SDMS US EPA REGION V -1

SOME IMAGES WITHIN THIS DOCUMENT MAY BE ILLEGIBLE DUE TO BAD SOURCE DOCUMENTS.

CONCEPT DESIGN
CONCEPT DESIGN ANALYSIS - APPENDICES
VOLUME II OF II
HAZARDOUS WASTE CONTAINMENT/CLEANUP
OMC - WAUKEGAN HARBOR
WAUKEGAN, ILLINOIS

Contract No. DACW 45-85-C-0023

Prepared By:

Warzyn Engineering Inc.
Madison, Wisconsin

For:

U.S. Army District
Omaha Corps of Engineers
Omaha, Nebraska

March, 1985

C 11837

WARZYN
ENGINEERING INC

VOLUME 2 - Appendices

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APPENDIX F
COMPUTER ANALYSIS - AREAS

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```
    !AREA AND VOLUME BY AVERAGE DEPTH ----'AREAVOLUME'
    PRINTER IS 701
    PRINT
    ! BY TJ 4/16/84  PROTECT CODE IS 'TJ'
    !*********************  VARIABLE LISTING  ******************************
    !
    !  VX= X COORDINATE                    VY= Y COORDINATE
    !  NN$= USER NAME                      DA$= DATE
    !  PN$= PROJECT NAME                   PR$= PROJECT NUMBER
    !  HS= HORZ. SCALE                     VS= VERT. SCALE
    !  HC$= HARD COPY ID.                  AI$= AREA ID.
    !  VT$= VOLUME TYPE                    DEPTH= AVE. DEPTH
    !  AY= AREA(SY)                        OVER$= PRECISION OVERRIDE FLAG
    !  AI= AREA(SI)                        AF= AREA(SF)
    !  ACRES= AREA(ACRES)                  VOL= VOLUME(CY)
    !  FI$= PRINTER FLAG                   BEEP$= SOUND FLAG
    !  A$= DIGITIZER COORD. STRING         N= COORDINATE COUNTER
    !  FS= FILTER FUNCTION SENSITIVITY     DUMMY$= DUMMY STRING AR.
    !  NN= AREA LOOP COUNTER               AREA= AREA HOLDING VARIABLE
    !  POSITION= LOCATION OF "," IN A$     ITTER= ITTERATION COUNTER
    !  PREC= PRECISION REQUIRED(%)         AREA1= FIRST ITTER. AREA
    !  DR= RD. DIFF. OF AREAS              VOL$= VOLUME COMP. FLAG
    !
    !*************************************************************************
!DIMENSION COORDINATES AND STRINGS
DIM Vx(5000),Vv(5000),A$[40],Ai$[40],Vt$[40],Pn$[15],Pr$[15],Nn$[15],Da$[10]
 !START HERE FOR PROGRAM RESTART
!RESET VARIABLES TO 0 OR NULL
Hs=0
Vs=0
Prec=0
Depth=0
Nn$=""
Pn$=""
Da$=""
Pr$=""
Ai$=""
Vt$=""
Hc$=""
Vol$=""
Dummy$=""
Beep$=""
 !BEGIN INSTRUCTIONS
 PRINTER IS 1
OUTPUT 2 USING "#,B";255,75
PRINT CHR$(129)
PRINT TABXY(22,2),"AREA AND VOLUME BY AVERAGE DEPTH"
PRINT CHR$(128)
INPUT "ENTER 'I' FOR INSTRUCTIONS OR PRESS ENTER TO CONTINUE".Dummy$
IF Dummy$<>"I" THEN 681
PRINT
PRINT "                                INSTRUCTIONS      "
PRINT
PRINT "THIS PROGRAM COMPUTES AREAS AND VOLUMES FROM DIGITIZED INPUT. USING"
PRINT "THE NUMONICS 2300 DIGITIZER. AREAS ARE TRACED WITH THE CURSOR, WITH V
OLUMES"
PRINT "BEING COMPUTED FROM USER SPECIFIED AVERAGE DEPTHS. TWO READINGS OF EA
CH"
PRINT "AREA ARE NEEDED, AND MUST MEET USER SPECIFIED PRECISION OR BE REDONE,
```

```
 UNLESS"
 PRINT "A DOCUMENTED USER OVERRIDE FOR PRECISION REQUIREMENTS IS USED"
 PRINT
 PRINT "                              THINGS TO REMEMBER  "
 PRINT
 PRINT "1) ONLY OPEN FIGURES MAY BE TRACED (ie.BOUNDARIES CANNOT INTERSECT)"
 PRINT "2) THE CURSOR LIGHT INDICATES THE RATE COORDINATES ARE READ, SO SLOW"
 PRINT "   DOWN ON CURVES AND PAUSE AT CORNERS IN ORDER TO GET ENOUGH POINTS"
 PRINT "3) YOU DON'T HAVE TO KEEP THE CURSOR MOVING DURING A READING, BUT DON
'T"
 PRINT "   LIFT IT FROM THE BOARD OR OFF THE AREA BOUNDARY DURING A READING"
 INPUT "PRESS ENTER TO CONTINUE",Dummy$
 !SET PRINTER FLAG FOR INITIAL 'I' SO THAT TITLE IS PRINTED
 Pi$="I"
 OUTPUT 2 USING "#,B";255,75
 PRINT CHR$(129)
 INPUT PROJECT INFORMATION
 PRINT TABXY(22,2),"AREA AND VOLUME BY AVERAGE DEPTH"
 PRINT CHR$(129)
 INPUT "DO YOU WANT VOLUMES AT ANY TIME DURING THIS SESSION? ENTER 'Y' OR 'N'
",Vol$
 IF Vol$<>"Y" AND Vol$<>"N" THEN 780
 INPUT "DO YOU WANT SOUND DURING DIGITIZING?, ENTER 'Y' OR 'N'",Beep$
 IF Beep$<>"Y" AND Beep$<>"N" THEN 782
 INPUT "USER INITIALS? ",Nn$
 PRINT TABXY(10,4),"USER INITIALS: ",Nn$
 INPUT "DATE? ",Da$
 PRINT TABXY(10,6),"DATE: ",Da$
 INPUT "PROJECT NAME? ",Pn$
 PRINT TABXY(10,8),"PROJECT NAME: ",Pn$
 INPUT "PROJECT NUMBER? ",Pr$
 PRINT TABXY(10,10),"PROJECT NUMBER: ",Pr$
 INPUT "DO YOU WANT HARD COPY? (Y OR N) ",Hc$
 IF Hc$<>"Y" AND Hc$<>"N" THEN 950
 ! BEGIN DIGITIZER INITIALIZATION
 OUTPUT 2 USING "#,B";255,75
 PRINT CHR$(129)
 PRINT TABXY(28,2),"DIGITIZER INITIALIZATION"
 PRINT CHR$(128)
 INPUT "HORIZONTAL SCALE (FT/INCH)? ",Hs
 PRINT TABXY(10,4),"HORIZONTAL SCALE (FT/INCH): ",Hs
 INPUT "VERTICAL SCALE (FT/INCH)? ",Vs
 PRINT TABXY(10,6),"VERTICAL SCALE (FT/INCH): ",Vs
 INPUT "PRECISION REQUIRED (%)?",Prec
 PRINT TABXY(10,8),"PRECISION REQUIRED (%): ",Prec
 INPUT " PRESS ENTER TO INPUT DATA",Dummy$
 !SET FORMAT OF COORDINATES
 OUTPUT 707;"FORMAT+12345.12,CL"
 !SET DIGITIZER TO STREAM MODE
 OUTPUT 707;"STREAM"
 !BEGIN DATA INPUT
 !RESET DATA INPUT VARIABLES TO 0 OR NULL
 Ai$=""
 Vt$=""
 Depth=0
 OUTPUT 2 USING "#,B";255,75
 PRINT CHR$(129)
 PRINT TABXY(30,2),"DATA INPUT"
 PRINT CHR$(128)
 INPUT "AREA ID.? ",Ai$
```

```
1470 PRINT TABXY(20,4),"AREA ID.: ",Ai$
1490 !BYPASS VOLUME TYPE IF FLAG IS 'N'
1510 IF Vol$="N" THEN 1570
1490 INPUT "VOLUME TYPE? ",Vt$
1510 PRINT TABXY(20,6),"VOLUME TYPE: ",Vt$
1530 INPUT "AVERAGE DEPTH(FT)? ",Depth
1550 PRINT TABXY(20,8),"AVERAGE DEPTH(FT)= ",Depth
1570! BEGIN ITTERATION LOOP HERE
1590!SET ITTERATION COUNTER TO 1
1610 Itter=1
1630!SET COORDINATE COUNTER TO -1
1650 N=-1
1670!CLEAR AREA FOR COORDINATES
1690 PRINT TABXY(1,13),"
                       "
1710 PRINT TABXY(1,14),"
                       "
1720 PRINT TABXY(1,15),"
                       "
1730 PRINT TABXY(1,16),"
                       "
1740 PRINT TABXY(1,17),"
                       "
1750!PRINT COORDINATE TITLE
1770 PRINT CHR$(129)
1790 PRINT TABXY(28,13),"ITTERATION ",Itter
1810 PRINT TABXY(30,14),"COORDINATES"
1830 PRINT CHR$(128)
1850 IF Itter=2 THEN 1890
1870 INPUT "PREPARE TO DIGITIZE DOCUMENT AND PRESS ENTER TO CONTINUE",Dummy$
1890 DISP " PRESS '-' KEY ON CURSOR TO START AND STOP DIGITIZER"
1910!BEGIN COORDINATE  ROUTINE
1930!ADD 1 TO COORDINATE COUNTER
1950 N=N+1
1970!BEGIN LOOP FOR COORDS. FAILING FILTER TEST
1990!READ COORDINATE STRING
2010 SEND 7;CMD 64+7
2030 ENTER 707;A$
2050 SEND 7;UNT
2070!DETERMINE ',' LOCATION
2090 Position=POS(A$,",")
2110!CHECK FOR LAST POINT INDICATOR '-'
2130 Last$=(A$[1,Position-1])
2150!RETURN STRING UNTIL BEGINNING CONDITION MET
2170 IF Last$<>"-" AND N=0 THEN 1990
2190!TEST FOR BEGINNING OF DIGITIZING
2210 IF Last$="-" AND N=0 THEN 1930
2230!TEST FOR END OF DIGITIZING
2250 IF Last$="-" THEN 2550
2270!DETERMINE X AND Y COORDINATE
2290 Vx(N)=VAL(A$[1,Position-1])
2310 Vy(N)=VAL(A$[Position+1,40])
2330!FILTER FUNCTION
2350!TEST FOR FIRST COORD. FILTER FUNCTION BYPASS
2370 IF N=1 THEN 2490
2390!SET SENSITIVITY
2410 Fs=.05
2430 IF ABS(Vx(N-1)-Vx(N))>Fs THEN 2470
2450 IF ABS(Vy(N-1)-Vy(N))<Fs THEN 1970
2470!COORDINATES HAVE PASSED THE FILTER TEST
```

```
2490!PRINT COORDINATES THAT PASS FILTER TEST
2510 PRINT TAB(1,25.1),Af
   0 IF Beep$="Y" THEN BEEP
2530 GOTO 1910
2550!BEGIN AREA COMPUTATION
2570 DISP "COMPUTING AREA, PLEASE WAIT"
2590!RESET COORD. COUNTER TO LAST VALID COORD.
2610 N=N-1
2630!COMPUTE AREA AT LIMITS
2650 Area=.5*((Vx(1)*(Vy(N)-Vy(2)))+(Vx(N)*(Vy(N-1)-Vy(1))))
2670!AREA COMPUTATION LOOP FOR REMAINDER OF COORDINATES
2690 FOR Nn=2 TO (N-1)
2710 Area=Area+(.5*(Vx(Nn)*(Vy(Nn-1)-Vy(Nn+1))))
2730 NEXT Nn
2750!AREA LOOP COMPLETED
2770 Area=ABS(Area)
2790 !TEST FOR ITTERATION
2810 IF Itter=2 THEN 2910
2830 Itter=2
   50 Area1=Area
2870 !RETURN TO COORDINATE LOOP FOR ITTERATION 2
2890 GOTO 1630
2910 !TEST FOR PRECISON
2930 Dr=Area1/Area
2950 IF Dr>1 THEN Dr=1/Dr
2970 Dr=Dr*100
2980 !RESET OVERRIDE FLAG
   91 Over$=""
2990 IF Dr>Prec THEN 3070
2991 !ROUND ACTUAL PRECISION
2992 Dr=(INT((Dr+.005)*100)/100)
2993 !DISPLAY PRECISION MESSAGE
3000 PRINT CHR$(129)
3010 PRINT TABXY(1,12),"READINGS DO NOT MEET THE REQUIRED PRECISION OF ",Prec,"%
"
3012 PRINT CHR$(129)
   13 PRINT TABXY(1,14),"
                        "
3020 PRINT TABXY(1,15),"PRECISION FOR LAST READINGS WAS ",Dr,"%"
3021 PRINT TABXY(1,16),"
                        "
3025 INPUT "ENTER 'R' TO REDO LAST READINGS OR 'O' TO OVERRIDE PRECISION REQUIRE
MENTS",Over$
3031 IF Over$<>"R" AND Over$<>"O" THEN 3025
3032 IF Over$="R" THEN 1570
3041 PRINT TABXY(1,13),"
                        "
3042 PRINT TABXY(1,14),"
                        "
3043 PRINT TABXY(1,15),"
                        "
3045 PRINT TABXY(1,16),"
                        "
   60!COMPUTE FINAL AREAS AND VOLUME
3080 Ai=(INT(((Area1-Area)/2)*10000))/10000
3090 Af=INT((Ai*Hs*Vs)+.5)
3120 Av=INT(((Ai*Hs*Vs)/9)+.5)
3130 Acres=((INT(((Af/43560)+.0005)*1000))/1000)
3150 Vol=INT(((Af*Depth)/27)+.5)
3170 PRINT CHR$(129)
```

