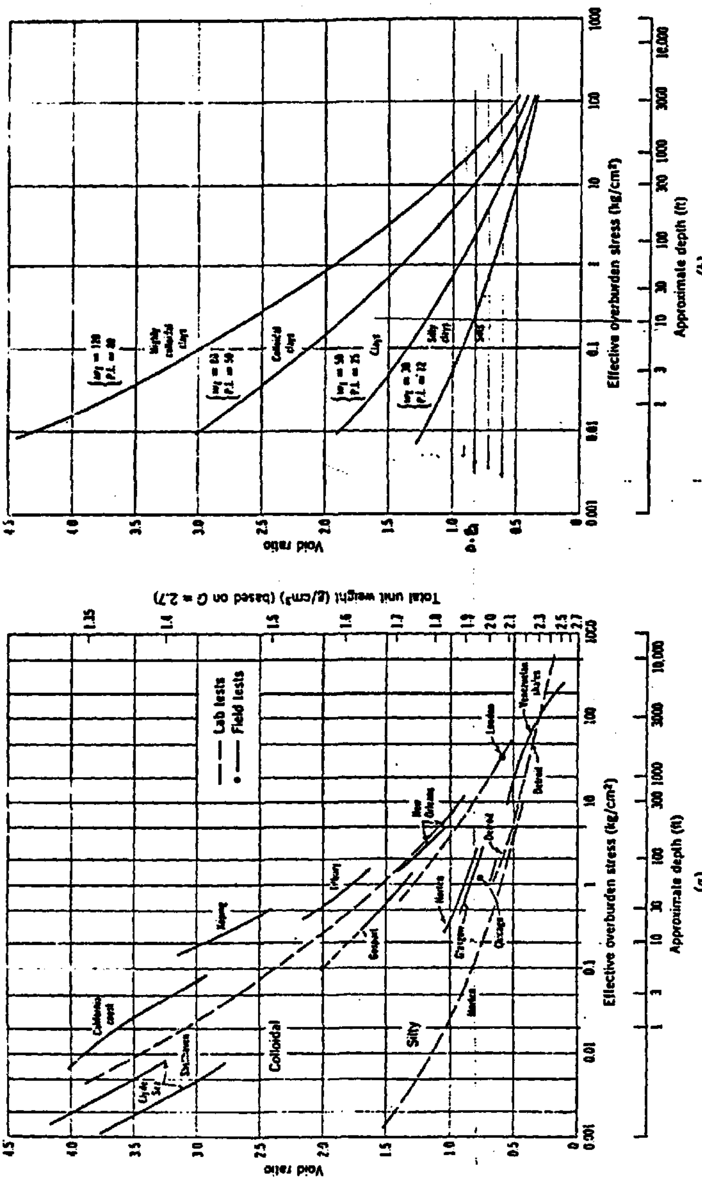


Fig. 13.1 Compression curves for several soils (From Lambe and Whitman, 1969).

$e = 0.8$

$n_e = \frac{e}{1+e} = 0.4444$

D'APPOLONIA
WASTE MANAGEMENT SERVICES

(98)

By WTC Date 4/27/84 Subject SUBSURFACE DRAINAGE Sheet No. 6 of 17

Chkd. By RGM Date 5/1/84 VERTAC CHEMICAL PLANT JACKSONVILLE AK Proj. No. 846012

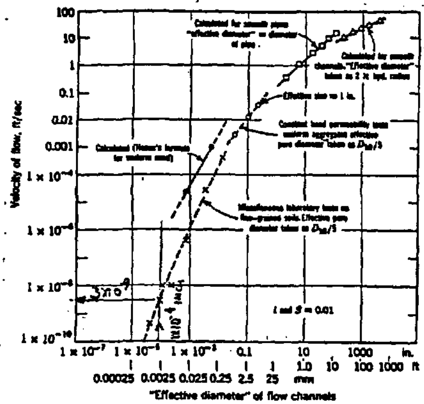


FIG. 2.2 Comparison of flow in porous media with flow in pipes and smooth channels (log-log plot).

Ref. 1 P.24

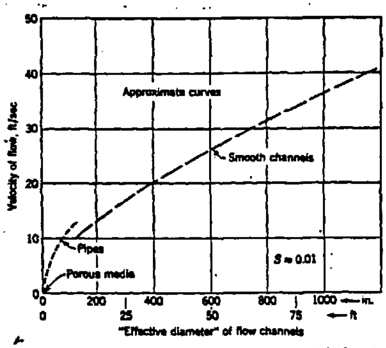


FIG. 2.3 Comparison of flow in porous media with flow in pipes and smooth channels (arithmetic plot). Ref. 1 P. 25

LAMINAR FLOW REGION

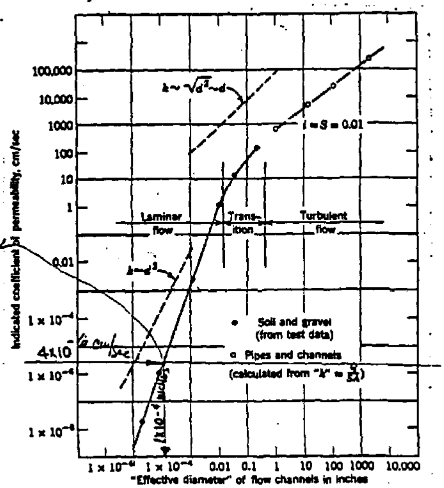


FIG. 2.5 Variations in "permeability" with size of flow channels.

Ref. 1 P. 31

By Darcy's law

$k = 4 \times 10^{-6}$ cm/sec

$= 4.14$ ft/year

$i = 1\%$ slope. PER DESIGN.

$n_e = \frac{e}{1+e} = \frac{0.8}{1.8} = 0.4444$

$V_s = \frac{ki}{n_e} = \frac{4.14 \times 0.01}{0.4444} = 0.09$ ft/yr $= 9.3 \times 10^{-2}$ ft/year

$= 1.8 \times 10^{-7}$ ft/min $= 3 \times 10^{-9}$ ft/sec

CHECK VELOCITY BY CHARTS

EFFECTIVE DIAMETER OF FLOW CHANNEL

FROM FIG 2.5 $d = 1 \times 10^{-4}$ in $= 0.0001$ INCH. (Ref 1 P.31)

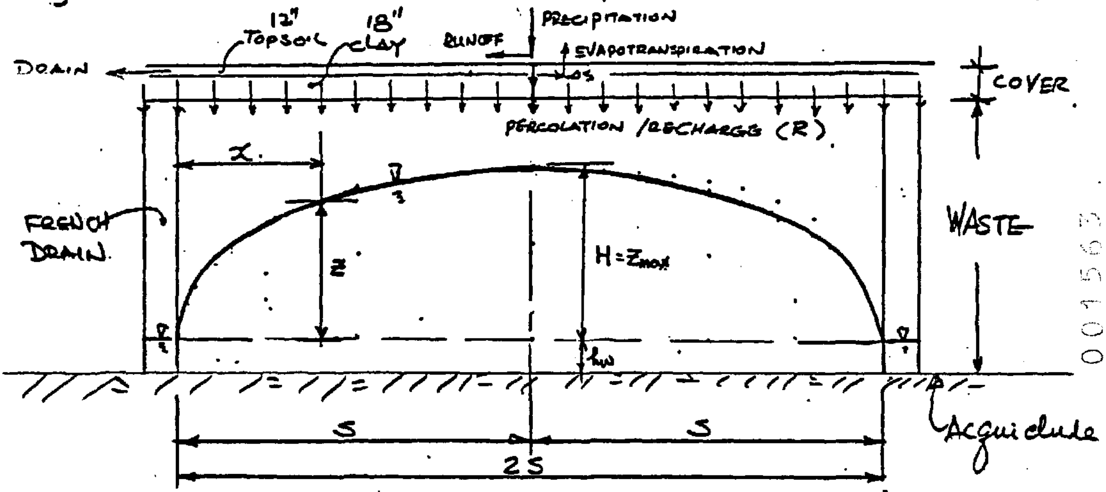
VELOCITY OF FLOW From Fig. 2.2 (Ref. 1, P.24)

$V = 3 \times 10^{-9}$ ft/sec OK.