```
3180 IF Vol$="N" THEN PRINT TABXY(22,10),"AREAS"
3190 IF Vol$="Y" THEN PRINT TABXY(23,10),"AREA AND VOLUME"
3200 PRINT CHR$(12)
3230 PRINT TABXY(20,12),"AREA(SI)= ",Ai
3250 PRINT TABXY(20,13),"                                    "
3260 PRINT TABXY(20,13),"AREA(SF)= ",Af
3270 PRINT TABXY(20,14),"AREA(SY)= ",Ay,"              "
3290 PRINT TABXY(20,15),"AREA(ACRES)= ",Acres,"          "
3300 PRINT TABXY(20,16),"                                    "
3310 IF Vol$="Y" THEN PRINT TABXY(20,17),"VOLUME(CY)= ",Vol
3320 IF Over$="0" THEN PRINT TABXY(1,18),"NOTE: A PRECISION OVERRIDE OF ",Dr,"%
WAS ACCEPTED FOR THIS AREA"
3330 !TEST FOR HARD COPY
3350 IF Hc$="N" THEN 3890
3370 !PRINTING SUBROUTINE
3390 DISP "PLEASE WAIT UNTIL PRINTING IS COMPLETE"
3410 PRINTER IS 701
3430 !LOOK AT PRINTER FLAG FOR 0 OR C
3450 IF Pi$="C" THEN 3690
3470 PRINT CHR$(27)&"(s5hu1P"
3481 IF Vol$="N" THEN PRINT "            AREA COMPUTATIONS"
3490 IF Vol$="Y" THEN PRINT "      AREA AND VOLUME COMPUTATIONS"
3510 PRINT "          WARZYN ENGINEERING INC."
3530 PRINT CHR$(27)&"(s10hubP"
3550 PRINT "USER INITIALS: ",Nn$,TAB(60),"DATE: ",Da$
3570 PRINT
3590 PRINT "*PROJECT INFORMATION*",TAB(45),"*INITIALIZATION DATA*"
3610 PRINT "PROJECT NAME: ",Pn$,TAB(45),"HORZ. SCALE(FT/IN): ",Hs
3630 PRINT "PROJECT NUMBER: ",Pr$,TAB(45),"VERT. SCALE(FT/IN): ",Vs
3640 PRINT TAB(45),"PRECISION(%): ",Prec
3650 !SET PRINTER FLAG TO COMPLETE(C)
3670 Pi$="C"
3690 PRINT
3710 PRINT
3730 PRINT "AREA ID.:     ",Ai$
3750 IF Vol$="Y" THEN PRINT "VOLUME TYPE: ",Vt$
3760 IF Vol$="Y" THEN PRINT "AVERAGE DEPTH(FT)= ",Depth
3770 PRINT "AREA(SI)=     ",Ai
3790 PRINT "AREA(SF)=     ",Af
3800 PRINT "AREA(SY)=     ",Ay
3810 PRINT "AREA(ACRES)= ",Acres
3830 IF Vol$="Y" THEN PRINT "VOLUME(CY)= ",Vol
3840 IF Over$="0" THEN PRINT "NOTE: A PRECISION OVERRIDE OF ",Dr,"% WAS ACCEPTED
 FOR THIS AREA"
3850 PRINTER IS 1
3870 !TEST FOR ANOTHER COMPUTATION
3880 !RESET DUMMY$ TO NULL
3881 Dummy$=""
3890 INPUT "ENTER 'A' FOR ANOTHER RUN; 'R' TO RESTART PROGRAM; 'Q' TO QUIT",Dumm
y$
3910 IF Dummy$="A" THEN 1350
3920 IF Dummy$="R" THEN 425
3930 IF Dummy$="Q" THEN 3970
3940 GOTO 3890
3970 DISP "BYE    ------>>>>>>>>>>              PLEASE LOG IN YOUR TIME !!!!!! "
3990 END
```

CRESCENT DITCH/OVAL LAGOON
CONTAINMENT CELL

WARZYN
ENGINEERING INC

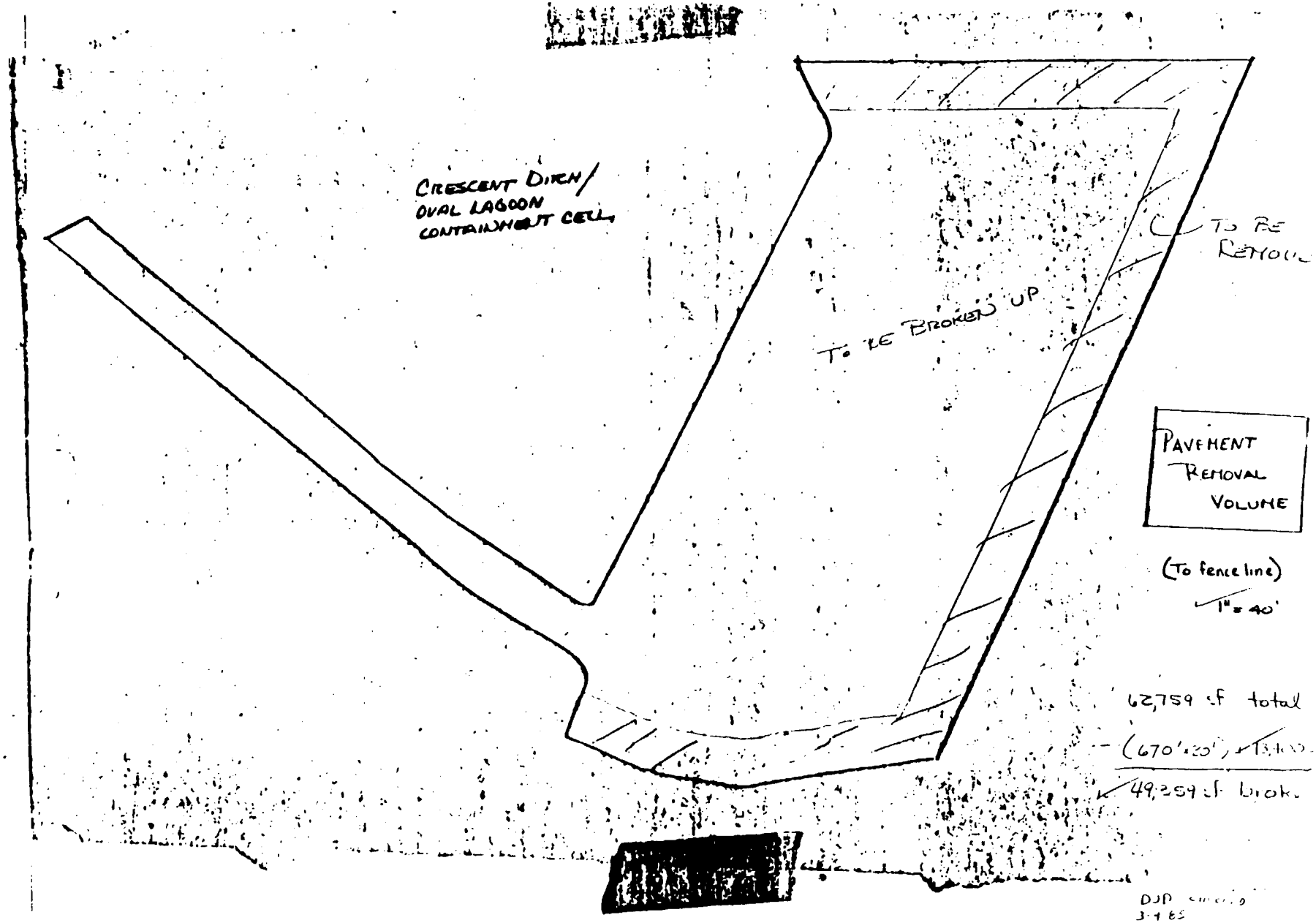
AREA COMPUTATIONS
WARZYN ENGINEERING INC.

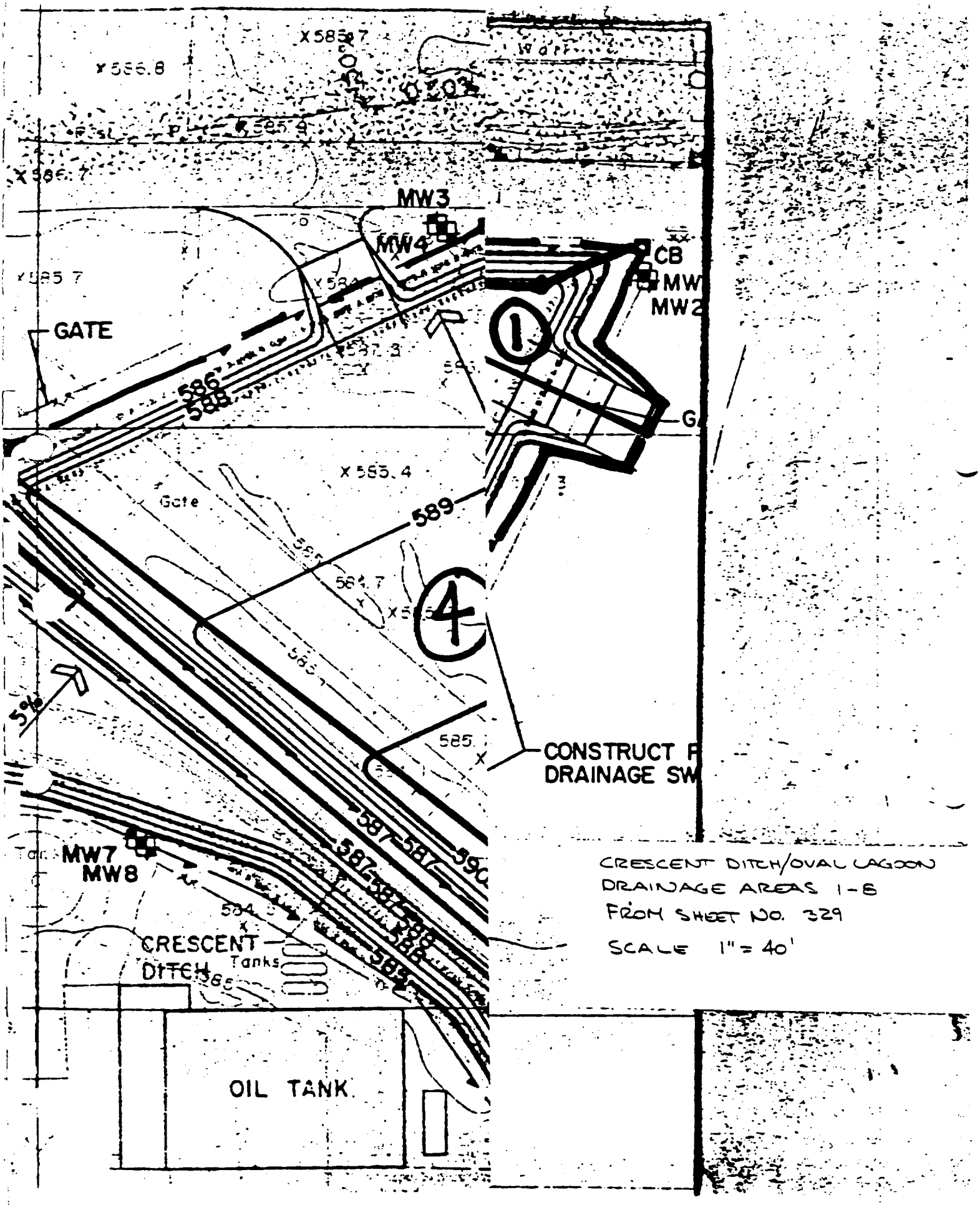
USER INITIALS: LAB / DJD CHECKED 3-4-85 DATE: 2-6-85

PROJECT INFORMATION
PROJECT NAME: OMC
PROJECT NUMBER: 11837

INITIALIZATION DATA
HORZ. SCALE(FT/IN): 40
VERT. SCALE(FT/IN): 40
PRECISION(%): 98

AREA ID.: PAVEMENT REMOVAL VOLUME - CRESCENT DITCH/OVAL LAGOON AREA
AREA(SI)= 39.2242
AREA(SF)= 62759 SF ✓
AREA(SY)= 6973
AREA(ACRES)= 1.441


CRESCENT DITCH/
OVAL LAGOON
CONTAINMENT CELL
TO BE REMOVED
TO BE BROKEN UP
PAVEMENT
REMOVAL
VOLUME
(To fence line)
1" = 40'
62,759 sf total
(670'x20') 13,500 sf removed
49,259 sf broke up
DJP
3-9-85


MW3
MW4
CB
MW
MW2
GATE
586
588
589
Gate
5%
CONSTRUCT F
DRAINAGE SW
MW7
MW8
587
590
CRESCENT
DITCH
Tanks
OIL TANK
1
4
CRESCENT DITCH/OVAL LAGOON
DRAINAGE AREAS 1-6
FROM SHEET NO. 329
SCALE 1" = 40'

CRESCENT DITCH
OVAL LAGOON

AREA COMPUTATIONS
WARZYN ENGINEERING INC.

USER INITIALS: LAB / DJD, CHECKED 3-9-85 DATE: 2-14-85

PROJECT INFORMATION
PROJECT NAME: OMC
PROJECT NUMBER: 11837

INITIALIZATION DATA
HORZ. SCALE(FT/IN): 40
VERT. SCALE(FT/IN): 40
PRECISION(%): 98

AREA ID.: FINAL COVER AREA
AREA(SI)= 62.1356
AREA(SF)= 99417
AREA(SY)= 11046
AREA(ACRES)= 2.282

ADD TO ABOVE: BERM AREA (FINAL COVERS IT)

24' × 1890' = 45,360 sf ✓

99417 sf
45360 sf
144,777 sf = 3.32 ACRES

DRAINAGE AREAS
CRESCENT DITCH/OVAL LAGOON

AREA COMPUTATIONS
WARZYN ENGINEERING INC.

USER INITIALS: LAB DJD CHECKED 3-4-85 DATE: 2-28-85

PROJECT INFORMATION
PROJECT NAME: OMC
PROJECT NUMBER: 11837

INITIALIZATION DATA
HORZ. SCALE(FT/IN): 40
VERT. SCALE(FT/IN): 40
PRECISION(%): 98

AREA ID.: DRAINAGE AREA 1
AREA(SI) = 1.7258
AREA(SF) = 2761
AREA(SY) = 307
AREA(ACRES) = .063
NOTE: A PRECISION OVERRIDE OF 95.86 % WAS ACCEPTED FOR THIS AREA

AREA ID.: AREA 2
AREA(SI) = 3.0194
AREA(SF) = 4831
AREA(SY) = 537
AREA(ACRES) = .111
NOTE: A PRECISION OVERRIDE OF 97.24 % WAS ACCEPTED FOR THIS AREA

AREA ID.: AREA 3
AREA(SI) = 14.5486
AREA(SF) = 23278
AREA(SY) = 2586
AREA(ACRES) = .534

AREA ID.: AREA 4
AREA(SI) = 18.4715
AREA(SF) = 29554
AREA(SY) = 3284
AREA(ACRES) = .678

AREA ID.: AREA 5
AREA(SI) = 8.6574
AREA(SF) = 13852
AREA(SY) = 1539
AREA(ACRES) = .318

AREA ID.: AREA 6
AREA(SI) = 13.8553
AREA(SF) = 22168
AREA(SY) = 2463
AREA(ACRES) = .509

AREA ID.: AREA 7
AREA(SI) = 6.1336
AREA(SF) = 9814

AREA(SY)= 1090
AREA(ACRES)= .225
NOTE: A PRECISION OVERRIDE OF 96.04 % WAS ACCEPTED FOR THIS AREA

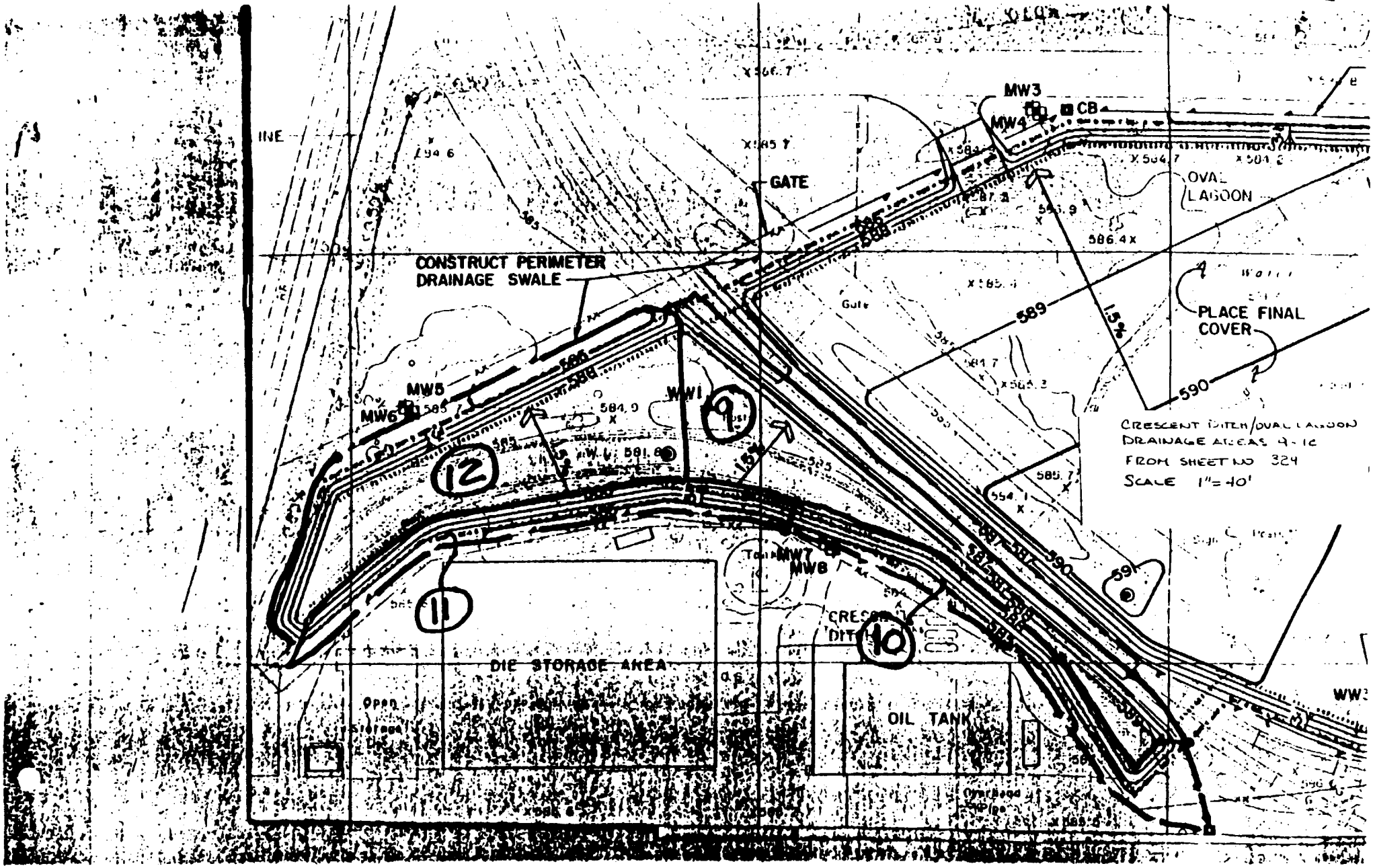
AREA ID.: AREA 8
AREA(SI)= 9.0958
AREA(SF)= 14553
AREA(SY)= 1617
AREA(ACRES)= .334

AREA ID.: AREA 9
AREA(SI)= 6.1515
AREA(SF)= 9842
AREA(SY)= 1094
AREA(ACRES)= .226
NOTE: A PRECISION OVERRIDE OF 97.59 % WAS ACCEPTED FOR THIS AREA

AREA ID.: AREA 10
AREA(SI)= 2.4826
AREA(SF)= 3972
AREA(SY)= 441
AREA(ACRES)= .091

AREA ID.: AREA 11
AREA(SI)= 2.7397
AREA(SF)= 4384
AREA(SY)= 487
AREA(ACRES)= .101
NOTE: A PRECISION OVERRIDE OF 97.99 % WAS ACCEPTED FOR THIS AREA

AREA ID.: AREA 12
AREA(SI)= 8.2471
AREA(SF)= 13195
AREA(SY)= 1466
AREA(ACRES)= .303


MW3
CB
MW4
GATE
OVAL LAGOON
CONSTRUCT PERIMETER DRAINAGE SWALE
PLACE FINAL COVER
589
590
15%
MW5
MW6
MW1
MW7
MW8
12
9
11
10
CRESCENT DITCH/OVAL LAGOON
DRAINAGE AREAS 9-12
FROM SHEET NO 324
SCALE 1"=40'
DIE STORAGE AREA
OIL TANK

PARKING LOT CONTAINMENT CELL

WARZYN

PLATEAU AREA

PARKING LOT CONTAINMENT

AREA COMPUTATIONS
WARZYN ENGINEERING INC.

USER INITIALS: LAB/DJD CHECKED 3-9-85 DATE: 2-19-85

PROJECT INFORMATION
PROJECT NAME: OMC
PROJECT NUMBER: 11837

INITIALIZATION DATA
HORZ. SCALE(FT/IN): 40
VERT. SCALE(FT/IN): 40
PRECISION(%): 98

AREA ID.: PAVEMENT AREA
AREA(SI) = 111.9198
AREA(SF) = 179072
AREA(SY) = 19897
AREA(ACRES) = 4.111

SMALL RIPRAP

PARKING LOT CONTAINMENT CELL

AREA COMPUTATIONS
WARZYN ENGINEERING INC.

USER INITIALS: LAB / DJD CHECKED 3-4-85 DATE: 2-19-85

PROJECT INFORMATION
PROJECT NAME: OMC
PROJECT NUMBER: 11837

INITIALIZATION DATA
HORZ. SCALE(FT/IN): 40
VERT. SCALE(FT/IN): 40
PRECISION(%): 98

AREA ID.: RIPRAP NEAR SHORE
AREA(SI)= 6.6976
AREA(SF)= 10716
AREA(SY)= 1191
AREA(ACRES)= .246

ALONG SHORE
A = 10716 + 24885 = 35,601 sf
x 1.05 to account for the 3:1 slope
35,601 x 1.05 = 37,381 sf

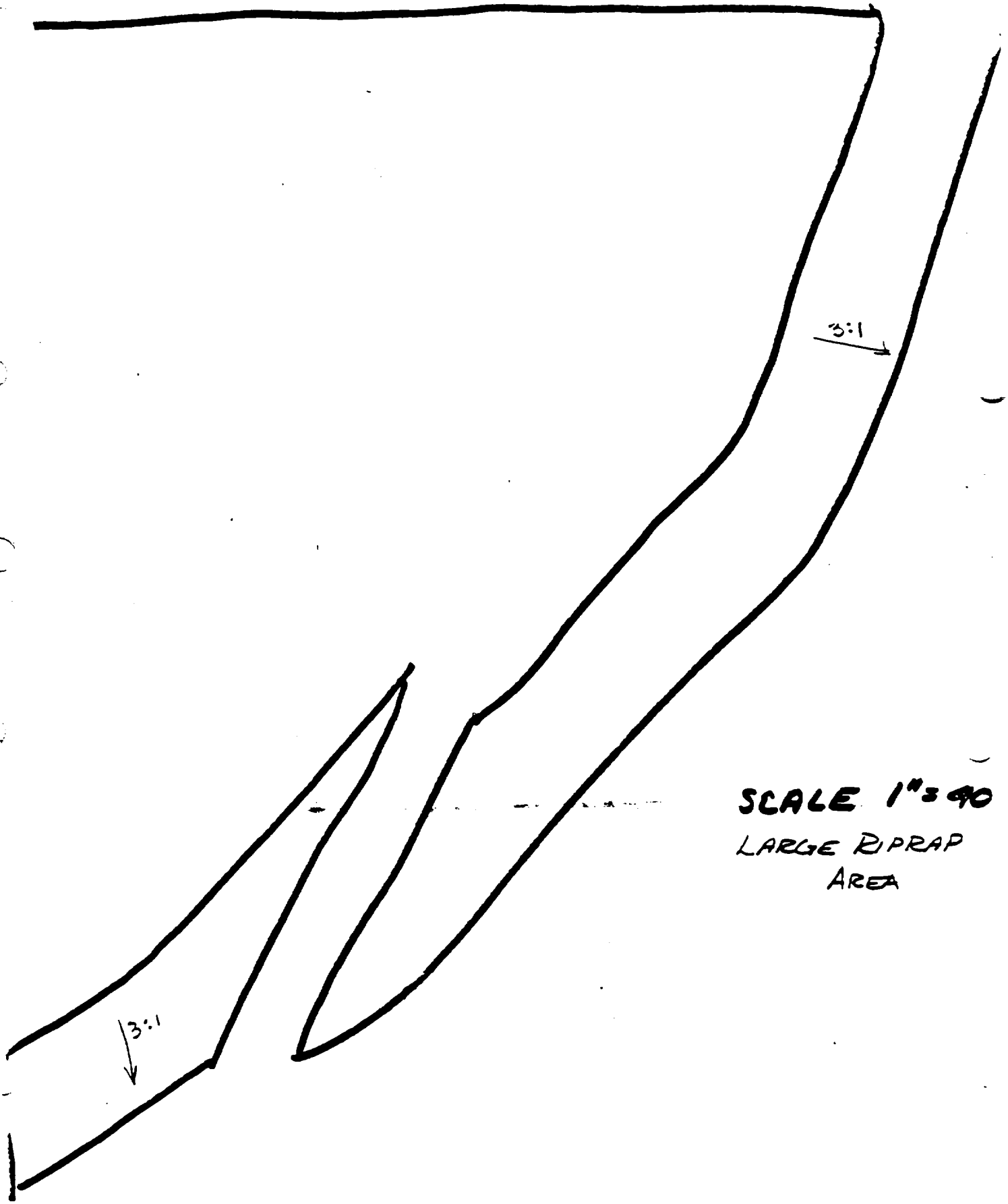
AREA ID.: RIPRAP NEAR SHORE
AREA(SI)= 15.5533
AREA(SF)= 24885
AREA(SY)= 2765
AREA(ACRES)= .571
NOTE: A PRECISION OVERRIDE OF 97.54 % WAS ACCEPTED FOR THIS AREA

AREA ID.: RIPRAP AWAY FROM SHORE
AREA(SI)= 28.9871
AREA(SF)= 46379
AREA(SY)= 5153
AREA(ACRES)= 1.065

AWAY FROM SHORE
A = 46,379 + 20,776 = 67,155 sf
x 1.05 = 70,512 sf

AREA ID.: RIPRAP AWAY FROM SHORE
AREA(SI)= 12.9851
AREA(SF)= 20776
AREA(SY)= 2308
AREA(ACRES)= .477

TOTAL AREA = 107,893 sf for small riprap



SCALE 1"=40

LARGE RIPRAP AREA

PARKING LOT
LARGE RIPRAP AREA

AREA COMPUTATIONS
WARZYN ENGINEERING INC.

USER INITIALS: LAB / DJD CHECKED 3-4-85 DATE: 3-1-85

PROJECT INFORMATION
PROJECT NAME: OMC
PROJECT NUMBER: 11837

INITIALIZATION DATA
HORZ. SCALE(FT/IN): 40
VERT. SCALE(FT/IN): 40
PRECISION(%): 98

AREA ID.: LARGE RIPRAP AREA
AREA(SI)= 15.1095
AREA(SF)= 24175 ✓
AREA(SY)= 2686
AREA(ACRES)= .555

AREA ID.: LARGE RIPRAP AREA
AREA(SI)= 3.0577
AREA(SF)= 4892 ✓
AREA(SY)= 544
AREA(ACRES)= .112
NOTE: A PRECISION OVERRIDE OF 97.6 % WAS ACCEPTED FOR THIS AREA

AREAS = (24,175 + 4,892) × 1.05 = 30,500 sf ✓

for 3:1 sideslope

AREA COMPUTATIONS
WARZYN ENGINEERING INC.

USER INITIALS: LAB / DJD CHECKED 3-4-85 DATE: 3-1-85

PROJECT INFORMATION
PROJECT NAME: OMC
PROJECT NUMBER: 11837

INITIALIZATION DATA
HORZ. SCALE(FT/IN): 40
VERT. SCALE(FT/IN): 40
PRECISION(%): 98

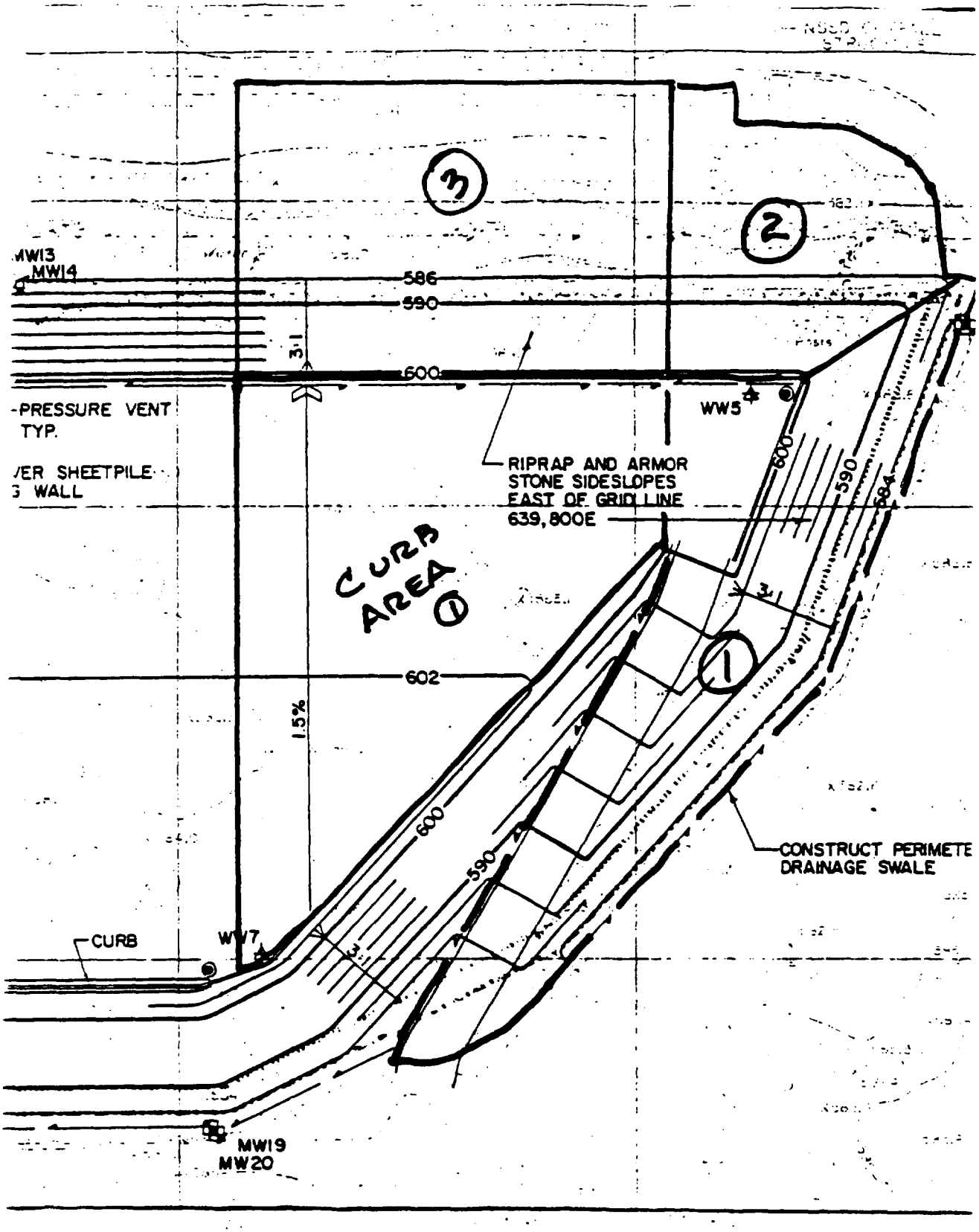
AREA ID.: DRAINAGE AREA 1
AREA(SI)= 13.2813
AREA(SF)= 21250 ✓
AREA(SY)= 2361
AREA(ACRES)= .488

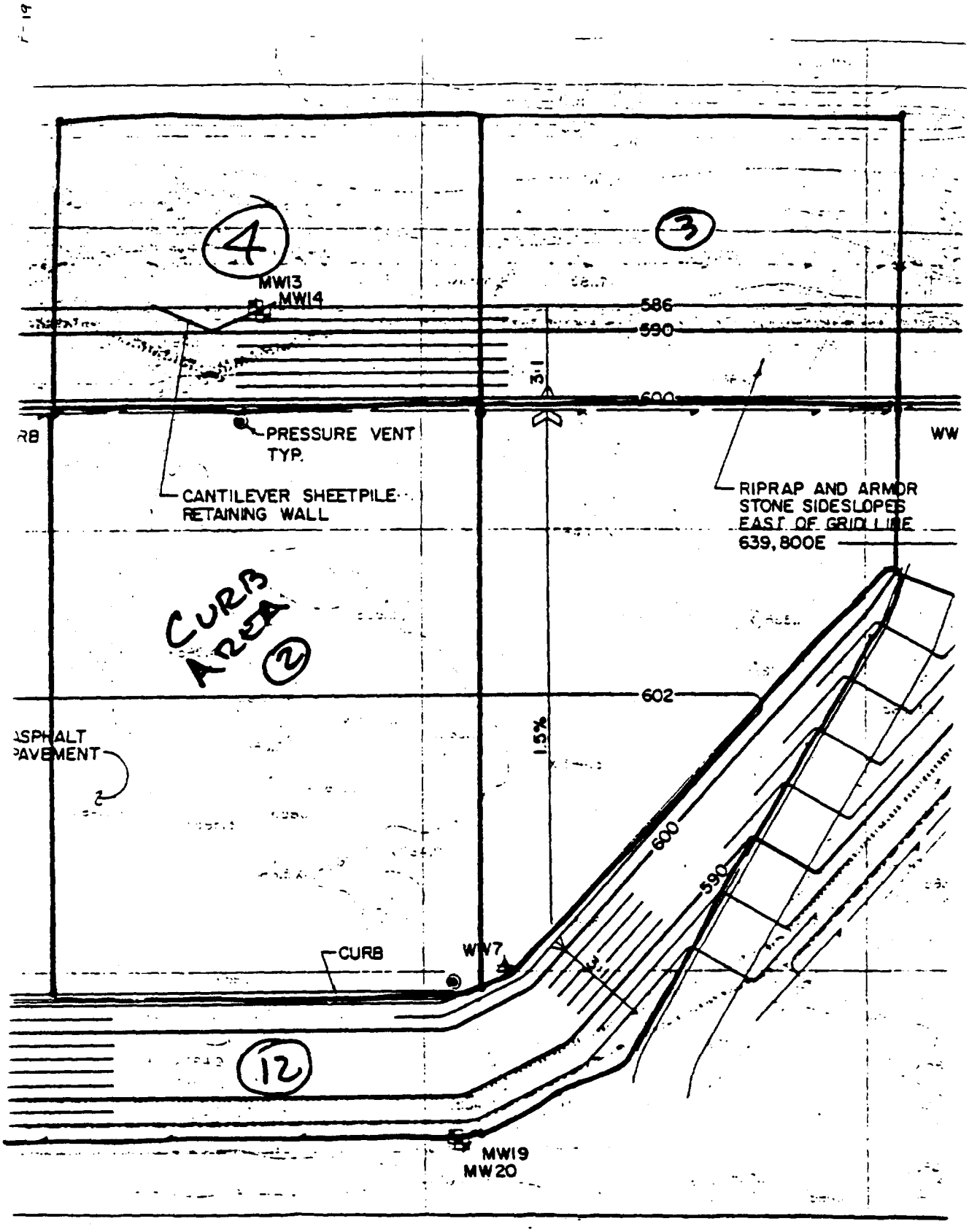
See attached print

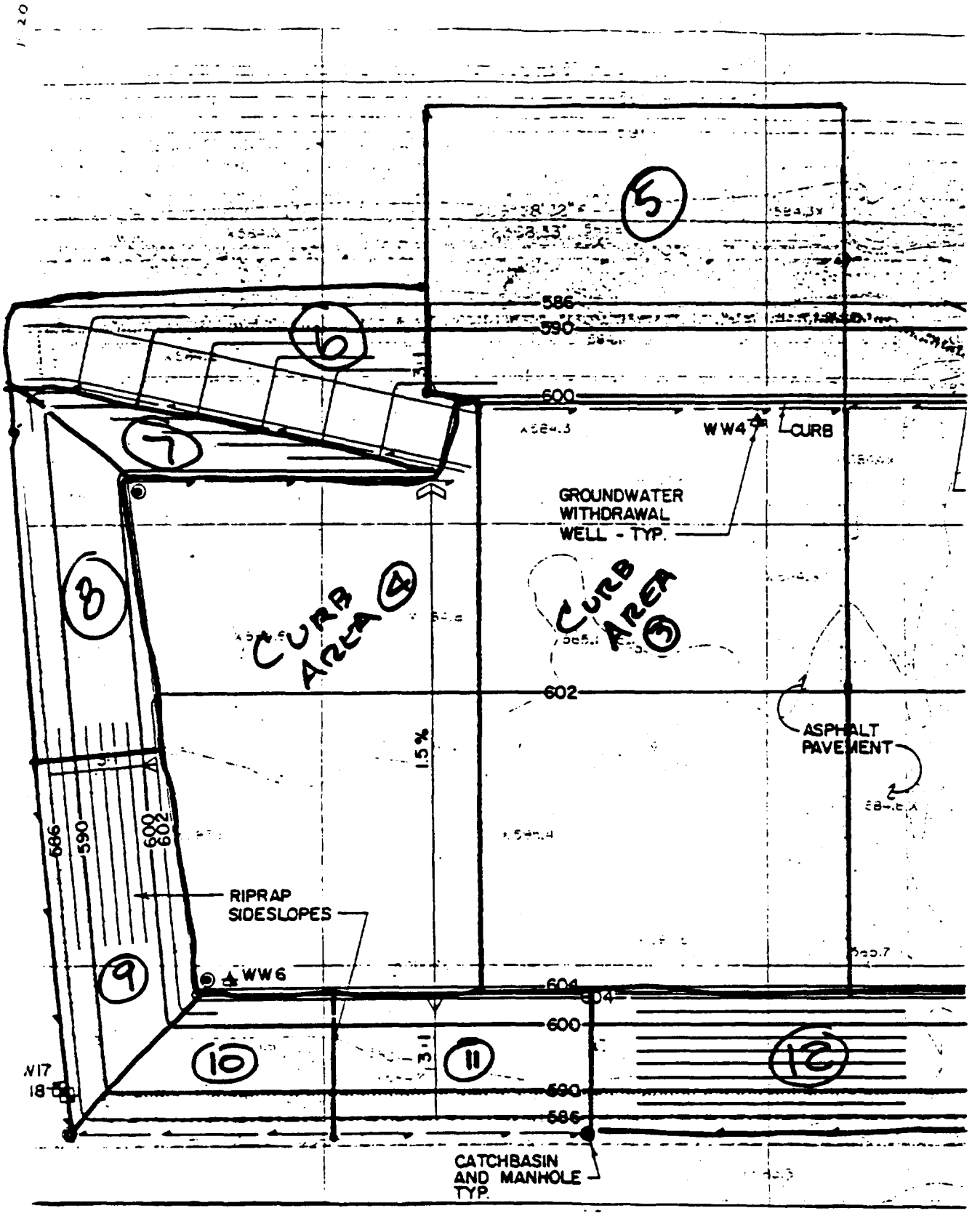
[REFER TO DRAINAGE CALCULATION SECTION FOR AREAS 3-11]

AREA ID.: DRAINAGE AREA 2
AREA(SI)= 7.5418
AREA(SF)= 12067 ✓
AREA(SY)= 1341
AREA(ACRES)= .277

AREA ID.: DRAINAGE AREA 12
AREA(SI)= 24.701
AREA(SF)= 39522 ✓
AREA(SY)= 4391
AREA(ACRES)= .907


3
2
1
MW13
MW14
586
590
600
3:1
-PRESSURE VENT
TYP.
/ER SHEETPILE
3 WALL
WW5
RIPRAP AND ARMOR
STONE SIDESLOPES
EAST OF GRID LINE
639,800E
CURB
AREA
602
1.5%
600
590
584
CONSTRUCT PERIMETE
DRAINAGE SWALE
CURB
WW7
MW19
MW20


4
3
MW13
MW14
586
590
600
3:1
PRESSURE VENT
TYP.
RB
WW
CANTILEVER SHEETPILE
RETAINING WALL
RIPRAP AND ARMOR
STONE SIDESLOPES
EAST OF GRID LINE
639,800E
CURB
AREA
2
602
ASPHALT
PAVEMENT
1.5%
600
590
CURB
WW7
3:1
12
MW19
MW20


5
6
7
8
9
10
11
12
586
590
600
602
604
WW4
CURB
GROUNDWATER
WITHDRAWAL
WELL - TYP.
CURB
AREA 4
CURB
AREA 3
ASPHALT
PAVEMENT
1.5%
3:1
RIPRAP
SIDESLOPES
WW6
N17
18
CATCHBASIN
AND MANHOLE
TYP.

PARKING LOT
DRAINAGE AREAS
FOR CURB DEPTH

AREA COMPUTATIONS
WARZYN ENGINEERING INC.

USER INITIALS: LAB / DJD CHECKED 3-4-85 DATE: 3-1-85

PROJECT INFORMATION
PROJECT NAME: OMC
PROJECT NUMBER: 11837

INITIALIZATION DATA
HORI. SCALE(FT/IN): 40
VERT. SCALE(FT/IN): 40
PRECISION(D): 98

AREA ID.: PARKING LOT DRAINAGE TO CURB - 1 (SEE PREVIOUS DRAWING)
AREA(SI)= 22.4567
AREA(SF)= 35931
AREA(SY)= 3992
AREA(ACRES)= .825

AREA ID.: DRAINAGE AREA 2 TO CURB
AREA(SI)= 31.2902
AREA(SF)= 50064
AREA(SY)= 5563
AREA(ACRES)= 1.149

AREA ID.: DRAINAGE AREA 3 TO CURB
AREA(SI)= 27.7959
AREA(SF)= 43655
AREA(SY)= 4817
AREA(ACRES)= .995

AREA ID.: DRAINAGE AREA 4 TO CURB
AREA(SI)= 21.5091
AREA(SF)= 34465
AREA(SY)= 3829
AREA(ACRES)= .791

APPENDIX G
DRAINAGE CALCULATIONS

WARZYN
ENGINEERING INC

CRESCENT DITCH/OVAL LAGOON
CONTAINMENT CELL

WARZYN
ENGINEERING INC

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY LAB DATE 2-26-85 SUBJECT QMC DRAINAGE CALCULATIONS SHEET NO. 1 OF 15
CHKD. BY DJL DATE 3-1-85 CONCEPT SUBMITTAL JOB NO. 1183J
CRESCENT DITCH/OVAL LAGOON AREA

APPENDIX G

12 drainage areas are to be considered. See areas in Appendix F.

AREA 1 = .06 Acre
AREA 2 = .11 Acre
AREA 3 = .53 Acre
AREA 4 = .68
AREA 5 = .32
AREA 6 = .51
AREA 7 = .23
AREA 8 = .33
AREA 9 = .23
AREA 10 = .09
AREA 11 = .10
AREA 12 = .30

} see computer comps. in Appendix F

Design Assumptions

Calcs. will be based on volume of water that results from a 24-hour, 25-year storm per Subpart N of 40 CFR 264.

Flows will be calculated using the Rational Formula

$$Q = CiA$$

where

Q = flow (cfs)

C = runoff coefficients for specified land use
C = .70 - .95 for asphalt (See Fig. 2, Detail E, p9
we will use C = .85 (see NOTE - Fig. 2)

i = rainfall intensity for the 25-year, 24-hr storm.
i = 5.7 in/day (see Table 3, p 10-3)

A = area (acres)

Only flows within the modified grades were evaluated here. Additional areas will be evaluated for final design after site access to determine actual drainage patterns.

WARZYN ENGINEERING, INC.
MADISON WISCONSIN

BY LAB DATE 2-26-85 SUBJECT DMC DRAINAGE CALCS SHEET NO. 2 OF 15
CHKD. BY DJQ DATE 3-6-85 CONCEPT SUBMITTAL JOB NO. 11837
CRESCENT DITCH/OVAL LAGOON

Calculation of intensity for each area
(See Fig. 15.23, p 11)

1. $t_c = 65'/2.5$ (1.5%, paved) + $40'/5.25$ (7%, paved) + $55'/1.4$ (.5%)
= 1.2 min
$i < .65$ in (See Table 1, p 10-2) 12.5 in/hr

2. $t_c = 45'/2.5 + 15'/11.5$ (33%) + $200'/1.4 = 2.7$ min
$i < .65$ in

3 $t_c = 50'/2.5 + 15'/11.5 + 190'/1.4 = 2.6$ min
$i < .65$ in

4. $t_c = 220'/2.5 + 20/11.5 + 185/1.4 = 3.7$ min
$i < .65$ in

5 $t_c = 90'/2.5 + 20/11.5 + 90'/1.4 = 1.7$ min
$i < .65$ in

6. $t_c = 180'/2.5 + 15/11.5 + 110'/1.4 = 2.5$ min
$i < .65$ in

7. $t_c = 180'/2.5 + 30'/5.25 + 50'/1.4 = 1.9$ min
$i < .65$ in

8. $t_c = 20'/11.5 + 480'/1.4 = 5.7$ min
$i = .72$ in (interpolated from table 1)

9 $t_c = 70'/2.5 + 20'/11.5 + 350'/1.4 = 4.7$ min
$i < .65$ in

10 $t_c = 20'/11.5 + 260'/1.4 = 3.1$ min
$i < .65$

11. $t_c = 20'/11.5 + 270'/1.4 = 3.2$ min
$i < .65$

12. $t_c = 70'/2.5 + 20'/11.5 + 300'/1.4 = 4.1$ min
$i < .65$

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY LAB DATE 2-27-85 SUBJECT OMC DRAINAGE SHEET NO. 3 OF 15
CHKD. BY DJD DATE 3-6-85 CONCEPT SUBMITTAL JOB NO. 11837
CRESCENT DITCH/OVAL LAGOON

Calculation of Flow Q (cfs) $Q = c\,i\,A$

1. Q = .85 (.65 in/5min)(.06) × 60 = .40 cfs ✓
2. Q = .85 (.65)(.11) ÷ 5 × 60 = .73 cfs ✓
3. Q = .85 (.65) (.53) ÷ 5 × 60 = 3.51 cfs ✓
4. Q = .85 (.65) (.68) ÷ 5 × 60 = 4.51 cfs ✓ ← largest flow
5. Q = .85 (.65)(.32) ÷ 5 × 60 = 2.12 cfs ✓
6. Q = .85 (.65)(.51) ÷ 5 × 60 = 3.38 cfs ✓
7. Q = .85 (.65)(.23) ÷ 5 × 60 = 1.52 cfs ✓
8. Q = .85 (.72)(.33) ÷ 5 × 60 = 2.42 cfs ✓
9. Q = .85 (.65)(.23) ÷ 5 × 60 = 1.52 cfs ✓
10. Q = .85 (.65)(.09) ÷ 5 × 60 = .60 cfs ✓
11. Q = .85 (.65)(.10) ÷ 5 × 60 = .66 cfs ✓
12. Q = .85 (.65)(.30) ÷ 5 × 60 = 2.0 cfs ✓

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY LAB DATE 2-27-85 SUBJECT OMC DRAINAGE SHEET NO. 4 OF 15
CHKD. BY DJD DATE 3-6-85 CONCEPT SUBMITTAL JOB NO. 1837
CRESCENT DITCH/OVAL LAGOON

Ditch Calculations

Assume a V-ditch.

bottom width B = 0
sideslopes SS = 2:1
slope = .5%
} Assumptions

largest flow = 4.51 cfs

Manning's equation (see attached Water Resources Engr. p 272) (p 12 of this packet)

$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ $R = A/P$

n = .013 see table 10-1, p12 (FOR CONCRETE/ASPHALT)

assume y = .8'
A = 1.28 ft²
P = 3.6'
$R = \frac{1.28}{3.6} = .36$ ft
S = .005

$Q = \frac{1.49}{.013}(1.28)(.360)(.005)^{1/2} = 5.25$ cfs

Largest Q from page 3 is 4.51 cfs

so depth = .8'

Since the drainage areas are so small and the groundwater is only 2'-3' below existing surface, drainage swales will be designed with an approximate maximum depth of 0.8' and a maximum slope of 0.5%.

PARKING LOT CONTAINMENT CELL

WARZYN

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY LAB DATE 2-27-85 SUBJECT OMC DRAINAGE CALCS SHEET NO. 5 OF 15
CHKD. BY DJD DATE 3-7-85 CONCEPT SUBMITTAL JOB NO. 1837
PARKING LOT CONTAINMENT

There are 12 drainage areas to ditches to be sized

AREA 1 = .49 acres
2 = .28 acres
3 = 190×125 = .55 Acre
4 = 130×185 = .55
5 = 130×185 = .55
6 = (40×190) + (180×45/2) = .27

AREA 7 = .09 acres
8 = 150×60 = .21
9 = (170+100/2)×60 = .19
10 = (60+120/2)×80 = .17
11 = 80×120 = .22
12 = .91 Acres

Also See computer comps in Appendix F

Design Assumptions
24 hour, 25-year storm
$Q = CiA$
$C = .85$ (Fig 2, DETAIL B)

See Crescent Ditch/Oval Lagoon section

Calculation of Intensity (Fig 15.2 for fps values, p 11)

1. $t_c = 250'/5.25\ (7\%) + 440'/1.1\ (.5\%) = 7.5$ min
2. $t_c = 40'/8.5 + 25/0.5 + 50'/1.1 = 1.7$ min
3. $t_c = 40'/8.5\ (33\%) + 45/1.8\ (1.5\%) + 190/1.1\ (.5\%) = 3.9$ min
4. $t_c = 40'/8.5\ (33\%) + 50/1.8 + 185/1.1 = 3.3$ or $40/8.5 + 20/1.8 + 185/1.1 = 1.5$
5. $t_c = 40'/8.5 + 40/1.8 + 180/1.1 = 3.2$ min
6. $t_c = 200'/5.25 + 30/1.1 = 1.1$ min
7. $t_c = 40'/1.8 + 230'/5.25 = 1.1$ min.
8. $t_c = 60'/8.5 + 165'/1.1 = 2.6$ min
9. $t_c = 60/8.5 + 165/1.1 = 2.6$ min
10. $t_c = 65'/8.5 + 110/1.1 = 1.8$ min
11. $t_c = 65'/8.5 + 110/1.1 = 1.8$ min
12. $t_c = 260/5.25 + 380/1.1 = 6.6$ min

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY LAB DATE 2-28-85 SUBJECT SMG DRAINAGE SHEET NO. 6 OF 15
CHKD. BY DJO DATE 3-7-85 CONCEPT SUBMITTAL JOB NO. 11837
PARKING LOT CONTAINMENT

Find intensity values (using Table 1, p 10-2)

1. $i = .9 \text{ in} / 7.5 \text{ min} \times 60 \text{ min/hr} = 7.2 \text{ in/hr}$
2. $i < .65 \text{ in} / 5 \times 60 = 7.8 \text{ in/hr}$
3. $i < .65 / 5 \times 60 = 7.8 \text{ in/hr}$
4. $i < .65 / 5 \times 60 = 7.8 \text{ in/hr}$
5. $i < .65 / 5 \times 60 = 7.8 \text{ in/hr}$
6. $i < .65 / 5 \times 60 = 7.8 \text{ in/hr}$
7. $i < .65 / 5 \times 60 = 7.8 \text{ in/hr}$
8. $i < .65 / 5 \times 60 = 7.8 \text{ in/hr}$
9. $i < .65 / 5 \times 60 = 7.8 \text{ in/hr}$
10. $i < .65 / 5 \times 60 = 7.8 \text{ in/hr}$
11. $i < .65 / 5 \times 60 = 7.8 \text{ in/hr}$
12. $i < 1.09 / 9.9 \times 60 = 7.0 \text{ in/hr}$

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY LAB DATE 2-28-85 SUBJECT OMC DRAINAGE SHEET NO. 7 OF 15
CHKD. BY DJD DATE 3-7-85 CONCEPT SUBMITTAL JOB NO. U837
PARKING LOT CONTAINMENT

Calculation of flow Q (cfs) $Q = ciA$

1. $Q = .85(7.2)(.49) = 3.0$ cfs
2. $Q = .85(7.8)(.28) = 1.9$ cfs
3. $Q = .85(7.8)(.55) = 3.6$ cfs
4. $Q = .85(7.8)(.55) = 3.6$ cfs
5. $Q = .85(7.8)(.55) = 3.6$ cfs
6. $Q = .85(7.8)(.27) = 1.8$ cfs
7. $Q = .85(7.8)(.09) = 0.6$ cfs
8. $Q = .85(7.8)(.21) = 1.4$ cfs
9. $Q = .85(7.8)(.19) = 1.3$ cfs
10. $Q = .85(7.8)(.17) = 1.1$ cfs
11. $Q = .85(7.8)(.22) = 1.5$ cfs
12. $Q = .85(7.0)(.91) = 5.4$ cfs ← largest flow

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY LAB DATE 2-28-85 SUBJECT OHC DRAINAGE CALCS SHEET NO. 8 OF 15
CHKD. BY DJD DATE 3-7-85 CONCEPT SUBMITTAL JOB NO. 11837
PARKING LOT AREA

Ditch Calculations

V ditch :.
bottom width = 0
sideslopes SS = 2:1
Slope .5%
} Assumptions

largest flow = 5.4 cfs (see p 12)

Manning's Equation

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

$n = .025$

say $d = 1'$
$A = 2\ ft^2$ $P = 4.47\ ft$
$R = 2/4.47 = .447$

$Q_1 = 4.9$ cfs ✓

say $d = 1.1'$
$A = 2.4\ ft^2$ $P = 4.9\ ft$
$R = 2.4/4.9 = .49$

$Q_2 = 6.3$ cfs ✓

therefore depth y is between 1.1' and 1.0' say $d = 1.0'$

Drainage ditches will be designed with an approximate maximum depth of 1.0' and a slope of 0.5 %.

DETAIL A

RUNOFF COEFFICIENTS (C), RATIONAL FORMULA

Land Use	Percent Impervious Area	Hydrologic Soil Group A			B			C			D		
		Slope Range (Percent)			Slope Range (Percent)			Slope Range (Percent)			Slope Range (Percent)		
		0-2	2-6	6 & Over	0-2	2-6	6 & Over	0-2	2-6	6 & Over	0-2	2-6	6 & Over
Industrial	90	0.67 0.85	0.68 0.85	0.68 0.85	0.68 0.85	0.68 0.85	0.69 0.85	0.69 0.85	0.69 0.85	0.69 0.87	0.69 0.85	0.69 0.85	0.70 0.88
Commercial	95	0.71 0.89	0.71 0.89	0.72 0.89	0.71 0.89	0.72 0.89	0.72 0.89	0.72 0.89	0.72 0.89	0.72 0.90	0.72 0.89	0.72 0.89	0.72 0.90
High-Density Residential	60	0.47 0.58	0.48 0.60	0.50 0.61	0.48 0.59	0.50 0.61	0.52 0.64	0.49 0.60	0.51 0.62	0.54 0.66	0.51 0.62	0.53 0.64	0.56 0.69
Medium-Density Residential	30	0.25 0.33	0.28 0.37	0.31 0.40	0.27 0.35	0.30 0.39	0.35 0.44	0.30 0.38	0.33 0.42	0.38 0.49	0.33 0.41	0.36 0.46	0.42 0.54
Low-Density Residential	15	0.14 0.22	0.19 0.26	0.22 0.29	0.17 0.24	0.21 0.28	0.26 0.34	0.20 0.28	0.25 0.32	0.31 0.40	0.24 0.31	0.28 0.35	0.35 0.46
Agriculture	5	0.08 0.14	0.13 0.18	0.16 0.22	0.11 0.16	0.15 0.21	0.21 0.28	0.14 0.20	0.19 0.25	0.26 0.34	0.18 0.24	0.23 0.29	0.31 0.41
Open Space	2	0.06 0.11	0.10 0.16	0.14 0.20	0.08 0.14	0.13 0.19	0.19 0.26	0.12 0.18	0.17 0.23	0.24 0.32	0.16 0.22	0.21 0.27	0.28 0.38
Freeways and Expressways	70	0.67 0.70	0.68 0.71	0.69 0.72	0.68 0.71	0.69 0.72	0.71 0.74	0.68 0.72	0.71 0.73	0.73 0.76	0.69 0.73	0.72 0.75	0.74 0.78

Source: SEWRPC

DETAIL B

RUNOFF COEFFICIENTS FOR SPECIFIC LAND USE

	Hydrologic Soil Group A			B			C			D		
	Slope Range (Percent)			Slope Range (Percent)			Slope Range (Percent)			Slope Range (Percent)		
LAND USE:	0-2	2-6	6 & Over	0-2	2-6	6 & Over	0-2	2-6	6 & Over	0-2	2-6	6 & Over
Row crops	.08 .22	.16 .30	.22 .39	.12 .26	.20 .34	.27 .44	.15 .30	.24 .37	.33 .50	.19 .34	.28 .41	.38 .56
Median strip-turf	.19 .24	.20 .26	.24 .30	.19 .25	.22 .28	.26 .33	.20 .26	.23 .30	.30 .37	.20 .27	.25 .32	.30 .40
Side slope-turf			.25 .32			.27 .34			.28 .36			.30 .38
PAVEMENT:												
Asphalt	.70 - .95 also see note below											
Concrete	.80 - .95											
Brick	.70 - .80											
Drives, Walks	.75 - .85											
Roofs	.75 - .95											
Gravel Roads Shoulders	.40 - .60											

NOTE: The lower C values in each range should be used with the relatively low intensities associated with 2-to 10-year design recurrence intervals whereas the higher C values should be used for intensities associated with the longer 25-to 100-year design recurrence intervals.

G-10 10-1/15

STATE OF ILLINOIS
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Illinois State Water Survey

WATER RESOURCES BUILDING • MAIL BOX 232, URBANA, ILLINOIS 61801 • AREA CODE 217
605 E. SPRINGFIELD, CHAMPAIGN PHONE 333-2210

WILLIAM C. ACKERMANN, CHIEF

Subject: Technical Letter 13 December 1970
Rainfall Frequencies

This letter is a re-issue of Illinois rainfall frequency relations that were presented in Technical Letter 1 (February 1959) and Technical Letter 4 (March 1960), which are now out of print. These data remain valid and have been combined here for convenience.

Tables 1, 2, and 3 provide point frequencies of 5 to 60 minutes, 1 to 18 hours, and 1 to 10 days, respectively, for each of the four sections of the state (see figure 1) having similar storm rainfall characteristics. Values presented in the tables were developed from station records of maximum yearly rainfall, and represent maximum-period rather than clock-hour or calendar-day amounts. Amounts apply to a point location, and within 5 percent limits, to areas up to 10 square miles.

Use of the tables is illustrated by this example for table 1: Assume that one wishes to obtain an estimate of the maximum 30-minute rainfall amount that will be equaled or exceeded in an average 10-year period, or 5 times in 50 years, for any location in the Northwest Section. To obtain the desired rainfall value, enter table 1 at a recurrence interval of 10 years under the Northwest Section and move horizontally to the column for 30-minute storm periods. This procedure yields a value of 1.50 inches. Other combinations of recurrence interval and storm period within any section can be obtained in the same manner.

These frequency values are based on mathematical relations discussed in Water Survey Bulletin 46 by F. A. Huff and J. C. Neill and on data presented in U. S. Weather Bureau Technical Papers 24 and 25. If additional materials are desired, please let us know.

Very truly yours,

William C. Ackermann

William C. Ackermann

TABLE 1

AVERAGE RAINFALL FREQUENCY FOR STORM PERIODS

OF 5 TO 60 MINUTES

Average Recurrence Interval (years)	Depth (inches) for Given Storm Period (minutes) 5	10	15	20	30	40	50	60
Northwest Section								
2	0.35	0.55	0.70	0.80	0.95	1.10	1.20	1.25
5	0.40	0.70	0.90	1.05	1.25	1.40	1.55	1.65
10	0.50	0.90	1.10	1.25	1.50	1.70	1.90	2.00
25	0.65	1.15	1.40	1.60	1.95	2.25	2.45	2.60
50	0.75	1.35	1.65	1.90	2.35	2.65	2.95	3.15
100	0.90	1.50	1.90	2.20	2.65	3.00	3.30	3.55
North Central Section								
2	0.35	0.55	0.70	0.80	0.95	1.10	1.20	1.25
5	0.40	0.65	0.85	1.00	1.25	1.35	1.45	1.55
10	0.50	0.80	1.00	1.20	1.45	1.60	1.75	1.95
25	0.60	1.00	1.25	1.45	1.75	1.95	2.15	2.35
50	0.70	1.15	1.45	1.65	2.00	2.30	2.50	2.65
100	0.80	1.30	1.65	1.90	2.35	2.65	2.90	3.10
South Central Section								
2	0.35	0.55	0.70	0.80	0.95	1.10	1.20	1.25
5	0.40	0.70	0.90	1.05	1.25	1.40	1.55	1.65
10	0.50	0.85	1.05	1.25	1.50	1.65	1.80	1.95
25	0.65	1.10	1.35	1.60	1.95	2.20	2.40	2.55
50	0.80	1.30	1.65	1.90	2.35	2.65	2.90	3.10
100	0.95	1.55	1.90	2.20	2.70	3.10	3.40	3.60
Southeast Section								
2	0.35	0.60	0.75	0.90	1.05	1.15	1.25	1.35
5	0.45	0.75	0.95	1.15	1.35	1.55	1.65	1.80
10	0.55	0.90	1.15	1.35	1.60	1.85	2.00	2.15
25	0.70	1.15	1.45	1.70	2.05	2.35	2.50	2.65
50	0.85	1.40	1.75	2.05	2.50	2.85	3.10	3.25
100	1.05	1.70	2.10	2.45	3.00	3.40	3.70	3.95

TABLE 3

AVERAGE RAINFALL FREQUENCY FOR STORM PERIODS OF 1 TO 10 DAYS

Northwest Section

Average Recurrence Interval (years)	Depth (inches) for Given Storm Periods (days)				
	1	2	3	5	10
2	2.6	2.9	3.1	3.5	4.2
5	3.6	3.9	4.2	4.8	5.8
10	4.4	4.8	5.3	6.0	7.1
25	5.7	6.2	6.9	7.8	9.3
50	7.2	7.5	8.4	9.4	11.4
100	8.4	9.2	10.0	11.2	13.2

North Central Section

	1	2	3	5	10
2	2.6	2.8	3.0	3.4	4.1
5	3.4	3.7	4.0	4.5	5.5
10	4.0	4.4	4.8	5.6	6.7
25	5.1	5.6	6.2	7.0	8.5
50	6.1	6.6	7.3	8.2	9.9
100	7.2	7.9	8.7	9.9	11.8

South Central Section

	1	2	3	5	10
2	2.7	3.0	3.3	3.8	4.5
5	3.7	4.0	4.4	5.2	6.3
10	4.5	4.9	5.5	6.3	7.7
25	5.8	6.3	7.0	8.0	9.8
50	7.0	7.5	8.4	9.5	11.7
100	8.4	9.1	10.0	11.5	13.9

Southeast Section

	1	2	3	5	10
2	3.2	3.4	3.7	4.2	5.2
5	4.2	4.5	4.9	5.7	6.8
10	4.9	5.4	6.0	6.8	8.1
25	6.3	6.8	7.6	8.5	10.3
50	7.3	7.9	8.6	9.7	11.7
100	8.8	9.5	10.4	11.9	14.3

FROM TECHNICAL LETTER 13
RAINFALL FREQUENCIES
ILLINOIS STATE WATER SURVEY

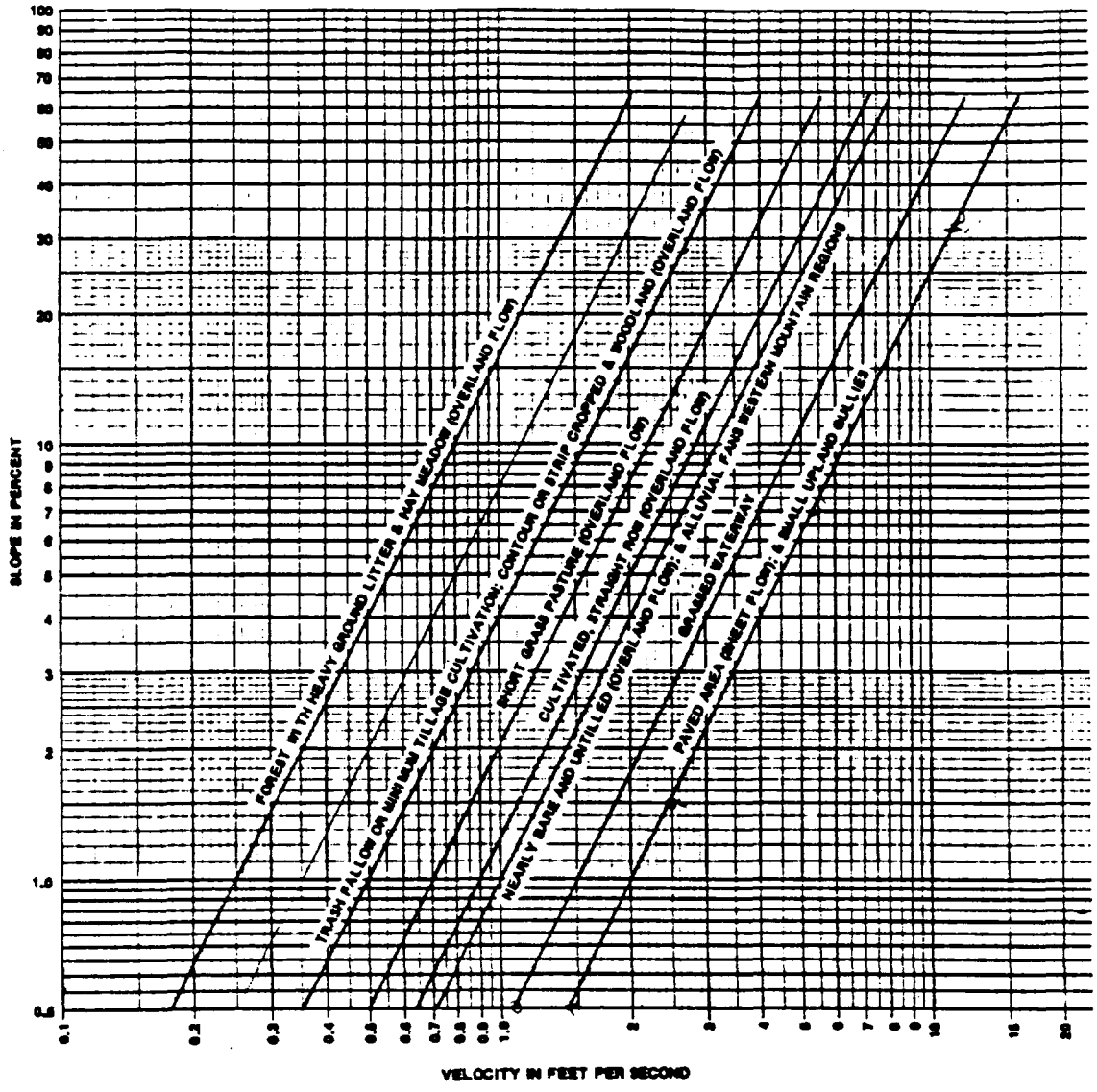


Figure 15.2.—Velocities for upland method of estimating T_c

2nd Edition
Linsley & Franzini

TABLE 10-1 Values of the Roughness Coefficient n

Channel material	*n*
Plastic, glass, drawn tubing	0.009
Neat cement, smooth metal	0.010
Planed timber, asbestos pipe	0.011
Wrought iron, welded steel, canvas	0.012
Ordinary concrete, asphalted cast iron	0.013
Unplaned timber, vitrified clay	0.014
Cast-iron pipe	0.015
Riveted steel, brick	0.016
Rubble masonry	0.017
Smooth earth	0.018
Firm gravel	0.023
Corrugated metal pipe	0.022
Natural channels in good condition	0.025
Natural channels with stones and weeds	0.035
Very poor natural channels	0.060

noted that V and Q are proportional to $1/n$ and S proportional to n^2 so that values from the nomograph may be readily adjusted to any other value of n.