PERMEABILITY $k = 4 \times 10^{-6}$ cm/sec,
FLOW VELOCITY $= 3 \times 10^{-9}$ ft/sec $= 9 \times 10^{-8}$ cm/sec

0041569

3) DETERMINE DRAINAGE ELLIPSE DUE TO UNIFORM RECHARGE



FROM REF 3.

THE RELATIONSHIP BETWEEN SEEPAGE ELLIPSE AND DRAINAGE DITCH with RESPECT TO RECHARGE RATE R, (PERCOLATION) & WASTE PERMEABILITY, K. (h_w = WATER DEPTH IN DITCH ABOVE Acquiclu.

$$(z + h_w)^2 - h_w^2 = \left(\frac{R}{K}\right)(2Sx - x^2)$$

if ASSUME $h_w \approx 0$ then

$$z^2 = \left(\frac{R}{K}\right)(2Sx - x^2) \qquad \text{EQ 1}$$

$z_{max} = H$ when $x = S$

$$z_{max} = S\sqrt{\frac{R}{K}} \qquad \text{EQ 2.}$$

FROM JM CALC. DATED 4/26/84 WATER BALANCE CALC

AND J.M CALC DATED 4/30/84 Cap Efficiency

CALC (for Cases 1+2)

ANNUAL PRECIPITATION = 49.2 INCHES

ANNUAL RUNOFF = 16.46 inches

ANNUAL EVAPOTRANSPIRATION = 78.21

ANNUAL ~~RECHARGE~~ = 1.0 ← INCH — recharge varies

(PERKOLATION) = 0.08 FT

PERMEABILITY OF WASTE ASSUME TO BE

$$K = 4 \times 10^{-6}\ cm/sec \quad (CH_2M\text{-}HILL\ REPORT)$$

$$= 50\ INCHES/YEAR$$

$$= 4.2\ FT/YEAR$$

$$\sqrt{\frac{R}{K}} = \sqrt{\frac{0.08}{4.2}} = 0.14$$

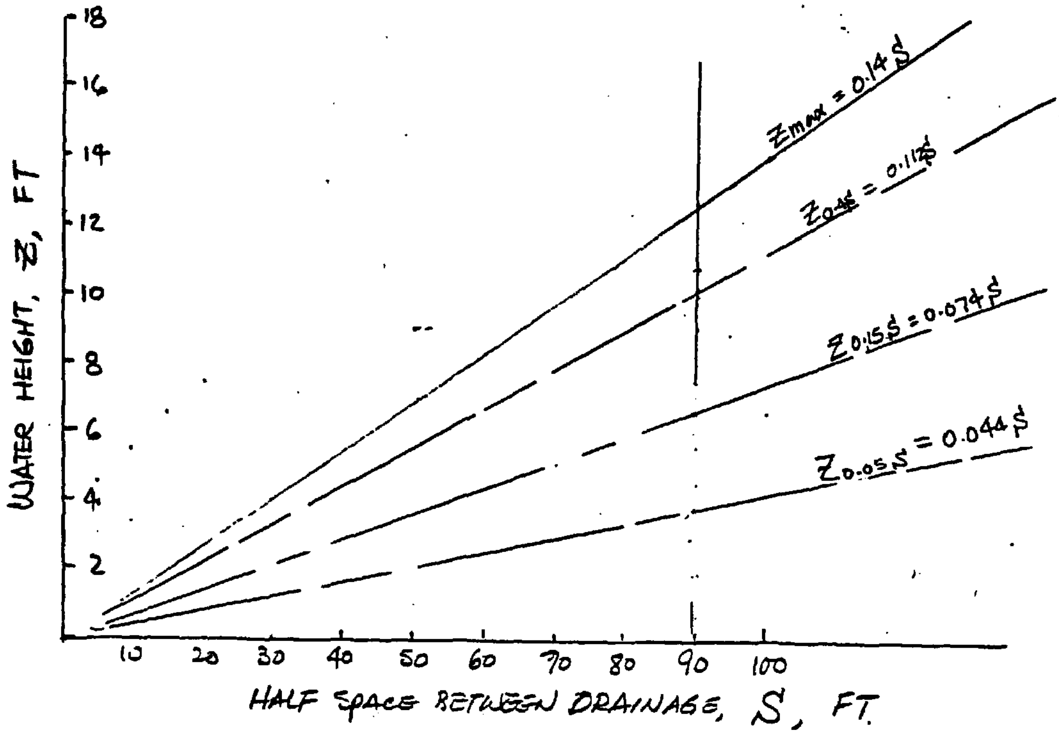
$$\boxed{Z_{max} = 0.14\ S}$$ FROM EQ. 2

$Z_{max} = .2S$ using 2 inches of recharge

FROM EQ 1

x	Z_x
0.05 S	0.3122 Z_{max}
0.10 S	0.4359 Z_{max}
0.15 S	0.5268 Z_{max}
0.4 S	0.800 Z_{max}

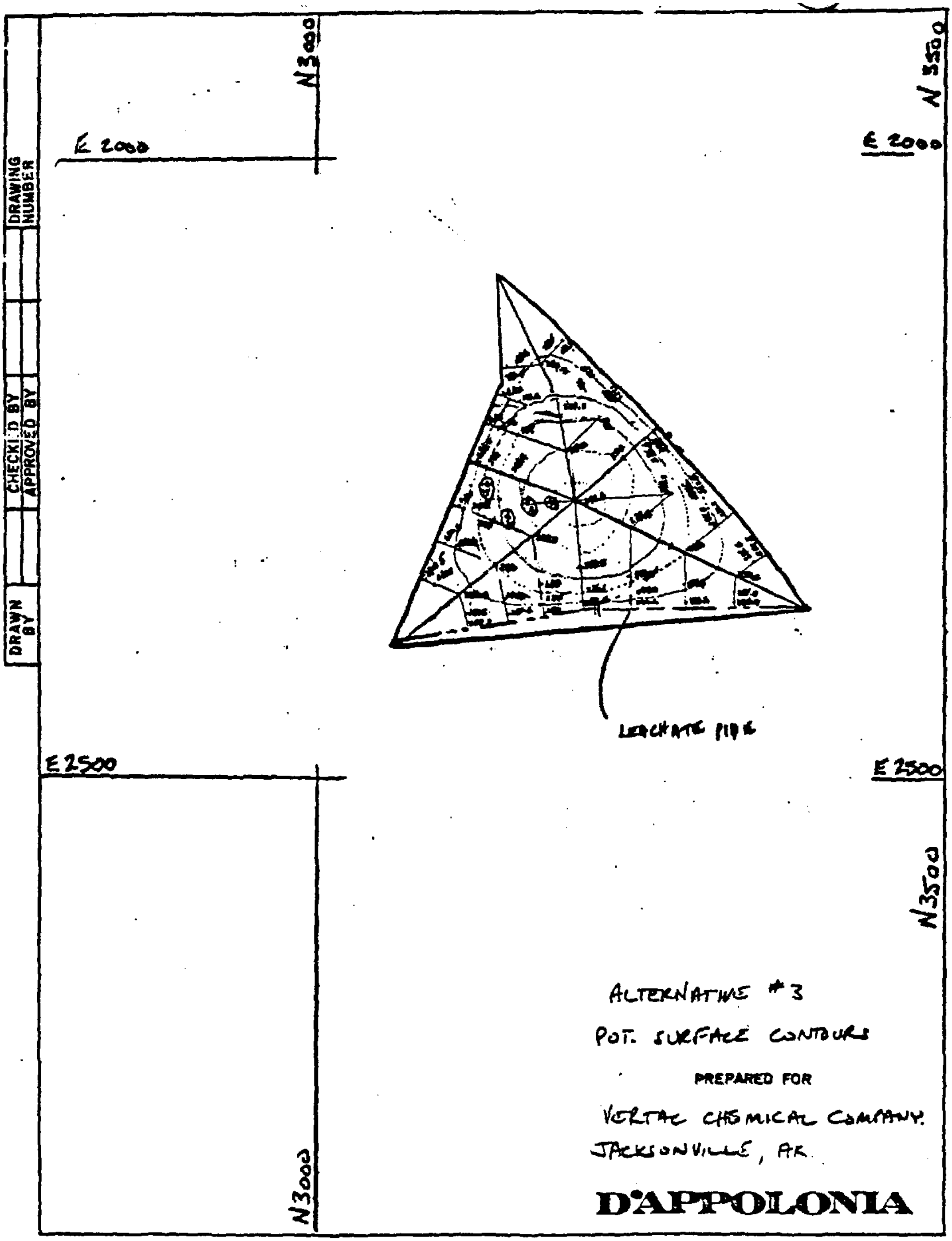
FROM LAYOUT MAX S ≈ 90' Z_{max} = 12.6 FT



0015[6]5

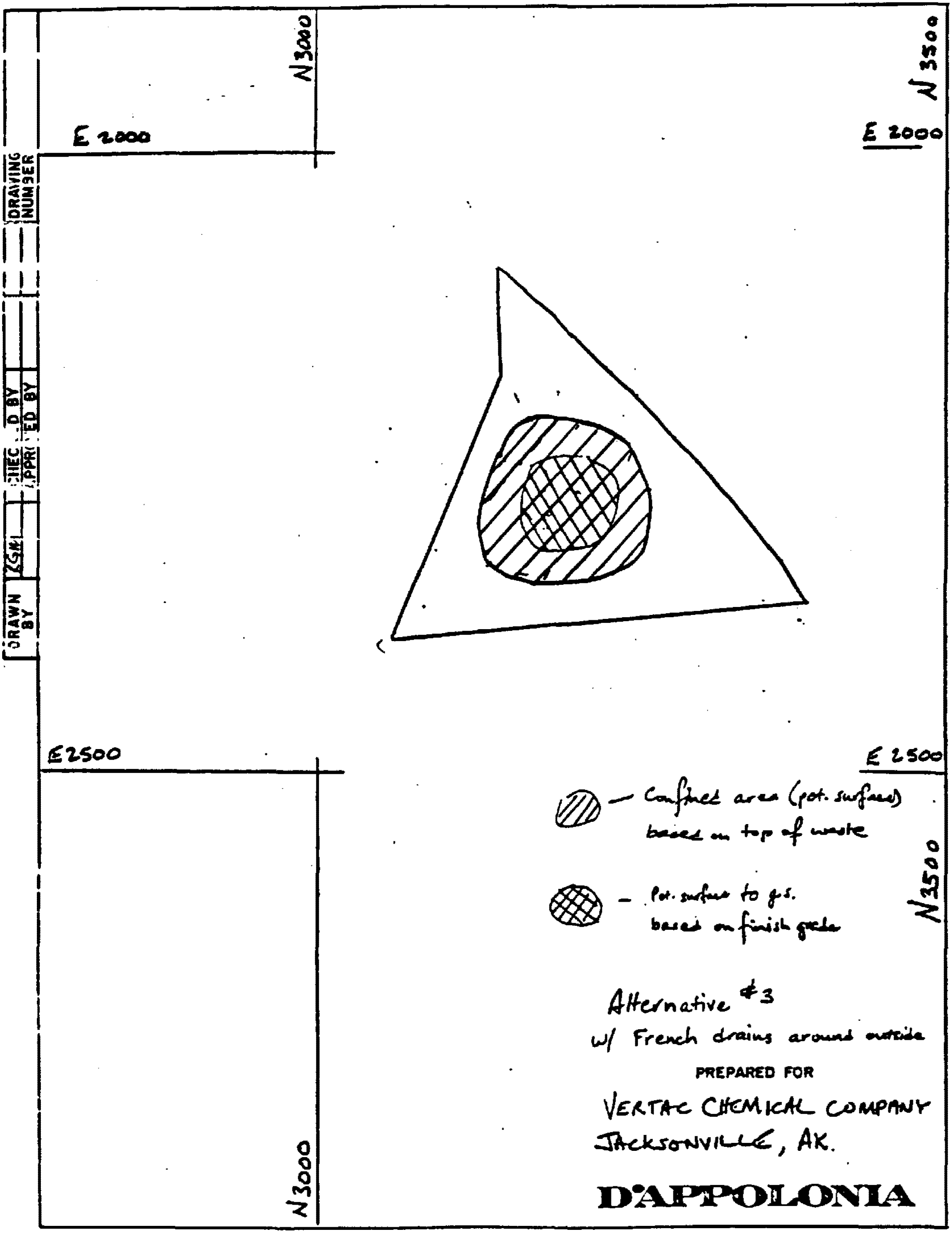
USING THE DRAINAGE ELLIPSE "Z" VALUES DONE BY WTC, PLOT THE POT. SURFACE CONTOURS WITHIN THE CONTAINMENT AREA. OVERLAYING THE CONTOURS OVER THE TOP OF WASTE ELEVATIONS, YIELDS THE AREA WHERE THERE EXISTS A CONFINED CONDITION. OVERLAYING THE CONTOURS OVER THE FINISH GRADE, YIELDS THE AREA OF SATURATED SOIL.

001566



001567

1283 HERCULENE. A&B SMITH CO., PGH., PA



19 1253 HERCULENE. A&B SMITH CO., PGH., PA

001568

ADDITIONAL DRAINAGE THROUGH THE CONTAINED AREA WILL BE REQUIRED TO PREVENT THE WATER RISING TO THE SURFACE BASED ON THE DRAINAGE ELLIPSE CALCS. ADDITIONAL DRAINAGE WILL REDUCE THE SPACING WHICH IN TURN WILL REDUCES THE [illegible] SURFACE IN THE AREA.

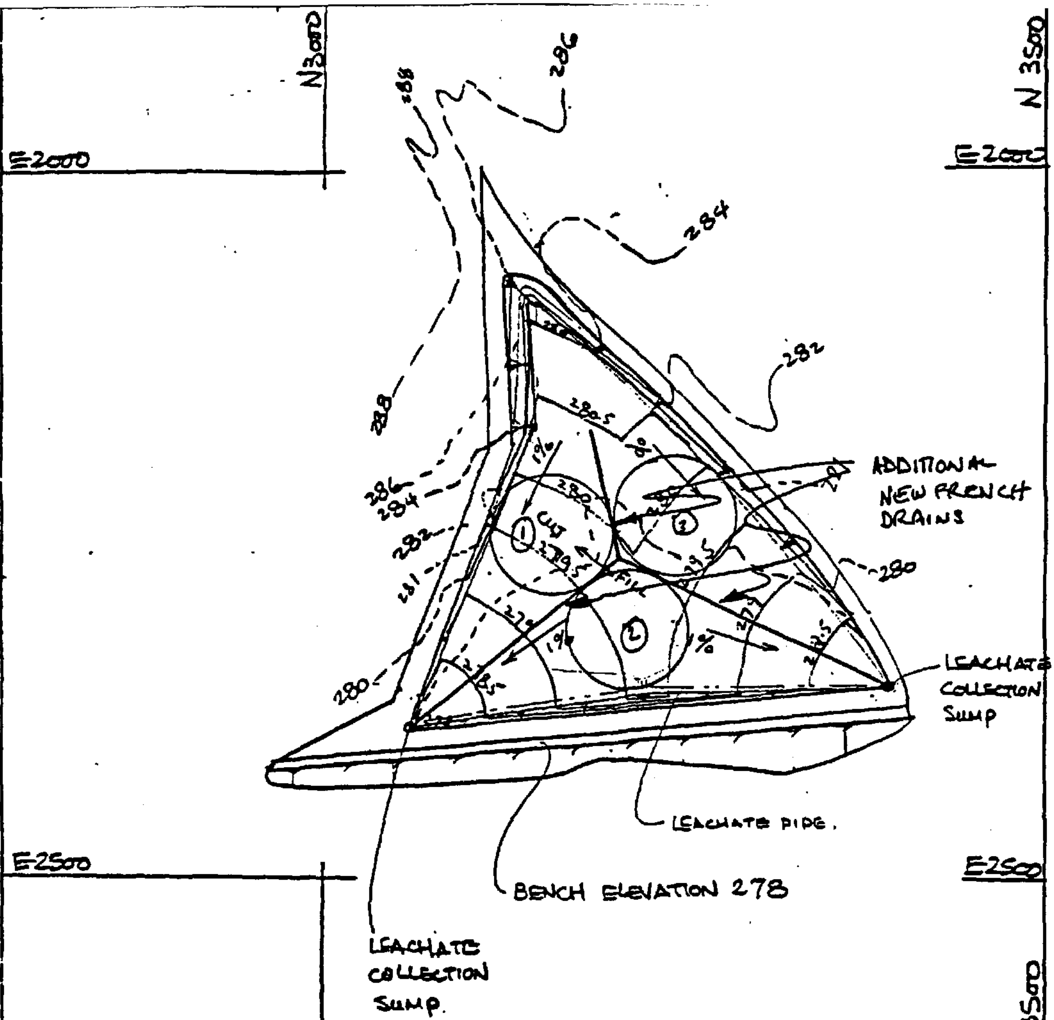
SEE NEXT PAGE FOR LOCATION OF NEW FRENCH DRAINS. (P.15)