A situation often encountered in hydraulic engineering, particularly in the case of sewers, is that of a closed conduit flowing partly full. Under this condition the liquid surface is at atmospheric pressure, and the flow is the same as that in an open channel. It is often inconvenient to compute R and A for partially full sections, and it is simpler to calculate V or Q for the pipe flowing full and to adjust to partly full conditions by use of a chart[1] such as Fig. 10-3. When the depth of flow in a circular pipe increases above $0.8D$, the wetted perimeter increases more rapidly than the cross-sectional area because of the convergence of the pipe walls. Hence R, and consequently V, decreases. Maximum discharge occurs when $d = 0.94D$.

10-2 Normal depth Normal depth d_n is the depth at which uniform flow will occur in an open channel. Normal depth may be determined by writing the Manning equation for discharge,

$$Q = \frac{1.49}{n} AR^{2/3} S^{1/2} \tag{10-5}$$

and substituting for A and R expressions involving d and other necessary dimensions of the channel cross section. The resulting equation requires

[1] The roughness coefficient n varies somewhat with depth of flow. This variation is reflected in Fig. 10-3. See "Design and Construction of Sanitary and Storm Sewers," *ASCE Manual of Practice* 37, 2d ed., pp. 87–95, American Society of Civil Engineers, New York, 1969.

FIG. 10-3 Hydrau

a trial-and-error
depth may be co
10-3 Cri
is defined as tha
velocity head) is
depth occurs in a

$$\frac{Q^2}{g} = \frac{A^3}{B}$$

where B is the su
while on a steep
10-4 Nor
natural streams
channel. While
uniform cross sec
of topographic c
nonuniform flow
nonuniform flow
the head loss in
by uniform flow
are equal to the
points of the rea
10-4, substituting

[1] Various tables for
book of Hydraulics"

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY LAB DATE 3.1.85 SUBJECT ONC DRAINAGE CALCS SHEET NO. 13 OF 15
CHKD. BY DJD DATE 3-2-85 CONCEPT SUBMITTAL JOB NO. 1837
PARKING LOT PLATEAU TO CURB

TO FIND DEPTH (d) OF CURB

FIND Q where $Q = ciA$

$C = 0.85$ see Cres. Ditch calcs

FIND AREA - 4 DRAINAGE AREAS (See Appendix F)

AREA 1 = 0.83 acres
2 = 1.2 acres
3 = 1.0 acres
4 = 0.79 acres

FIND t_c

AREA 1 $t_c = 250/2.5$ (1.5% paved, see p 11 Fig 15.2) $+ 180/1.4$ (.5%)
$= 3.8$ min

AREA 2 $t_c = 260/2.5 + 180/1.4 = 3.9$ min

AREA 3 $t_c = 260/2.5 + 160/1.4 = 3.6$ min

AREA 4 $t_c = 230/2.5 + 140/1.4 = 3.2$ min

FIND Intensity i (See Table 1 of Ill. p 10-2 STATE WATER SURVEY)

AREA 1 $i = 0.65/5 \times 60 = 7.8$ in/hr
2 $i = 0.65/5 \times 60 = 7.8$ in/hr
3 $i = 0.65/5 \times 60 = 7.8$ in/hr
4 $i = 0.65/5 \times 60 = 7.8$ in/hr

FIND Flow Q

AREA 1 $Q = .85(7.8)(.83) = 5.5$ cfs
2 $Q = .85(7.8)(1.2) = 8.0$ cfs ← largest flow
3 $Q = .85(7.8)(1.0) = 6.6$ cfs
4 $Q = .85(7.8)(.79) = 5.2$ cfs

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY LAB DATE 3:1:85 SUBJECT CMC DRAINAGE SHEET NO. 14 OF 15
CHKD. BY DJD DATE 3-7-85 CONCEPT SUBMITTAL JOB NO. 1137
PARKING LOT PLATEAU TO CURB

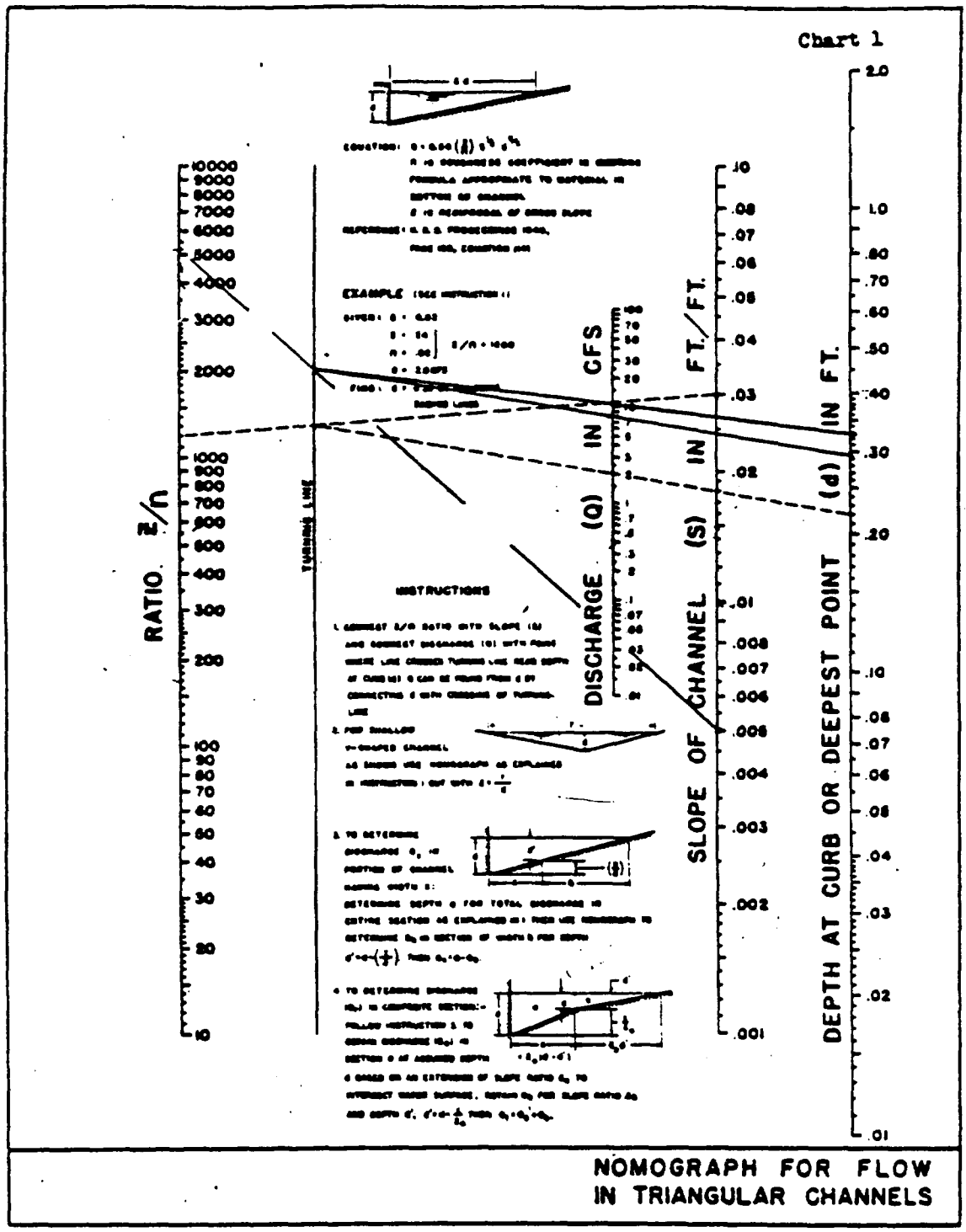
ESTIMATE DEPTH USING FIG. 1 'NOMOGRAPH FLOW IN TRIANGULAR CHANNELS
on page 15

MAX Q = 8.0 cfs
longitudinal slope = .005 ft/ft
cross slope = 1.5% = .015 ft/ft
Z = 1/.015 = 66.7
Z/n = 66.7/.013 where n = .013 for pavement (p 12)
= 5128

using nomograph (p 15)

d = .29 ft use d = 6" CURB

NOMOGRAGH FOR FLOW & DEPTH IN CHANNELS



NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS

APPENDIX H
DECONTAMINATION PROCEDURES

WARZYN
ENGINEERING INC

TECHNICAL MEMORANDUM

DATE: February 6, 1985

TO: Project File - Waukegan Harbor Cleanup

FROM: Ken Snell

SUBJECT: Decontamination Procedures

When handling and transferring hazardous materials attention must be given to proper decontamination of the equipment and personnel in order to minimize the possibility of offsite transport of contaminants. Decontamination areas must be located to reduce the need for contaminant movement. These locations may include:

1. Points of exit from the facility
2. Areas of material handling and transfer
3. Near temporary equipment

The actual location of the decontamination areas cannot be made until material handling procedures are finalized. However, it is anticipated that 3 or 4 decon areas may be required. These locations may include:

1. Slip 3 clamshell dredging area
2. Batch plant and curing cell transfer areas
3. North ditch excavation area
4. Parking lot disposal area

Decontamination areas will also have to be able to handle several types of equipment including:

1. Vehicles; transport trucks, construction/excavation equipment.

2. Temporary on-site equipment;cofferdam, sediment dispersal control device, batch plant, draglines, dredges, etc.

3. Personnel contamination.

Regardless of the items that need to be decontaminated several general procedures should be used. The final design of the decontamination stations and their locations will be determined once material handing schemes are finalized. Presented below are general procedures that should be included in the decontamination process.

Vehicle/Equipment Decontamination

In general, decontamination of vehicles and equipment should take place on a grating which overlies a concrete pad. The pad should be contoured to direct washing fluids to a catch area. Contained fluids could either be directed to the treatment plant or an absorbent could be used to fix the fluids which could then be disposed of off-site or in the parking lot area.

General decontamination procedures would include:

1. High pressure detergent wash with scrubbing when necessary. This step would remove all sediments from the equipment. Care must be taken to use only as much water as necessary and to keep splashing to a minimum.

2. water rinse

3. Wipe test. This step should not be necessary on all equipment leaving the site but a periodic schedule should be implemented to insure sufficient decon is being done.

4. Absorb washing solutions and dispose of.

Equipment that will be necessary at the decon station will include; water supply, detergent, brushes, absorbent, waste containers, emergency eyewash unit, first aid supplies, air monitoring equipment, wind speed/direction indicator, wipe test equipment, and personnel decontamination equipment.

Personnel Decontamination

Procedures for personnel decon and monitoring should be addressed in the SSSP. Presented here are some general procedures. The actual setup needs to be coordinated with the consultant doing the SSSP.

General Procedures:

1. Soap and water wash of hands, feet, and any other areas which may have contacted contaminated sediments.

2. Water rinse, and remove respirator for cleaning.

3. Remove disposable gloves, boots and coveralls and contain for disposal.

4. Decontaminate respirators.

Equipment would include; water supply, wash tubs and buckets, brushes, waste containers, extra disposable clothing, and first aid and emergency equipment.

KS/lkw

APPENDIX I
FIXATION STUDIES

WARZYN
ENGINEERING INC

TECHNICAL MEMORANDUM

DATE: February 22, 1985

TO: Project File - Waukegan Harbor Cleanup

FROM: Loren Trick

SUBJECT: Warzyn Engineering - Waukegan Harbor Cleanup
Fixation of Dredging Material from Waukegan Harbor

Introduction

This memorandum summarizes our laboratory evaluation of the effectiveness of cement and pozzolanic fly ash in removing free water from Waukegan Harbor sediment. The term fixation in this memorandum means the removal of free water. The purposes of the testing were to: (1) Define the physical properties of the fixed materials and establish the approximate quantity of agent necessary to produce a solid easily handled and transported for disposal, (2) Estimate the impact of oil content of the sediment on the effectiveness of the fixation agents, (3) Estimate the effect of change in water content of sediment on the fixation process, (4) Estimate the effect of change in silt to sand ratio in the sediment on the fixation process, (5) Estimate the relative cost associated with each fixation agent. This information will be used as general guidance by the contractor responsible for cleanup actions in the Waukegan Harbor. It was specifically not the purpose of this work to evaluate the ability of the fixation agents to reduce the leachability of PCBs from the sediment solids.

Physical and Chemical Properties of Harbor Samples

Sediment samples were collected at two harbor locations on November 19, 1984, by USEPA personnel and shipped to Donohue & Associates' laboratory in Sheboygan, Wisconsin. The chain of custody record is in Appendix A. Three drums were received November 20, 1984: Two contained samples and the third contained contaminated equipment. The two sample drums were labeled as follows:

Station No. 1 At outfall northwest corner.
Station No. 2 At corner of Slip 3 and harbor.

Initial observations of the dredged materials showed that some sedimentation had occurred. Approximately 20 percent by volume of each sample was clear supernatant liquid. The drums were thoroughly mixed and samples withdrawn for grain size analysis, total suspended solids, specific gravity, oil and grease, and PCB analysis. Laboratory results are shown in Appendix B and summarized in Table 1.

Fixation Test Procedures

Fixation studies were conducted using portland cement and fly ash. The cement was Type I material obtained from Lone Star Industries, Waukegan terminal. Fly ash was Type C pozzolanic, cementitious material obtained from National Minerals Corporation, Pleasant Prairie, Wisconsin.

Each of the harbor dredgings was tested for degree of solidification using increasing quantities of cement or fly ash. The amount of agent added was based on the weight of water in the sample and ranged in magnitude from 20 percent to 100 percent.

Initial tests were made using two inch diameter by four inch high plastic cylinders for molds. It was necessary to extrude the fixed material from the molds for observation and relative strength measurements. This proved difficult, therefore all subsequent tests were molded in nine ounce (266 ml) paper cups. Cups were convenient for blending the sample and fixation agent, and the cured material unmolded easily for inspection.

For each, the drum of dredged material was thoroughly blended, a sample was withdrawn and mixed with the desired agent, placed in a plastic storage chest for humidity control, and cured at approximately 20 degrees C. The sample was removed at intervals for observation and physical measurements. Record photos were taken at the conclusion of each test and representative samples were retained. The overall increase in volume was measured for representative admixtures and the bulk density of the excavated fixed material was estimated.

Relative strength measurements were taken using a SOILTEST Model CL-700 pocket penetrometer calibrated in tons per square foot. Determination of flowable consistency was made using the liquid limit device specified in ASTM Method D-423-66. A small amount of fixed material was broken up, placed on the pan, and dropped repeatedly (up to 60 drops maximum). The sample was classified as flowable if free water was observed, the material acted as a fluid, and sample voids were observed to close.

The test procedures were applied to the dredged materials as received and on the material adjusted as follows:

1. The dredged materials were diluted with tap water to obtain a sample with 25 percent solids.

2. Ten percent by volume of waste hydraulic oil was added to the dredged material to simulate potential pockets of oily sediment.

3. One hundred percent (dry weight of sediment basis) of sand was added to simulate dredgings with silt:sand ratios less than the samples as received.

Results

The results of the testing are shown on Tables 2 and 3.

The testing was conducted using material from Stations No. 1 and 2. Each fixation agent was evaluated in increments from 20 to 100 percent by weight of water in the dredgings. The amount of agent is indicated in the test sample number. The testing also attempted to determine if changes in water, oil (PCB), or sand content would significantly affect solidification.

Based on the results of the test series, the following general statements can be made:

1. Either fly ash or portland cement can be utilized as a fixation agent for the dredged materials.

2. Cement is usable in the approximate range 40 to 60 percent by weight of water in the dredgings. More fly ash, 50 to 70 percent, is needed to achieve the same degree of solidification. If less than these minimum amounts of either cement or fly ash are used, the sample will not solidify and will contain a significant amount of free water after curing. When greater amounts of agent are used, the sample will cure into a solid mass which may be difficult to excavate from the curing cell.

3. Samples prepared with cement continued to harden over time and reached significant strength after 48 hours. The reaction using fly ash was very rapid, 15 minutes to one hour, but no significant increase in strength was seen after 24 hours.

4. Samples which were diluted with water to 25 percent solids (W) were much softer after 24 hours of curing than unaltered samples at the same fixation agent to water ratio. This was true for both cement and fly ash mixtures. The diluted samples mixed with cement continued to harden, however, and achieved a relative strength comparable to the unaltered dredgings after 48 hours.

5. The addition of sand produced cured samples with slightly increased strengths relative to samples without added sand. This was true for both cement and fly ash, although the differences were more marked for those samples using cement as the fixation agent.

6. The addition of oil to a dredged material sample mixed with 50 percent cement (center of usable range) produced a slightly weaker but otherwise satisfactory fixed material.

7. Within the acceptable ranges of fixation agent:water ratios (0.4-0.6 cement, 0.5-0.7 flyash) the material after curing 24 hours was generally soft to medium hard, crumbly, damp material which could be easily broken and handled.

8. The undisturbed fixed material had a specific gravity of between 1.3 and 1.5 g/cubic cm, and exhibited a volume increase of 15 to 20 percent. The material as transported may have a lower bulk density.

Conclusions

It has been demonstrated that either portland cement or pozzolanic fly ash is feasible for use as a fixation agent for the Waukegan harbor dredged material within the approximate range of 40 to 70 percent by weight of water.

The rapid curing of fly ash relative to cement mixtures offers an advantage in the use of fly ash in that the agent-to-sediment ratio may be adjusted during the work day based on observation of the cured material. The effect of changes in sediment water content, texture, or other physical changes on the characteristics of the cured material may be evaluated rapidly and easily. It appears that the use of fly ash is especially advantageous when very wet dredgings are being handled. More fly ash than normal can be added to produce an acceptable cured material under these conditions. Cement mixtures can achieve the desired fixed material strength at unchanged agent-to-sediment ratios but will require longer curing times than material containing less water. This could result in decreased work effort to allow for longer time in the curing cells. An increase in the cement-to-sediment ratio is not the correct action under wetter conditions since this could result in the formation of a cured material which would be solid and difficult to handle.

Changes in oil or sand content appear to cause only minor changes in the characteristics of the fixed material, whereas changes in water content will cause more of an impact on the daily fixation process.

Recommendations

We recommend the use of fly ash (Type C, pozzolonic, cementitious) as the fixation agent for the Waukegan Harbor dredgings. Based on the volume of dredgings to be removed, the estimated water content, and an average requirement for fixation agent of 50 percent, about 2,400 tons of agent will be required. Because

fly ash offers the advantages discussed above, and because the cost is considerably less than cement ($12.00/ton versus $72.00/ton for cement, bulk F.O.B. Waukegan Harbor), a material cost savings of about $150,000 is possible. Although approximately 4 percent more material (by volume and mass) must be transported and disposed when fly ash is used as an agent, for a total cost increase of $69,000, an overall net savings of $75,000 will still be realized. This savings may be more substantial since the rapid curing properties of fly ash mixtures will allow the contractor to continuously monitor the curing material and minimize the fly ash requirement.

LCT/psk

EAGY/DUO

APPENDIX A
CHAIN OF CUSTODY RECORD

ENVIRONMEI PROTECTION AGENCY
Office of Enforcement

RE d b
230 South L rborn Street
Chicago, Illinois 60604

CHAIN OF CUSTODY RECORD

PROJ. NO.: 5-841 11-05
PROJECT NAME: Waukegan HARBOR
SAMPLERS: (Signature) Dean Lees

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	Soil Collection Sed. Disposal						REMARKS: CUSTODY SEAL	TAG #
1	11-14-84	1145	V		AT OUTFALL N.W. Corner	1 drum	V						13059 + 13381	46645
2	11-14-84	1245	V		At Corner of Slip 3 + Harbor	1 drum	V						13399 20457	46646
					Contaminated Equipment	1 drum		V						

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Dean Lees	11/20/84 0850	Richard Steinberg			
Richard Steinberg	11/20/84 1200	Lauren Soltys			
Lauren Soltys	11/14/85 1200	Loren C. Trick			

Received for Laboratory by: (Signature) Loren C. Trick — Date / Time: 1/14/85 1200

Remarks: [illegible]

Distribution: White - Accompanies Shipment; Pink - Coordinator Field Files; Yellow - Laboratory File

E 9810

APPENDIX B
LABORATORY RESULTS

TABLE 1

RESULTS OF PHYSICAL AND CHEMICAL ANALYSIS

OF WAUKEGAN HARBOR SEDIMENT SAMPLES

	Station No. 1	Station No. 2
Percent Solids	35.85	50.0
Specific Gravity	1.15	1.41
PCB, mg/kg	8,200	500
Oil & Grease, % dry solids	1.22	0.184

EAGY/DW7

Donohue

Warzyn

ATTN: Mr. Loren C. Trick

PROJECT NUMBER: 13935.902
COLLECTION DATA: Submitted by Client
SAMPLE TAKEN: 02-12-85
SAMPLE RECEIVED: 02-12-85

SAMPLE NO. 19395 SAMPLE DESCRIPTION Station No. 1

PCB - Sediment/Tissue	8,200	mg/kg
Oil & Grease	1.22	percent
Percent Total Solids	35.8	percent

SAMPLE NO. 19396 SAMPLE DESCRIPTION Station No. 2

PCB - Sediment/Tissue	500	mg/kg
Oil & Grease	0.184	percent
Percent Total Solids	50.0	percent

Donohue Analytical, Inc.
4738 North 40th Street
Sheboygan, Wisconsin 53081
Analytical & Field Services
414-458-8711

Analyses performed in accordance with procedures approved by the U.S. EPA.

Jerome F. Ford 2/26/85

Project Manager Date

TABLE 2

RESULTS OF FIXATION STUDIES ON
DREDGED HARBOR SEDIMENTS
STATION No. 1

Test Sample Number	Harbor Station Number	Water Added	Oil Added	Sand Added	Fixation Agent	Cure Time, hrs	Penetrometer* Reading	Description
1-40C	1	No	No	No	Cement	24	0 (F)	Very soft, wet, sticky
1-50C	1	No	No	No	Cement	24	2.0	Soft, crumbly, moist
1-60C	1	No	No	No	Cement	24	2.0	Soft, crumbly, moist
1-70C	1	No	No	No	Cement	24	3.0	Medium hard, crumbly, dry
1-40F	1	No	No	No	Fly Ash	24	0 (F)	Very soft, wet, sticky
1-50F	1	No	No	No	Fly Ash	24	0 (F)	Soft, crumbly, moist
1-60F	1	No	No	No	Fly Ash	24	0	Soft, crumbly, moist
1-70F	1	No	No	No	Fly Ash	24	1.0	Soft, crumbly, damp
W1-40C	1	Yes	No	No	Cement	24	0 (F)	Very soft, wet, sticky
W1-50C	1	Yes	No	No	Cement	24	0 (F)	Very soft, wet, sticky
W1-60C	1	Yes	No	No	Cement	24	0 (F)	Soft, crumbly, moist
W1-70C	1	Yes	No	No	Cement	24	1.5	Soft, crumbly, moist
W1-40F	1	Yes	No	No	Fly Ash	24	0 (F)	Very soft, set, sticky
W1-50F	1	Yes	No	No	Fly Ash	24	0 (F)	Very soft, set, sticky
W1-60F	1	Yes	No	No	Fly Ash	24	0 (F)	Very soft, set, sticky
W1-70F	1	Yes	No	No	Fly Ash	24	1.0	Soft, crumbly, moist
1S-30C	1	No	No	Yes	Cement	24	0	Soft, crumbly, sticky
1S-40C	1	No	No	Yes	Cement	24	0	Soft, crumbly, moist
1S-50C	1	No	No	Yes	Cement	24	1.0	Soft, crumbly, moist
1S-60C	1	No	No	Yes	Cement	24	4.5	Hard, dry
1S-30F	1	No	No	Yes	Fly Ash	24	0	Very soft, wet, sticky
1S-40F	1	No	No	Yes	Fly Ash	24	0	Soft, crumbly, moist
1S-50F	1	No	No	Yes	Fly Ash	24	0	Soft, crumbly, moist
1S-60F	1	No	No	Yes	Fly Ash	24	1.0	Soft, crumbly, moist
1-40C	1	No	No	No	Cement	96	0	Soft, crumbly, damp
1-50C	1	No	No	No	Cement	96	3.5	Medium hard, crumbly, damp
1-60C	1	No	No	No	Cement	96	3.5	Medium hard, crumbly, damp
1-70C	1	No	No	No	Cement	96	4.5	Hard, dry
1-40F	1	No	No	No	Fly Ash	96	0	Very soft, moist, sticky
1-50F	1	No	No	No	Fly Ash	96	0	Very soft, moist, sticky
1-60F	1	No	No	No	Fly Ash	96	0.5	Soft, crumbly, moist
1-70F	1	No	No	No	Fly Ash	96	1.0	Soft, crumbly, damp

TABLE 2
(Continued)

Test Sample Number	Harbor Station Number	Water Added	Oil Added	Sand Added	Fixation Agent	Cure Time, hrs	Penetrometer[A] Reading	Description
W1-40C	1	Yes	No	No	Cement	96	0	Very soft, crumbly, moist
W1-50C	1	Yes	No	No	Cement	96	0	Soft, crumbly, moist
W1-60C	1	Yes	No	No	Cement	96	2.5	Medium hard, crumbly, damp
W1-70C	1	Yes	No	No	Cement	96	4.0	Hard, dry
W1-40F	1	Yes	No	No	Fly Ash	96	0 (F)	Very soft, wet, sticky
W1-50F	1	Yes	No	No	Fly Ash	96	0	Very soft, wet, sticky
W1-60F	1	Yes	No	No	Fly Ash	96	0	Soft, crumbly, moist
W1-70F	1	Yes	No	No	Fly Ash	96	1.0	Soft, crumbly, damp
1S-30C	1	No	No	Yes	Cement	96	0	Soft, crumbly, moist
1S-40C	1	No	No	Yes	Cement	96	2.0	Soft, crumbly, damp
1S-50C	1	No	No	Yes	Cement	96	3.5	Soft, crumbly, damp
1S-60C	1	No	No	Yes	Cement	96	4.5	Medium hard, crumbly, damp
1S-30F	1	No	No	Yes	Fly Ash	96	0 (F)	Very soft, wet, sticky
1S-40F	1	No	No	Yes	Fly Ash	96	0 (F)	Very soft, crumbly, moist
1S-50F	1	No	No	Yes	Fly Ash	96	0	Soft, crumbly, moist
1S-60F	1	No	No	Yes	Fly Ash	96	0	Soft, crumbly, moist

[A](F) denotes sample is flowable.

EAGY/DW8

TABLE 3
RESULTS OF FIXATION STUDIES ON
WAUKEGAN HARBOR SEDIMENTS
STATION NO. 2

Test Sample Number	Harbor Station Number	Water Added	Oil Added	Sand Added	Fixation Agent	Cure Time, hrs	Penetrometer[A] Reading	Description
2-20C-1	2	No	No	No	Cement	24	0 (F)	Very soft, wet, sticky
2-20C-2	2	No	No	No	Cement	24	0 (F)	Very soft, wet, sticky
2-30C-1	2	No	No	No	Cement	24	0 (F)	Soft, wet, sticky
2-30C-2	2	No	No	No	Cement	24	0.4	Soft, wet, sticky
2-W30C-1	2	Yes	No	No	Cement	24	1.0	Soft, slightly wet, sticky
2-030C	2	No	Yes	No	Cement	24	0.5	Soft, slightly wet, sticky
2-W030C	2	Yes	Yes	No	Cement	24	1.0	Soft, slightly wet, sticky
2-S30C	2	No	No	Yes	Cement	24	4.5	Crumbly, damp
2-WS30C	2	Yes	No	Yes	Cement	24	4.5	Crumbly, damp
2-40C-1	2	No	No	No	Cement	24	0	Soft, slightly wet, sticky
2-40C-2	2	No	No	No	Cement	24	0	Soft, crumbly, moist
2-50C-1	2	No	No	No	Cement	24	1.5	Medium hard, crumbly, moist
2-50C-2	2	No	No	No	Cement	24	4.0	Medium hard, crumbly, moist
2-W50C	2	Yes	No	No	Cement	24	2.8	Medium hard, moist
2-050C	2	No	Yes	No	Cement	24	1.0	Soft, crumbly, moist
2-W050C	2	Yes	Yes	No	Cement	24	2.0	Soft, crumbly, moist
2-60C-1	2	No	No	No	Cement	24	1.5	Medium hard, crumbly, moist
2-60C-2	2	No	No	No	Cement	24	3.5	Medium hard, crumbly, damp
2-70C	2	No	No	No	Cement	24	4.5	Hard, dry
2-80C	2	No	No	No	Cement	24	4.5	Crumbly, dry, hard
2-100C	2	No	No	No	Cement	24	4.5	Crumbly, dry, hard
W2-20C[AA]	2	Yes	No	No	Cement	24	0 (F)	Very soft, wet, sticky
W2-30C-2	2	Yes	No	No	Cement	24	0 (F)	Very soft, wet, sticky
W2-40C	2	Yes	No	No	Cement	24	0 (F)	Soft, wet, sticky
W2-50C	2	Yes	No	No	Cement	24	0	Medium hard, wet
W2-60C	2	Yes	No	No	Cement	24	1.5	Medium hard, moist
W2-70C	2	Yes	No	No	Cement	24	1.5	Medium hard, moist
2-20F-1	2	No	No	No	Fly Ash	24	0 (F)	Very soft, wet, sticky
2-20F-2	2	No	No	No	Fly Ash	24	0 (F)	Very soft, wet, sticky
2-30F	2	No	No	No	Fly Ash	24	0 (F)	Very soft, wet, sticky
2-40F-1	2	No	No	No	Fly Ash	24	0 (F)	Very soft, wet, sticky
2-40F-2	2	No	No	No	Fly Ash	24	0 (F)	Soft, crumbly, wet

TABLE 3
(Continued)

Test Sample Number	Harbor Station Number	Water Added	Oil Added	Sand Added	Fixation Agent	Cure Time, hrs	Penetrometer^ Reading	Description
2-50F	2	No	No	No	Fly Ash	24	1.0	Soft, crumbly, moist
2-60F-1	2	No	No	No	Fly Ash	24	0.3	Soft, crumbly, moist
2-60F-2	2	No	No	No	Fly Ash	24	2.0	Soft, crumbly, damp
2-70F	2	No	No	No	Fly Ash	24	3.0	Medium hard, crumbly, damp
2-80F	2	No	No	No	Fly Ash	24	0.5	Crumbly, moist
2-100F	2	No	No	No	Fly Ash	24	0.5	Crumbly, moist
W2-20F^AAA	2	Yes	No	No	Fly Ash	24	0 (F)	Very soft, wet, sticky
W2-30F	2	Yes	No	No	Fly Ash	24	0 (F)	Very soft, wet, sticky
W2-40F	2	Yes	No	No	Fly Ash	24	0 (F)	Soft, crumbly, wet
W2-50F	2	Yes	No	No	Fly Ash	24	0 (F)	Soft, crumbly, moist
W2-60F	2	Yes	No	No	Fly Ash	24	1.5	Soft, crumbly, moist
W2-70F	2	Yes	No	No	Fly Ash	24	1.5	Soft, crumbly, moist
2-20C	2	No	No	No	Cement	48	0 (F)	Very soft, wet, sticky
2-30C	2	No	No	No	Cement	48	1.0	Soft, crumbly, moist
2-40C	2	No	No	No	Cement	48	3.0	Medium hard, crumbly, damp
2-50C	2	No	No	No	Cement	48	3.5	Medium hard, crumbly, damp
2-60C	2	No	No	No	Cement	48	4.5	Crumbly, dry, hard
2-70C	2	No	No	No	Cement	48	4.5	Crumbly, dry, hard
W2-20C	2	Yes	No	No	Cement	48	0 (F)	Very soft, wet, sticky
W2-30C	2	Yes	No	No	Cement	48	0 (F)	Very soft, wet, sticky
W2-40C	2	Yes	No	No	Cement	48	0.5 (F)	Soft, wet, sticky
W2-50C	2	Yes	No	No	Cement	48	2.0	Crumbly, moist
W2-60C	2	Yes	No	No	Cement	48	4.5	Hard, damp
W2-70C	2	Yes	No	No	Cement	48	4.5	Hard, damp
2-20F	2	No	No	No	Fly Ash	48	0 (F)	Very soft, wet, sticky
2-30F	2	No	No	No	Fly Ash	48	0 (F)	Soft, crumbly, wet
2-40F	2	No	No	No	Fly Ash	48	0 (F)	Soft, crumbly, wet
2-50F	2	No	No	No	Fly Ash	48	1.5	Soft, crumbly, moist
2-60F	2	No	No	No	Fly Ash	48	2.0	Soft, crumbly, damp
2-70F	2	No	No	No	Fly Ash	48	3.0	Medium hard, crumbly, damp
W2-20F	2	Yes	No	No	Fly Ash	48	0 (F)	Very soft, wet, sticky
W2-30F	2	Yes	No	No	Fly Ash	48	0 (F)	Very soft, wet, sticky
W2-40F	2	Yes	No	No	Fly Ash	48	0 (F)	Soft, crumbly, wet
W2-50F	2	Yes	No	No	Fly Ash	48	0 (F)	Soft, crumbly, moist
W2-60F	2	Yes	No	No	Fly Ash	48	0 (F)	Medium hard, crumbly, moist
W2-70F	2	Yes	No	No	Fly Ash	48	0 (F)	Medium hard, crumbly, moist

TABLE 3
(Continued)

Test Sample Number	Harbor Station Number	Water Added	Oil Added	Sand Added	Fixation Agent	Cure Time, hrs	Penetrometer^ Reading	Description
2-20C-1	2	No	No	No	Cement	144	0.5	Very soft, wet, sticky
2-40C-1	2	No	No	No	Cement	144	4.5	Hard, crumbly,moist
2-60C-1	2	No	No	No	Cement	144	4.5	Hard, crumbly, dry
2-80C	2	No	No	No	Cement	144	4.5	Hard, cannot extrude from mold
2-100C	2	No	No	No	Cement	144	4.5	Hard, cannot extrude from mold
2-20F-1	2	No	No	No	Fly Ash	144	0	Very soft, wet, sticky
2-40F-1	2	No	No	No	Fly Ash	144	0.3	Very soft, wet, sticky
2-60F-1	2	No	No	No	Fly Ash	144	1.5	Soft, crumbly, moist
2-80F	2	No	No	No	Fly Ash	144	3.5	Medium hard, crumbly, moist
2-100F	2	No	No	No	Fly Ash	144	4.5	Hard, dry

^(F) denotes sample is flowable.
^^All tests in W2-C series: Insufficient cement to adsorb all water.
Molds have 1/2 in. water layer at top.
^^^Tests W2-20, 30, 40: Insufficient fly ash to adsorb all water.
Molds have 1/2 in. water layer at top.

EAGY/DW8

APPENDIX J
VOLATILIZATION OF POLYCHLORINATED BIPHENYLS

WARZYN
ENGINEERING INC

TECHNICAL MEMORANDUM

DATE: February 15, 1985

TO: Project File - Waukegan Harbor Cleanup

FROM: Ken Snell

SUBJECT: Volatilization of Polychlorinated Biphenyls and Control Measures for Waukegan Harbor Cleanup

INTRODUCTION

Material handling operations which involve polychlorinated biphenyl (PCB) contaminated materials require precautions to minimize worker exposure. Toxic effects of PCBs will vary depending on concentration, duration of exposure and route of entry; therefore, each of these factors must be considered when evaluating handling procedures. Knowledge of PCB volatilization during dredging, dewatering, transportation, and other handling operations is required in order to reduce the potential for worker exposure. This technical memorandum is a discussion of the volatility of polychlorinated biphenyls as well as a discussion of materials which may be used to reduce the potential for volatilization. An analysis of specific questions related to the Waukegan Harbor cleanup is presented in Appendix A.

TECHNICAL INFORMATION

Polychlorinated biphenyls (PCBs) constitute a large class of compounds produced by the partial or complete chlorination of the biphenyl molecule. The molecular weight of PCBs ranges from 188-494, and vapor pressures are low, approximately 4.0×10^{-4} mmHg. Generally, compounds having high molecular weights and low vapor pressure are expected to have very low evaporation rates. However, a factor which is often overlooked that also affects evaporation is the activity coefficient.

Ideally, the concentration of a solute in the vapor phase above the solution is directly related to the concentration of the solute in the solution and its vapor pressure. This relationship is given in Raoult's Law as:

$$yi = \frac{(Xi)(Pvi)}{P} \qquad (1)$$

where; yi = mole fraction of component i in vapor phase
Xi = mole fraction of component i in liquid phase
Pvi = vapor pressure of component i
P = total pressure

For this equation to be accurate, the liquid phase must behave as an ideal solution and the vapor phase as an ideal gas. At atmospheric pressures the primary reason for departure from Raoult's Law is that the liquid phase does not conform to ideal solution behavior, this is the case in a PCB-water solution. PCB molecules are non-polar and quite large relative to the highly

polar water molecules. Thus, the intermolecular forces between the water molecules are much stronger than the forces between the water and PCB molecules, resulting in a large positive deviation from ideal behavior.

To account for the deviation from ideal, an activity coefficient term (Qi) is used. This term will modify equation 1 as:

$$yi = \frac{(Qi)(Xi)(Pvi)}{P} \qquad (2)$$

Therefore, when a solution has a high activity coefficient, the vapor phase concentration of the solute can be much greater than would be expected solely from vapor pressure data. For a PCB-water solution the activity coefficient is very high, with values reported as high as $4.8 \times 10^{+4}$. Therefore, PCBs, as well as other chlorinated hydrocarbons, potentially evaporate at high rates.

Mackay and Wolhoff (1973) utilized these equilibrium thermodynamic considerations to calculate the vapor composition of low solutility chlorinated hydrocarbons from aqueous solutions. A brief summary of some of their results is shown in Table 1.

TABLE 1

EVAPORATION PARAMETERS FOR VARIOUS PCBs AT 25°C

PCB	Solubility (mg/l)	Vapor Pressure (mmHg)	Half-life (τ)
Aroclor 1242 ($C_{12}H_7Cl_3$)	0.24	4.06×10^{-4}	5.96 hrs
Aroclor 1248 ($C_{12}H_6Cl_4$)	5.4×10^{-2}	4.94×10^{-4}	58.3 min
Aroclor 1254 ($C_{12}H_5Cl_5$)	1.2×10^{-2}	7.71×10^{-5}	1.2 min
Aroclor 1260 ($C_{12}H_4Cl_6$)	2.7×10^{-3}	4.05×10^{-5}	28.8 min

The half-life (τ) indicates the theoretical time for a 50 percent reduction in the concentration of the PCB from a saturated water solution, assuming a water column with one square meter surface area and one meter in depth. These half-lives indicate substantial volatilization of PCBs from the water column. However, in order to calculate these theoretical values several assumptions were required. Among these assumptions is that the contaminates (PCBs) are truly in solution, not in suspension, colloidal, ionic, complexed or absorbed. Also, the water column is assumed to be a homogeneous mixture with adequate mixing to keep the interface composition equal to the bulk concentration. Therefore, these half-lives would represent an ideal rate in the natural environment, with the actual rate dependent on turbulance, degradation and absorption.

In the natural environment, hydrophobic compounds (such as PCBs) can absorb to microorganisms or suspended particulate matter (collectively termed seston). At low concentrations, absorption of a contaminate can be adequately described by a partition coefficient as;

$$K = \frac{Ca}{Cw} \qquad (3)$$

where:

K = partition coefficient
Ca = concentration of contaminate on absorbent $\frac{\text{mg PCB}}{\text{g seston}}$
Cw = concentration of contaminate in the water at equilibrium $\frac{\text{mg PCB}}{\text{l water}}$

Griffin and Chian (1980) experimentally measured the partition coefficient for water soluble PCBs absorbed by several soil materials. They found a simple linear relationship can be used to describe the coefficient, which will yield a unique coefficient for each absorbent. Some experimental K values are summarized in Table 2.

TABLE 2

EXPERIMENTAL PARTITION COEFFICIENTS OF SEVERAL SOIL MATERIALS

Soil Material	Surface Area (m_2/g)	Sand %	Silt %	Clay %	Organic Carbon %	Partition Coefficient K
Med. Temp. Coal Char	253	-	-	-	74.04	1938
High Temp. Coal Char	44	-	-	-	76.62	1220
Catlin Silt Loam	26.5	11.6	60.9	27.2	4.73	532
Montmorillonite Clay	20.1	0	0	100	0.93	172
Ottawa Silica Sand	0.4	100	0	0	1.01	22

The concentration of PCBs in an aquatic system can be strongly influenced by the extent of absorption. This influence has been described by Paris (1978) as;

$$Ct = K(M/W)Cd + Cd$$

where;

Ct = Dissolved concentration and absorbed concentration of PCB
Cd = Dissolved concentration of PCB
M = Mass of seston
W = Mass of water
K = Partition coefficient

Equation 4 shows that as the amount of seston in the water and the partition coefficient increase, the dissolved PCB concentration will decrease. In systems rich in particulate matter (i.e., sludges) a vast majority of the PCBs will be absorbed onto the particulate matter. However, when not highly absorbed to particulate matter, volatilization could be a significant transport pathway.

For good volatilization control, PCBs should be preferentialy absorbed to the control material (high partition coefficient). Griffin (1980) studied the influence of total organic carbon (TOC) and surface area (SA) on the partition coefficient. He found that a linear relationship could very adequately describe the influences as;

$$K = 188 + 3.36\ SA + 11.4\ TOC \qquad (5)$$

It can be seen from the magnitude of the coefficients in Equation 5 that TOC is the dominate property by a factor of greater than 3. Therefore, materials high in TOC will generally have a greater partition coefficient and thus absorb PCBs more readily from a water column.

CONCLUSIONS AND RECOMMENDATIONS

Due to the high activity coefficient of a PCB-water solution, the possibility of PCB volatilization during dredging, dewatering, transportation, and other handling operations will be present. Volatilization will most likely occur when handling highly contaminated waters with low particulate matter concentrations, especially particulate matter with low partition coefficients (i.e., sands). Volatilization can be controlled using a material high in total organic carbon, such as an organic sludge. This material would reduce the PCB concentration in the water column and thus reduce the potential for volatilization. Although PCB volatilization can be reduced in this manner, PCB transport via contaminated dust must also be controlled. Volatilization control material will have a high concentration of absorbed PCBs and therefore potential worker exposure due to dust inhalation will be present. This exposure route can be minimized by dust control measures and/or adequate respiratory protection.

KS/gp

References

1. CH2M Hill, (1984), Conceptual Design; OMC Hazardous Waste Site, Waukegan, Illinois, Prepared for USEPA, USEPA 13-5M28.0.

2. Griffin, R.A., and E S.K. Chian, (1980), Attenuation of Water-Soluble Polychlorinated Biphenyls by Earth Materials, Publication EPA-600/2-80-027, USEPA, Cincinnati, Ohio.

3. Mackay, D , and A.W. Wolkoff, (1973), Rate of Evaporation of Low Solubility Contaminants From Water Bodies to Atmosphere: Environmental Science and Technology, V. 7, p. 611-614.

4. Paris, D.F., W.C. Steen, and G.L. Baughman, (1978), Role of Physico-Chemical Properties of Aroclors 1016 and 1242 in Determining Their Fate and Transport in Aquatic Environments: Chemosphere, V. 4, p. 319-325.

5. Versar Inc. (1976), PCBs in the U.S.; Industrial Use and Environmental Distribution.

APPENDIX A

Using data supplied in the conceptual design, (CH2M Hill, 1984), along with information presented in this memo, calculations are done to answer questions which may impact on the cleanup design and/or cleanup procedures. It should be noted that these calculations are best estimates and that on-site monitoring would be required to insure worker safety.

WHAT CONCENTRATIONS OF PCBs ARE LIKELY TO BE FOUND IN WATER THAT CONTACTS CONTAMINATED SEDIMENTS?

Using Equation 4 and rearranging yields;

$$Ca = K(M/W)Cd \qquad (5)$$

where;

Ca is the absorbed concentration of PCBs. This value will be taken to be the concentrations reported in the conceptual design.

K is the partition coefficient. A value of 500 will be used which is an approximate value for a silty loam, based on the work of Griffin (1980).

(M/W) is the mass of sediment divided by the mass of water. For material being dredged from slip no. 3, a value of 0.526 was found in the conceptual design, (CH2M Hill, 1984).

Using these assumed values in equation 5 along with various values for Ca, the following data was generated:

Ca, PCB concentration in sediments, (mg PCB/kg sed.)	10,000	500	50	10
Cd, PCB concentration in water, (mg PCB/ liter water)	20.0	1.0	0.1	0.02

The values of 20 mg/l and 1.0 mg/l exceed the solubility of PCBs. The solubility of PCB 1242 is 0.24 mg/l. (Versar, 1976). This data indicates that water allowed to reach equilibrium with highly contaminated sediments may become saturated with PCBs. Significant volatilization of PCBs from a saturated water column could be expected. Using a volatilization control material with a high TOC value, such as wastewater treatment sludge, the K value in equation 5 will increase as well as the M/W value. An increase in both of these factors will result in a decrease in the concentration of PCBs in the water column.

ASSUMING A CONCENTRATION OF PCB IN WATER, WHAT WILL THE EQUILIBRIUM VAPOR CONCENTRATION OF PCB BE, AND WILL THIS VAPOR CONCENTRATION EXCEED THE MAXIMUM PERMISSIBLE EXPOSURE LEVELS?

To address this question, equation 2 is used. The following values, taken from Paris (1978) and Versar (1976) were used in equation 2;

$Q = 4.8 \times 10^4$
$Pv = 5.26 \times 10^{-7}$ atm.

Using these values equation 2 simplifies to;

$$yi = Xi\ (2.52 \times 10^{-2}) \qquad (6)$$

To utilize this equation the concentration of PCBs in the liquid phase, Xi, must be a mole fraction. Assuming a saturated liquid phase, a concentration of 0.24 mg/l converts to 1.44×10^{-8} moles PCB per mole water. Using this value in equation 6 yields an equilibrium vapor mole fraction of 3.63×10^{-10} moles PCB per mole air. This mole fraction converts to a concentration of $4.9 \mu g/m^3$ (micrograms per cubic meter). This concentration may be compared to published exposure limit values presented in Table A1.

TABLE A1

PUBLISHED PCB EXPOSURE LIMITS

	I OSHA	II NIOSH	III ACGIH TWA	IV ACGIH STEL	V OSHA IDLH
PCB (1242)	1.0 mg/m^3	1.0 $\mu g/m^3$	1.0 mg/m^3	2.0 mg/m^3	10 mg/m^3
PCB (1254)	1.0 mg/m^3	1.0 $\mu g/m^3$	0.5 mg/m^3	1.0 mg/m^3	5 mg/m^3

I. Occupational Safety and Health Administration (OSHA) permissible exposure limit, reported as a work-shift time weighted average (TWA) level.
II. National Institute for Occupational Safety and Health (NIOSH) recommended revision of the OSHA standard, reported as a 10 hr. TWA.
III. American Conference of Governmental Industrial Hygienists (ACGIH) recommended exposure limit.
IV. ACGIH, recommended short-term exposure limit (STEL) considered to be a maximal allowable concentration.
V. OSHA's exposure limit concentration which is Immediately Dangerous to Life or Health (IDLH). This concentration represents a level from which one could escape within 30 minutes without any irreversible health effects.

The calculated equilibrium vapor concentration of 4.9 $\mu g/m^3$ is well below the IDLH concentration. This vapor concentration is also below the permissible exposure limits recommended by OSHA and ACGIH. The only permissible exposure limit it exceeds is that recommended by NIOSH as a 10 hr. work shift TWA. It should be noted however that the calculated vapor concentration is for a vapor phase in equilibrium with a saturated water column and this would represent a maximum. The actual vapor concentration could be much less due to dilution and mixing by wind. Using a good volatilization

control material would also reduce the vapor phase concentration. It appears unlikely that the NIOSH standard will be exceeded; however, monitoring would be required to insure that proper respiratory protection is practiced.

APPENDIX K
EXCAVATION VOLUMES FOR
SLURRY WALL CONSTRUCTION BERMS

WARZYN
ENGINEERING INC

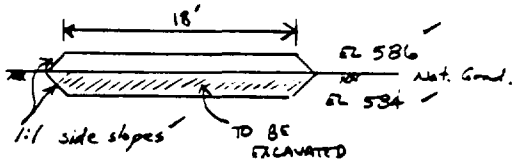
WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY MN Schultz DATE 2/25/85 SUBJECT OMC/WAUKEGAN/SUPERFUND SHEET NO. 1 OF 5
CHKD. BY RHWeber DATE 2/27/85 EXCAVATION VOLUME - SLURRY WALL DIKE JOB NO. C11837
(Mike Schultz)

Problem: Estimate yardage volume to be excavated for preplacement of the compacted clay dike prior to slurry wall installation. The bottom of the compacted clay dike is @ EL 584 except where passing beneath the railroad tracks. ✓

Given: 1) Profile sections of the slurry wall alignment for both the east and west walls.

2) Following cross section of dike:



Assumptions: 1) Top of dike is 18' wide with 1:1 side slopes (BASE 22' WIDE)
2) Excavation side slopes also 1:1 (max excavation 1' for eastern and western dikes except in railroad crossing areas where it is at most 5½' deep)

Reasoning & Solution:

A) Eastern Slurry Wall

i) From slurry wall profile section:

Section	Area	Avg Area	Distance	Volume	Cum Volume (yd^3)
1	0				
		9.5 ft^2	50'	18 yd^3	18
2	19 ft^2				
		19 ft^2	755'	531 yd^3	549
3	19 ft^2				
		9.5 ft^2	225'	79 yd^3	628
4	0				

Say 650 yd^3

B) Western Slurry Wall - Divide into two parts

i) Volume excavated above EL 584

ii) Volume excavated below EL 584 (vicinity of railroad track crossing)
(TO PROVIDE ADEQUATE SUPPORT WHERE RR TRACK CROSSES SLURRY WALL)

(over)

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY MNS DATE 2/25/95 SUBJECT OMC/WAUKEGAN/SUPERFUND SHEET NO. 2 OF 5
CHKD. BY DATE 2/27/95 EXCAVATION VOLUME - SLURRY WALL DIKE JOB NO. C11837

i) Volume above El 584 (from slurry wall profile section)

Section	Height	Area	Avg Area	Distance	Volume (yd³)	Cum Vol (yd³)
1	0	0				
			20 ft²	505	374	374
2	2	40 ft²				
			51.5 ft²	10	19	393
3	3	63 ft²				
			31.5 ft²	15	18	411
4	0	0				
			0	15	0	411
5	0	0				
			20 ft²	5	4	415
6	2	40				
			29.5 ft²	20	22	436 437
7	1	19 ft²				
			19 ft²	425	299	735 +1 ↓
8	1	19 ft²				
—			—	—	—	735
9	1	19 ft²				
—			19 ft²	150	106	841
10	1	19 ft²				
			55.5 ft²	20	41	882 883
11	4	92 ft²				
			92 ft²	15	51	933
12	4	92 ft²				
			66 ft²	15	37	970
13	2	40 ft²				
			40 ft²	140	207	1177
14	2	40 ft²				
			29.5 ft²	20	22	1199
15	1	19 ft²				
			19 ft²	75	53	1252
16	1	19 ft²				
			9.5 ft²	110	39	1291 1292
17	0	0				

Sub Total = 1291 1292 yd³

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY MNS DATE 2/25/85 SUBJECT OMC/WAUKEGAN/SUPERFUND SHEET NO. 3 OF 5
CHKD. BY DAW DATE 2/27/85 EXCAVATION VOLUME - SLURRY WALL DIKE JOB NO. C11837

ii) Volume below El. 584 (railroad track crossing)

Area (A): (See Section B-B' sketch done by MNS on 2/24/85, This Job #)

Area = ½(30+42)(2) = 72 ft² ✓

18' wide

72(18)/27 = 48 yd³ ✓

Area (B) = (See Section C-C' sketch done by MNS on 2/24/85, This Job #)

Area = ½(25+19)(1) = 22 ft² ✓

18' wide

22(18)/27 = 15 yd³ ✓

Subtotal = 63 yd³ ✓

Total = 63 + 1291 = 1354 yd³ ✓

Say 1350 yd³ ✓

Conclusions: Excavation Volume

1350 + 650 = 2000 yd³ ✓

SUMMARY

EAST SLURRY WALL (PARKING LOT)

① EXCAVATION VOLUME TO PREPARE FOR SLURRY WALL CONSTRUCTION BERM — 628 YD³

NOTE: THIS CUT MATERIAL CAN BE USED AS FILL IN LOW AREAS BELOW EL. 584 TO PREPARE THE BERM SUBGRADE, EXCESS TO BE DISPOSED INSIDE CONTAINMENT CELL

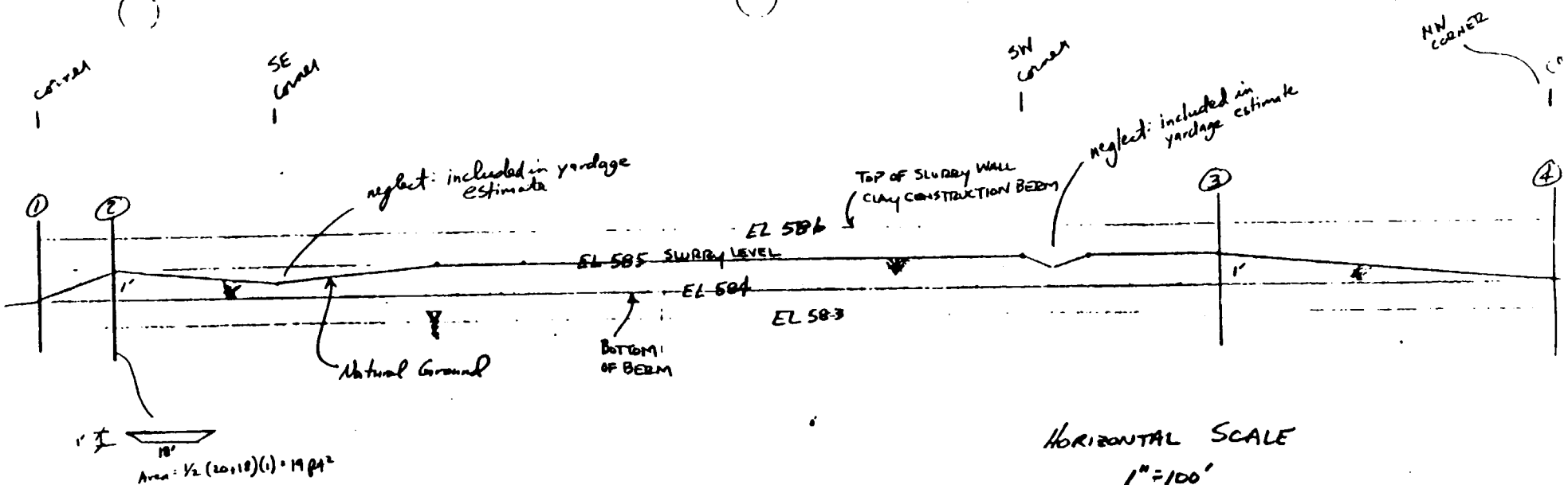
WEST SLURRY WALL (OVAL LAGOON / CRESCENT DITCH)

① SAME AS ABOVE — 1292 YD³

② EXCAVATION VOLUME TO PLACE COMPACTED) CLAY BENEATH RR TRACKS WHERE IT CROSSES SLURRY WALL AT WEST AND EAST SIDE — 63 YD³

NOTE: DISPOSE MATERIAL IN EITHER CONTAINMENT CELL, AS APPROPRIATE — TOTAL 1983 YD³

SAY 2000 YD³



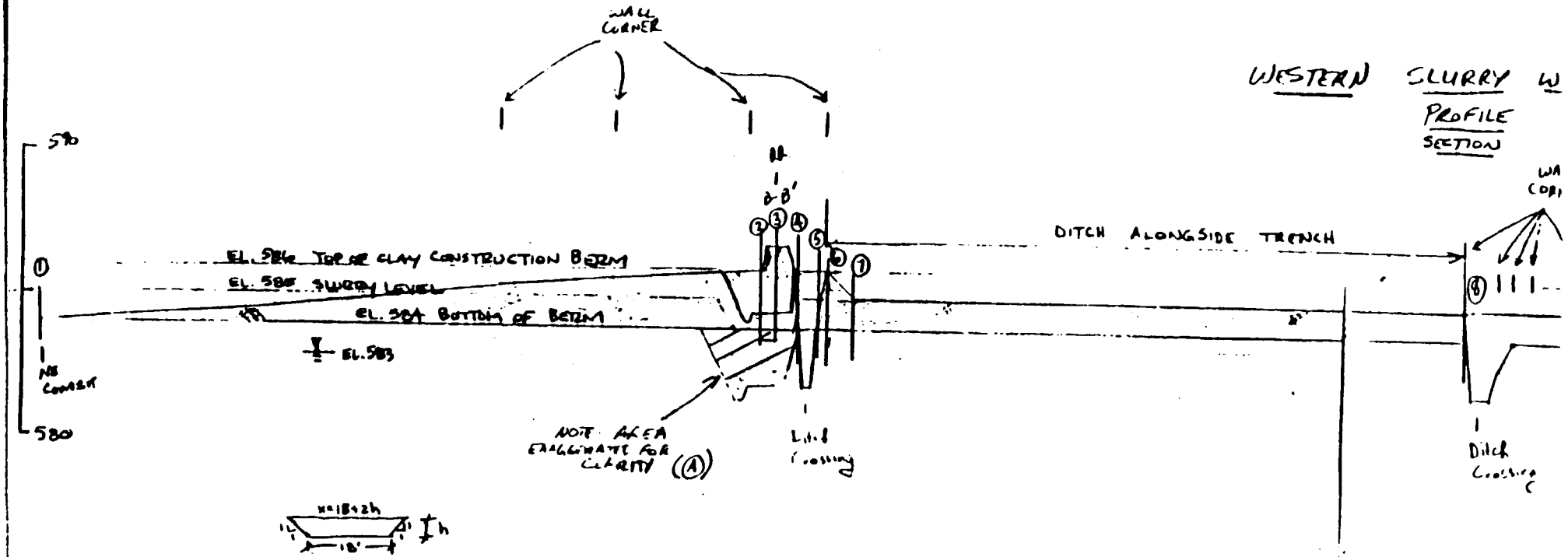
HORIZONTAL SCALE
1" = 100'
Vertical Scale 1" = 5'

EASTERN SLURRY WALL

PROFILE SECTION

(PROFILE BASED ON AEROMETRIC ENGINEERING INC. TOPOGRAPHIC MAPS, 8/84)

OMC/WAUKEGAN/SUPERFUND
EXCAVATION VOLUME - SLURRY WALL DIKE
MWS 2/15/85 Sheet 4/5
C11837



WESTERN SLURRY W

PROFILE SECTION

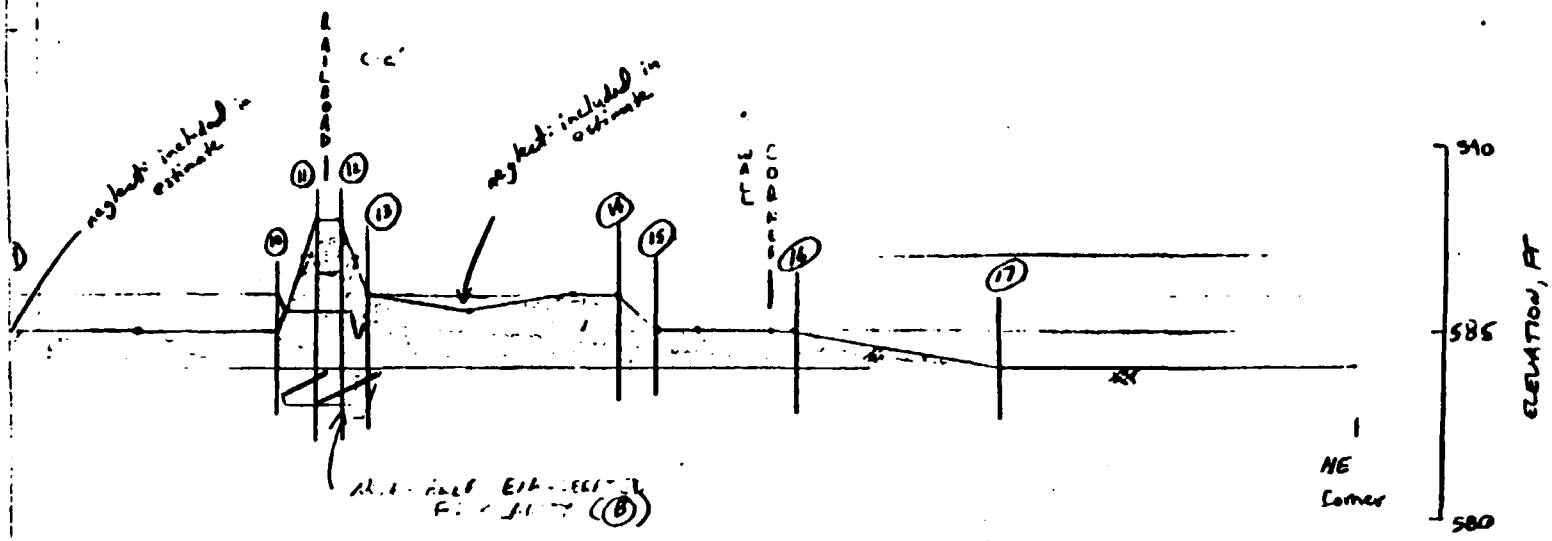
HORIZONTAL S
1"=100

VERTICAL SC
1"=5'

(PROFILE BASED ON AEROMETRIC ENGINEERING INC. TOPOGRAPHIC MAPS, 8/84)

DMC/WAHLSTROM/SHEPPERSON
ESTIMATED VOLUME - SLURRY WALL DIKE
MNS 4/25/85 Sheet 5/5 C118

K-5



RAILROAD BALLAST (18")

TO BE EXCAVATED & BACKFILLED DURING DIKE CONSTRUCTION

APPENDIX L
PERMITTING

WARZYN
ENGINEERING INC

TJL

March 7, 1985
C 11837

MEMORANDUM

To: Tom Lynch

From: Michael Reardon MR

Re: Update Regarding Permitting Requirements for the OMC Project

A preliminary Section 404 Permit is currently being prepared for COE and will be ready for submittal to Bob Smart, COE Project Manager, at the Concept Review meeting scheduled for March 12, 1985. A Section 401 Certification (Clean Water Act) will be required by IEPA prior to issuance of the COE Section 404 Permit. Both of the above permits will be addressed on a joint application form entitled: "Protecting Illinois Waters".

The IEPA has stated they will provide the Section 401 Certification only after final design specifications have been submitted. Consequently, the preliminary Section 404 Permit will not meet their requirements and will need to be expanded with more detailed engineering design information as it becomes available. We need to talk with Bob Smart and Skip Bergmann, COE Permit Coordinator, at the Concept Review meeting about how they would like to handle the incorporation of additional information into the Section 404 Permit as the final design is completed.

The IEPA has decided not to require permits related to the development of a storage/treatment facility and solid waste management site. Only the following permits related to the construction and operation of the water treatment plants will be required.

Form WPC-PC-1 - Authorization to Construct: This applicaton form authorizes construction of the water treatment plant. It is a procedural form and does not require detailed project information.

Schedule J - Industrial Treatment Works or Pretreatment Works: This permit in conjunction with the above form authorizes construction and operation of the water treatment plant. Information that must be provided includes:

- Schematic wastewater flow diagram showing the flow of water from the source, through the treatment facility, to the outfall. It should consist of a line drawing depicting wastewater flow through the facility. Average and maximum flow rates should be shown. Specific treatment processes must be discussed in detail.

WARZYN
ENGINEERING INC

- Piping, including direction of flow.
- Type, size, pertinent features and specified capacity of all pumps, blowers, motors and other mechanical devices.
- Hydraulic profiles showing the flow of wastewater. These must include minimum, average and maximum hydraulic flow.

Schedule N-Waste Characteristics: This permit, along with Form WPC-PC-1 and Schedule J, is required prior to IEPA approving the construction of the wastewater treatment facility. It must be submitted to show waste characteristics, effluent quality and quality of the receiving waters. The following information must be provided:

- Effluent parameter concentrations
- An effluent monitoring program, including the type of sample (grab, composite) and number of samples. Sampling points should be indicated on the wastewater flow diagram.

The U.S. EPA has decided they would like us to prepare all the information necessary for a Toxic Substances Disposal Permit. There still appears to be some question whether they will actually require the permit. However, they would like the permit prepared in case a decision is rendered in favor of submitting the permit. The following information should be included in the permit:

- A detailed description of the cleanup plan, including general site plans and design drawings.
- An engineering report on the design and construction of the containment cells, including information on their anticipated performance.
- Expected waste volumes of PCB's.
- Operations plan addressing the disposal of PCB-contaminated material in the containment cell constructed in the OMC parking lot.
- Local, state or federal permits or approvals.
- Project schedule.

In addition to the COE and IEPA permits, building and dredging permits must be submitted to the City of Waukegan and Waukegan Port Authority, respectively. Mr. Louis Vasseur, Environmental Officer, City of Waukegan, has been contacted concerning the building permit. He said only one (1) application for a building permit needs to be submitted if only one (1) contract is issued for all construction activities. However, if construction activities are phased, separate building permits will need to be submitted for each activity. Detailed drawings should also be submitted to ensure that specifications comply

with the City Building Code. The Waukegan Port Authority does not have any "formal" application procedures for a dredging permit. They would like information concerning the types of dredging, areas affected and project schedule submitted early in the design phase of the cleanup project (30%) and again at the end (final design). They are concerned about the impacts the cleanup project will have on businesses dependent on the harbor for their livelihood and harbor users (public). The COE Public Notice should contain the necessary information required by the Waukegan Port Authority.

The following information is attached to this memorandum:

1. A draft of the preliminary Section 404 Permit (public notice).