NOW S (SPACING) IS REDUCED TO A MAXIMUM OF 50 FEET

2S IS DISTANCE BETWEEN DRAINS.

USING THE EQUATIONS ON PP. 8 & 9, DETERMINE THE NEW "Z" VALUES.

001560



NOTE ALL SLOPES 3H to 1V OR SPECIFIED AS MARKED

ALTERNATIVE #3
PLATFORM PLAN

SCALE 1"=100'
100' 50 0 100

N

N3000

PREPARED FOR
VERTAC CHEMICAL CORP PLANT
JACKSONVILLE AK.

D'APPOLONIA

001570

$Z_{max} = 0.14\ S = 0.14(50') = 7'$

∴ POT. SURFACE FOR THE CENTERS OF THE THREE AREAS SHOWN ON P. 15.

ARE : AREA 1 = 279.5' + 7' = 286.5'

AREA 2 = 279.5' + 7' = 286.5'

AREA 3 = 280' + 7' = 287'

COMPARE TOP OF WASTE ELEVATIONS WITH THE POT. SURFACE FOR THE RESPECTIVE AREAS

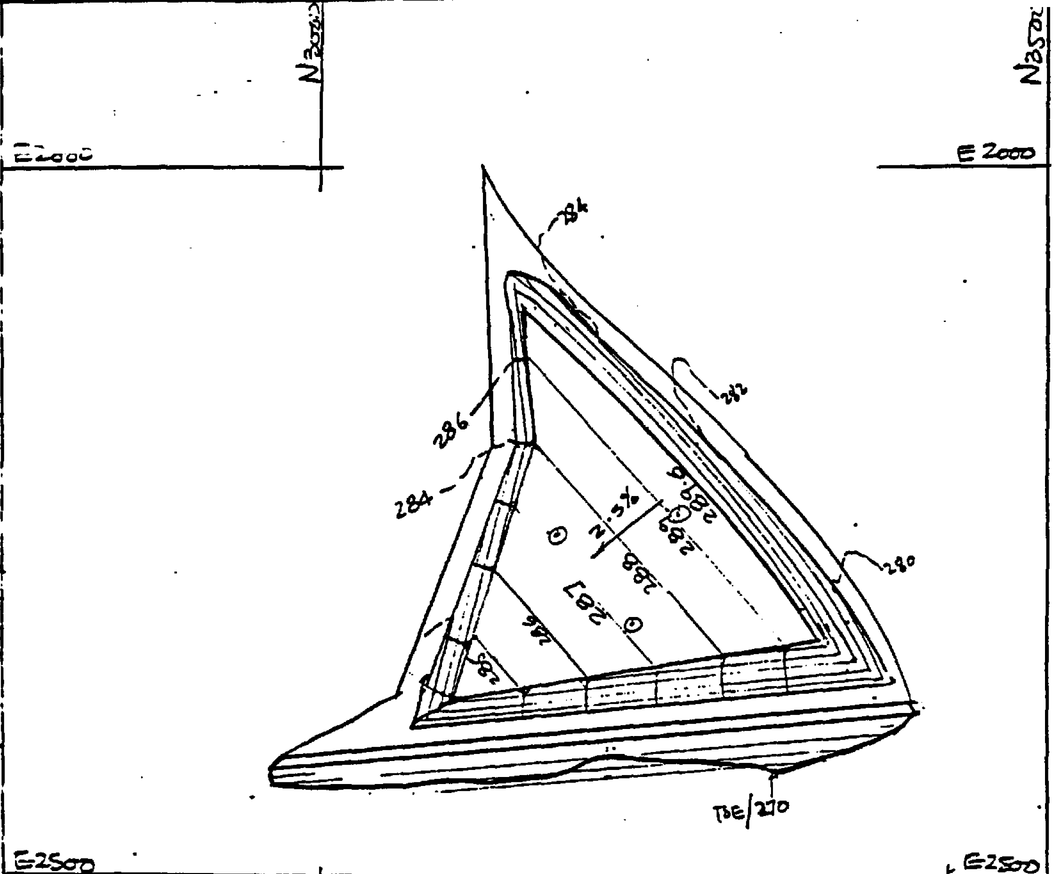
AREA 1 = 287'

AREA 2 = 287'

AREA 3 = 299'

⟹ THE POT. SURFACES ARE BENEATH THE TOP OF THE WASTE. AND SO SUFFICIENT DRAINAGE IS BEING PROVIDED

0015771



NOTE ALL SLOPES 3H to 1V OR SPECIFIED AS MARKED

ALTERNATIVE # 3 -
TOP / WASTE PLAN

SCALE 1" = 100'

100 50 0 100

N ←

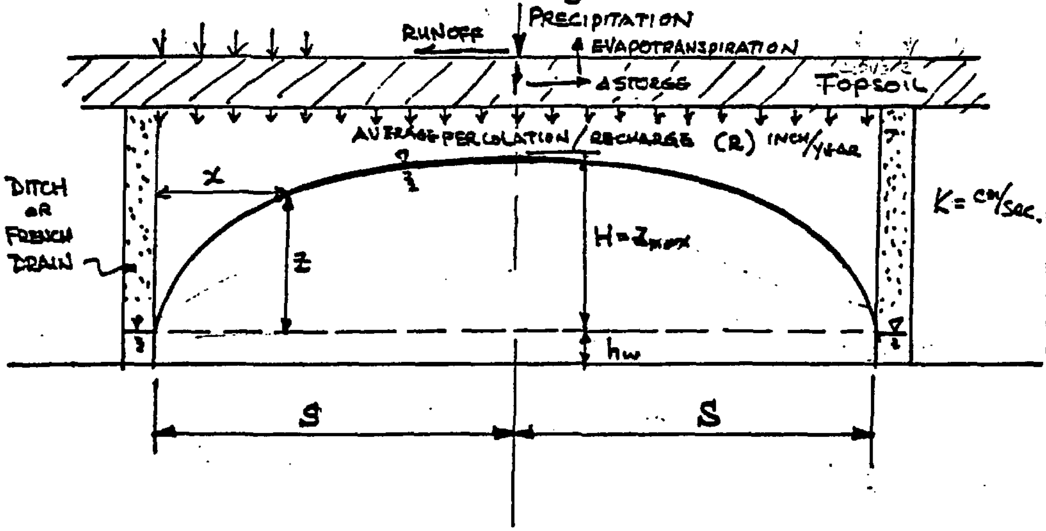
PREPARED FOR

VERTAC CHEMICAL CORP PLANT
JACKSONVILLE, AK,

D'APPOLONIA

By WTC Date 5/3/84 Subject ___ Sheet No. 1 of 4
Chkd. By JM Date 5/17/84 HP-41CV PROGRAM Proj. No. 846012