2. A letter from IEPA which outlines their permitting requirements for the OMC project,

3. An "Application for Building Permit" from the City of Waukegan, and

4. IEPA application forms which pertain to the construction and operation of the water treatment facilities.

MWR/blc/SGW
[blc-66-16]

JOINT APPLICATION FORM

1. Application Number (To be assigned by Agency)

2. Date
Day Month Year

3. For Agency use only (Date Received)

4. Name and address of applicant

DRAFT COPY

Telephone no. during business hours
A/C ( ) _____
A/C ( ) _____

Telephone no. during business hours
A/C ( ) _____
A/C ( ) _____

5. Describe in detail the proposed activity, its purpose, and intended use. If additional space is needed, attach additional support information to each agency application.

The attached cleanup plan has been designed to remove PCB-contaminated sediment and soil in and around Waukegan Harbor. This plan was developed under the direction of the U.S. Environmental Protection Agency. The major components of this cleanup plan include: 1) dredging of contaminated sediment from Waukegan Harbor, 2) excavation of contaminated soil near the Outboard Marine Corporation, 3) construction of containment cells around PCB-contaminated soil, 4) construction of on-site water treatment facilities, and 5) discharge of treated water into Waukegan Harbor. An environmental assessment of the proposed cleanup plan is contained in the "Source Control Feasibility Study - OMC Hazardous Waste Site Waukegan, Illinois".

7. Names, addresses, and telephone numbers of all adjoining and potentially affected property owners, including the owner of subject property if different from applicant.

Larsen Marine, 625 Seahorse Drive, Waukegan, IL 60085 (312)336-5456
North Shore Sanitary District, Dahringer Road, Waukegan, IL 60085 (312)249-3895
National Gypsum Company, 515 Seahorse Drive, Waukegan, IL 60085 (312)623-8100
Outboard Marine Corporation, 100 Seahorse Drive, Waukegan, IL 60085 (312)689-6200
City of Waukegan, Bldg. Dept., 1101 Belvidere Rd., Waukegan, IL 60085 (312)360-9000

8. Location of activity
Address:
Outboard Marine Corporation & Waukegan Harbor
Street, road, or other descriptive location
Waukegan
In or near city or town
Lake Illinois 60085
County State Zip Code

Legal Description:
Parts of 22&15 T45N R23E ____
Vs Sec. Twp. Rge. P.M.

Tax Assessor's Description (If known):
Map No. Subdiv. No. Lot No.

Name of waterway at location of the activity
Waukegan Harbor

9. Date activity is proposed to commence September, 1985 Date activity is expected to be completed November, 1988

10. Is any portion of the activity for which authorization is sought now complete? ___ Yes ___ No If answer is "Yes" give reasons in the remark section. Month and Year the activity was completed _____ Indicate the existing work on drawings.

11. List all approvals or certifications required by other federal, interstate, state, or local agencies for any structures, construction, discharges, deposits, or other activities described in this application. If this form is being used for concurrent application to the Corps of Engineers, Illinois Department of Transportation, and Illinois Environmental Protection Agency, these agencies need not be listed.

Issuing Agency	Type Approval	Identification No.	Date of Application	Date of Approval
USEPA	Toxic Substances Disposal Permit			
City of Waukegan	Construction Permit(s)			
Waukegan Port Authority	Dredging Permit			

12. Has any agency denied approval for the activity described herein or for any activity directly related to the activity described herein.
___ Yes ___ No (If "Yes", explain in remarks.)

13. Remarks

14. Application is hereby made for authorizations of the activities described herein. I certify that I am familiar with the information contained in the application, and that to the best of my knowledge and belief, such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities.

_____
Signature of Applicant or Authorized Agent

DRAFT COPY

WAUKEGAN HARBOR CLEANUP PLAN

DESCRIPTION AND PURPOSE

The United States Environmental Protection Agency has proposed a cleanup plan to remove and contain PCB contaminated sediment and soil from Waukegan Harbor and vicinity (Attachments 1 and 2). This plan was selected as the most cost-effective alternative that is technologically feasible, protects human health and the environment, and considers the need to balance funds under the Superfund program. It is authorized by regulations promulgated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), as required by Section 105 of CERCLA. The Corps of Engineers (COE) is the construction management agency for all Superfund activities and the Chicago District will manage all construction activities for this project.

CLEANUP PLAN

The proposed cleanup plan would consist of the following eight (8) cleanup actions:

Action 1: Slip No. 3 - Remove Hot Spots and Dispose Off-Site

Action 2: Slip No. 3 - Central and Eastern Sections - Dredge, Dewater, Fix and Dispose in Parking Lot

Action 3: Upper Harbor - Dredge, Dewater and Dispose in Parking Lot

Action 4: Crescent Ditch/Oval Lagoon Area - Remove Hot Spots and Dispose Off-Site

Action 5: Crescent Ditch/ Oval Lagoon Area - Contain and Cap

Action 6: Parking Lot Area - Contain and Cap

Action 7: Dewatering Lagoon

Action 8: Water Treatment

Many of the above cleanup activites are interrelated and would be performed in conjunction with one another. For example, sediment hydraulically dredged from Slip No. 3 (Action 2) and Upper Harbor (Action 3) would be routed to the dewatering lagoon (Action 7), which would be used to separate the contaminated sediment and slurry water. In addition, on-site water treatment facilities (Action 8) would be used to treat wastewater generated by several of the cleanup actions.

Actions 1, 2 and 3 which deal with the cleanup of Slip No. 3 and Upper Harbor, have been designed with the intent to remove all contaminated sediment with PCB concentrations of 50 ppm or greater. The volume of contaminated sediment that must be removed to achieve this goal is based on numerous sediment core samples collected and analyzed from selected locations in Slip No. 3 and Upper Harbor. Contaminated sediment with PCB concentrations less than 50 ppm would remain after completion of the proposed cleanup plan. Cleanup actions in Waukegan Harbor would be limited to Slip No. 3 and a portion of the Upper Harbor located between and adjacent to property owned by National Gypsum Company and Outboard Marine Corporation (Attachment 2).

The sediment strata in Slip No. 3 and Upper Harbor consist of: 1) top soft muck layer 2) underlying sand layer 3) a hard silty clay layer. Attachment 3 depicts the orientation of the sediment strata. The depth of the muck layer varies considerably, ranging from 0 to 10.5 feet. The sand layer in Slip No. 3 varies from 2 to 8 feet, depending on location.

Highly contaminated soil ("hot spots") from the Crescent Ditch/Oval Lagoon Area (Action 4) would be excavated and disposed of off-site in a licensed chemical waste landfill. Soil with PCB concentrations greater than 10,000 ppm would be removed by this action. The remaining contaminated soil would be enclosed within a contaminant cell (Action 5) to prevent further migration of PCB's into the surrounding environment. Contaminated soil in the Parking Lot Area (Action 6) would also be enclosed within a containment cell. No removal of contaminated soil from the Parking Lot Area would be performed.

Detailed activities of each cleanup action will be as follows:

Action 1: Slip No. 3 - Remove Hot Spots and Dispose Off-Site

This cleanup action would remove highly contaminated sediment from the westernmost section of Slip No. 3 (Area A, Attachment 4). This sediment would be isolated from the central and eastern sections of Slip No. 3 by a temporary, single sheet pile cofferdam extending across Slip No. 3 (Attachment 5). This cofferdam would reduce the dispersal of PCB-laden sediment outside the work area. During dredging within this section of Slip No. 3, water levels inside the cofferdam would be kept lower than the outside to cause water flow toward the contained area. The removed water would be routed to an on-site 1500-gpm treatment plant (Action 8), treated down to one part per billion (ppb) or less PCB's and discharged to the harbor (see Attachment 4 for outfall location).

All of the contaminated sediment within the westernmost section of Slip No. 3 (Area A) would be excavated with a clamshell dredge. Some areas near the former Outboard Marine Corporation (OMC) outfall contain sediment with PCB

concentrations greater than 10,000 parts per million (ppm). These areas, referred to as "hot spots", would be excavated to a depth of approximately 13 feet. To facilitate the removal of deep contaminated sand and silt, an additional semi-circular cofferdam would be constructed near the former OMC outfall (Attachment 5). After removal, the contaminated sediment from Area A would be transported to a batch plant for fixation. The batch plant is a temporary facility which would be used to mix the sediment with a fixing agent.

Fixation, a process that removes free water from the dredged materials, would be accomplished by adding portland cement, Locksorb or another fixing agent to the solids at the batch plant. Enough fixing agent would be added to ensure the solids obtain a nonflowable consistency. The mix would be transported to curing cells for additional solidification and temporary storage (Attachments 4 and 7). The fixed solids would be disposed of in an off-site licensed chemical waste landfill.

This action would remove approximately 5,400 cubic yards of contaminated sediment. This composes approximately 90 percent of all PCB's now found in Slip No. 3 and Upper Harbor. All of this material would be disposed of off-site.

Action 2: Slip No. 3 - Central and Eastern Sections - Dredge, Dewater, Fix and Dispose in Parking Lot

Sediment with PCB concentrations as high as 1,000 to 10,000 ppm have been identified in the central and eastern sections of Slip No. 3 (Area B, Attachment 4). This sediment would be removed by hydraulic dredging. The sediment slurry produced by the hydraulic dredging would be pumped to a

dewatering lagoon, fixed and disposed of in a containment cell constructed in the OMC parking lot (Attachment 6). A clay-lined dewatering lagoon would be constructed on Outboard Marine Corporation's vacant foundry property immediately east of the Upper Harbor (Attachment 4). The dewatering lagoon would be divided into two separate lagoons. Contaminated sediment from Slip No. 3 (Area B) would be pumped and treated in Lagoon Area 1. Sediment dredged from the Upper Harbor would be routed to Lagoon Area 2 for dewatering.

Approximately 1,000 cubic yards of contaminated sediment would be removed from Slip No. 3 (Area B) by hydraulic dredging and pumped to Lagoon Area 1 for dewatering. The sediment would settle and consolidate by gravity. Supernatant would be decanted and routed to the on-site 1,500 gpm water treatment plant (described under Action 8). Due to the highly contaminated nature of these deposits, volatilization of PCB's would be controlled by covering the lagoon surface with organic sludge. Solids would be removed from Lagoon Area 1 by drag line and transported to the batch plant for fixation.

A sediment dispersal control device, consisting of a double-silt curtain, would be installed at the eastern end of Slip No. 3 to confine sediment suspended by hydraulic dredging (Attachment 5). A monitoring program would be implemented to detect movement of material out of the area being dredged and to warn of the need for additional control measures.

Action 3: Upper Harbor-Dredge, Dewater and Dispose in Parking Lot

Studies have shown some sediment in the Upper Harbor (Area C, Attachment 4), to have PCB concentrations from 50 to 1,000 ppm. Approximately 38,300 cubic yards of sediment would be removed from the Upper Harbor by hydraulic dredging and pumped to Lagoon Area 2 for dewatering. As in Action 2, the supernatant would be decanted and routed to the on-site 1500-gpm water treatment plant. Surface treatment to control volatilization of PCB's is not proposed. The top layer of solids would dry by evaporation and be periodically removed by dragline. The dried solids would be loaded into trucks and transported to the containment cell in the OMC parking lot for disposal.

Two sediment control devices, similar in design to the one discussed under Action 2, would be installed at the south end of the Upper Harbor to prevent the migration of suspended sediment into the Lower Harbor. The control devices would not extend across the entire width of the Upper Harbor. Instead, they would be separated by a distance of 50 feet and installed parallel to one another, with each device left open on opposite ends for a distance of 50 feet (see Attachment 5). This configuration would allow boat traffic continued access to the Upper Harbor during cleanup activities.

Action 4: Crescent Ditch/Oval Lagoon Area - Remove Hot Spots and Dispose Off-Site

Highly contaminated soil would be excavated from the Crescent Ditch/Oval Lagoon Area (Area D, Attachment 4). Past studies have shown some soil in this area to have PCB concentrations in excess of 10,000 ppm. This highly contaminated soil would be removed by backhoes in a dewatered condition. Because the solids would be removed in a dewatered condition, no fixing

would be required. The solids would be disposed of in an off-site licensed chemical waste landfill.

Prior to removing the PCB-contaminated soil from the Crescent Ditch/Oval Lagoon Area, a bypass would be constructed to divert surface water flow around the area and to collect surface water runoff from the OMC parking lot. The bypass would be constructed along the western property line of the parking lot and along the east-west portion of the North Ditch, which would be partly excavated (in a dewatered condition) to install the bypass drainage pipeline (Attachment 6). The bypass would discharge into Lake Michigan at the existing North Ditch outfall. The PCB-contaminated soil from the North Ditch bypass excavation would be placed in the containment cell to be constructed in the eastern half of the OMC parking lot or Oval Lagoon excavation. Action 6 discusses in detail the construction of this cell.

During dewatering of the excavations, water would be routed to a 200-gpm, on-site water treatment plant for removal of PCB's down to 1 ppb or less. The treatment plant would be located in the OMC parking lot between the Crescent Ditch/Oval Lagoon and Parking Lot Areas (Attachment 6). The water would be discharged into the bypass drainage pipeline. The water treatment plant would be similar in design to the 1,500-gpm on-site water treatment plant used to treat the water from the dredging operations and dewatering lagoon.

Soil in the Crescent Ditch would be excavated to a depth of approximately 5.5 feet in the eastern half and 20 feet in the western half. This would yield about 4,700 cubic yards of contaminated material. A braced excavation system would be constructed to support the 20-foot deep excavation. Soil in the Oval Lagoon would be excavated (after dewatering) to a depth of approximately 5.5 feet. This would yield about 1,500 cubic yards of contaminated material. The above contaminated material (6,200 cubic yards) contains approximately 90 percent of all the PCB's found in the Crescent Ditch/Oval Lagoon Area. As stated earlier, all of this highly contaminated material would be disposed of off-site in a licensed chemical waste landfill.

Action 5: Crescent Ditch/Oval Lagoon Area - Contain and Cap

A containment cell would be constructed around the Crescent Ditch/Oval Lagoon Area to restrict the movement of the remaining PCB-contaminated soil not removed by Action 4 (Attachment 6). A slurry wall would be constructed to encircle the contaminated area and would extend into the underlying glacial till. The slurry wall would be constructed with bentonite and have a permeability of 10^{-7} cm/sec. The existing glacial till beneath the site would act as the bottom seal. The till is composed of a low permeability silty clay. The top of the containment cell would be capped with clay and covered with pavement. The cap would be composed of a compacted clay layer overlain by a synthetic membrane. The clay layer would have a permeability of 10^{-7} cm/sec.

Groundwater monitoring wells would be installed through the containment cell and around the outside perimeter. These wells would respectively monitor internal pressure and potential PCB migration outside the cell. If internal pressure, caused by groundwater inflow, was to build-up to a level where the structural integrity of the containment cell might be compromised, dewatering would be necessary. If dewatering would be required in the future, water removed from the containment cell would be routed to a portable water treatment plant temporarily brought on-site for removal of PCB's. This water would be discharged into the bypass drainage pipeline.

Action 6: Parking Lot Area - Contain and Cap

PCB-contaminated soil found in the Parking Lot Area (Area E, Attachment 4), would be enclosed within a containment cell similar in design to the cell described under Action 5; no contaminated soil from the Parking Lot Area would be excavated and disposed of off-site. This action would address 100 percent of all the PCB's found in the Parking Lot Area. In addition, the following contaminated material would be brought to the Parking Lot Area for disposal:

1. Dredged solids from Slip No. 3;
2. Excavated soil from the North Ditch;
3. Lagoon and curing cell liner materials; and
4. Volatilization control material (organic sludge).

The height of the Parking Lot Area containment cell would be approximately 14 feet higher than the existing grade. Groundwater monitoring wells would be installed through the cell and around the outside for detection of internal pressure build up and potential PCB migration.

Action 7: Dewatering Lagoon

The dewatering lagoon would receive the sediment and slurry water produced by the hydraulic dredging of the central and eastern sections of Slip No. 3 and Upper Harbor. It would be installed before hydraulic dredging begins and removed after completion of the dewatering process. The lagoon (along with the fixation area, 1500-gpm water treatment plant and curing cells) would be constructed on vacant land which borders the eastern side of the Upper Harbor and is owned by the OMC Corporation. Attachment 7 shows the configuration of the lagoon. Spoils from the last dredging of Waukegan Harbor (1974) were placed in mounds up to 14 feet high on the vacant land to be occupied by the dewatering lagoon. These mounds are composed of sand. The U.S. Environmental Protection Agency reports that most of the sand contains less than 1 ppm PCB's; however, there are localized areas with higher concentrations. The highest concenteration reported was 17 ppm. The mounds would be pushed down and spread out to form a sub-base for the dewatering lagoon.

The dewatering lagoon would be divided into two areas by a clay divider dike. Lagoon Area 1 would be approximately 240 feet wide by 420 feet long and used to dewater contaminated dredged sediment from Slip No. 3 (Area B). After dewatering, the sediment would be fixed and disposed of in the containment cell constructed in the OMC parking lot. Lagoon Area 2 would be approximately 450 feet wide by 810 feet long and would be used to dewater contaminated sediment dredged from the Upper Harbor (Area C). The capacities of Lagoon Area 1 and Lagoon Area 2 would be approximately 24,300 and 89,300 cubic yards, respectively. The perimeter dike surrounding the entire dewatering lagoon would rise between 13.5 to 14 feet above the existing grade and have an inner and outer slope of 3 horizontal: 1 vertical.

The dewatering lagoon would have a liner system composed of the following sections:

1. A 1-foot thick compacted clay liner with a permeability of less - than 10^{-7} cm/sec;
2. A 1-foot thick granular layer with pipe underdrains;
3. A 1-foot thick, compacted inner clay liner with a permeability of 10^{-7} cm/sec; and
4. A 6-inch thick protective layer.

(Note: The use of a synthetic membrane in conjunction with or in place of part of the above liner system is currently being evaluated.)

During the dismantling of the dewatering lagoon, the protective layer and inner clay liner would be considered contaminated and would require disposal in the containment cell constructed in the OMC parking lot. The remaining sections of the liner would not be contaminated and would be disposed of on-site.

Action 8: Water Treatment

The primary 1,500-gpm water treatment plant (shown on Attachment 7) would be used to treat:

1. Water from within the cofferdam in Slip No. 3;
2. Slurry water generated by the hydraulic dredging of Slip No. 3 and Upper Harbor; and
3. Rainwater and leachate water generated during solids dewatering.

Contaminated water would be treated by available conventional and advanced water treatment processes to meet U.S. EPA's discharge requirement of one part per billion (ppb) PCB's. The water treatment system would be a "package

plant" of factory-constructed modules and would consist of flocculation, sedimentation, pressure sand filtration and carbon adsorption. The modules could be easily installed and removed. The carbon filters would remove the soluble PCB's. It has been demonstrated that carbon filtration will remove PCB's to 1 ppb or below.

The 1,500-gpm water treatment plant would be operated only during non-freezing weather. However, when the plant is operating it would run continuously. Treated water would be discharged to the harbor. During non-dredging periods, should the water surface in the dewatering lagoon drop to sediment level, treated water would be recycled back to the sedimentation basin to maintain continuous flow through the treatment plant. The lagoon would serve as an equalization basin.

After the completion of the dredging activities, the 1,500-gpm water treatment plant would be replaced with a 200-gpm treatment plant. This plant would treat rainwater and leachate water for the duration of the dewatering process. The 200-gpm water plant would be similar to the 1500-gpm water treatment plant, but at a smaller scale.

A second 200-gpm water treatment plant would be installed in the OMC parking lot between the Crescent Ditch/Oval Lagoon and Parking Lot Areas. Any water removed from the excavations would be routed to this plant. Treated water from this plant would be discharged to the bypass drainage pipeline. This plant would be similar in design to the plants described above. It would be a portable plant, brought on-site only as-needed during dewatering activities.

Treated water from all the treatment plants would be monitored for PCB's and turbidity before being discharged. Laboratory facilities would be available on-site to test for these parameters. If monitoring indicates unacceptable levels of PCB's in the treated water, it would be recycled back for retreatment.

OFF-SITE DISPOSAL

The off-site disposal of the highly contaminated material removed from Slip No. 3 and Crescent Ditch/Oval Lagoon Area will be the responsibility of the company awarded the contract for the cleanup. The only restriction is that the contaminated material must be transported by a licensed hauler and disposed of in a chemical waste landfill licensed to receive PCB's.

At the present time, the closest landfill licensed to receive PCB's is the CECOS facility located near Williamsburg, Ohio. It is owned and operated by Clermont Environmental Reclamation Company. The haul distance to this site from Waukegn Harbor is approximately 350 miles. CECOS site management has expressed interest in receiving the PCB-contaminated material.

SUMMARY OF DREDGING/EXCAVATION ACTIVITIES

Site	Method	Quantity* (cubic yards)	Disposal Site
Westernmost Section of Slip No. 3 (Area A)	Clamshell Dredge	5,400	Off-site
Central and Eastern Sections of Slip No. 3 and Upper Harbor (Areas B and C)	Hydraulic Dredge	39,300	Parking Lot Containment Cell
Crescent Ditch/Oval Lagoon (Area D)	Excavate	6,200	Off-Site
North Ditch	Excavate	2,000	Parking Lot Containment Cell

* Best available estimate; subject to change as additional information becomes available

MITIGATION OF LAND USE AND RECREATIONAL RESTRICTIONS

The land use in the project area is mostly industrial, with some commercial and recreational use. All of these land uses are water-dependent and, consequently, have located near Lake Michigan. Nearly all of Slip No. 3 and Upper Harbor are surrounded by either industrial or recreational land uses consisting of OMC, National Gypsum and Larsen Marine. The eastern border of the Upper Harbor is occupied by vacant land owned by OMC (the dewatering lagoon, fixation area and curing cells would be constructed on this property). Other land uses bordering the project area include the North Shore Sanitary District's wastewater treatment plant directly north of the OMC plant and public beach and beach house facilities along the Lake Michigan shoreline. The wastewater treatment plant would not be impacted by the cleanup activities. The beach and associated facilities, including parking areas, would remain open throughout the entire duration of this project. However, access to the beach on the road paralleling OMC property would be impeded during cleanup activities. Truck traffic would be heavy during the construction of the dewatering lagoon, curing cells and fixation area. Additional congestion would occur when the highly contaminated sediment dredged from Slip No. 3 is transported to an off-site licensed chemical waste landfill.

Many types of recreation facilities are available at Waukegan Harbor. Because it is the only protected harbor on the northern Illinois shoreline, it is utilized by a large number of boat owners and fisherman from Illinois and Wisconsin.

The only recreational facility that would be directly impacted by the dredging operations would be a marina owned by Larsen Marine. Their marina occupies Slip No. 3 and the northern end of the Upper Harbor (Attachment 5). The marina is busy during late May and June, putting boats into the water, and again in October, taking boats out. Weekends during the summer are very busy, with numerous boats taken out of storage for fishing use and returned at the end of the day. Weekday traffic is about half that experienced on weekends. In addition, boats are continually serviced and fueled during business hours.

The clamshell and hydraulic dredging in Slip No. 3 (Areas A and B) would require that this area be completely closed to boat traffic during its cleanup. Approximately five floating piers would be removed. The entire slip would be unavailable to boat traffic for a period of six months, lasting from the beginning of March to September, 1986.

The hydraulic dredging in the Upper Harbor would not require closure of the area. However, access to the Upper Harbor would be impeded by the dredging equipment and sediment dispersal control device, which would be installed across the south end to prevent migration of PCB-contaminated sediment into other parts of the harbor. Dredging in the Upper Harbor could be done with minimal boat traffic interferance by scheduling work at night and using submerged dredge piping. The sediment control device would be constructed to accommodate heavy and almost continual boat traffic. As discussed under Action 3, two sediment dispersal control barriers would be installed parallel to one another and left open for a distance of 50 feet. They would be sep-

arated by a distance of 50 feet. This configuration would allow boat traffic access to the Upper Harbor. Fixed piers located near the boat hoist at the northern end of the Upper Harbor would be removed prior to dredging. The entire dredging operation in the Upper Harbor would take approximately four months, lasting from the end of June to early September, 1986.

SCHEDULE

A preliminary construction schedule is presented in Figure 1. Estimated key milestone implementation dates are presented in Table 1.

Construction is scheduled to begin in September, 1985, with the initiation of site preparation. This would include relocating utilities and installing air and water monitoring equipment. Primary construction, which would include project components such as the water treatment plant and dewatering lagoon, would not begin until early February, 1986.

Cofferdam construction and clamshell and hydraulic dredging in Slip No. 3 would begin in March of 1986. The 1,500-gpm water treatment plant, sediment dispersal control device and cofferdams would be installed before clamshell and hydraulic dredging begins in Slip No. 3. The hydraulic dredging would be done in conjunction with the clamshell dredging. The slurry produced by hydraulic dredging in Slip No. 3 would be dewatered in Lagoon Area 1 for approximately 3 months.

The cleanup of the Upper Harbor would begin in late June, 1986. The slurry produced by the hydraulic dredging would be routed to Lagoon Area 2. Solids would be dewatered and removed periodically over about a 16-month period.

FIGURE 1

CONCEPT CONSTRUCTION SCHEDULE

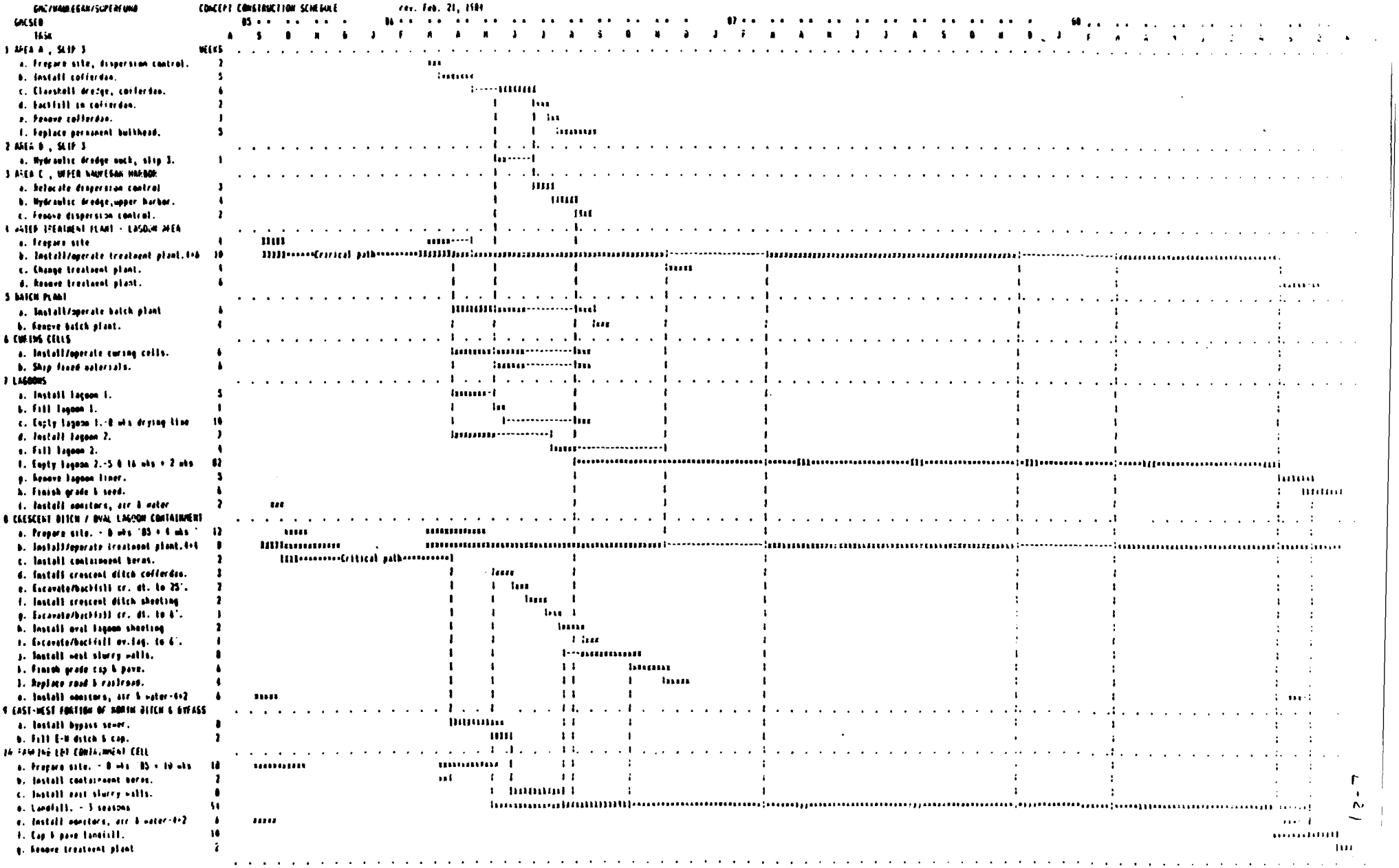


TABLE 1

IMPLEMENTATION SCHEDULE*

Schedule	Month of Implementation	Month of Completion
Award/IAG for Design Coordination	--	Completed
Notice to Proceed With Design	--	Completed
30% Design Completion	--	March, 1985
90% Design Completion	--	June, 1985
Completed Design	--	July, 1985
Award Superfund State Contract for Construction	--	August, 1985
Start Construction	--	September, 1985
Cleanup Actions		
Areas A & B, Slip No. 3	March, 1986	September, 1986
Area C, Upper Harbor	June, 1986	September, 1986
Area D, Crescent Ditch/ Oval Lagoon Excavation and Containment	September, 1985	November, 1986
Area E, Parking Lot Containment Cell	September, 1985	November, 1988
Dewatering Lagoon Construction, Operation and Dismantling	April, 1986	November, 1988
Water Treatment Plants - Installation and Removal	September, 1985	November, 1988

* All implementation and completion dates are preliminary and will be influenced by weather and site preparation conditions, construction season length and legal and funding considerations.

MWR/blc
[blc-64-2]

PERMITTING REQUIREMENTS

The applicant has been notified of the required coordination with State agencies regarding this project. The necessary approvals must be granted, conditioned or waived before a final decision on a Federal permit is reached. The U.S. EPA has determined that the July 14, 1983, "Source Control Feasibility Study, OMC Hazardous Waste Site, Waukegan, Illinois" and the May 15, 1984, "Record of Decision, Remedial Alternative Selections", meet the functionally equivalent requirement by the National Environmental Policy Act (NEPA). The Chicago District Engineer concurs with the U.S. EPA determination and an EIS for the Corps of Engineers permit action will not be required.

The applicant has applied to the Illinois Environmental Protection Agency (IEPA) for state certification of the proposed work, in accordance with Section 401 of the Clean Water Act. The certification, if issued, will express the Agency's opinion that the proposed activities will not violate applicable water quality standards. In addition, the construction and operation of the water treatment facilities will require permits from the IEPA. Written comments concerning possible impacts to waters of Illinois should be addressed to: IEPA, Division of Water Pollution Control, Permit Section, 2200 Churchill Road, Springfield, Illinois 62706, with copy provided to the Corps of Engineers.

The IDOT/DWR application is being processed pursuant to an Act in Relation to the Regulation of the Rivers, Lakes and Streams of the State of Illinois (I.R.S., Chapter 19, par. 52 et seq.). Comments concerning the IDOT/DWR permit should be addressed to the Illinois Department of Transportation,

Division of Water Resources, 300 N. State Street, Chicago, Illinois 60610. Mr. Dan Injerd 312/793-3123 may be contacted for additional information.

In response to this public notice, the U.S. Fish and Wildlife Service will review this proposed activitiy for potential impacts on threatened or endangered species or their critical habitat pursuant to Section 7 (c) of the Endangered Species Act as amended.

The decision whether to issue a permit will be based on an evaluation of the proposed activity on the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. All factors which may be relevant will be considered, including conservation of resources, economics, aesthetics, general environmental concerns, historic values, fish and wildlife values, flood damage prevention, land use, navigation, recreation, water supply, water quality, energy needs, safety, food production and, in general, the needs and welfare of the people.

This activity involves the discharge of dredged or fill material into navigable waters of the United States. Therefore, the Corps of Engineers' evaluation of the impact of the activity on the public interest will include application of the guidelines promulgated by the Administrator, U.S. Environmental Protection Agency, under Authority of Section 404 (b) of the Clean Water Act (40 CFR Part 230).

This notice is being published in compliance with title 33 Code of Federal Regulations 25.3. Any interested parties and agencies entertaining objections to or desiring to express their views concerning the work must do so by filing their comments in writing no later than 30 days from the date of issuance of this notice. It is presumed that all interested parties will wish to respond to this public notice; therefore, a lack of response will be interpreted as meaning that there is no objection to the permit application. Any person may request, in writing, within the comment period specified in this notice, that a public hearing be held to consider this application. Requests for public hearings shall state, with particularity, the reasons for holding a public hearing. Any comments submitted should refer to the Public Notice Number shown on this notice, and should be addressed to the District Engineer (Attn: Regulatory Functions Branch), 219 Dearborn Street, Chicago, Illinois 60604. Mr. Skip Bergmann of the Regulatory Functions Branch, telephone number 312/353-6433, may be contacted for additional information

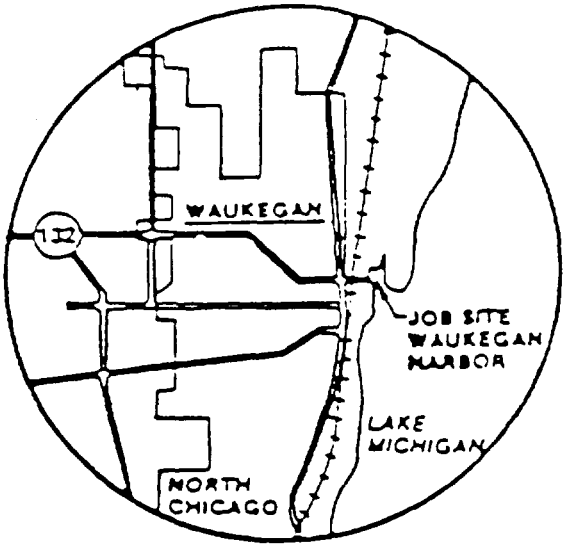
This public notice is not a paid advertisement, and is for public information only. Issuance of this notice does not imply Corps of Engineers indorsement of the proposed project.

Christos A. Dovas, P.E.
LTC, Corps of Engineers
District Engineer

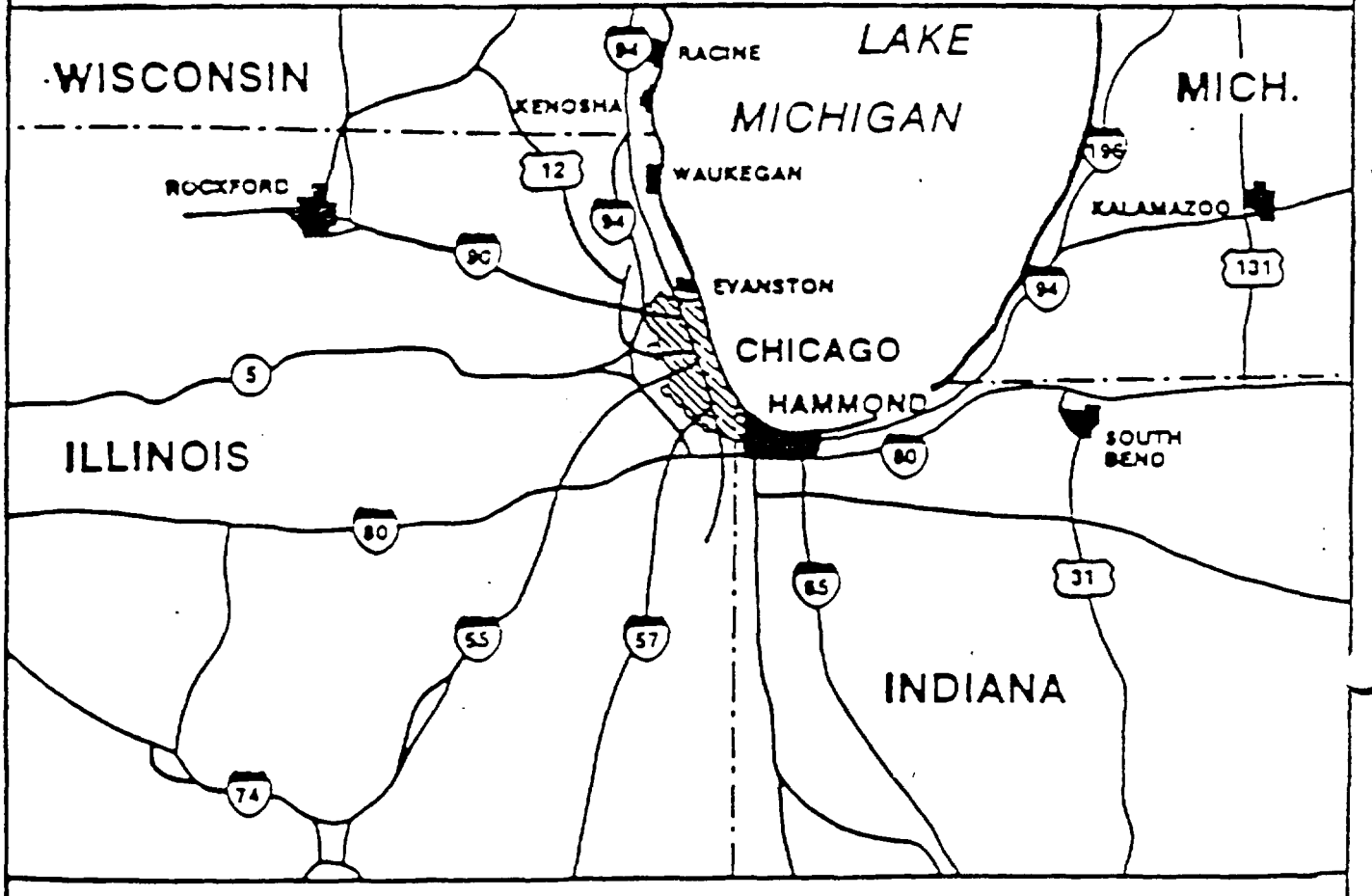
MWR/blc
[blc-64-2]

Encl: 7

Notice to Postmasters: It is requested that this notice be conspicuously and continuously posted for 30 days from the date of issuance.



VICINITY MAP

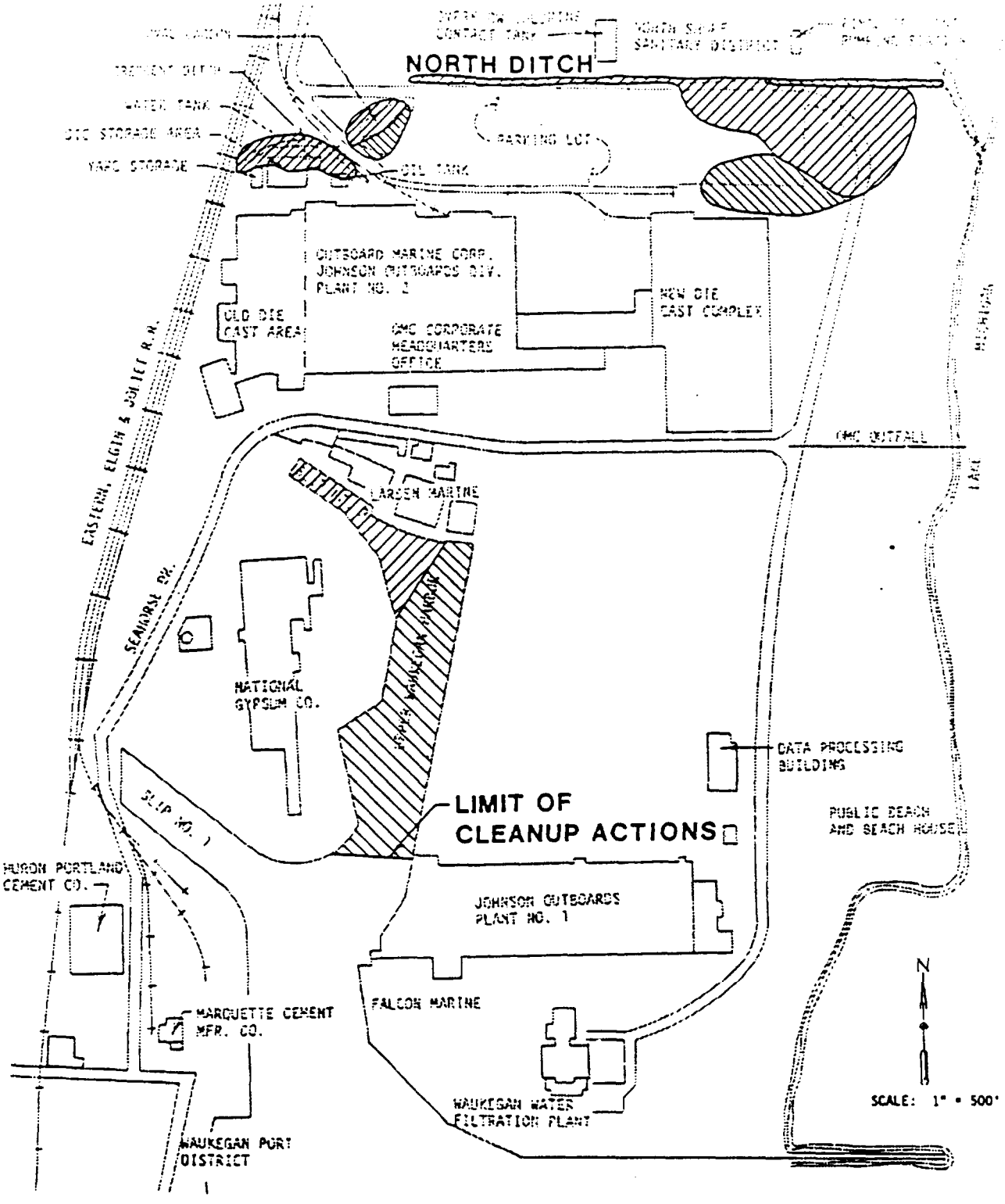


LIST OF ADJACENT PROPERTY OWNERS

1. Outboard Marine Corporation
2. Larsen Marine
3. National Gypsum
4. North Shore Sanitary District

PROJECT DESCRIPTION:
SUPERFUND-PCB removal and containment

LOCATION:
Waukegan Harbor
Lake County, Illinois

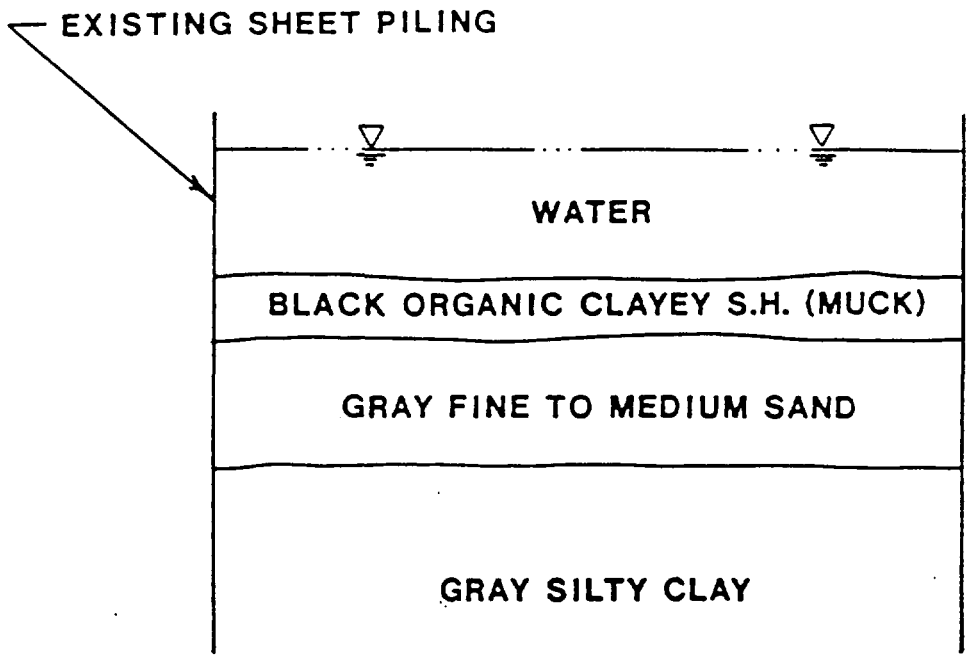


LEGEND

PCB CONCENTRATIONS OVER 500 PPM

PCB CONCENTRATIONS BETWEEN 50 AND 500 PPM

PROJECT DESCRIPTION:
Superfund-PCB removal and containment
LOCATION:
Waukegan Harbor
Lake County, Illinois

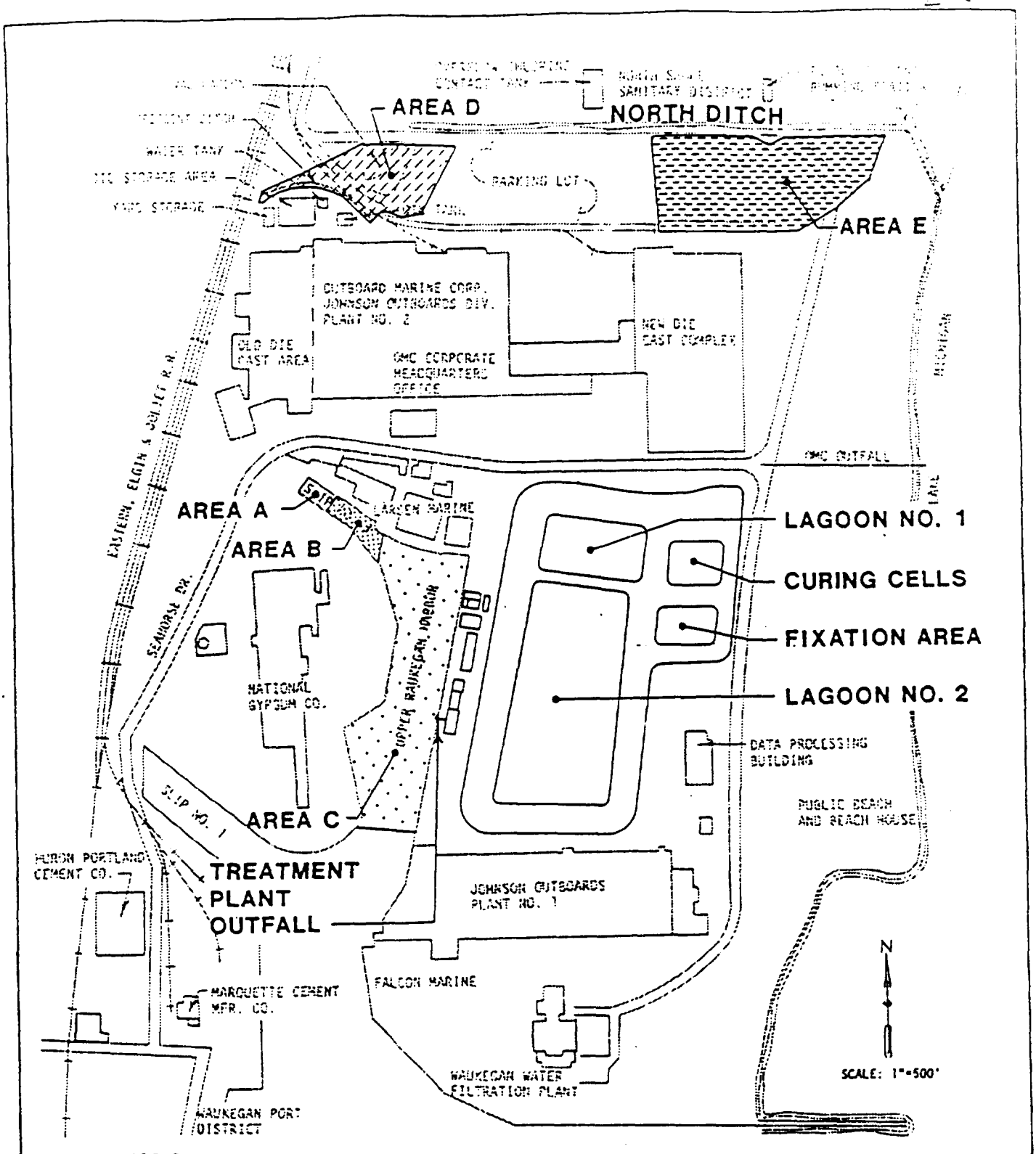


CROSS SECTION OF SEDIMENT STRATA IN SLIP NO. 3 AND UPPER HARBOR

NO SCALE (ILLUSTRATIVE ONLY)

PROJECT DESCRIPTION:
Superfund-PCB removal and containment

LOCATION:
Waukegan Harbor
Lake County, Illinois

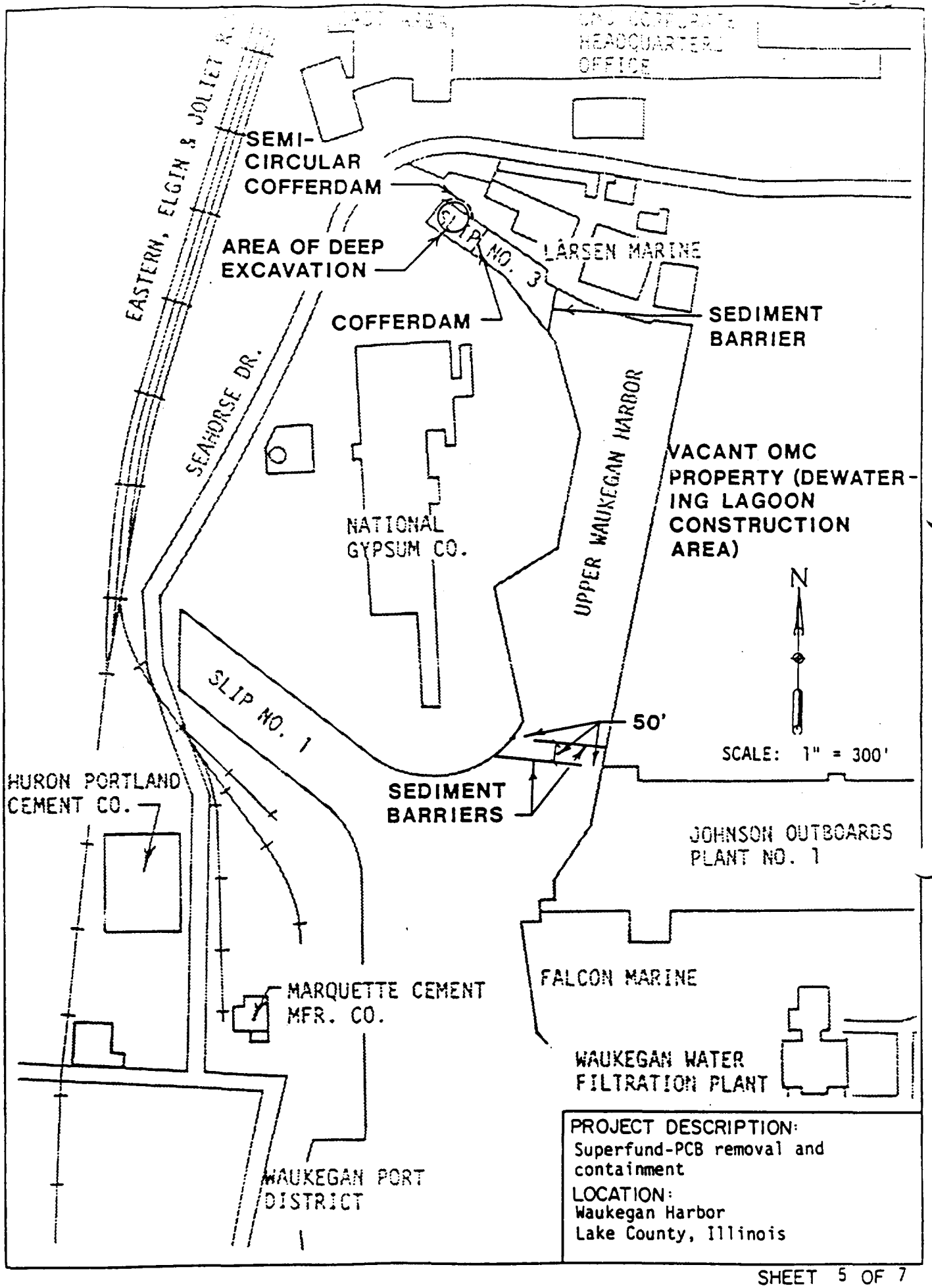


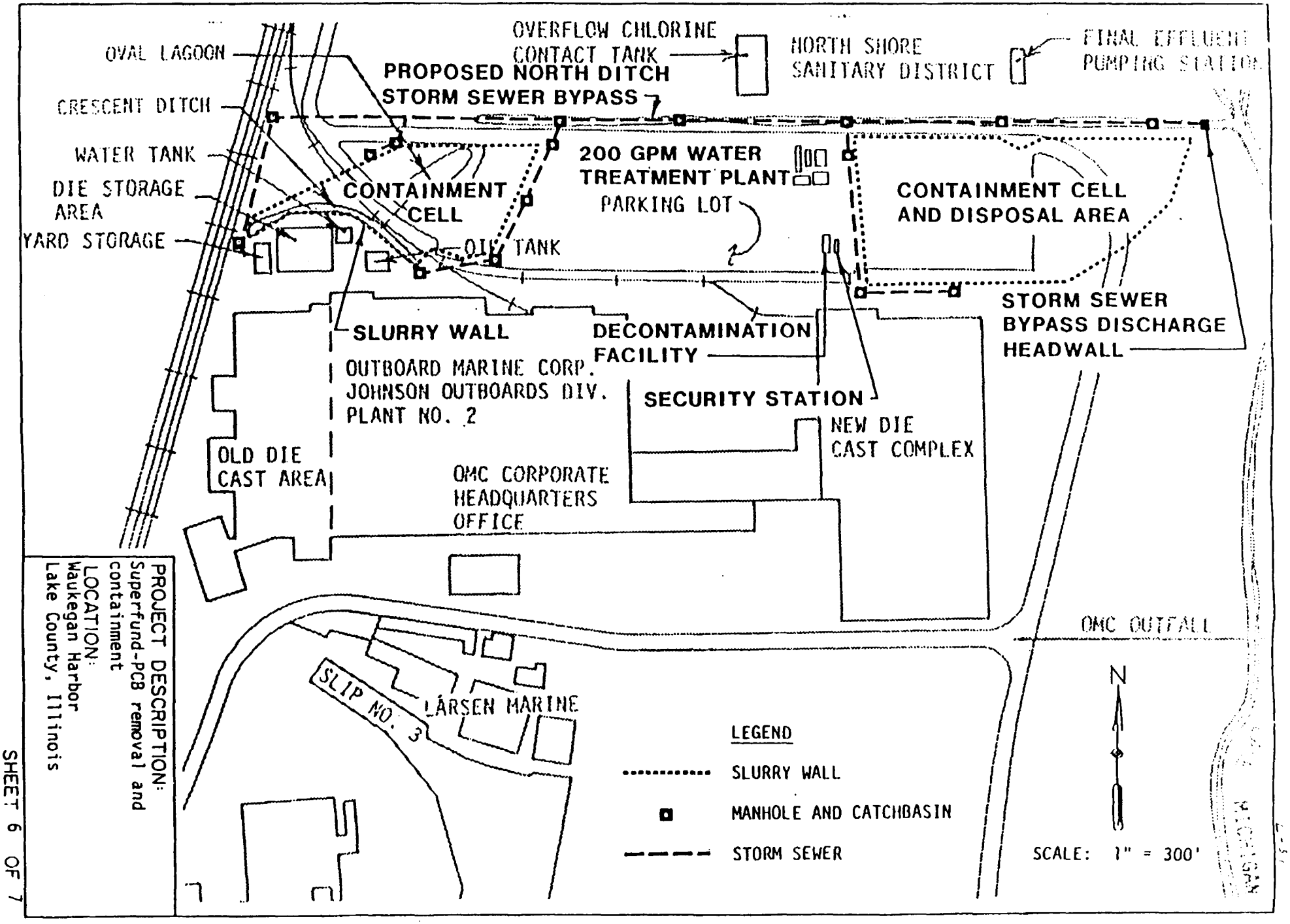
LEGEND

- AREA A - SLIP NO. 3
- AREA B - SLIP NO. 3
- AREA C - UPPER HARBOR
- AREA D - CRESCENT DITCH / OVAL LAGOON AREA
- AREA E - PARKING LOT AREA

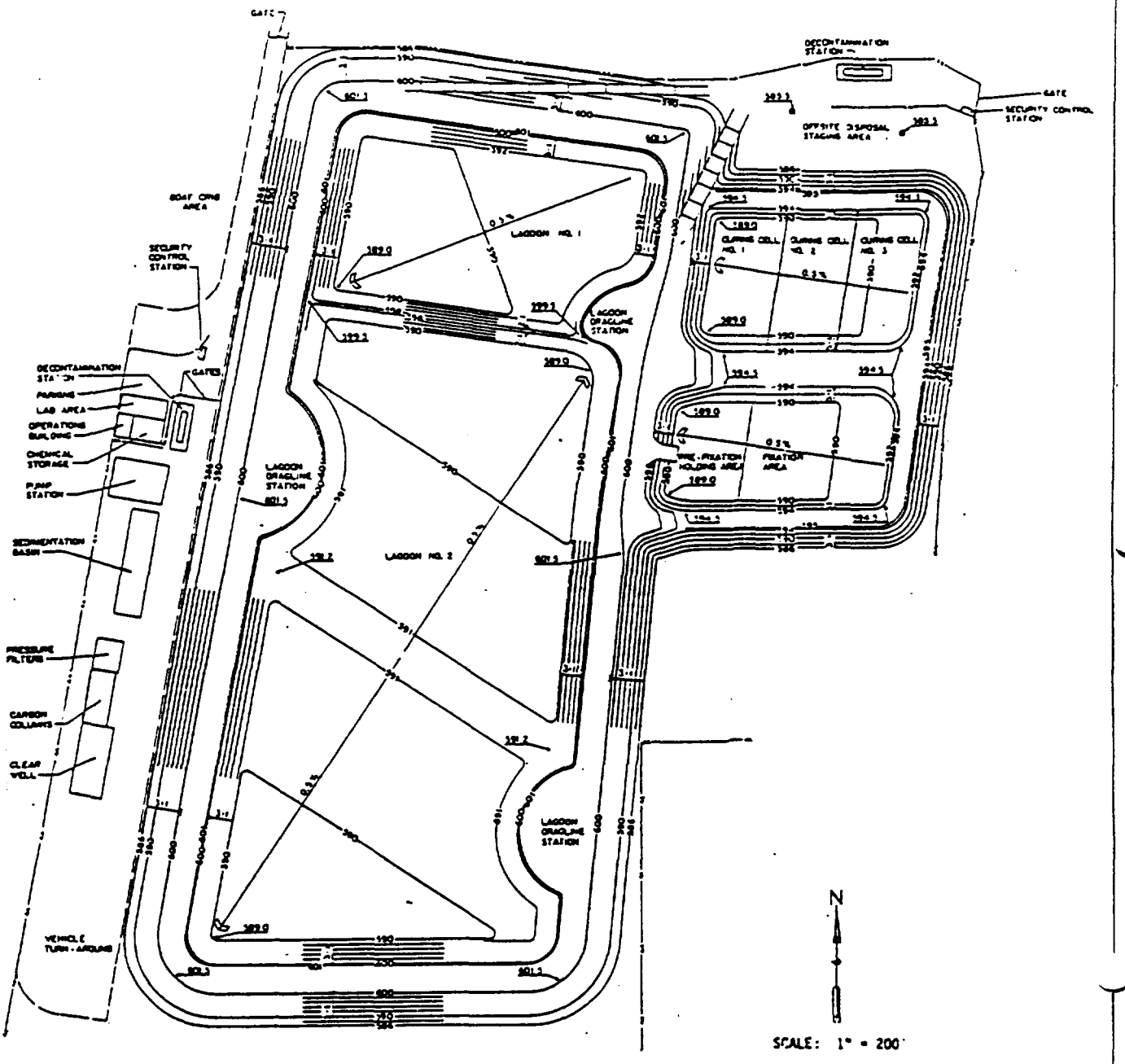
PROJECT DESCRIPTION:
Superfund-PCB removal and containment

LOCATION:
Waukegan Harbor
Lake County, Illinois


EASTERN, ELGIN & JOLIET R.R.
SEMI-CIRCULAR COFFERDAM
AREA OF DEEP EXCAVATION
SLIP NO. 3
LARSEN MARINE
COFFERDAM
SEDIMENT BARRIER
SEAHORSE DR.
NATIONAL GYPSUM CO.
UPPER WAUKEGAN HARBOR
VACANT OMC PROPERTY (DEWATERING LAGOON CONSTRUCTION AREA)
N
SCALE: 1" = 300'
50'
SLIP NO. 1
SEDIMENT BARRIERS
HURON PORTLAND CEMENT CO.
JOHNSON OUTBOARDS PLANT NO. 1
FALCON MARINE
MARQUETTE CEMENT MFR. CO.
WAUKEGAN WATER FILTRATION PLANT
WAUKEGAN PORT DISTRICT
PROJECT DESCRIPTION:
Superfund-PCB removal and containment
LOCATION:
Waukegan Harbor
Lake County, Illinois


OVAL LAGOON
CRESCENT DITCH
WATER TANK
DIE STORAGE AREA
YARD STORAGE
OVERFLOW CHLORINE CONTACT TANK
NORTH SHORE SANITARY DISTRICT
FINAL EFFLUENT PUMPING STATION
PROPOSED NORTH DITCH STORM SEWER BYPASS
CONTAINMENT CELL
200 GPM WATER TREATMENT PLANT
PARKING LOT
OIL TANK
CONTAINMENT CELL AND DISPOSAL AREA
STORM SEWER BYPASS DISCHARGE HEADWALL
SLURRY WALL
DECONTAMINATION FACILITY
OUTBOARD MARINE CORP. JOHNSON OUTBOARDS DIV. PLANT NO. 2
SECURITY STATION
NEW DIE CAST COMPLEX
OLD DIE CAST AREA
OMC CORPORATE HEADQUARTERS OFFICE
OMC OUTFALL
SLIP NO. 3
LARSEN MARINE
LEGEND
SLURRY WALL
MANHOLE AND CATCHBASIN
STORM SEWER
N
SCALE: 1" = 300'
PROJECT DESCRIPTION: Superfund-PCB removal and containment
LOCATION: Waukegan Harbor Lake County, Illinois

SHEET 6 OF 7



PROJECT DESCRIPTION:
Superfund-PCB removal and containment

LOCATION:
Waukegan Harbor
Lake County, Illinois

DRAFT COPY

MATERIAL ANALYSIS FOR SECTION 401
WATER QUALITY CERTIFICATION - UPPER WAUKEGAN HARBOR
C 11837

MATERIAL ANALYSIS FOR SECTION 401 WATER QUALITY CERTIFICATION - UPPER WAUKEGAN HARBOR

INTRODUCTION

This report brings together the results from three (3) subsurface investigations performed in Upper Waukegan Harbor which includes Slip No. 3 located at the north end of the harbor. It provides particle size information which is required by the Illinois Environmental Protection Agency for the issuance of a Section 401 Water Quality Certification in conjunction with the U.S. Army Corps of Engineers Section 404 Permit.

The investigations gathered data on the depths and physical properties of the sediment strata. Approximately 15 boreholes were completed in selected locations of the Upper Harbor and Slip No. 3. Samples were collected from throughout the sediment profiles. However, particular attention was directed toward collecting samples from the uppermost sediment strata which typically consisted of organic silt (muck). Sediment samples were analyzed for particle size (sieve and hydrometer), Atterberg limits, percent moisture and loss on ignition.

The attached appendices contain boring logs, soil testing results and borehole location maps. Each appendix contains information related to a specific subsurface investigation. The appendices are arranged as follows:

Appendix A - "Outboard Marine Corporation, Waukegan Harbor Boring, Waukegan, Illinois - C 9291". Prepared for Mason & Hanger-Silas Mason Company, Inc., and USEPA Region V, Chicago, Illinois. 1980.

Appendix B - "Sand Sample Collection, Waukegan Harbor Slip No. 3, Waukegan, Illinois - C 9560". Prepared for Mason & Hanger-Silas Mason Company, Inc., and USEPA Region V, Chicago, Illinois. 1981.

Appendix C - "Sediment and Shore Sample Collection, Waukegan Harbor Slip No. 3, Waukegan, Illinois - C 9729". Prepared for Mason & Hanger-Silas Mason Company, Inc., and USEPA Region V, Chicago, Illinois. 1981.

SUMMARY OF SUBSURFACE CONDITIONS

The Upper Harbor begins at the north side of OMC Plant No. 1 and extends north to include Slip No. 3. Water depths in the Harbor generally vary from 14 to 25 feet with some depths as shallow as 9 feet at the southwest corner of Slip No. 3. The harbor sediments typically consist of organic silt (muck) underlain by granular deposits that are underlain by glacial till.

The upper sediments were visually described as black organic clayey silt with trace to some sand (muck)(OL). The muck was typically 1 to 7 feet thick. The muck is very soft and contains an average of 50 percent solids. Moisture content tests indicate a range from 90 to 190 percent with an average of approximately 140 percent. Loss on ignition tests indicated 22.5 percent organics by combustion. Sieve analyses indicate the muck contains a fines content (material passing a No. 200 sieve) ranging between 40 to 68 percent.

The granular deposits primarily consist of gray fine to medium sand with little to some silt, trace gravel and occasional thin lenses of organic materials (SP-SM, SM). Moisture content tests indicate a range from 10 to 24 percent with an average of approximately 20 percent. Sieve analyses indicate the sand contains from 0.2 to 29 percent fines.

The glacial till stratum was classified as both low plasticity silt (ML) and clay (CL). A typical description is gray silty clay with little sand and trace gravel. The till extended to the maximum depths penetrated by the borings. Atterberg limits test results indicate an average liquid limit of 23 and plastic limit of 16. Sieve analyses indicate the till contains from 74 to 95 percent fines.

MWR/cwl
[cwl-72-32]

APPENDIX A

"OUTBOARD MARINE CORPORATION, WAUKEGAN HARBOR BORING, WAUKEGAN, ILLINOIS - C 9291".

WARZYN ENGINEERING INC

LOG OF TEST BORING

General Notes

L-38

Descriptive Soil Classification

GRAIN SIZE TERMINOLOGY

Soil Fraction	Particle Size	U.S. Standard Sieve Size
Boulders	Larger than 12"	Larger than 12"
Cobbles	3" to 12"	3" to 12"
Gravel: Coarse	¾" to 3"	¾" to 3"
Fine	4.76 mm to ¾"	#4 to ¾"
Sand: Coarse	2.00 mm to 4.76 mm	#10 to #4
Medium	0.42 mm to 2.00 mm	#40 to #10
Fine	0.074 mm to 0.42 mm	#200 to #40
Silt	0.005 mm to 0.074 mm	Smaller than #200
Clay	Smaller than 0.005 mm	Smaller than #200

Plasticity characteristics differentiate between silt and clay.

GENERAL TERMINOLOGY

Physical Characteristics
Color, moisture, grain shape, fineness, etc.

Major Constituents
Clay, silt, sand, gravel

Structure
Laminated, varved, fibrous, stratified, cemented, fissured, etc.

Geologic Origin
Glacial, alluvial, eolian, residual, etc.

RELATIVE DENSITY

Term	"N" Value
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

RELATIVE PROPORTIONS OF COHESIONLESS SOILS

Proportional Term	Defining Range By Percentage of Weight
Trace	0%- 5%
Little	5%-12%
Some	12%-35%
And	35%-50%

CONSISTENCY

Term	q_u-tons/sq. ft.
Very Soft	0.0 to 0.25
Soft	0.25 to 0.50
Medium	0.50 to 1.0
Stiff	1.0 to 2.0
Very Stiff	2.0 to 4.0
Hard	Over 4.0

ORGANIC CONTENT BY COMBUSTION METHOD

Soil Description	Loss on Ignition
Non Organic	Less than 4%
Organic Silt/Clay	4-12%
Sedimentary Peat	12-50%
Fibrous and Woody Peat	More than 50%

PLASTICITY

Term	Plastic Index
None to Slight	0-4
Slight	5-7
Medium	8-22
High to Very High	Over 22

The penetration resistance, N, is the summation of the number of blows required to effect two successive 6" penetrations of the 2" split-barrel sampler. The sampler is driven with a 140 lb. weight falling 30" and is seated to a depth of 6" before commencing the standard penetration test.

Symbols

DRILLING AND SAMPLING

CS—Continuous Sampling
RC—Rock Coring: Size AW, BW, NW, 2" W
RQD—Rock Quality Designator
RB—Rock Bit
FT—Fish Tail
OC—Open Casing
C—Casing: Size 2½", NW, 4", HW
CW—Clear Water
DM—Drilling Mud
HSA—Hollow Stem Auger
FA—Flight Auger
HA—Hand Auger
COA—Clean-Out Auger
SS—2" Diameter Split-Barrel Sample
2ST—2" Diameter Thin-Walled Tube Sample
3ST—3" Diameter Thin-Walled Tube Sample
PT—3" Diameter Piston Tube Sample
AS—Auger Sample
WS—Wash Sample
PTS—Peat Sample
PS—Pitcher Sample
NR—No Recovery
S—Sounding
PMT—Borehole Pressuremeter Test
VS—Vane Shear Test
WPT—Water Pressure Test

LABORATORY TESTS

q_p—Penetrometer Reading, tons/sq. ft.
q_u—Unconfined Strength, tons/sq. ft.
W—Moisture Content, %
LL—Liquid Limit, %
PL—Plastic Limit, %
SL—Shrinkage Limit, %
LI—Loss on Ignition, %
D—Dry Unit Weight, lbs./cu. ft.
pH—Measure of Soil Alkalinity or Acidity
FS—Free Swell, %

WATER LEVEL MEASUREMENT

▽—Water Level at time shown
NW—No Water Encountered
WD—While Drilling
BCR—Before Casing Removal
ACR—After Casing Removal
CW—Caved and Wet
CM—Caved and Moist

Note: Water level measurements shown on the boring logs represent conditions at the time indicated and may not reflect static levels, especially in cohesive soils.

UNIFIED SOIL CLASSIFICATION SYSTEM

COARSE-GRAINED SOILS

(More than half of material is larger than No. 200 sieve size.)

GRAVELS More than half of coarse fraction larger than No. 4 sieve size

Clean Gravels (Little or no fines)

GW	Well-graded gravels, gravel-sand mixtures, little or no fines
GP	Poorly graded gravels, gravel-sand mixtures, little or no fines

Gravels with Fines (Appreciable amount of fines)

GM^{d}_{u}	Silty gravels, gravel-sand-silt mixtures
GC	Clayey gravels, gravel-sand-clay mixtures

SANDS More than half of coarse fraction smaller than No. 4 sieve size

Clean Sands (Little or no fines)

SW	Well-graded sands, gravelly sands, little or no fines
SP	Poorly graded sands, gravelly sands, little or no fines

Sands with Fines (Appreciable amount of fines)

SM^{d}_{u}	Silty sands, sand-silt mixtures
SC	Clayey sands, sand-clay mixtures

FINE-GRAINED SOILS

(More than half of material is smaller than No. 200 sieve.)

SILTS AND CLAYS Liquid limit less than 50%

ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
OL	Organic silts and organic silty clays of low plasticity

SILTS AND CLAYS Liquid limit greater than 50%

MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
CH	Inorganic clays of high plasticity, fat clays
OH	Organic clays of medium to high plasticity, organic silts

HIGHLY ORGANIC SOILS

PT	Peat and other highly organic soils

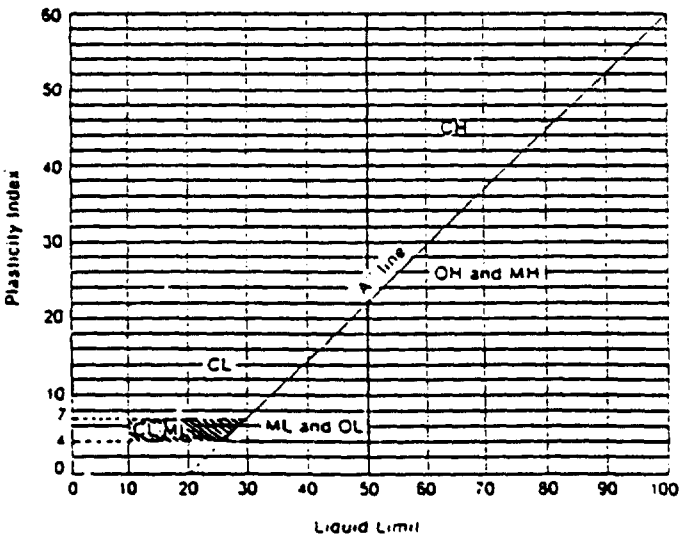
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 per cent	GW, GP, SW, SP
More than 12 per cent	GM, GC, SM, SC
5 to 12 per cent	Borderline cases requiring dual symbols

PLASTICITY CHART



For classification of fine-grained soils and fine fraction of coarse-grained soils.

Atterberg Limits plotting in hatched area are borderline classifications requiring use of dual symbols

Equation of A-line: PI = 0.73 (LL - 20)

L-4

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Outboard Marine Corporation
Waukegan Harbor Borings
Location: Waukegan, Illinois

Boring No. 1
Surface Elevation
Job No. C 9291
Sheet 1 of 1

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
					5	Water to 15'					
					10						
					15						
S-1	SS	X	W	0		Very Soft, Black Organic Clayey SILT, Trace to Some Sand (OL)					
2	SS	X	W	8/6"							
S-3	SS	X	W	12/6"	20	Medium Dense, Dark Gray/Brown Silty Fine SAND Trace Clay, Trace Organics, Occasional Fine to Medium Gravel (SM) *					
S-4	SS	X	M	27/6"			(2.5-4.5)	17.9	15.1		
					25	Very Stiff to Hard Gray SILT Some Clay, Trace to Some Fine Sand Trace Gravel (ML)					
					30	End Boring at 30'					
					35	* 6" Fine to Medium Sand, Fine Gravel at 21'6"	( ) Pocket Penetrometer Reading, TSF				
					40						

WATER LEVEL OBSERVATIONS

While Drilling N/A
Upon Completion of Drilling N/A
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 7/2/80 Complete 7/2/80
Crew Chief JVS Rig CME 550
Drilling Method CS 15-30'
4" HW Casing 0-22'

WARZYN ENGINEERING INC

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

LOG OF TEST BORING

Project: Outboard Marine Corporation
Waukegan Harbor Borings
Location: Waukegan, Illinois

Boring No. 2
Surface Elevation
Job No. C 9291
Sheet 1 of 1

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES Qu	W	LL	PL	D
					5	Water to 18'					
					10						
					15						
S-1	SS	X	W	0	20	Very Soft, Black Organic Clayey SILT, Trace to Some Sand (OL)					
S-2	SS	X	W	16/6"		*					
S-3	SS	X	M	18/6"	25	Hard, Gray SILT, Some Clay Trace to Some Sand Trace Gravel (ML)	(4.5+)				
						End Boring at 26'					
					30	* Loose, Brown Fine to Medium SAND, Little to Trace Silt, Occasional Thin Organic Seams (SM)	( ) Pocket Penetrometer Reading, TSF				
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling N/A
Upon Completion of Drilling N/A
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 7/2/80 Complete 7/2/80
Crew Chief JVS Rig CME 550
Drilling Method CS 17-26'
4" HW Casing 0-24'

WARZYN ENGINEERING INC

1409 EMIL STREET · P.O. BOX 9538, MADISON, WIS. 53715 · TEL. (608) 257-4848

LOG OF TEST BORING

Project: Outboard Marine Corporation
Waukegan Harbor Borings
Location: Waukegan, Illinois

Boring No. 3
Surface Elevation
Job No. C 9291
Sheet 1 of 1

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
Recovery			Moisture				q_u	W	LL	PL	D
No.	Type	↓	↓	N	Depth						
					5	Water to 19'					
					10						
					15						
					20	Very Soft, Black Organic Clayey SILT, Trace to Some Sand (OL)					
S-1	SS	X	W	5 0/6"							
S-2	SS	X	W			*					
					25	Hard, Gray Silty CLAY, Trace to Some Sand (CL)	(4.5)		28.5	16.7	
S-3	SS	X	M	37/6"		End Boring at 25'					
					30	* Loose, Brown Fine to Medium SAND, Little to Trace Silt, Occasional Thin Organic Seams (SM)					
					35		( ) Pocket Penetrometer Reading, TSF				
					40						

WATER LEVEL OBSERVATIONS

While Drilling N/A
Upon Completion of Drilling N/A
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 7/2/80 Complete 7/2/80
Crew Chief JVS Rig CME 550
Drilling Method CS 19-26'
4" HW Casing 0-24'

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Outboard Marine Corporation
Waukegan Harbor Borings
Location: Waukegan, Illinois

Boring No. 4
Surface Elevation
Job No. C 9291
Sheet 1 of 1

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
Recovery			Moisture				q_u	W	LL	PL	D
No.	Type	↓	↓	N	Depth						
					5						
					10	Water to 22'					
					15						
					20						
S-1	SS	X	W	0		Very Soft, Black Organic Clayey SILT, Trace to Some Sand (OL)					
S-2	SS	X	M	38	25	*	(4.0)				