DRAIN SPACING EQUATION by DUPUIT - FORCHHEIMER



THE RELATIONSHIP BETWEEN SEEPAGE ELLIPSE AND DRAINAGE DITCH WITH RESPECT TO RECHARGE RATE, R (PERCOLATION) AND WASTE PERMEABILITY, K (h_w = WATER DEPTH IN DITCH ABOVE ACQUICLUDE.

$$(z + h_w)^2 - (h_w)^2 = \left(\frac{R}{K}\right)(2Sx - x^2)$$

$$z^2 + 2h_w z + h_w^2 - h_w^2 = \frac{R}{K}(2Sx - x^2)$$

$$z^2 + 2h_w z - \frac{R}{K}(2Sx - x^2) = 0$$

$$\boxed{z^2 + 2h_w z + \frac{R}{K}(x^2 - 2Sx) = 0} \quad \text{EQ-1.}$$

REFERENCE: AGRONOMY No. 17, "DRAINAGE FOR AGRICULTURE", BY JAN VAN SCHILFGAARDE, AMERICAN SOCIETY OF AGRONOMY INC. 1970 P207.

A much simpler equation than Eq. [1] can be derived for design of drain spacing if the ratios $h/2s$ and $H/2s$ are small. Use of the equation leads to a design that is not safe. For ditch drainage, however, when the layer that impedes drainage is at shallow depth, the equation will not be very unsafe as we shall see. The simpler equation may be obtained (Kirkham, 1967) as

$$(z + h_w)^2 - h_w^2 = (R/K)(2sx - x^2) \qquad [3]$$

in which, as in Fig. 10—4, h_w is the height of the ditch water above the im-

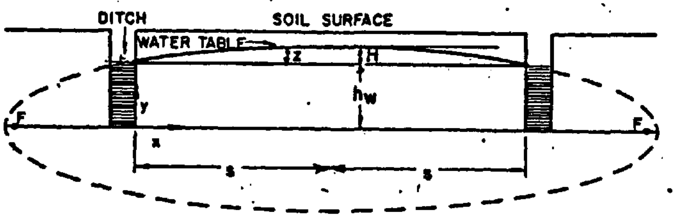


Fig. 10—4. Ditch drainage and the Dupuit-Forchheimer ellipse (Kirkham, 1967).

permeable layer, $z + h_w$ is the height of the water table above the impermeable layer, x is distance from a ditch, R is the rainfall or recharge rate, K is the hydraulic conductivity of the soil, and $2s$ is the ditch spacing. H as in Fig. 10—1 is the height of the water-table arch.

Equation [3] is based on the controversial D-F theory in which two assumptions are made:

1) For small inclinations of the free surface, the streamlines can be taken as horizontal.
2) The velocities associated with these streamlines are proportional to the slope of the free surface but are independent of the depth.

Kirkham (1967) showed that these assumptions give exact results if they are applied to a soil having infinite conductivity in the vertical direction. For other soils the two assumptions result in approximate results. Infinite vertical conductivity is approximated by a soil that has many vertical worm holes, root holes, and cracks.

Equation [3] is the equation of an ellipse, as illustrated in Fig. 10—4, for an ellipse of major-to-minor axis ratio of 4. The ellipse is drawn for $R/K = 1/16$ and $2s = 6h_w$. The foci F are as shown. The maximum water table height H_m is at the center of the ellipse and is obtained by putting $x = s$ in Eq. [3] which gives, after we define H_m by

$$H_m = H + h_w \qquad [4]$$

and rearrange, the result for the semispacing s of the ditches as

$$s = [(K/R)(H_m^2 - h_w^2)]^{1/2}. \qquad [5]$$

Equation [5] is sometimes used for tile drainage as well as for ditch drainage, even though the radius of the tile does not occur in Eq. [5]. When used either for tile or ditch drainage, the water arch height H in Fig. 10—4 is found to be too small (Kirkham, 1967) when compared with the arch height given by the more accurate potential theory of Eq. [1].

EXEMPLE: DETERMINE WATER PROFILE FOR FOLLWING CONDITIONS

DITCH SPACING $S = 150$ FT.

PERMEABILITY $K = 3.5 \times 10^{-4}$ cm/sec.

RECHARGE RATE $R = 2.8$ INCH/YEAR.

DITCH STANDING WATER = 1.5 FT.

$$(Z + 1.5)^2 - (1.5)^2 = \left(\frac{2.8 \text{ "/yr}}{3.5 \times 10^{-4} \text{ cm/sec} \times \frac{60 \times 60 \times 24 \times 365}{2.54}} \right) \left[(2)(150)(x) - (x)^2 \right]$$

	$K = 3.5 \times 10^{-4}$ cm/sec	$K = 2 \times 10^{-6}$ cm/sec
X, FT	Z, FT	* Z.
10	0.5294	16.6454
20	0.9204	
30	1.2330	
40	1.4919	
50	1.7100	
60	1.8954	
70	2.0530	
80	2.1865	
100	2.3906	
120	2.5209	
140	2.5845	
150	2.5924	

```
01◆LBL "DRAIN"
02 CF 22
03 "HW=?FT"
04 PROMPT
05 FS?C 22
06 STO 01
07 "R=?INCH/YEAR"
08 PROMPT
09 FS?C 22
10 STO 02
11 "K=?CM/SEC"
12 PROMPT
13 FS?C 22
14 STO 03
15 "S=?FT"
16 PROMPT
17 FS?C 22
18 STO 04
19 RCL 04
20 STO 05
21 STO 06
22 "NO. OF PT. ?"
23 PROMPT
24 STO 00
25 ST/ 05
26 ST/ 06
27◆LBL 01
28 FIX 0
29 "X="
30 ARCL 05
31 "├FT"
32 AVIEW
33 RCL 05
34 X↑2
35 RCL 05
36 2
37 *
38 RCL 04
39 *
[illegible]
[illegible]
42 *
43 RCL 03
44 12415748.03
45 *
46 /
47 RCL 01
48 2
49 *
50 1
51 XEQ 02
52 RCL 06
53 ST+ 05
54 DSE 00
55 GTO 01
56 GTO "DRAIN"
57◆LBL 02
58 ST/ Z
59 /
60 -2
61 /
62 ENTER↑
63 ENTER↑
64 X↑2
65 R↑
66 -
67 SQRT
68 ST- Z
69 +
70 X<=Y?
71 X<>Y
72 FIX 4
73 "Z="
74 ARCL X
75 "├FT"
76 AVIEW
77 ADV
78 END

LBL'DRAIN
END          177 BYTES
.END.        [illegible] BYTES
```

```
            XEQ "DRAIN"
HW=?FT
             1.5000     RUN
R=?INCH/YEAR
             2.8000     RUN
K=?CM/SEC
             3.5-04     RUN
S=?FT
           150.0000     RUN
NO. OF PT. ?
            15.0000     RUN
X=10.FT
Z=0.5294FT

X=20.FT
Z=0.9204FT

X=30.FT
Z=1.2330FT

X=40.FT
Z=1.4919FT

X=50.FT
Z=1.7100FT

X=60.FT
Z=1.8954FT

X=70.FT
Z=2.0530FT

X=80.FT
Z=2.1865FT

X=90.FT
Z=2.2984FT

X=100.FT
Z=2.3906FT

X=110.FT
Z=2.4644FT

X=120.FT
Z=2.5209FT

X=130.FT
Z=2.5608FT

X=140.FT
Z=2.5845FT

X=150.FT
Z=2.5924FT
```