						End Boring at 26'					
					30	* Very Stiff to Hard Gray Silty CLAY, Trace Fine Sand Trace Gravel (CL)	( ) Pocket Penetrometer Reading, TSF				
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling N/A
Upon Completion of Drilling N/A
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 7/1/80 Complete 7/1/80
Crew Chief JVS Rig CME 550
Drilling Method CS 22-26'

W-1

L-42

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Outboard Marine Corporation, Waukegan Harbor Borings
Location: Waukegan, Illinois

Boring No. 5
Surface Elevation
Job No. C 9291
Sheet 1 of 1

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
Recovery			Moisture				q_u	W	LL	PL	D
No.	Type	↓	↓	N	Depth						
					5						
					10	Water to 23'					
					15						
					20						
S-1	SS	X	W	0	25	Very Soft, Black Organic Clayey SILT, Trace to Some Sand (OL)					
S-2	SS	X	M	72/6"		Hard, Gray SILT, Some Clay Trace to Some Sand Trace Gravel (ML)	(4.0)				
					30	End Boring at 27'6"					
					35		( ) Pocket Penetrometer Reading, TSF				
					40						

WATER LEVEL OBSERVATIONS

While Drilling N/A
Upon Completion of Drilling N/A
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 7/1/80 Complete 7/1/80
Crew Chief JVS Rig CME 550
Drilling Method CS 23-27½'

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Outboard Marine Corporation
Waukegan Harbor Borings
Location: Waukegan, Illinois

Boring No. 6
Surface Elevation
Job No. C 9291
Sheet 1 of 1

1409 EMIL STREET · P.O. BOX 9538, MADISON, WIS. 53715 · TEL. (608) 257-4848

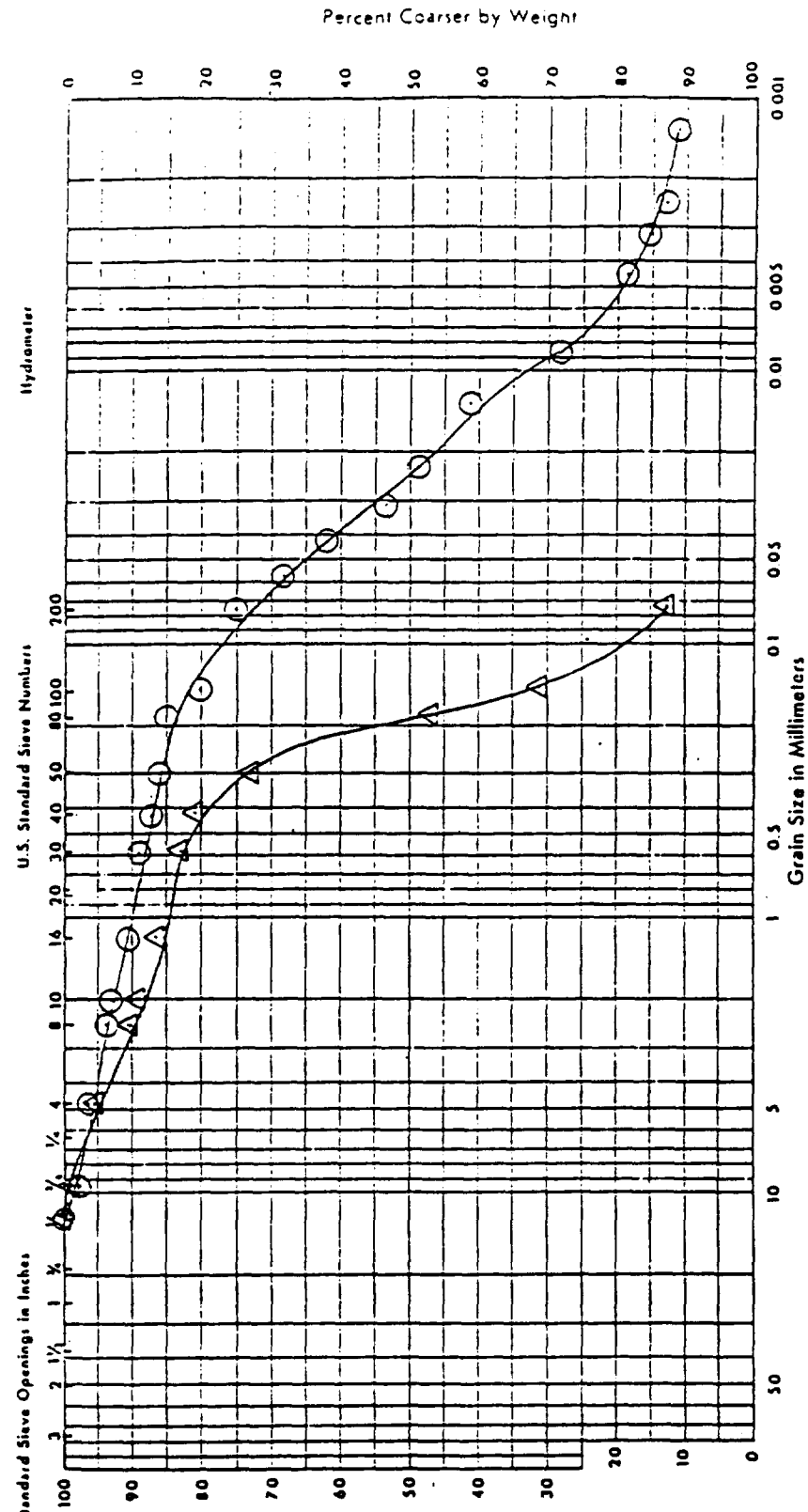
SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
Recovery			Moisture								
No.	Type			N	Depth		qu	W	LL	PL	D
					5	Water to 23'					
					10						
					15						
					20						
S-1	SS	X	M	5 6"	25	*					
S-2	SS	X	M	10 6"		**					
						***					
					30	End Boring at 25'6"					
					35	* Very Soft, Black Organic Clayey SILT, Trace to Some Sand (OL)					
					40	** Loose, Brown Fine to Medium SAND, Little to Trace Silt, Occasional Thin Organic Seams (SM)					
						*** Hard, Gray Silty CLAY, Trace to Some Sand Trace Gravel (CL)					

WATER LEVEL OBSERVATIONS

While Drilling N/A
Upon Completion of Drilling N/A
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 7/1/80 Complete 7/1/80
Crew Chief JVS Rig CME 550
Drilling Method CS 0-25'½'



Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
△	B1-2	18'				5	82	13		SAND, LITTLE SILT, CLAY & GRAVEL (SP)
○	B1-4	23'		17.9	2.8	4	22	55	19	CLAYEY SILT, SOME SAND, TRACE GRAVEL (ML)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS

OUTBOARD MARINE CORPORATION
WAUKEGAN HARBOR BORINGS
WAUKEGAN, ILLINOIS

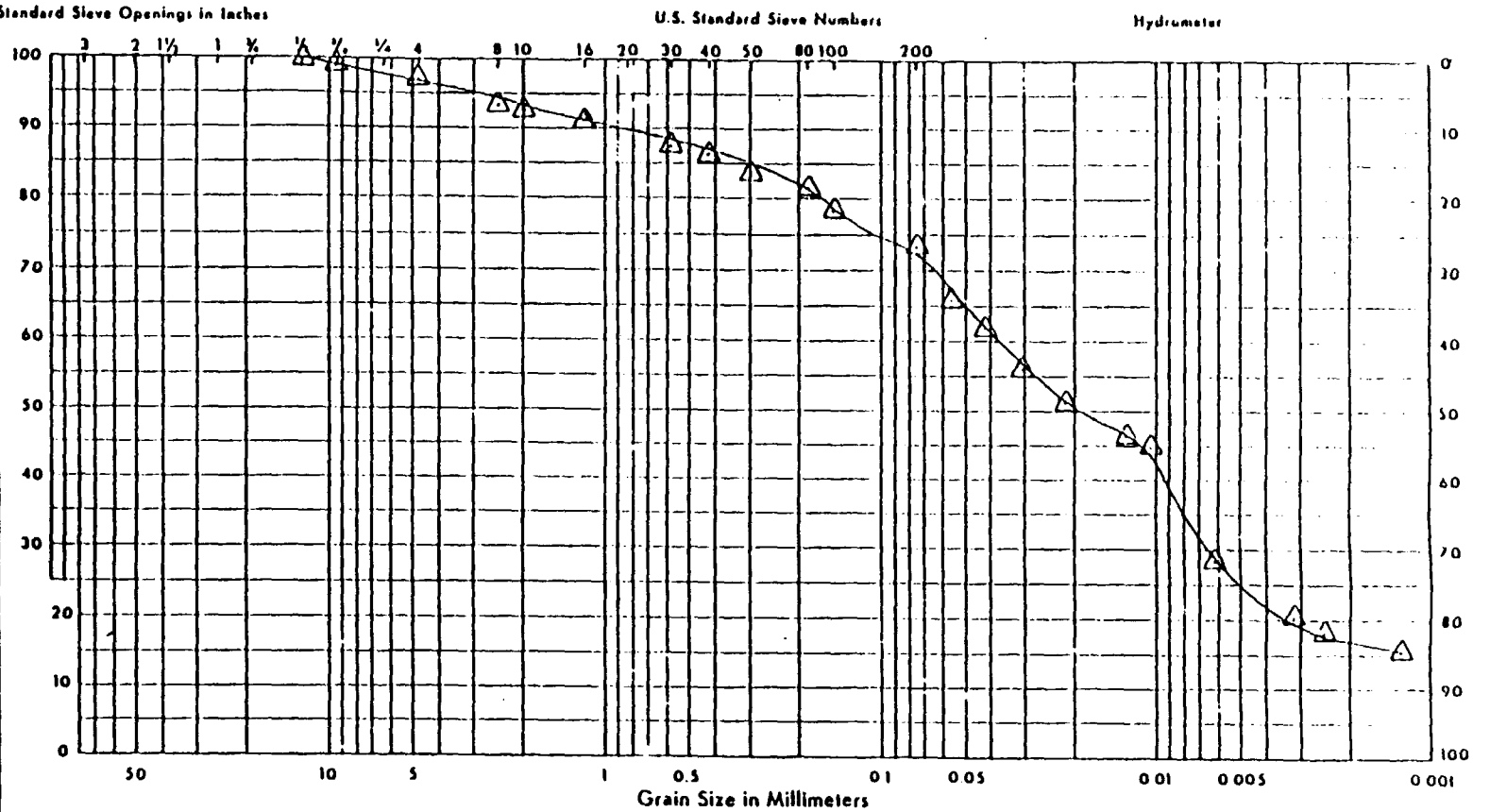
DWN JCC	CHK'D CGK	APP'D Daniel R. Vitale	DATE 8/5/1980	C9291-A1

DWN JCC | CHK'D CGK | APP'D Daniel R. Urt | DATE 8/5/1980 | C9291-A3

WARZYN ENGINEERING INC.

GRAIN SIZE ANALYSIS

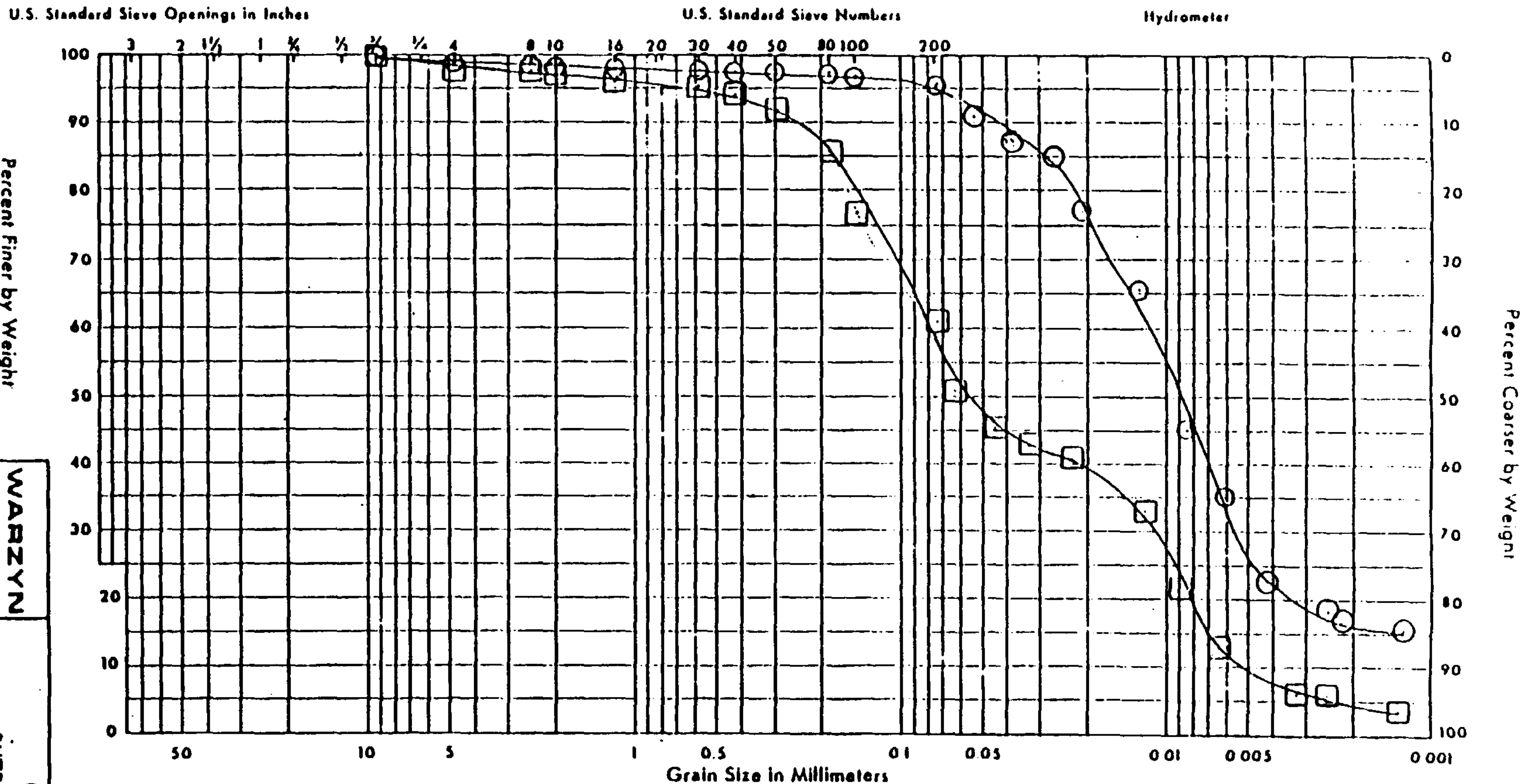
OUTBOARD MARINE CORPORATION
WAUKEGAN HARBOR BORINGS
WAUKEGAN, ILLINOIS



COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

Unified Classification System (ASTM D2487)

Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
△	B6-2	25'				3	24	48	25	CLAYEY SILT SOME SAND, TRACE GRAVEL (ML)
	B5-1	25'	90.2	(LOSS ON IGNITION 22.5)						ORGANIC CLAYEY SILT (OL)



COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

Unified Classification System (ASTM D2487)

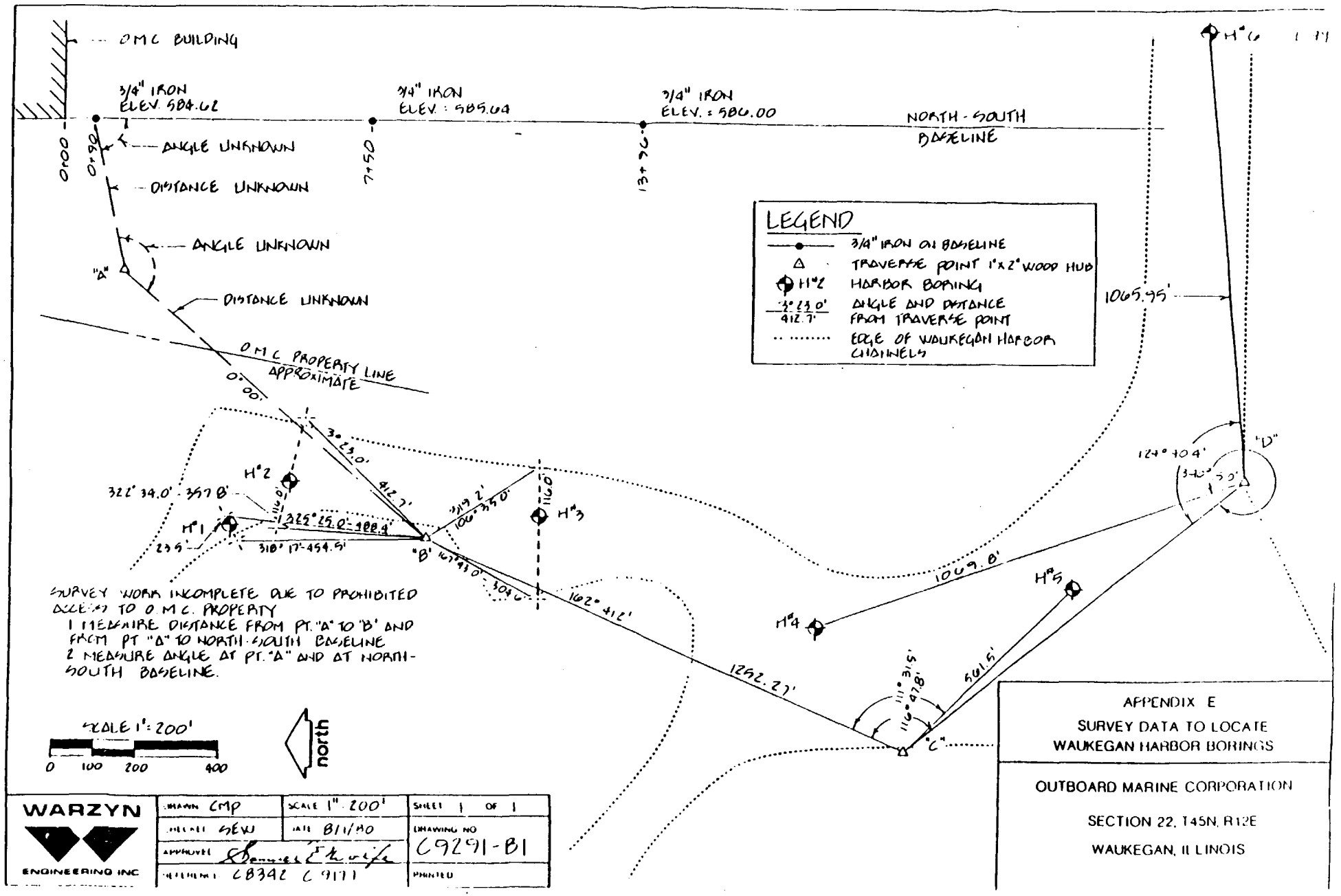
Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	B2-3	26'				1	4	68	27	CLAYEY SILT, TRACE SAND & GRAVEL (ML)
⊡	B3-1	19'-23'				2	40	49	9	SANDY SILT, LITTLE CLAY, TRACE GRAVEL (OL)
	B3-3			28.5	11.8					SILTY CLAY (CL)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS

OUTBOARD MARINE CORPORATION
WAUKEGAN HARBOR BORINGS
WAUKEGAN, ILLINOIS

DWN JCC	CHK'D CGK	APP'D Daniel R. Vite	DATE 8/5/1980	C9291-A2



WARZYN ENGINEERING INC	DRAWN CMP	SCALE 1" = 200'	SHEET 1 OF 1
	CHECKED SEW	DATE 8/1/80	DRAWING NO C9291-B1
	APPROVED		
	AGREEMENT CB342 C 9171		PRINTED

APPENDIX E

SURVEY DATA TO LOCATE WAUKEGAN HARBOR BORINGS

OUTBOARD MARINE CORPORATION

SECTION 22, T45N, R12E

WAUKEGAN, ILLINOIS

APPENDIX B

"SAND SAMPLE COLLECTION, WAUKEGAN HARBOR SLIP NO. 3, WAUKEGAN, ILLINOIS - C 9560".

WARZYN ENGINEERING INC

WARZYN ENGINEERING INC

LOG OF TEST BORING

SAND Sample Collection
Project: Waukegan Harbor Slip #3
Location: 45'SE of NW End of Slip & 5'SW of Retaining Wall

Boring No. B1
Surface Elevation 2.33' below B.M.
Job No. C 9560
Sheet 1 of 1

L-5

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
Recovery			Moisture				q_u	W	LL	PL	D
No.	Type	↓	↓	N	Depth						
					5	WATER to 9.8 feet					
					10	Very Loose, Black, Organic Clayey SILT, Trace Fine Sand (Muck) (OL)					
1	SS	15	W	14	15	Medium Dense, Gray Fine to Coarse SAND, Some Fine Gravel, Little Silt, Very Oily (SW-SM)					
2	SS	17	M	33		*					
					20	End Boring at 18.0'					
					25	* Very Stiff, Gray, Silty CLAY, Little Fine to Coarse Sand, Little Fine to Coarse Gravel. Very Oily					
					30						
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 11/22/80 Complete 11/22/80
Crew Chief SL Rig 55-2
Drilling Method CS 14.2' to 18.0'

WARZYN ENGINEERING INC

LOG OF TEST BORING

Waukegan Harbor Slip #3
83'SE of NW End of Slip & 44'SW of Retaining Wall

Location

Boring No. B2
Surface Elevation 2.14' below B.M.
Job No. C 9560
Sheet 1 of 1

1409 EMIL STREET · P.O. BOX 9538, MADISON, WIS. 53715 · TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
Recovery			Moisture								
No.	Type	↓	↓	N	Depth		q_u	W	LL	PL	D
						WATER to 7.5 feet					
					5						
						Very Loose, Black, Organic Clayey SILT, Some Fine Sand (Muck) (OL)					
					10						
1	SS	15	W	15		Medium Dense, Gray Fine SAND, Some Silt (SM)					
2	SS	10	W	13	15						
						*					
3	SS	16	M	28		**					
					20	End Boring at 19.3'					
						* Medium Dense, Dark Gray to Black Fine to Coarse SAND, Some Fine Gravel, Little Silt (SW-SM)					
					25						
						** Very Stiff, Gray Silty CLAY, Little Fine to Coarse Sand, Trace Fine to Coarse Gravel					
					30						
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Started 11/21/80 Completed 11/21/80
Crew Chief WG Rig 55-2
Drilling Method CS 11.75' to 19.3'

L-5

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: SAND Sample Collection, Waukegan Harbor Slip #3, 125'SE of NW End of Slip & 45'SW of Retaining Wall

Boring No. B3
Surface Elevation 2.22' below B.M.
Job No. C 9560
Sheet 1 of 1

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-48-18

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES qu	W	LL	PL	D
					5	WATER to 9.2'					
					10	Very Loose, Black, Organic Clayey SILT Trace Fine Sand (Muck) (OL)					
1	SS	11	W	10							
2	SS	13	W	27	15	Medium Dense, Gray Fine SAND, Trace Silt (SP)					
3	SS	15	W	32							
					20	End Boring at 18.5'					
						* Very Stiff, Gray, CLAY, Some Silt, Little Fine to Medium Sand, Trace Fine to Medium Gravel					
					25						
					30						
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 11/21/80 Complete 11/21/80
Crew Chief WG Rig 55-2
Drilling Method CS 12.0' to 18.5'

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Sand Sample Collection
Waukegan Habor Slip #3
166'SE of NW End of Slip &
Location 11'NW of Retaining Wall

Boring No. 84
Surface Elevation 2.55' below B.M.
Job No. C 9560
Sheet 1 of 1

1409 EMIL STREET · P.O. BOX 9538, MADISON, WIS. 53715 · TEL. (608) 257-4848

SAMPLE No.	Type	Recovery ↓	Moisture ↓	N	Depth	VISUAL CLASSIFICATION and Remarks
						WATER to 6.5'
					5	
						Very Loose, Black, Organic Clayey SILT Trace Fine Sand (Muck) (OL)
					10	
1	3"ST	15	W	-		Pusned Tube 10.5'-12.5', 15" Recovery of Medium Dense, Gray Fine SAND, Trace Silt (SP)
2	3"ST	16	W	-		Pushed Tube 12.5'-14.5', 16" Recovery, Same As Sample 1
3	SS	12	W	28	15	3" Lense of Coarse Sand & Fine Gravel @ 14.7', Pushed Tube
4	3"ST	14	W	-		16.5'-18.0' (Refusal) 14" Recovery
5	SS	11	W	72		*
						**
6	SS	14	M	60	20	
						End Boring at 20.5'
					25	
						* Gravel Lense at 18.5'
					30	
						** Very Stiff, Gray, CLAY, Some Silt, Little Fine to Coarse Sand, Trace Fine to Medium Gravel
					35	
					40	

SOIL PROPERTIES				
q_u	W	LL	PL	D

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 11/20/80 Complete 11/20/80
Crew Chief WG Rig 55-2
Drilling Method CS 10.5' to 20.5'

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: SAND Sample Collection
Waukegan Harbor Slip #3
Location: 200'SE of NW End of Slip & 47'SW of Retaining Wall

Boring No. 35
Surface Elevation 2.42' below B.M.
Job No. C 9560
Sheet 1 of 1

1409 EMIL STREET · P.O. BOX 9538, MADISON, WIS 53715 · TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
Recovery			Moisture								
No.	Type	↓	↓	N	Depth		q_u	W	LL	PL	D
					5	WATER to 9.2'					
						*					
1	3"ST	18	W	-	10	**					
						End Boring at 11.7'					
					15						
					20	* Very Loose, Black Organic SILT, Some Fine Sand (OL)					
						** Pushed Tube 9.7' to 11.7', 18" Recovery of Medium Dense, Gray Fine SAND, Trace Silt, (SP)					
					25	*** Gray Silty CLAY (Assumed)					
					30						
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 11/19/80 Complete 11/19/80
Crew Chief WG Rig 55-2
Drilling Method CS 9.7' to 11.7'

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: SAND Sample Collection Waukegan Harbor Slip #3

Location: 35'SE of NW End of Slip & 39'SW of Retaining Wall

Boring No. 66A

Surface Elevation 2.25' below B.M.

Job No. C 9560

Sheet 1 of 1

1409 EMIL STREET · P.O. BOX 9538, MADISON, WIS. 53715 · TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
Recovery			Moisture				q_u	W	LL	PL	D
No.	Type			N	Depth						
						WATER to 6.5'					
					5						
						Very Loose, Black Organic Clayey SILT Some Fine Sand (Muck) (OL)					
					10						
1	SS	13	W	16		*					
2	SS	13	W	22		Medium Dense, Gray Fine SAND, Trace Silt (SP)					
					15						
3	SS	15	W	39		Dense Gray, Fine SAND, Some Silt (SM)					
4	SS	16	W	31		**					
					20	End Boring at 19.0'					
						* Medium Dense, Black Fine SAND, Trace Silt (SP)					
					25	** Very Stiff, Gray Silty CLAY, Little Fine to Coarse Sand, Little Fine to Coarse Gravel					
					30						
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling

Depth to Water

Depth to Cave In

GENERAL NOTES

Start 11/21/80 Complete 11/21/80

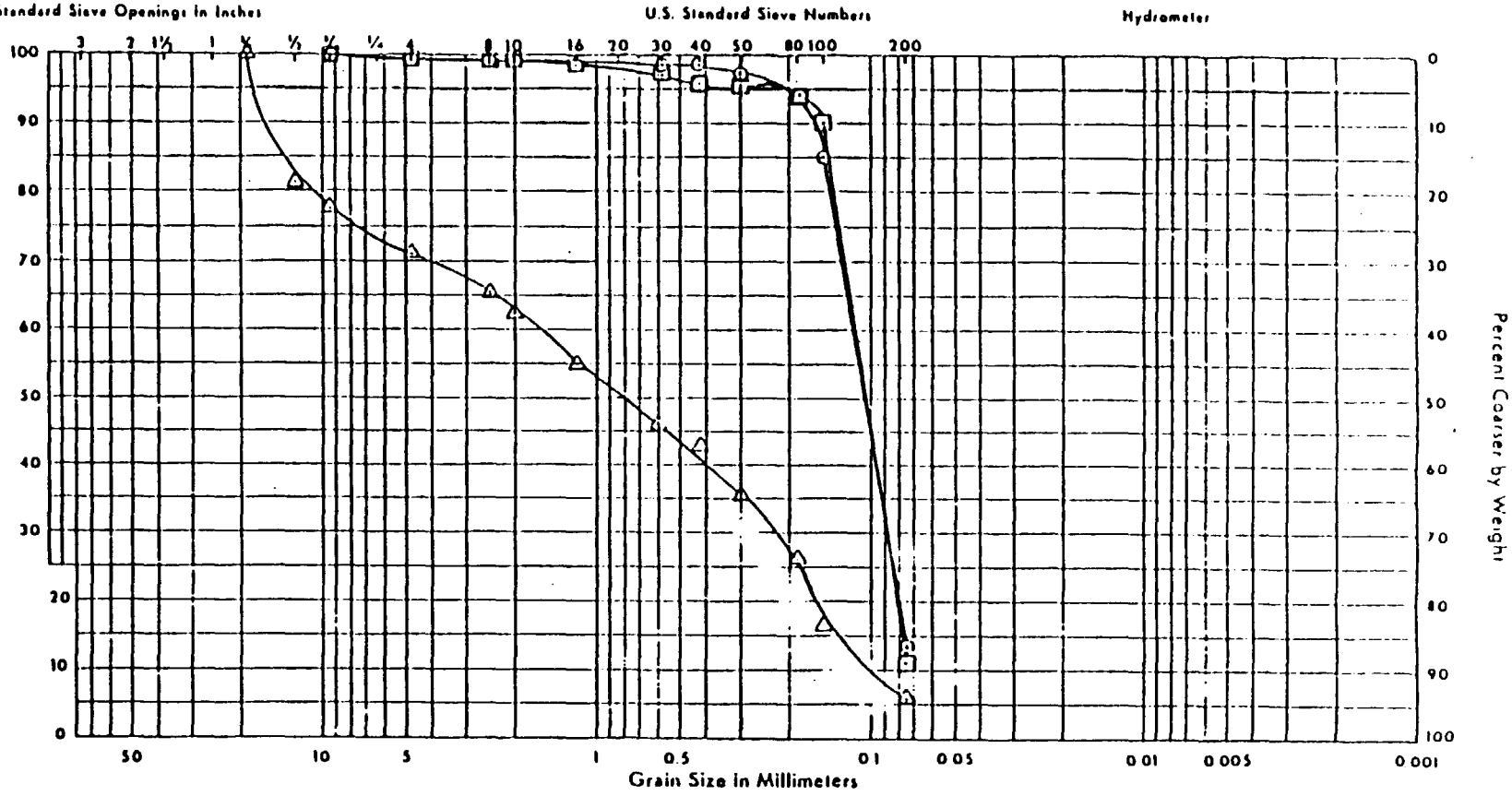
Crew Chief SL Rig 55-2

Drilling Method CS 10.6' to 19.0'

DWN LWS | CHK'D GFP | APP'D Dominic P. Visi | DATE 1/6/81 | C95600-A5

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS
SAND SAMPLE COLLECTION
WAUKEGAN HARBOR SLIP #3
WAUKEGAN, ILLINOIS



COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

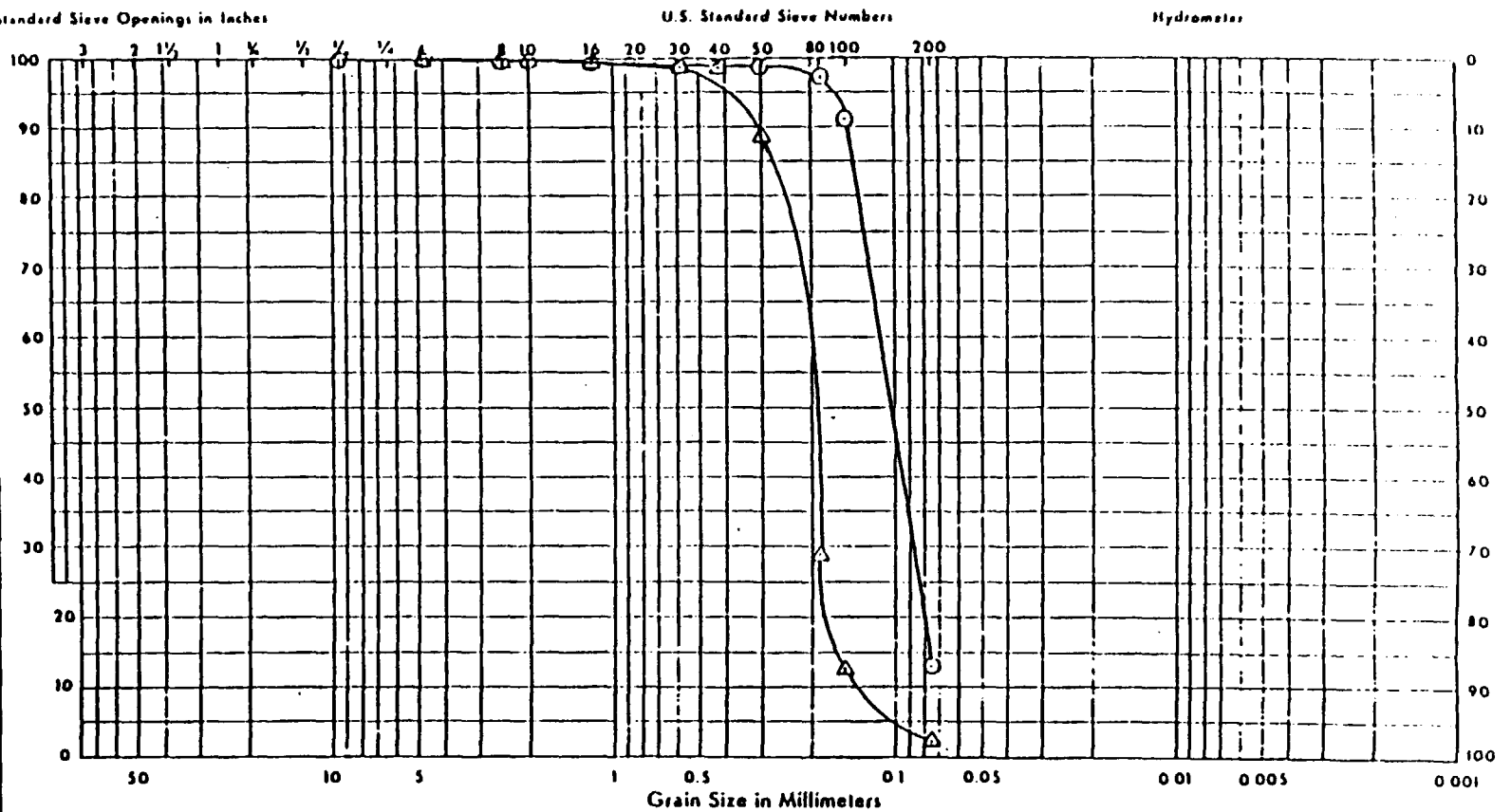
Unified Classification System (ASTM D2487)

Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
△	B#1, S1A	4.4-6.4	10.2			28.6	65.5	5.9		FINE TO COARSE SAND, LITTLE SILT (SW-SM)
○	B#2, S1A	4.5-6.5	22.5			0.5	85.9	13.6		FINE SAND, SOME SILT (SM)
□	B#2, S1B	7.7-9.7	22.7			0.6	88.4	11.0		FINE SAND, LITTLE SILT (SP-SM)

DWN KKS | CHK'D GFP | APP'D Daniel P. Veit | DATE 1/6/81 | C9560-A.6

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS
SAND SAMPLE COLLECTION
WAUKEGAN HARBOR SLIP #3
WAUKEGAN, ILLINOIS



COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

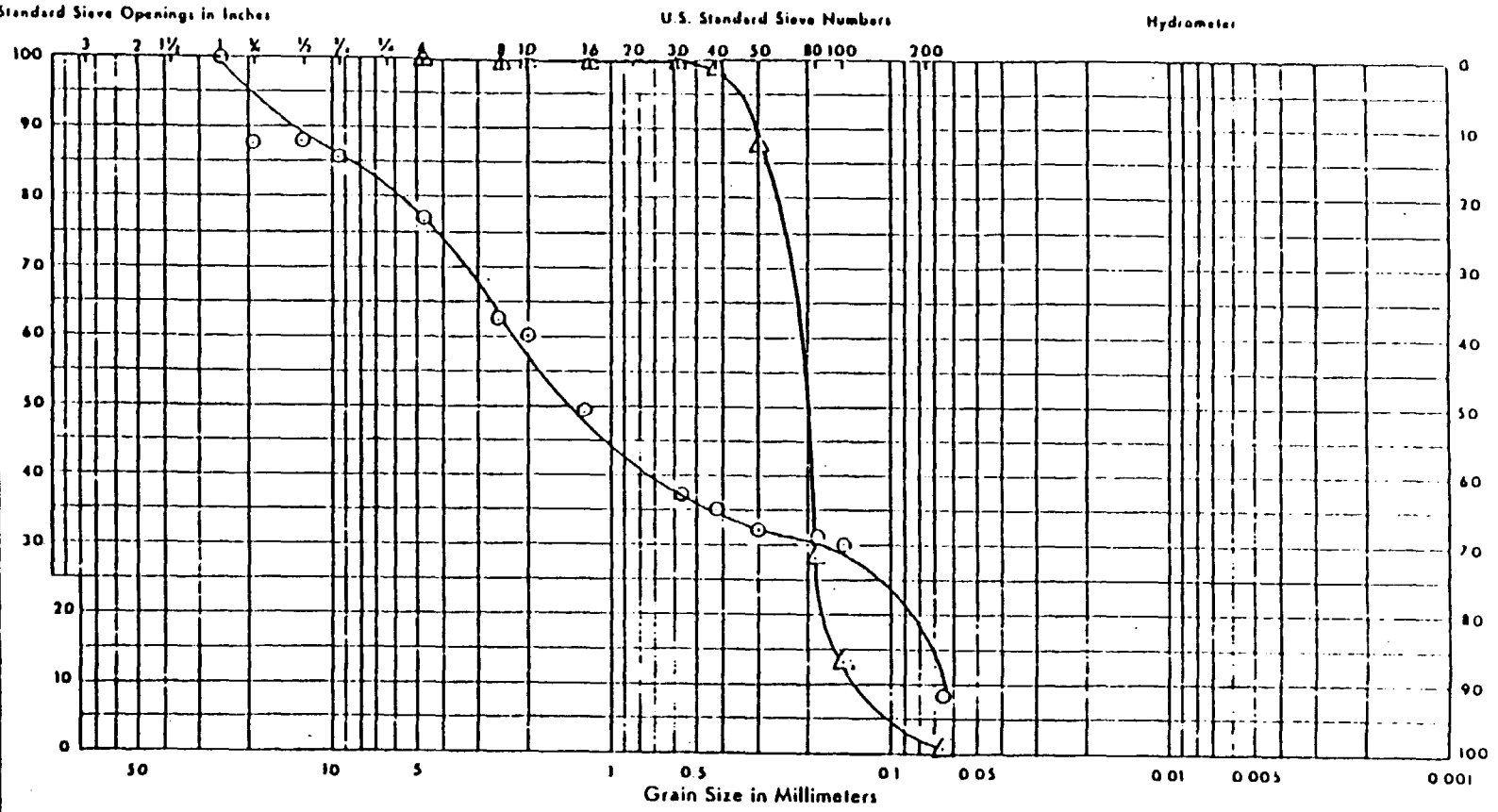
Unified Classification System (ASTM D2487)

Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
△	B-3, S1A	2.6-4.6	23.8			0.0	97.7	2.3		FINE SAND, TRACE SILT (SP)
○	B-3, S2A	4.9-6.9	23.8			0.0	86.6	13.4		FINE SAND, SOME SILT (SM)

DWN KJS | CHK'D GFP | APP'D Daniel R. Vitt | DATE 1/6/81 | C9560-A7

WARZYN ENGINEERING INC

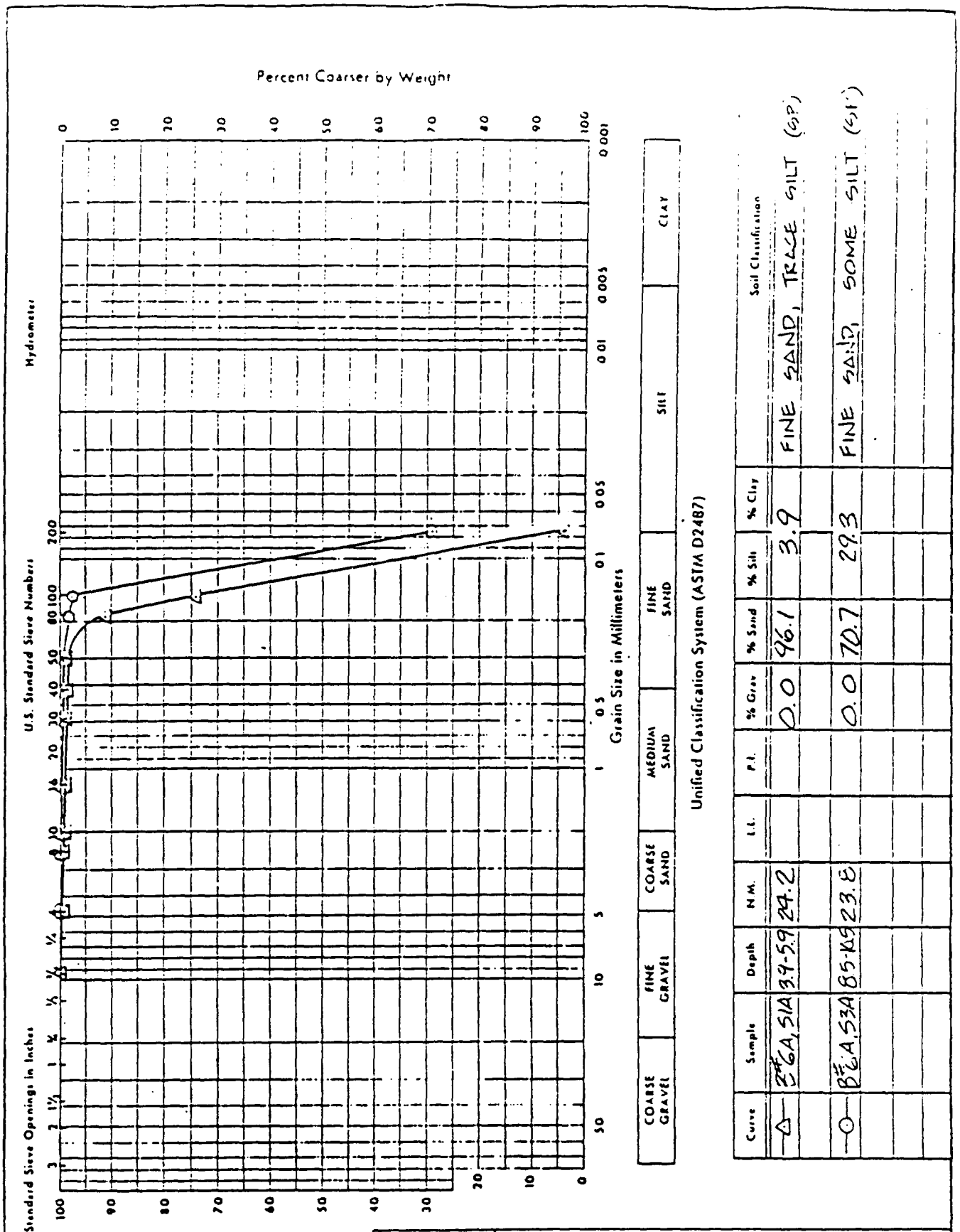
GRAIN SIZE ANALYSIS
SAND SAMPLE COLLECTION
WAUKEGAN HARBOR SLIP #3
WAUKEGAN, ILLINOIS



COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

Unified Classification System (ASTM D2487)

Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
△	B#4, S1A	1.5-3.5	19.9			0.0	99.8	0.2		FINE SAND, TRACE TO NO SILT (SP)
○	B#4, S5A	10.2-11.7	11.3			33.0	59.0	8.0		FINE TO COARSE SAND, SOME GRAVEL, LITTLE SILT (SW-SM)

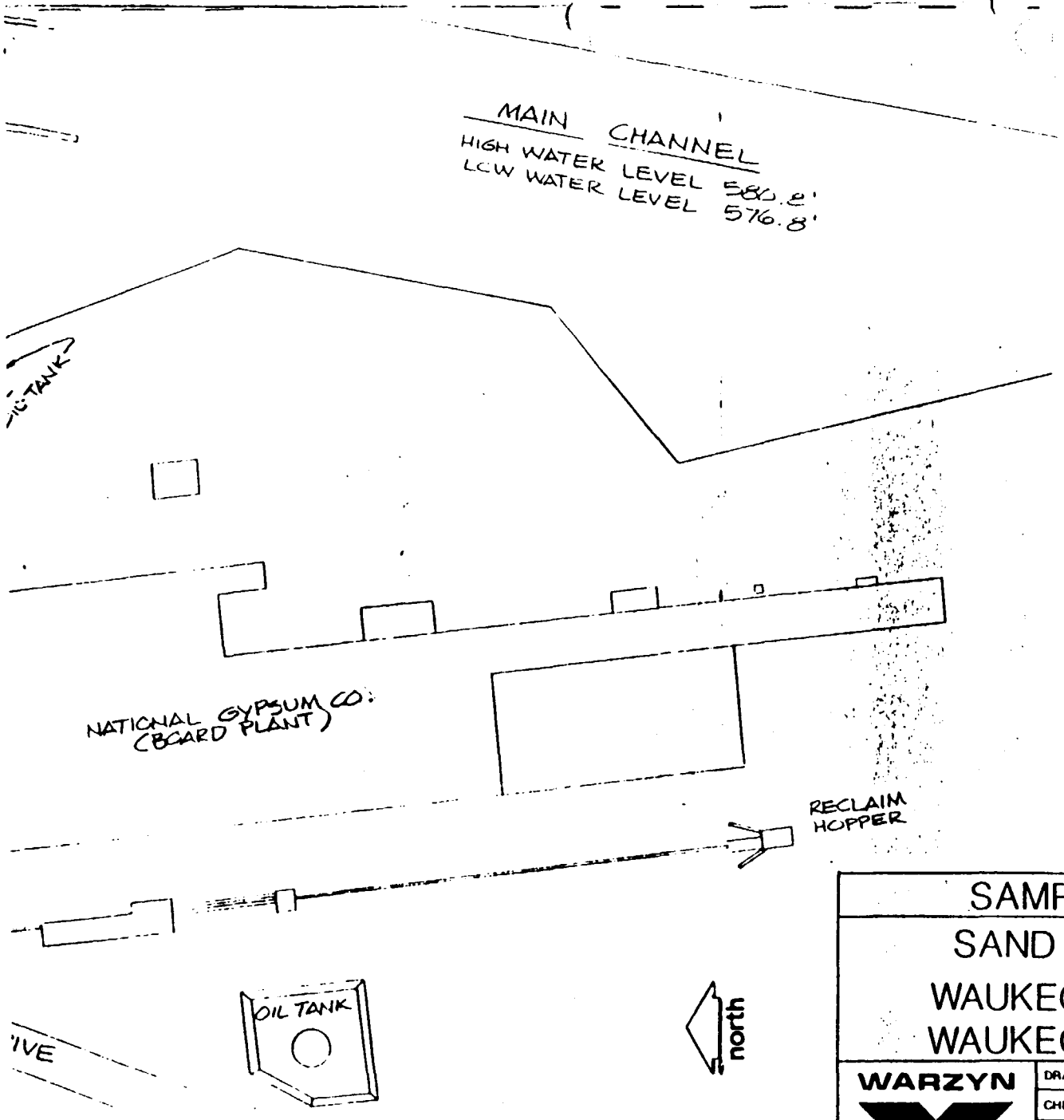


Curve	Sample	Depth	N.M.	L.L.	P.I.	% Gravel	% Sand	% Silt	% Clay	Soil Classification
△	B-6A, S1A	3.9-5.9	24.2			0.0	96.1	3.9		FINE SAND, TRACE SILT (SP)
○	B-6A, S3A	8.5-10.5	23.6			0.0	70.7	29.3		FINE SAND, SOME SILT (SM)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS
SAND SAMPLE COLLECTION
WAUKEGAN HARBOR SLIP #3
WAUKEGAN, ILLINOIS

DWN LDS	CHK'D GFP	APP'D Daniel R. Vitt	DATE 1/6/81	C4560-A8



NOTES

1.) BASE MAP GENERATED FROM BLUE LINE COPY SUPPLIED BY MASON AND HANGER, SILAS MASON COMPANY, INC.

2.) BORING LOCATIONS AND CONSOLIDATION TEST LOCATIONS WERE OBTAINED BY TAPE MEASUREMENT FROM SLIP NO. 3 AND SHEET PILING RETAINING WALLS.

3.) FIELD WORK PERFORMED BY WARZYN ENGINEERING INC. DURING THE PERIOD: NOV. 19-22, 1980.

4.) CONSOLIDATION AND SOIL BORING PROCEDURES DESCRIBED IN ATTACHED TEXT.

LEGEND

B4 ✦ SOIL BORING & NO.

P4 ■ PENETRATION TEST & NO.

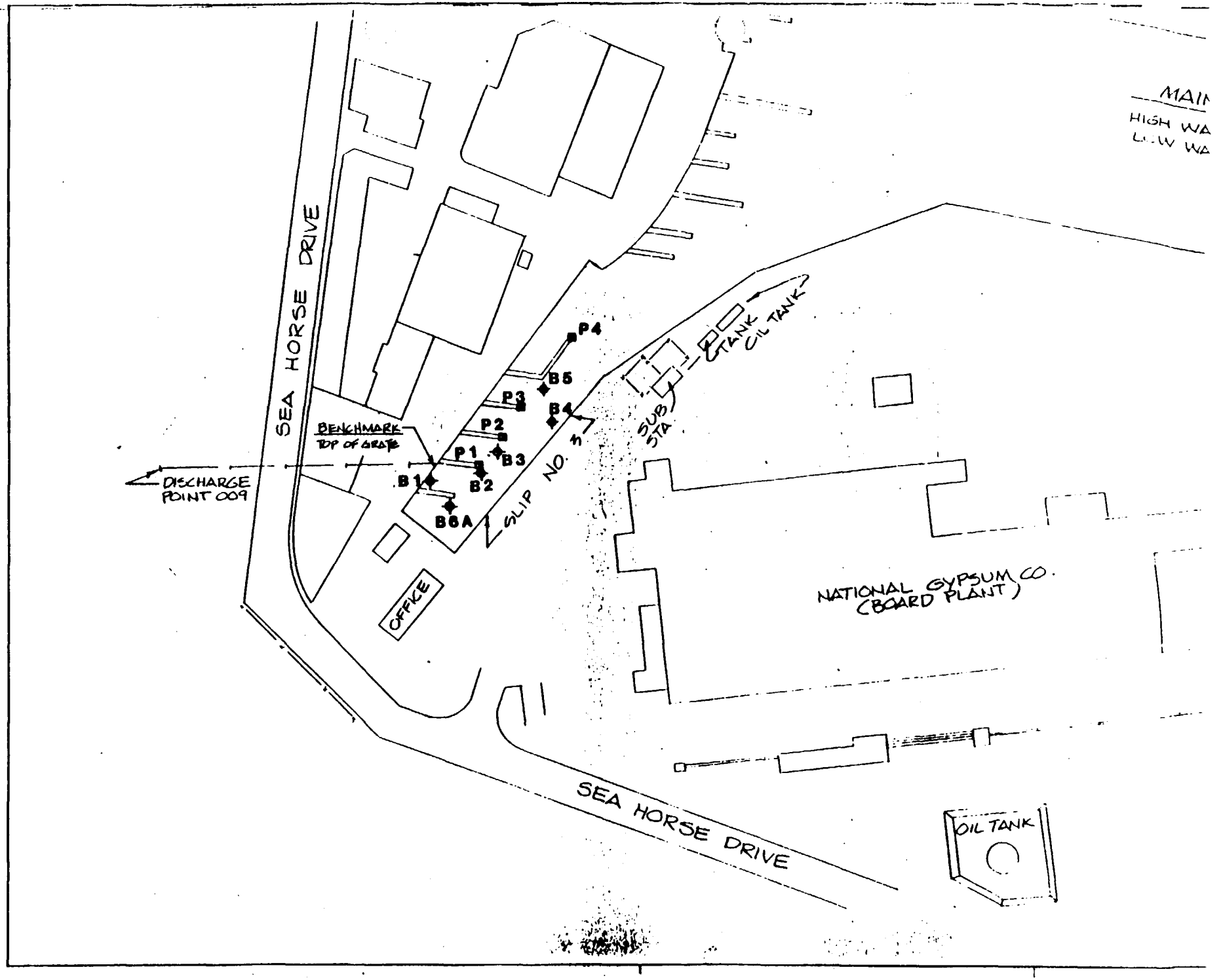
SAMPLE LOCATION PLAN

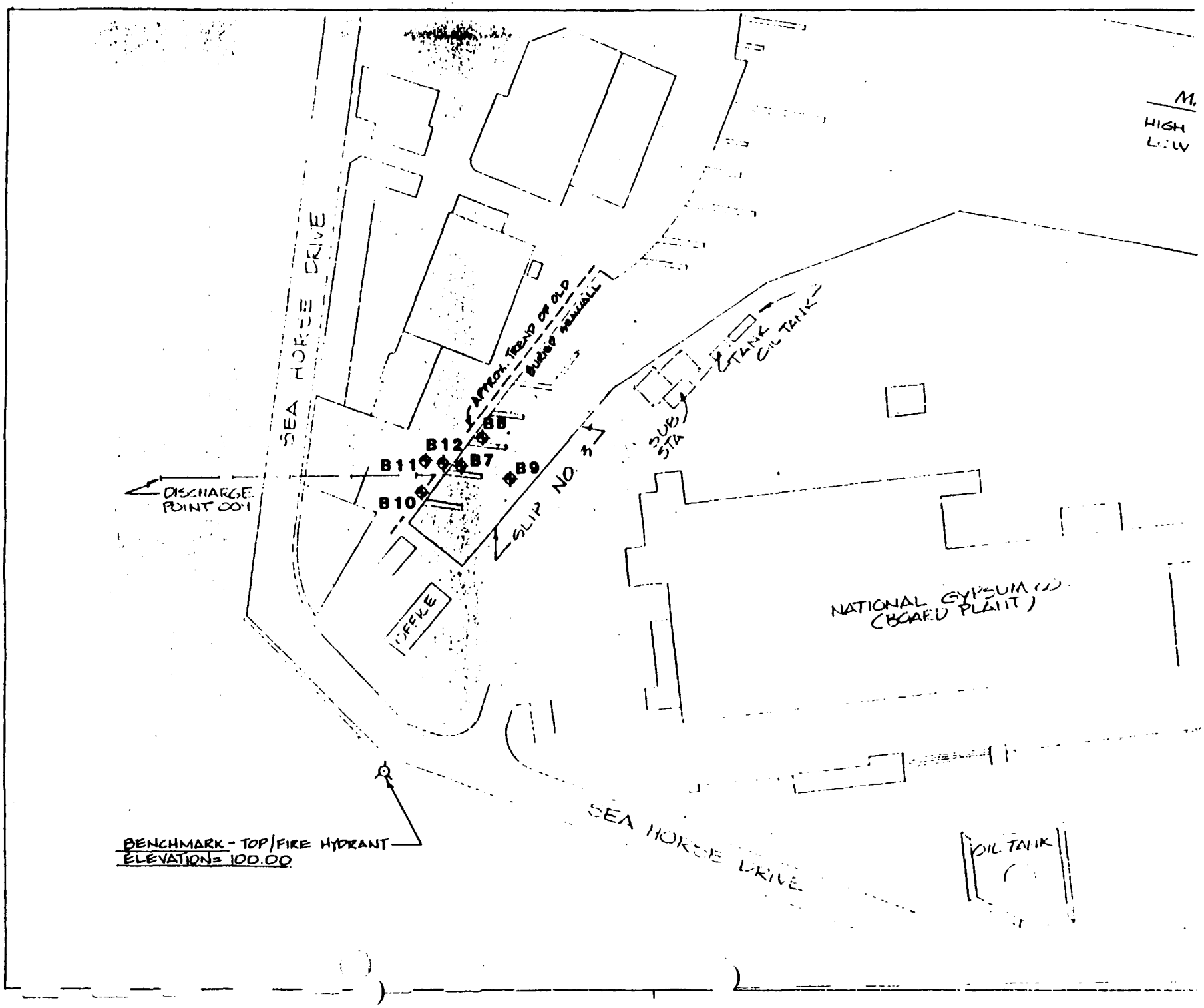
SAND SAMPLE COLLECTION

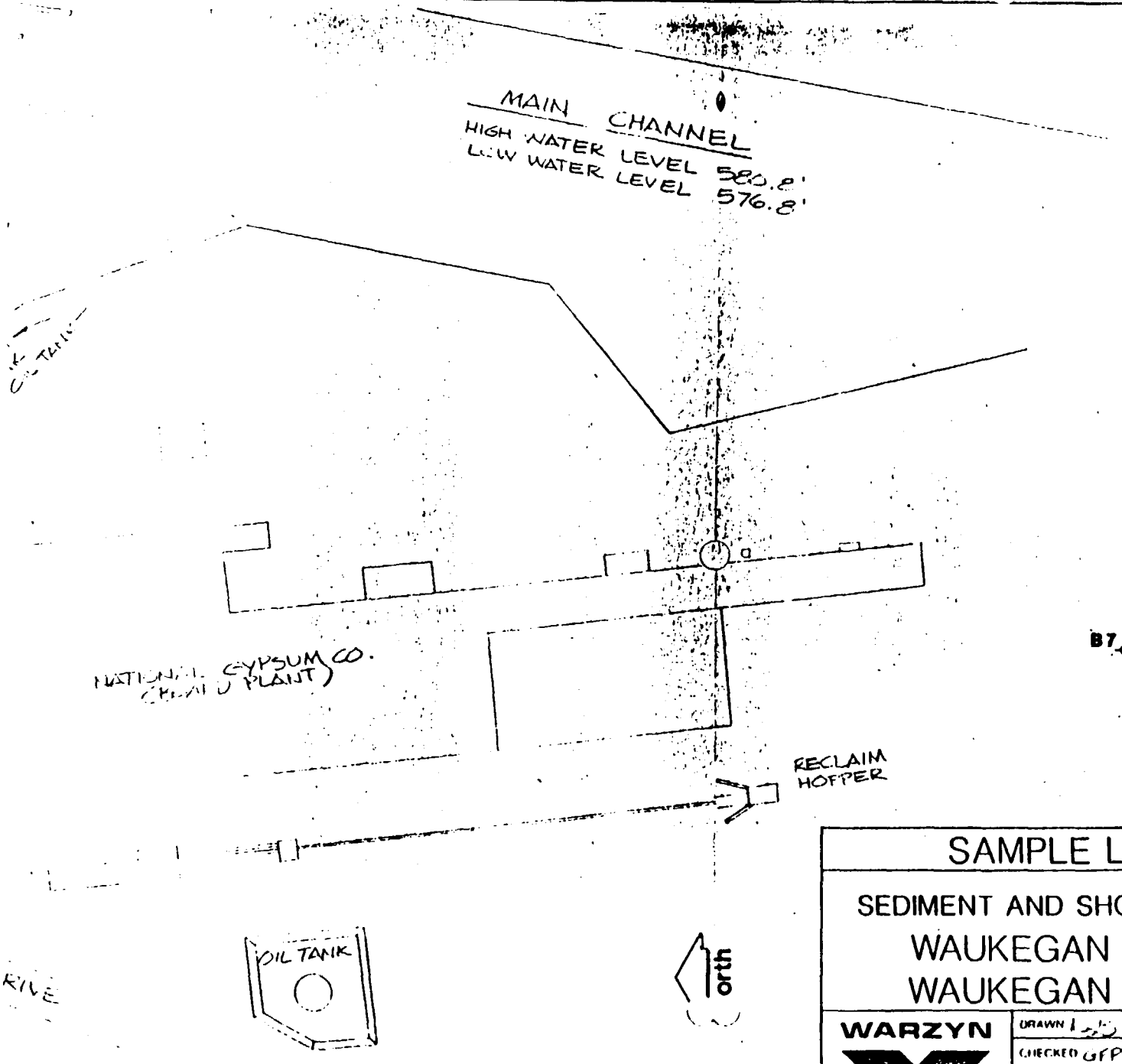
WAUKEGAN HARBOR SLIP #3

WAUKEGAN ILLINOIS

WARZYN ENGINEERING INC	DRAWN DJS	SCALE 1"=100'	SHEET 1 OF 1
	CHECKED GFP	DATE 1/6/81	DRAWING NO C 9560-B1
	APPROVED Daniel L. Vitale		
	REFERENCE		PRINTED MAR 8 1985


SEA HORSE DRIVE
BENCHMARK
TOP OF GRATE
DISCHARGE
POINT 009
P1
P2
P3
P4
B1
B2
B3
B4
B5
B6A
SLIP NO. 3
SUB STA
TANK
OIL TANK
OFFICE
NATIONAL GYPSUM CO.
(BOARD PLANT)
SEA HORSE DRIVE
OIL TANK
MAIN
HIGH WA
L.W WA


SEA HORSE DRIVE
APPROX. TREND OF OLD BURIED SEAWALL
B8
B12
B11
B7
B9
B10
DISCHARGE POINT 001
SLIP NO 3
SUB STA
OIL TANK
OFFICE
NATIONAL GYPSUM (C) (BOARD PLANT)
BENCHMARK - TOP/FIRE HYDRANT
ELEVATION = 100.00
SEA HORSE DRIVE
OIL TANK
M.
HIGH
L.W



NOTES

1.) BASE MAP GENERATED FROM BLUE LINE COPY SUPPLIED BY MASON AND HANGER, SILAS MASON COMPANY, INC.

BORING LOCATIONS WERE OBTAINED BY TAPE MEASUREMENT FROM NORTH CORNER OF SLIP NO. 3 AND SHEET PILING RETAINING WALLS.

3.) FIELD WORK PERFORMED BY WARZYN ENGINEERING INC. DURING THE PERIOD: MAR 16-25, 1981

4.) SOIL BORING PROCEDURES DESCRIBED IN ATTACHED TEXT.

LEGEND

B7 ✦ SOIL BORING & NO.

SAMPLE LOCATION PLAN

SEDIMENT AND SHORE SAMPLE COLLECTION

WAUKEGAN HARBOR SLIP #3

WAUKEGAN ILLINOIS

WARZYN ENGINEERING	DRAWN [illegible]	SCALE 1"=100'	SHEET 1 OF 1
	CHECKED GFP	DATE 5/26/81	DRAWING NO 69769-B1
	APPROVED [illegible]		
	REFERENCE		PRINTED MAR 8 1982

APPENDIX C

"SEDIMENT AND SHORE SAMPLE COLLECTION, WAUKEGAN HARBOR SLIP NO. 3, WAUKEGAN, ILLINOIS - C 9729".

WARZYN
ENGINEERING INC

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Sheepegan Harbor Slip #3
Location: 60'SL & 7.5'SW of North Corner of Slip #3

Ground Elevation: 579.12
Job No.: C 9729
Sheet 1 of 1

1109 EMIL STREET • P.O. BOX 9530, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
Recovery			Moisture								
No.	Type			N	Depth		qu	W	LL	PL	D
					5	WATER to 10.4'					
					10	Black MUCK (OL)					
					15	Dense, Gray, Fine to Medium SAND, Some Silt Trace Fine to Coarse Gravel (SP-SM) Very Oily at 18-18.5'					
	SS	X	W	43							
2	SS	X	M	37	20	Very Stiff, Gray, Silty CLAY, Little Fine to Coarse Sand, Trace Fine to Coarse Gravel (CL) Oily to 19.5'					
3	SS	X	M	21							
4	SS	X	M	83							
5	SS	X	M	110							
						Very Dense, Gray SILT, Little Fine Sand (ML) Not Oily					
					25	Borehole Backfilled with Bentonite End Boring at 24.5'					
					30						
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 3/16/81 Complete 3/16/81
Crew Chief JR Rig CME 550
Drilling Method 4" Casing to 20.5'; Rotary Wash Bore & Split Spoon

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Waukegan Harbor Slip #3
Location: 122'SE & 5'SW of North Corner of Slip #3

Surface Elevation: 578.92
Job No: C 9729
Sheet: 1 of 1

1402 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-3340

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
Recovery			Moisture				q_u	W	LL	PL	D
No.	Type			N	Depth						
					5	WATER to 10.9'					
					10	Very Loose, Black MUCK (OL)					
	SS	X	W	19	15	Medium Dense, Gray Fine to Coarse SAND, Little Silt, Little Fine to Coarse Gravel Slightly Oily (SW-SM)					
2	SS	X	W/M	39	20	Very Stiff, Gray Silty CLAY, Little Fine to Coarse Sand, Trace Fine to Coarse Gravel Not Oily (CL)					
3	SS	X	M	29	25						
4	SS	X	M	85		Not Oily at Bottom of Boring					
					30	Borehole Backfilled with Bentonite End Boring at 27.5'					
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 3/19/81 Complete 3/19/81
Crew Chief JR Rig CME 550
Drilling Method 4" Casing to 21.5'; Rotary Wash Bore & Split Spoon

WARZYN ENGINEERING INC

LOG OF TEST BORING

Boring No. 30
Surface Elevation 573.32
Job No. C 9729
Sheet 1 of 1

Location: Muskegan Harbor Slip #3
105'SE & 59'SW of North
Corner of Slip #3

1100 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-1811

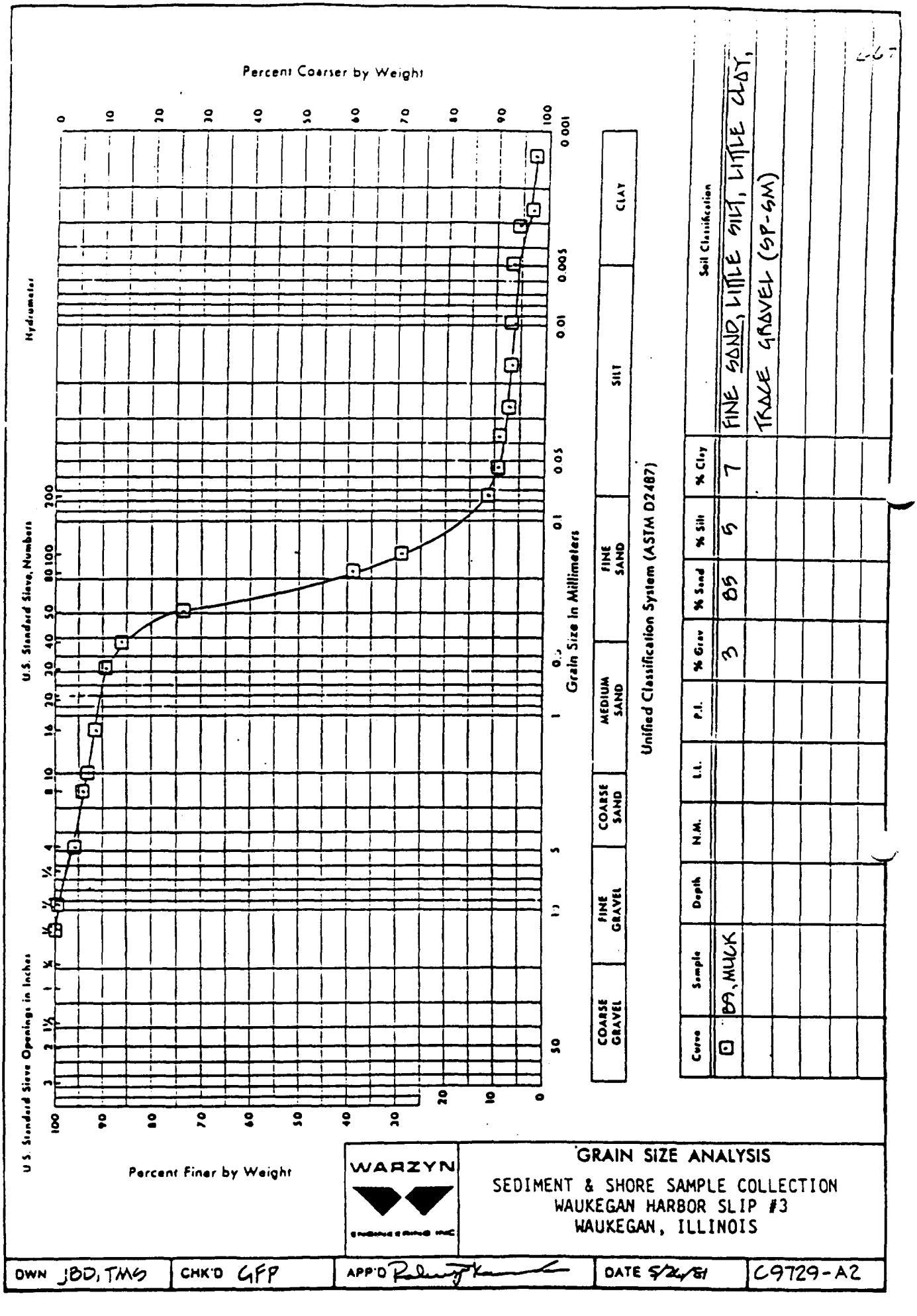
SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES q_u	W	LL	PL	Q
						WATER to 5.7'					
					5	*					
1	SS	0		0		Very Loose, Gray & Black Fine to Medium SAND, Some Silt, Some Organics (Stratified Muck & Sand) Not Oily (SP-SM/OL)					
					10	Split Spoon Settled from 6.1-9.1'					
2	SS	X	W	1		Under Weight of Hammer-No Blows					
					15	Loose, Gray Fine to Medium SAND, SomeSilt, Not Oily (SM)					
	SS	X	W	7							
4	SS	X	M	79	20	Very Stiff, Gray Silty CLAY, Little Fine to Coarse Sand, Little Fine to Coarse Gravel Not Oily (CL)					
5	SS	X	M	80		4" Lense of Fine to Coarse Sand at 19.8-20.1'					
6	SS	X	M	63	25	Not Oily At Bottom of Boring Borehole Backfilled with Bentonite End Boring at 24.5'					
					30						
						* Black, Fine to Coarse SAND, Little Fine to Coarse Gravel, Little Silt (SW-SM)					
					35						
					40						

WATER LEVEL OBSERVATIONS

Date Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Started 3/18/81 Completed 3/18/81
Crew Chief JR Rig CME 550
Drilling Method 4" Casing to 20.5'; Rotary Wash Bore & Split Spoon

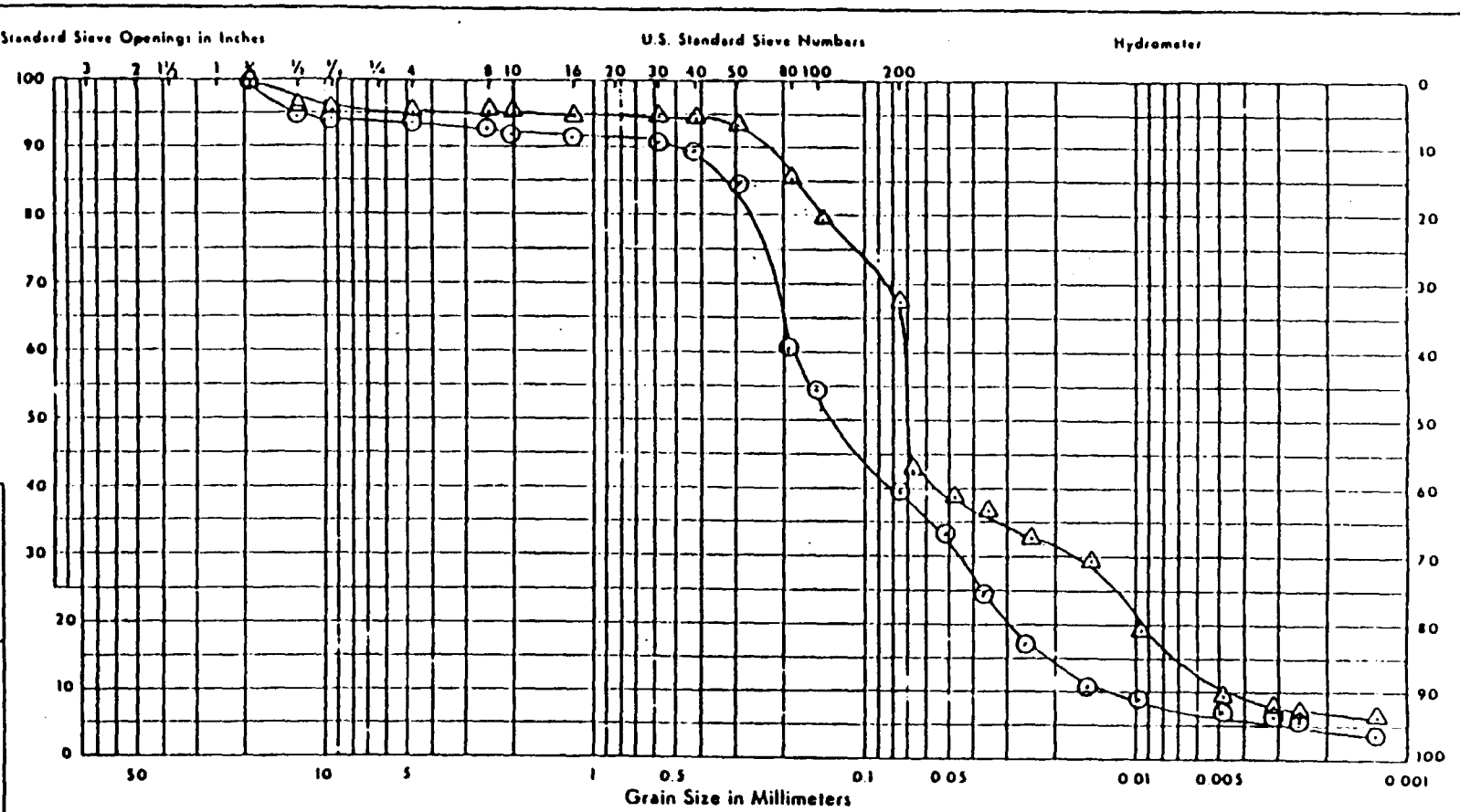

Percent Coarser by Weight
Percent Finer by Weight
Hydrometer
U.S. Standard Sieve, Numbers
U.S. Standard Sieve Openings in Inches
Grain Size in Millimeters
COARSE GRAVEL
FINE GRAVEL
COARSE SAND
MEDIUM SAND
FINE SAND
SILT
CLAY
Unified Classification System (ASTM D2487)
Soil Classification
FINE SAND, LITTLE SILT, LITTLE CLAY, TRACE GRAVEL (SP-SM)
Curve
Sample
Depth
N.M.
L.L.
P.I.
% Grav
% Sand
% Silt
% Clay
B9, MUCK
3
85
5
7
WARZYN
GRAIN SIZE ANALYSIS
SEDIMENT & SHORE SAMPLE COLLECTION
WAUKEGAN HARBOR SLIP #3
WAUKEGAN, ILLINOIS
DWN JBD, TMS
CHK'D GFP
APP'D
DATE 5/24/91
C9729-A2

DWN JBD, TMS | CHK'D GFP | APP'D [signature] | DATE 5/24/81 | C9729-A1

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS

SEDIMENT & SHORE SAMPLE COLLECTION
WAUKEGAN HARBOR SLIP #3
WAUKEGAN, ILLINOIS



Unified Classification System (ASTM D2487)

Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
△	B7, MUCK					5	27	58	10	SILT, SOME FINE SAND, LITTLE CLAY,
										TRACE GRAVEL (ML)
⊙	B8, MUCK					6	54	32	8	FINE SAND, SOME SILT, LITTLE CLAY,
										LITTLE GRAVEL (SM)

1-69

Illinois Environmental Protection Agency · 2200 Churchill Road, Springfield, IL 62706

217/782-6760

Refer to: 09719017 -- Lake County
Waukegan/OMC
Superfund/General Correspondence

MAR 4 1985

February 28, 1985

Mr. Michael W. Reardon
Warzyn Engineer Inc.
1409 Emil Street
P.O. Box 9538
Madison, WI 53715

Dear Mr. Reardon:

After discussions with the various permitting sections within the Agency it has been determined that you will be required to submit the following to the Agency for approval for the cleanup project that has been proposed at the OMC facility at Waukegan Harbor.

1. Section 401 Certification (Clean Water Act) will be required prior to issuance of the Corps of Engineers Section 404 Permit. The "Joint Application/Protecting Illinois Waters" form should be submitted along with maps, drawings and other pertinent information at the same time the ~~440~~ 404 application is submitted to the Corps.

2. Pursuant to State of Illinois Rules and Regulations, Title 35: Environmental Protection, Subtitle C: Water Pollution under Sections 309.202 and 309.203 permits are required for the construction and operation of all treatment works. You are required to submit form WPC-PS-1, Schedule ~~J~~ J, Schedule N, and final plans/specifications.

I have enclosed copies of the application forms that are required for the above permits. Should you have any questions about the applications please contact Bruce Yurdin at 217/782-0610.

Sincerely,

Robert K. Cowles

Robert K. Cowles, P.E., Manager
Remedial Response Unit
Hazardous Substance Control Section
Division of Land Pollution Control

RKC:mkb:S/91

Enclosure

cc: Bob Kuykendall
Jim Frank
Bruce Yurdin
Dan Caplice, USEPA

Note:—No Permit will be issued until this application has been submitted to the building department, completely filled in. PRINT OR TYPE

BUILDING DEPARTMENT, WAUKEGAN, ILLINOIS

APPLICATION FOR BUILDING PERMIT

Zoning _____

Date _____

I, _____ the undersigned owner hereby apply to the Building Department of Waukegan, Illinois for a permit to erect, alter, construct or enlarge the structure of part thereof hereinafter described, and if granted the permit applied for I will comply with all the requirements of the City Ordinances relating thereto and pay the fees required by said Ordinances.

The building or structure is (or is to be), used for the purpose of _____
Single family, Business, etc.

Multi-Family: _____ units _____ one br. _____ two br. _____ three br. _____

and is (or is to be), located on lot _____ block _____ Subdivision _____

_____

_____
Give any further legal description

Street Address _____

CONSTRUCTION DATA

Width of lot _____ Depth of lot _____ Area of Lot (S.F.) _____

List below all buildings, existing and contemplated and show whether dwelling etc. or accessory buildings.

Buildings Width over all: Length over all: Height grade to peak:

_____

_____

NEW BUILDINGS

The building is to be constructed of _____
Frame, Brick, Concrete, etc., or combination

rooms		automatic washers		No. of Stories	
bedrooms		heating		thickness	
bath rooms		fuel		width	
plumbing fixtures		air-conditioning		thickness of masonry walls	
bath tubs		artificial ventilation		above foundation: 1st Sty.	
lavatories		basement		2nd Sty.	3rd Sty.
toilets		attic		roof	
showers		utility room		garage	
kitchen sinks		kind of foundation walls		constructed of	
slop sinks		thickness		no. of stalls	
laundry tubs		depth of footing below grade		Sump pump	
floor drains					

ALTERATIONS—ADDITIONS—ETC.

Note:—Show number of buildings existing, lot data, etc., in space provided above.

The work contemplated consists of _____
Interior work—Add'l. rooms—dormers—exterior addn. baths, etc.

_____

_____

and is to be of _____ (frame, brick, combination, etc.)

No. rooms in present bldg.		bath rooms added		slop sinks	
rooms added		bath tubs		laundry tubs	
total		lavatories		others	
ground area of additions		toilets		new electric work	
ground area of existing bldg. and additions		showers		heating additions	
Present parking spaces		kitchen sinks		fuel	

REMARKS clarifying work _____

_____

The items are more fully set forth in the plans submitted with this application. The total cost as estimated, of the work contemplated, includes all the branches of labor, all materials, all appurtenances and all other necessary expenses to completely erect, alter, construct or enlarge the building. Such cost is itemized as follows:

	Name of Contractor	Address	Phone	Amt. of contract
General				$
Excavating				$
Concrete				$
Masonry				$
Plumbing				$
Carpentry				$
Electric				$
Sheet metal				$
Structural iron				$
Plastering				$
Heating				$
Painting				$
Others				$
Total Cost of Building				$

Owner's name _____ Address _____ Phone _____

Architect _____ Address _____ Phone _____

TO BE FILLED IN BY BUILDING DEPT.

Zoning_____ Permit No._____
Plans checked by_____ Date_____
Application checked by_____ Date_____
Permit issued_____ Date_____
Street number_____
Issued by_____
Electric Permit No._____
Heating Permit No._____

Note:—Although the above fee for building permit is based on all of the value for all classes of work additional permits are required before work can be started on Sewer and Water Taps, Electrical work, heating work and other permits which from time to time are provided for and for which separate applications are required.

A street obstruction bond is required whenever use is made of any portion of the City Streets, including walks, parkway and/or paving.

APPLICATION FOR CERTIFICATE OF OCCUPANCY AND CONFORMITY OF PREMISES

The undersigned owners of the herein described property and buildings, thereon, hereby applies for a certificate of occupancy of said buildings and premises and hereby agrees not to occupy them until certificate of occupancy has been granted. Said buildings and premises are to be used exclusively for

_____

Single family dwelling, Business (state type) Apart., Hotel, etc.