SENSITIVITY OF GROUND WATER LEVEL TO PERMEABILITY

PURPOSE: TO DETERMINE GROUND WATER LEVEL ASSUMING

Case 1 · $K = 10^{-1}$ cm/sec

Case 2 $K = 10^{-3}$ cm/sec

Case 3 $K = 10^{-5}$ cm/sec

Case 4 $K = 10^{-7}$ cm/sec

Case 5 $K = 10^{-9}$ cm/sec

Case 6 $K = 10^{-6}$ cm/sec

Case 7 $K = 10^{-4}$ cm/sec

FRENCH DRAIN SPACING FOR NORTH BURIAL AREA IS

$2S \cong 600$ FT $\Rightarrow$ $S = 300'$ (FOR CALC. purpose)

RECHARGE AND PERCOLATION RATE = 1 INCH = R

This recharge value is used here only to demonstrate how Groundwater levels vary with different permeabilities (Actual percolation may be larger)

Trench Water level $\simeq 3'' \simeq 0.25' = h_w$ (Assumed)

METHOD: USE DRAIN SPACING EQUATION by DUPUIT-FORCHHEIMER

$$(Z + h_w)^2 - (h_w)^2 = \left(\frac{R}{K}\right)(2Sx - x^2)$$

REFERENCE: "DRAINAGE FOR AGRICULTURE" By JAN VAN SCHILFGAARDE AGRONOMY NO. 17, AMERICAN SOCIETY OF AGRONOMY 1974

0015777

DAPPOLONIA
WASTE MANAGEMENT S[illegible]VICES

(115)

By WTC Date 5/4/84 Subject SENSITIVITY GROUND WATER Sheet No. 2 of 6

Chkd. By JM Date 5/17/84 VERTAC CHEMICAL JACKSONVILLE Proj. No. 846012

```
XEQ "DRAIN"
HW=?FT
.2500        RUN
R=?INCH/YEAR
1.0000       RUN
K=?CM/SEC
1-01         RUN
S=?FT
300.0000     RUN
NO. OF PT. ?
30.0000      RUN
X=10.FT
Z=0.0093FT
X=20.FT
Z=0.0180FT
X=30.FT
Z=0.0262FT
X=40.FT
Z=0.0338FT
X=50.FT
Z=0.0409FT
X=60.FT
Z=0.0477FT
X=70.FT
Z=0.0539FT
X=80.FT
Z=0.0598FT
X=90.FT
Z=[illegible]
X=100.FT
Z=0.0706FT
X=110.FT
Z=0.0754FT
X=120.FT
Z=0.0[illegible]FT
X=130.FT
Z=0.0842FT

X=140.FT
Z=0.0882FT
X=150.FT
Z=0.0919FT
X=160.FT
Z=0.0953FT
X=170.FT
Z=0.0984FT
X=180.FT
Z=0.1013FT
X=190.FT
Z=0.1039FT
X=200.FT
Z=0.1063FT
X=210.FT
Z=0.1084FT
X=220.FT
Z=0.1103FT
X=230.FT
Z=0.1120FT
X=240.FT
Z=0.1134FT
X=250.FT
Z=0.1147FT
X=260.FT
Z=0.1156FT
X=270.FT
Z=0.1164FT
X=280.FT
Z=0.1170FT
X=290.FT
Z=0.1173FT
X=300.FT
Z=0.1174FT
```

Case 1

NO

```
HW=?FT
             RUN
R=?INCH/YEAR
             RUN
K=?CM/SEC
1-03         RUN
S=?FT
             RUN
NO. OF PT. ?
30.0000      RUN
X=10.FT
Z=0.4833FT
X=20.FT
Z=0.7484FT
X=30.FT
Z=0.9499FT
X=40.FT
Z=1.1163FT
X=50.FT
Z=1.2591FT
X=60.FT
Z=1.3847FT
X=70.FT
Z=1.4966FT
X=80.FT
Z=1.5975FT
X=90.FT
Z=1.6889FT
X=100.FT
Z=1.7723FT
X=110.FT
Z=1.8485FT
X=120.FT
Z=1.9184FT
X=130.FT
Z=1.9824FT

X=140.FT
Z=2.0412FT
X=150.FT
Z=2.0950FT
X=160.FT
Z=2.1443FT
X=170.FT
Z=2.1893FT
X=180.FT
Z=2.2302FT
X=190.FT
Z=2.2673FT
X=200.FT
Z=2.3007FT
X=210.FT
Z=2.3305FT
X=220.FT
Z=2.3569FT
X=230.FT
Z=2.3800FT
X=240.FT
Z=2.3998FT
X=250.FT
Z=2.4165FT
X=260.FT
Z=2.4300FT
X=270.FT
Z=2.4405FT
X=280.FT
Z=2.4480FT
X=290.FT
Z=2.4525FT
X=300.FT
Z=2.4540FT
```

Case 2

yes

HW=?FT
RUN
R=?INCH/YEAR
RUN
K=?CM/SEC
1-05 RUN
S=?FT
RUN
NO. OF PT. ?
30.0000 RUN

X=10.FT
Z=6.6480FT

X=20.FT
Z=9.4191FT

X=30.FT
Z=11.4884FT

X=40.FT
Z=13.1842FT

X=50.FT
Z=14.6347FT

X=60.FT
-Z=15.9062FT

X=70.FT
Z=17.0380FT

X=80.FT
Z=18.0563FT

X=90.FT
Z=18.9790FT

X=100.FT
Z=19.8193FT

X=110.FT
Z=20.5872FT

X=120.FT
Z=21.2904FT

X=130.FT
Z=21.9351FT

X=140.FT
Z=22.5263FT

X=150.FT
Z=23.0680FT

X=160.FT
Z=23.5635FT

X=170.FT
Z=24.0158FT

X=180.FT
Z=24.4272FT

X=190.FT
Z=24.7998FT

X=200.FT
Z=25.1351FT

X=210.FT
Z=25.4348FT

X=220.FT
Z=25.7000FT

X=230.FT
Z=25.9317FT

X=240.FT
Z=26.1309FT

X=250.FT
Z=26.2983FT

X=260.FT
Z=26.4345FT

X=270.FT
Z=26.5399FT

X=280.FT
Z=26.6150FT

X=290.FT
Z=26.6599FT

X=300.FT
Z=26.6749FT

Case 3

HW=?FT
RUN
R=?INCH/YEAR
RUN
K=?CM/SEC
1-07 RUN
S=?FT
RUN
NO. OF PT. ?
30.0000 RUN

X=10.FT
Z=60.6854FT

X=20.FT
Z=96.4094FT

X=30.FT
Z=117.1080FT

X=40.FT
Z=134.0693FT

X=50.FT
Z=148.5766FT

X=60.FT
Z=161.2924FT

X=70.FT
Z=172.6126FT

X=80.FT
Z=182.7962FT

X=90.FT
Z=192.0239FT

X=100.FT
Z=200.4276FT

X=110.FT
Z=208.1071FT

X=120.FT
Z=215.1398FT

X=130.FT
Z=221.5872FT

X=140.FT
Z=227.4991FT

X=150.FT
Z=232.9163FT

X=160.FT
Z=237.8723FT

X=170.FT
Z=242.3956FT

X=180.FT
Z=246.5100FT

X=190.FT
Z=250.2354FT

X=200.FT
Z=253.5892FT

X=210.FT
Z=256.5859FT

X=220.FT
Z=259.2370FT

X=230.FT
Z=261.5554FT

X=240.FT
Z=263.5475FT

X=250.FT
Z=265.2214FT

X=260.FT
Z=266.5832FT

X=270.FT
Z=267.6376FT

X=280.FT
Z=268.3882FT

X=290.FT
Z=268.8375FT

X=300.FT
Z=268.9872FT

Case 4

0015759

```
HW=?FT
                        RUN
R=?INCH/YEAR
                        RUN
K=?CM/SEC
              1-09      RUN
S=?FT
                        RUN
NO. OF PT. ?
           30.0000      RUN
X=10.FT
Z=689.0997FT

X=20.FT
Z=966.3466FT

X=30.FT
Z=1,173.3271FT

X=40.FT
Z=1,342.9404FT

X=50.FT
Z=1,488.0138FT

X=60.FT
Z=1,615.1723FT

X=70.FT
Z=1,728.3739FT

X=80.FT
Z=1,830.2899FT

X=90.FT
Z=1,922.4871FT

X=100.FT
Z=2,006.5244FT

X=110.FT
Z=2,083.3193FT

X=120.FT
Z=2,153.6463FT

X=130.FT
Z=2,218.1209FT

X=140.FT
Z=2,277.2401FT

X=150.FT
Z=2,331.4112FT

X=160.FT
Z=2,380.9720FT

X=170.FT
Z=2,426.2050FT

X=180.FT
Z=2,467.3483FT

X=190.FT
Z=2,504.6032FT

X=200.FT
Z=2,538.1412FT

X=210.FT
Z=2,568.1077FT

X=220.FT
Z=2,594.6265FT

X=230.FT
Z=2,617.8824FT

X=240.FT
Z=2,637.7235FT

X=250.FT
Z=2,654.4630FT

X=260.FT
Z=2,668.0809FT

X=270.FT
Z=2,678.6248FT

X=280.FT
Z=2,686.1307FT

X=290.FT
Z=2,690.6242FT

X=300.FT
Z=2,692.1204FT
```

Case 5

```
                 XEQ "DRAIN"
HW=?FT
              .2500     RUN
R=?INCH/YEAR
             1.0000     RUN
K=?CM/SEC
              1-06      RUN
S=?FT
           300.0000     RUN
NO. OF PT. ?
            30.0000     RUN
X=10.FT
Z=21.5506FT

X=20.FT
Z=[illegible].3173FT

X=30.FT
Z=36.8626FT

X=40.FT
Z=42.2261FT

X=50.FT
Z=46.8137FT

X=60.FT
Z=50.8347FT

X=70.FT
Z=54.4145FT

X=80.FT
Z=57.6348FT

X=90.FT
Z=60.5528FT

X=100.FT
Z=63.2103FT

X=110.FT
Z=65.6387FT

X=120.FT
Z=67.8626FT

X=130.FT
Z=69.9015FT

X=140.FT
Z=71.7710FT

X=150.FT
Z=73.4840FT

X=160.FT
Z=75.0513FT

X=170.FT
Z=76.4817FT

X=180.FT
Z=77.7827FT

X=190.FT
Z=78.9608FT

X=200.FT
Z=80.0214FT

X=210.FT
Z=80.9690FT

X=220.FT
Z=81.8076FT

X=230.FT
Z=82.5405FT

X=240.FT
Z=83.1704FT

X=250.FT
Z=83.6998FT

X=260.FT
Z=84.1304FT

X=270.FT
Z=84.4638FT

X=280.FT
Z=84.7012FT

X=290.FT
Z=84.8433FT

X=300.FT
Z=84.8906FT
```

Case 6

001580

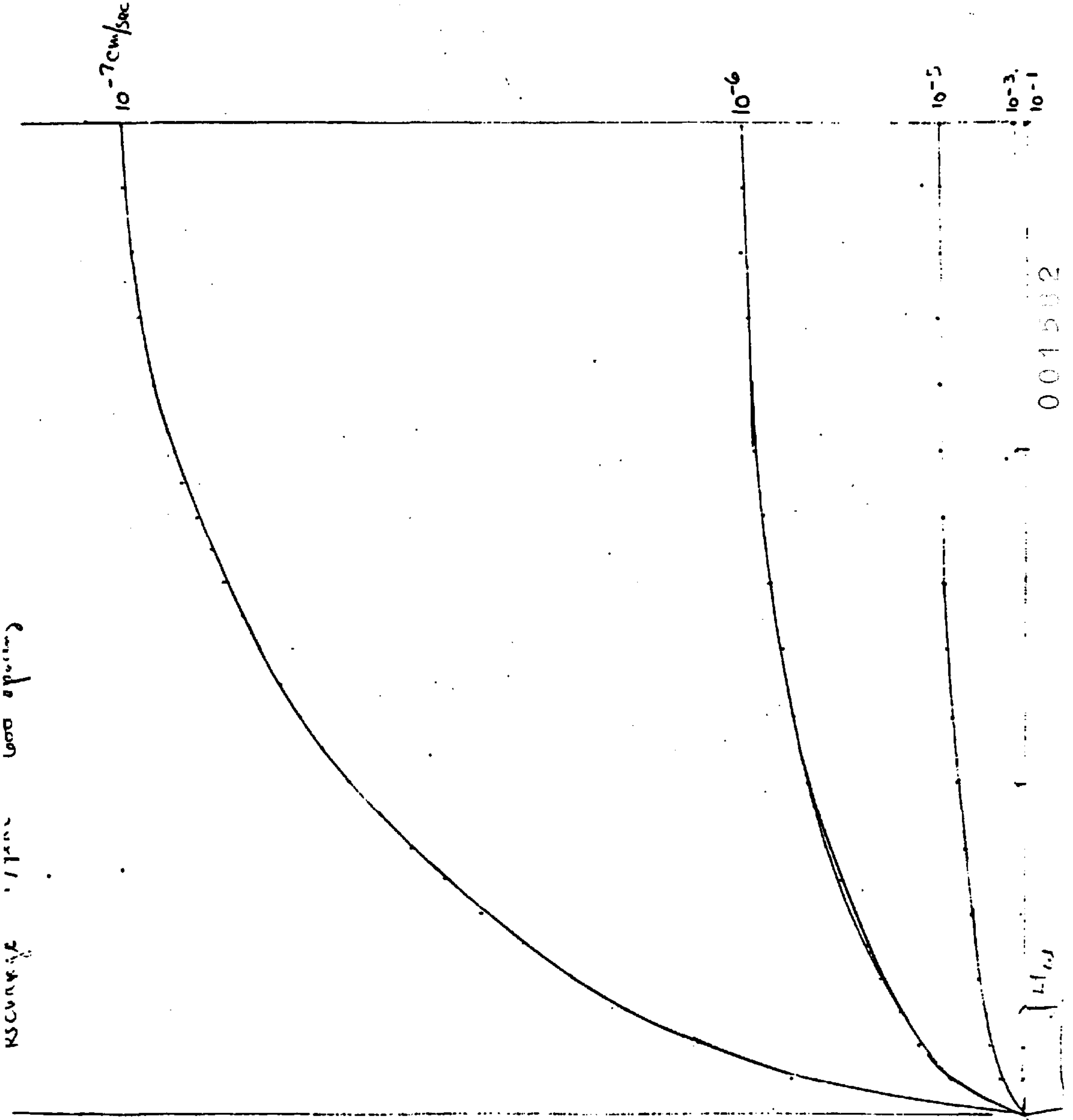
```
HW=?FT
                    RUN
R=?INCH/YEAR
                    RUN
K=?CM/SEC
            1-04    RUN
S=?FT
                    RUN
NO. OF PT. ?
         30.0000    RUN
X=10.FT
Z=1.9442FT

X=20.FT
Z=2.8168FT

X=30.FT
Z=3.4696FT

X=40.FT
Z=4.0049FT

X=50.FT
Z=4.4629FT

X=60.FT
Z=4.8645FT

X=70.FT
Z=5.2221FT

X=80.FT
Z=5.5438FT

X=90.FT
Z=5.8354FT

X=100.FT
Z=6.1009FT

X=110.FT
Z=6.3436FT

X=120.FT
Z=6.5658FT

X=130.FT
Z=6.7696FT

X=140.FT
Z=6.9564FT

X=150.FT
Z=7.1276FT

X=160.FT
Z=7.2842FT

X=170.FT
Z=7.4272FT

X=180.FT
Z=7.5572FT

X=190.FT
Z=7.6750FT

X=200.FT
Z=7.7810FT

X=210.FT
Z=7.8757FT

X=220.FT
Z=7.9595FT

X=230.FT
Z=8.0328FT

X=240.FT
Z=8.0957FT

X=250.FT
Z=8.1487FT

X=260.FT
Z=8.1917FT

X=270.FT
Z=8.2250FT

X=280.FT
Z=8.2488FT

X=290.FT
Z=8.2630FT

X=300.FT
Z=8.2677FT
```

Case 7.

```
01♦LBL "DRAIN"
02 CF 22
03 "HW=?FT"
04 PROMPT
05 FS?C 22
06 STO 01
07 "R=?INCH/YEAR"
08 PROMPT
09 FS?C 22
10 STO 02
11 "K=?CM/SEC"
12 PROMPT
13 FS?C 22
14 STO 03
15 "S=?FT"
16 PROMPT
17 FS?C 22
18 STO 04
19 RCL 04
20 STO 05
21 STO 06
22 "NO. OF PT. ?"
23 PROMPT
24 STO 00
25 ST/ 05
26 ST/ 06
27♦LBL 01
28 FIX 0
29 "X="
30 ARCL 05
31 "├FT"
32 AVIEW
33 RCL 05
34 X↑2
35 RCL 05
36 2
37 *
38 RCL 04
39 *
40 -
41 RCL 02
42 *
43 RCL 03
44 12415748.03
45 *
46 /
47 RCL 01
48 2
49 *
50 1
51 XEQ 02
52 RCL 06
53 ST+ 05
54 DSE 00
55 GTO 01
56 GTO "DRAIN"
57♦LBL 02
58 ST/ Z
59 /
60 -2
61 /
62 ENTER↑
63 ENTER↑
64 X↑2
65 R↑
66 -
67 SQRT
68 ST- Z
69 +
70 X<=Y?
71 X<>Y
72 FIX 4
73 "Z="
74 ARCL X
75 "├FT"
76 AVIEW
77 ADV
78 END
```

HP41CV PROGRAM

By WTC Date 5/4/84 Subject SENSITIVITY GROUND WATER Sheet No. 6 of 6
Chkd. By JM Date 5/17/84 VERTAC CHEMICAL JACKSONVILLE AK Proj. No. 846012



D'APPOLONIA
WASTE MANAGEMENT SERVICES

(120)

By WTC Date 5/2/84 Subject NORTH BURIAL AREA Sheet No. 1 of 3
Chkd. By JM Date 5/17/84 VERTAC CHEMICAL JACKSONVILLE Proj. No. 84-6012

0041535

NORTH BURIAL AREA – EPA FINAL ALTERNATIVE III

PURPOSE: TO DETERMINE THE EFFECTIVENESS OF GROUND WATER CONTROL AS PROPOSED BY EPA FINAL ALTERNATIVE III WHICH CONSISTS OF

- SURROUNDING NORTH BURIAL AREA WITH 3' SLURRY WALL ($K = 10^{-7}$ cm/sec) to WEATHERED ROCK.
- PROVIDE FRENCH DRAIN JUST INSIDE NORTH BURIAL AREA
- COVER THE NORTH BURIAL WITH 12" TOPSOIL, 24" DRAIN LAYER, 30 MILL SYNTHETIC MEMBRANE AND 24" CLAY LINER.

METHOD: DETERMINE HYDRAULIC GRADIENT IN ROCK USING WELL #8 AND #19 NEAR NORTH B.

DETERMINE GROUND WATER LEVEL AFTER INSTALLATION USING PERMEABILITY COEF. OBTAINED FROM DISC & CH_2M-HILL REPORTS AND DUPUIT-FORCHHEIMER DRAIN-SPACING EQUATION

DATA BASE 1) PERMEABILITY FOR BACKFILL AROUND DRUMS $\simeq 10^{-5}$ cm/sec (ASSUMED)

2) RECHARGE RATE $\simeq$ 0.6"/year. (SEE J.M CALC 5/3/84

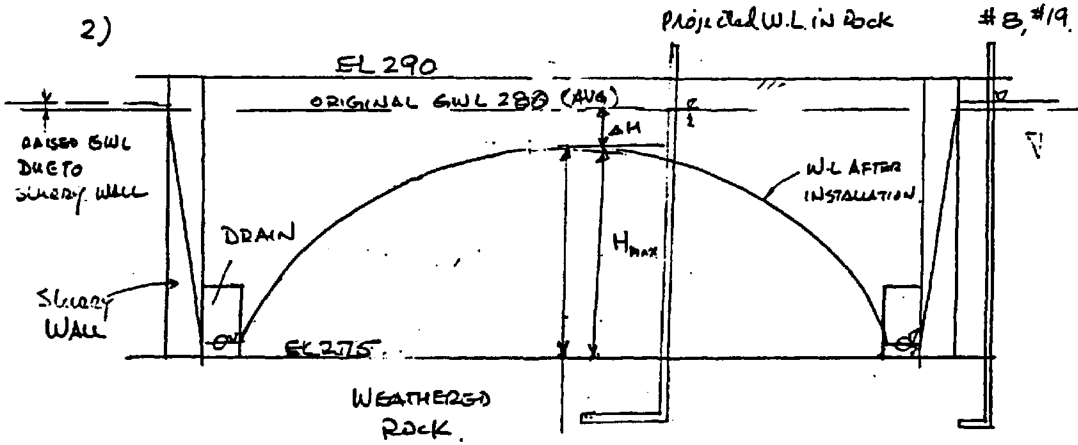
3) WATER LEVEL READING FOR #8 & #19 FOR JUL

	#8	#19	
JULY 83	279.2	278.4	Δ(#8-#19) = 0.8'
JAN 84	283	279.4	Δ(#8-#19) = 3.6'
Δ (SEASONAL)	3.8'	1.0'	

GENERALIZED CONDITIONS

1) WATER LEVEL @ MIDDLE OF NORTH BURIAL IS AT EL 280 ± (AVG)

2)



3) ROCK SURFACE EL. 275 ±

4) GROUND WATER LEVEL FROM MODEL
HIGH ≈ EL 288
AVG ≈ 280

(5) IF GWL IS BELOW ORIGINAL GWL AFTER INSTALLATION THEN THE SYSTEM WILL PROVIDE INWARD FLOW PATTERN

001584

(122)

By WTC Date 5/17/84 Subject NORTH BURIAL AREA Sheet No. 3 of 3
Chkd. By JM Date 5/17/84 VERTAC CHEMICAL JACKSONVILLE AK Proj. No. 846012

USING DRAIN SPACING EQUATION

BY DUPUIT - FORCHHEIMER

$$(Z+h_w)^2-(h_w)^2=\left(\frac{R}{K}\right)(2Sx-x^2)$$

$Z_{max} = 6.35$ @ MIDDLE $x = 300'$

EL 281.4 WHICH IS ABOUT AT PRESENT WATER LEVEL.

THEREFORE IT HAS NO EFFECT TO REDUCE GROUND WATER LEVEL WITHIN NORTH BURIAL AREA.

```
XEQ "DRAIN"
HW=?FT
         .2500    RUN
R=?INCH/YEAR
         .6000    RUN
K=?CM/SEC
          1-04    RUN
S=?FT
      300.0000    RUN
NO. OF PT. ?
       15.0000    RUN
X=20.FT
Z=2.1308FT

X=40.FT
Z=3.0496FT

X=60.FT
Z=3.7148FT

X=80.FT
Z=4.2407FT

X=100.FT
Z=4.6719FT

X=120.FT
Z=5.0319FT

X=140.FT
Z=5.3343FT

X=160.FT
Z=5.5881FT

X=180.FT
Z=5.7995FT

X=200.FT
Z=5.9728FT

X=220.FT
Z=6.1110FT

X=240.FT
Z=6.2165FT

X=260.FT
Z=6.2908FT

X=280.FT
Z=6.3350FT

X=300.FT
Z=6.3497FT
```

500500