Draw below to scale, an accurate plat of the lot or property. Show all existing or proposed buildings and additions to existing buildings. Make said plat complete with all dimensions of premises, overall dimensions of buildings, and show distances of buildings from all lot lines:

PLOT PLAN TO SCALE

No error or omission in either the plans or application, whether said plans and application has been approved by the building department or not, shall permit or relieve the applicant from constructing the work in any other manner than that provided for in the ordinances of this City, relating thereto. The owner having read the application for the building permit and for certificate of occupancy and having checked the plat plan hereon shown and fully understanding the intent thereof, declares that the statements made and the drawings shown are true to the best of his or her belief.

NO CONSTRUCTION SHALL BE STARTED UNTIL PERMIT IS ISSUED.

Do not sign unless you have read and checked this application and everything is complete.

Signature of owner._____
Present address_____ Phone_____

INDUSTRIAL - COMMERCIAL - INSTITUTIONAL - MULTI-FAMILY

Workday

*1st Day: _____1. (5) sets of complete plans/specifications

_____A. Electrical

_____B. Plumbing

_____C. HVAC

_____D. Structural

_____2. Complete Site Plan

_____A. Legal description of proposed site.
1.) Proposed setbacks from front, side, and rear yards.

_____B. Show complete site improvements.

_____C. Must show drainage and storm water detention if plus two acres involved.

_____D. Must show driveway approaches.

_____3. General Contractors

_____A. Electrical Contractor
_____B. Plumbing Contractor
_____C. HVAC Contractor
} sub contractors

_____D. Misc. Sub-contractors

_____4. NORTH SHORE Sanitary permit if required.

_____ EPA permit

_____5. Building Department forward plans.

*2nd Day: _____A. Engineering & Planning Review **
DATE CALLED _____ DATE PICKED UP _____

*3rd Day: _____B. Building Dept. Plan Review
DATE CALLED _____ DATE PICKED UP _____

_____C. Dept. of Public Works Plan Review
DATE CALLED _____ DATE PICKED UP _____

_____D. Waukegan Fire Prevention Bureau Plan Review
DATE CALLED _____ DATE PICKED UP _____

_____E. Water Dept. Plan Review
DATE CALLED _____ DATE PICKED UP _____

-OVER-

10th Day: _____6. Certificate of Compliance Returned

_____A. Engineering and Planning

_____B. Department of Public Works

_____C. Waukegan Fire Prevention

_____D. Water Department

_____E. Building Department

11th Day: _____7. Contractor Conference (for as-built plans)

16th Day: _____8. Issuance of Building Permit when above requirements are met.

_____9. BOCA Basic Building Code Plan Review where applicable. (Additional 20 working days).

_____10. Time extension will be granted upon request of the applicant.

*Working Days

**Building Permit review process stops if a negative Zoning Certification is filed by the Planning and Zoning Department. Applicant will then be instructed to made necessary applications to obtain Zoning compliance.

This Agency is authorized to require this information under Illinois Revised Statutes, 1979, Chapter 111 1/2, Section 1039. Disclosure of this information is required under that Section. Failure to do so may prevent this form from being processed and could result in your application being denied. This form has been approved by the Forms Management Center.

FOR IEPA USE:
LOG NO.
DATE RECEIVED:

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF WATER POLLUTION CONTROL
PERMIT SECTION
Springfield, Illinois 62706

APPLICATION FOR PERMIT OR CONSTRUCTION APPROVAL

WPC-PS-1

1. NAME AND LOCATION:

Name of project: _____

Municipality or Township: _____ County: _____

2. BRIEF DESCRIPTION OF PROJECT: _____

_____

3. DOCUMENTS BEING SUBMITTED: If the project involves any of the items listed below, submit the corresponding schedule, and check the appropriate spaces.

PROJECT

Private Sewer Connection	A ____	Spray Irrigation	H ____
Public Sewer Extension	B ____	Septic Tanks	I ____
Sewer Extension Construct Only	C ____	Industrial Treatment or Pretreatment	J ____
Sewage Treatment Works	D ____		
Excess Flow Treatment	E ____	Cyanide Acceptance	L ____
Lift Station/Force Main	F ____	Updating Cyanide Acceptance Form	M ____
Sludge Disposal	G ____	Waste Characteristics	N ____

LAND TRUST: Is the project identified in item number 1 herein, for which a permit is requested, to be constructed on land which is the subject of a trust? ☐ Yes ☐ No
If yes, item number 6.1.1 herein must be signed by a beneficiary, trustee or trust officer, and a trust disclosure must be submitted (see instructions, item 3).

Plans: Title _____

_____ Number of Pages: _____

Specifications: Title _____ Number of Books/Pages: _____

Other Documents (Please Specify) _____

_____

4. THIS IS AN APPLICATION FOR (CHECK):

_____ A. Joint Construction And Operating Permit
_____ B. Authorization To Construct (See Instructions) NPDES Permit No. IL00_____ Issue Date _____
_____ C. Construct Only Permit (Does Not Include Operations)
_____ D. Operate Only Permit (Does Not Include Construction)

5. CERTIFICATIONS AND APPROVAL:

5.1 Certificate by Design Engineer
I hereby certify that I am familiar with the information contained in this application, including the attached schedules indicated above, and that to the best of my knowledge and belief such information is true, complete and accurate. The plans and specifications (specifications other than Standard Specifications or local specifications on file with this Agency) as described above were prepared by me or under my direction.

ENGINEER _____ _____ _____
NAME REGISTRATION NUMBER SEAL

FIRM: _____

ADDRESS: _____

_____ PHONE NUMBER: _____

SIGNATURE _____

6. CERTIFICATIONS AND APPROVALS FOR PERMITS:

6.1 Certificate by Applicant(s)
I/We hereby certify that I/we have read and thoroughly understand the conditions and requirements of this Application, and am/are authorized to sign this application in accordance with the Rules and Regulations of the Illinois Pollution Control Board.
I/We hereby agree to conform with the Standard Conditions and with any other Special Conditions made part of this Permit.

6.1.1 NAME OF APPLICANT FOR PERMIT OR AUTHORIZATION TO CONSTRUCT _____

_____
STREET CITY STATE ZIP CODE

SIGNATURE _____

TITLE _____ ORGANIZATION _____

IL 532-0010
WPC 150 Rev. 2/83

6.1.2 NAME OF APPLICANT FOR PERMIT TO OWN AND OPERATE _____

STREET CITY STATE ZIP CODE

SIGNATURE _____

TITLE _____

6.2 Attested (Units of Government)

DATE _____ SIGNATURE _____ TITLE _____
(CITY CLERK, VILLAGE CLERK, SANITARY DISTRICT CLERK, ETC.)

6.3 Applications from non-governmental applicants which are not signed by the owner, must be signed by a principal executive officer of at least the level of vice president, or his duly authorized representative.

6.4 CERTIFICATE BY INTERMEDIATE SEWER OWNER

I hereby certify that (Please check one):

_____ 1. The sewers to which this project will be tributary have adequate reserve capacity to transport the wastewater that will be added by this project without causing a violation of the Environmental Protection Act or Subtitle C, Chapter I, or

_____ 2. The Illinois Pollution Control Board, in PCB _____ dated _____ granted a variance from Subtitle C, Chapter I to allow construction and operation of the facilities that are the subject of this application.

Name and location of sewer system to which this project will be tributary:

_____

SEWER SYSTEM OWNER _____

STREET CITY STATE ZIP CODE

SIGNATURE _____ DATE _____ TITLE _____

6.4.1 ADDITIONAL CERTIFICATE BY INTERMEDIATE SEWER OWNER

I hereby certify that (Please check one):

_____ 1. The sewers to which this project will be tributary have adequate reserve capacity to transport the wastewater that will be added by this project without causing a violation of the Environmental Protection Act or Subtitle C, Chapter I, or

_____ 2. The Illinois Pollution Control Board, in PCB _____ dated _____ granted a variance from Subtitle C, Chapter I to allow construction and operation of the facilities that are the subject of this application.

Name and location of sewer system to which this project will be tributary:

_____

SEWER SYSTEM OWNER _____

STREET CITY STATE ZIP CODE

SIGNATURE _____ DATE _____ TITLE _____

6.5 CERTIFICATE BY WASTE TREATMENT WORKS OWNER

I hereby certify that (Please check one):

_____ 1. The waste treatment plant to which this project will be tributary has adequate reserve capacity to treat the wastewater that will be added by this project without causing a violation of the Environmental Protection Act or Subtitle C, Chapter I, or

_____ 2. The Illinois Pollution Control Board, in PCB _____ dated _____ granted a variance from Subtitle C, Chapter I to allow construction and operation of the facilities that are the subject of this application.

I also certify that the industrial waste discharges described in the application is capable of being treated by the treatment works, and such waste discharges will be in compliance with all currently applicable local, state or federal pretreatment requirements.

Name and location of waste treatment works to which this project will be tributary:

_____

TREATMENT WORKS OWNER _____

STREET CITY STATE ZIP CODE

SIGNATURE _____ DATE _____ TITLE _____

INSTRUCTIONS FOR SCHEDULE J - INDUSTRIAL TREATMENT WORKS OR PRETREATMENT WORKS

This application form is intended for applications for Permits or Authorizations to Construct or Permits to operate industrial treatment works or pertreatment works. Schedule J must be submitted with a WPC-PS-1 Form.

All blanks must be filled. When the question is not applicable to your project write "not applicable" or "N.A."

1.1 The name of the project must be the same as that indicated in WPC-PS-1.

1.2.1 Give the location of the discharge point to the nearest quarter section including section, township, range and principal meridian.

1.2.2 Give the location of the discharge point and degrees, minutes, and seconds by interpolation from a quadrangle map.

1.2.3 Name of U. S. Geological Survey Quadrangle Map used in making above determinations.

2. Such a description and schematic waste flow diagram should show the flow of the water from the source to the treatment works. The diagram should specifically include both routine and potential sources of contamination. It may be that information included for this subject could be included on the schematic diagram required in Part 3 below. If this is the case, so indicate and do not duplicate other information provided.

3.1 A schematic wastewater flow diagram must be submitted. It should generally conform to the following description:

A line drawing of wastewater flow through the facility producing the proposed discharges. Average flow rates should be shown for various wastewaters. Specific treatment processes are to be indicated.

A location map is also required. The map should generally conform to the following:

A map showing the location of each discharge structure including any and all outfall devices, dispersive devices, and non-structural points of discharge. The usual meridian arrow showing north as well as the map scale must be shown. On all maps of rivers, the directions of the current is to be indicated by an arrow. Preferably this location map should be done on a copy of U. S. Geological Survey Quadrangle Map for the area involved.

Plans and specifications: For instruction on completion or plans and specifications please refer to the instructions for Schedule D Treatment Works Item 3.

4. Receiving Stream: Please refer to the instructions on receiving stream for Schedule D - Item 4. If the industrial waste treatment or pretreatment is tributary to a municipal sanitary, storm, or combined sewer, signatures of the appropriate municipal or sanitary district official should be provided on Form WPC-PS-1 in Items 5.5 and 5.6 and a current copy of the industrial waste ordinance must be provided.

5. The Agency's design criteria mandates that waste treatment facilities shall be located at an elevation which is not subject to flooding or otherwise be adequately protected against flood damage. Therefore, it will not be acceptable to include in a design the possibility of the waste treatment facilities being subject to flooding at any time regardless of the extent of the flooding.

6. The approximate time schedule is requested to allow the scheduling of Agency field engineering personnel to begin visits to the waste treatment facility site. The date of completion and the date of operation are expected to be essentially the same. The 100 percent design load to be reached by the year indicated is essentially the design year at which time additional facilities must be provided to treat additional waste load to the treatment plant if necessary.

7.5 Contact the Illinois Water Survey in Urbana.

7.6 See the definition of dilution ratio in Chapter 3 Illinois Pollution Control Board Regulations.

8.1.2 Use maximum daily flow for last twelve months.

11. Rule 601(a) of the Illinois Pollution Control Board Chapter 3 Regulations indicates that all treatment works and associated facilities shall be so constructed and operated as to minimize violations of the applicable standards during such contingencies as flooding, adverse weather, power failure, equipment failure, or maintenance through such measures as multiple units, holding tanks, duplicate power sources or other measures.

N/A 12. A Schedule G is necessary if sludge must be disposed of from this facility.

13. Submit Schedule N. Use the instructions for Schedule N for completing the information required.

14. The requirements for Operator Certification are given in Part 12 of Chapter 3 Illinois Pollution Control Board Regulations.

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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF WATER POLLUTION CONTROL
PERMIT SECTION
Springfield, Illinois 62706

SCHEDULE J INDUSTRIAL TREATMENT WORKS CONSTRUCTION OR PRETREATMENT WORKS

1. NAME AND LOCATION:

1.1 Name of project _____

1.2 Plant Location

1.2.1 _____ (Quarter Section) _____ (Section) _____ (Township) _____ (Range) _____ (P.M.)

1.2.2 Latitude _____ _____° _____ _____' _____ _____"North

Longitude _____ _____° _____ _____' _____ _____"West

1.2.3 Name of USGS Quadrangle Map (7.5 or 15 Minutes) _____

2. NARRATIVE DESCRIPTION AND SCHEMATIC WASTE FLOW DIAGRAM: (see instructions)

_____

_____

_____

2.1 PRINCIPAL PRODUCTS: _____

_____

2.2 PRINCIPAL RAW MATERIALS: _____

_____

3. DESCRIPTION OF TREATMENT FACILITIES:

3.1 Submit a flow diagram through all treatment units showing size, volumes, detention times, organic loadings, surface settling rate, weir overflow rate, and other pertinent design data. Include hydraulic profiles and description of monitoring systems.

3.2 Waste Treatment Works is: Batch____, Continuous____; No. of Batches/day____, No. of Shifts/day____

3.3 Submit plans and specifications for proposed construction.

3.4 Discharge is: Existing_____; Will begin on_____.

4. DIRECT DISCHARGE IS TO: Receiving Stream_____ Municipal Sanitary Sewer_____, Municipal storm or municipal combined sewer_____. If receiving stream or storm sewer indicated complete the following:

Name of receiving stream_____; tributary to_____;

tributary to_____; tributary to_____.

5. Is the treatment works subject to flooding? If so, what is the maximum flood elevation of record (in reference to the treatment works datum) and what provisions have been made to eliminate the flooding hazard?_____

_____

6. APPROXIMATE TIME SCHEDULE: Estimated construction schedule:

Start of Construction_____; Date of Completion_____

Operation Schedule_____; Date Operation Begins_____

100% design load to be reached by year_____.

This Agency is authorized to require this information under Illinois Revised Statutes, 1979, Chapter 111 1/2, Section 1039. Disclosure of this information is required under that Section. Failure to do so may prevent this form from being processed and could result in your application being denied. This form has been approved by the Forms Management Center.

7. DESIGN LOADINGS

7.1 Design population equivalent (one population equivalent is 100 gallons of wastewater per day, containing 0.17 pounds of BOD_5 and 0.20 pounds of suspended solids;

BOD_____; Suspended Solids_____; Flow_____.

7.2 Design Average Flow Rate_____MGD.

7.3 Design Maximum Flow Rate_____MGD.

7.4 Design Minimum Flow Rate_____MGD.

7.5 Minimum 7-day, 10-year low flow_____cfs_____MGD.

Minimum 7-day, 10-year flow obtained from_____.

7.6 Dilution Ratio_____:_____.

8. FLOW TO TREATMENT WORKS (if existing):

8.1 Flow (last 12 months)

8.1.1 Average Flow_____MGD

8.1.2 Maximum Flow_____MGD

8.2 Equipment used in determing above flows_____.

9. Has a preliminary engineering report for this project been submitted to this Agency for Approval?

YES___ NO___. If so, when was it submitted and approved. Date Submitted_____

Certification#_____

Dated_____

10. List Permits previously issued for the facility:_____

_____

11. Describe provisions for operation during contingencies such as power failures, flooding, peak loads, equipment failure, maintenances shut-downs and other emergencies.

12. Complete and submit Schedule G if sludge disposal will be required by this facility.

13. WASTE CHARACTERISTICS: Schedule N must be submitted.

14. TREATMENT WORKS OPERATOR CERTIFICATION: List names and certification numbers of certified operators:

_____

_____

INSTRUCTIONS FOR SCHEDULE D - TREATMENT WORKS

.s application form is primarily intended for the applications for Permits or Authorizations to Construct or Permits to :rate treatment works for municipalities, sanitary districts, commercial or other establishments with domestic type ..astes.

. blanks must be completed. When the question is not applicable to your project, write "Not Applicable," or "N.A."

..nedule items which are self-explanatory are omitted in these instructions.

1.1 The name of the project must be the same as that indicated in WPC-PS-1.

1.2.2 Give the location of the discharge point to the nearest quarter section including section, township, range and principal meridian.

1.2.3 Give the location of the discharge point in degrees, minutes and seconds by interpolation from a quadrangle map.

1.2.4 Name of U. S. Geological Survey quadrangle map used in making above determination.

The approximate construction schedule for the project is requested to allow the scheduling of surveillance personnel to begin visits to the waste treatment facility site.

2.1 This is essentially design year of the treatment works.

A schematic wastewater flow diagram must be submitted. It should generally conform to the following description: A line drawing of the flow through the process units. Average and maximum flow rates should be shown. Specific treatment processes are to be indicated.

A location map is also required. The map should generally conform to the following; (A) show the location of each discharge structure including any and all outfall devices and dispersion devices. (B) Show the distance and direction to the nearest residence. The usual meridian arrow showing North as well as the map scale must be shown. On all maps of rivers, the direction of the current is to be indicated by an arrow. Preferably this location map should be done on a copy of the U. S. Geological Survey Quadrangle Map for the area involved.

Plans and specifications prepared by a Registered Professional Engineer must be submitted for all proposed construction.

Plans of sewage treatment works:

Location Plan

A plan shall be submitted, showing the sewage treatment works in relation to the remainder of the system. Sufficient topographic features shall be included to indicate its location with relation to streams and the point of discharge of treated effluent.

General Layout

Layouts of the proposed sewage treatment works shall be submitted, showing:

a. Topography of the site.

b. Size and location of treatment works structure.

c. Schematic flow diagram showing the flow through various treatment works units.

d. Piping, including any arrangements made for by-passing individual units. Materials handled and direction of flow through pipes shall be shown.

e. Hydraulic profiles showing the flow of sewage, supernatant liquor and sludge.

f. Test borings and ground water elevations.

Detailed Plans

Detailed plans shall show the following:

a. Location, dimensions and elevations of all existing and proposed treatment works facilities.

b. Elevations of high and low water level of the body of water to which the treatment works effluent is to be discharged.

c. Type, size, pertinent features, and specified capacity of all pumps, blowers, motors and other mechanical devices at the design condition.

d. Minimum, average and maximum hydraulic flow in profile.

e. Adequate description of any features not otherwise covered by specification or engineer's report.

INSTRUCTIONS FOR SCHEDULE N - WASTE CHARACTERISTICS

This schedule must be submitted to show raw waste characteristics, effluent quality, and upstream and downstream quality of the receiving waters, sludge characteristics and other wastewater characteristics as required for the various schedules.

1. The name of the project must be the same as that indicated in WPC-PS-1.

2. Flow data

   2.1 Indicate existing, if applicable, and proposed or present design average flow.

   2.2 Indicate existing, if applicable, or proposed or present design maximum flow depending on the schedule originating the request.

   2.3 The information submitted to the Agency for temperature must be sufficient to prove that violations of the temperature portion, 203(i) of the Illinois Pollution Control Board Regulations Chapter 3 will not occur.

   In the case of discharges from power plants, a graphical description of the discharge plume must be provided to the Agency which describes the various isotherm regimes in the plume and defines the boundaries of the discharge plume in relation to the receiving stream.

   The definition of mixing zone is given in Rule 201(a) of the Illinois Pollution Control Board's Regulations. Make sure you are using the latest Illinois Pollution Control Board's interpretation of this definition - mixing zone.

   2.6 The flow rate in the receiving stream at the time of stream sampling must be indicated.

3. Chemical Characteristics: The applicant must prove that the facility if permitted, will not cause violations of the Environmental Protection Act or of Regulations adopted by the Board pursuant to the Act. If the characteristics are not applicable so indicate with the letters NTF (not tested for).

   For existing facilities, the type of sample (grab, composite) and the number of samples taken should be indicated on Schedule N. The Sampling points should be indicated on an appropriately labeled process flow sketch for raw wastewater and treated effluent. The process flow sketch should show all wastewater influent points to the treatment works before ultimate discharge.

   Please review the following comments prior to proceeding.

   3.1 The characteristics must show the average concentration of the particular waste parameter in the design year except when the schedule is being submitted to depict the current conditions.

   3.2 For existing domestic waste treatment works, as a minimum the influent and effluent analyses should include ammonia nitrogen, fecal coliform, (effluent only), nitrite and nitrate nitrogen, pH, phosphorous as p, suspended solids, total dissolved solids and biochemical oxygen demand (5day).

   3.3 The influent and effluent should be analyzed for chemical parameters appropriate to reflect industrial discharges into the sewer system tributary to the treatment works. Guidelines for such additional analyses are contained in Table 1, which may also be used by industrial discharges as minimum required analysis guidelines.

   3.4 The effluent parameter concentrations shown must reflect the average and maximum concentrations of the treatment works or discharge effluent.

   3.5 An analysis must be performed on the influent and effluent, if it is existing, for each parameter shown on Table 1 for the appropriate industry.

   3.6 If the proper industrial category is not provided on Table 1, the consulting engineer should write the Illinois Environmental Protection Agency requesting a letter with a statement of the required parameters or use the parameters for a similar category on Table 1.

   3.7 If background concentration, Rule 401(b), is considered by the applicant to be a factor in the allowable contaminants being discharged, submit an analysis of the water supply showing the concentration of the applicable parameters.

   3.8 If any constituent level in any discharge or effluent exceeds the water quality standard then analyses must be performed for that parameter upstream and downstream in the receiving stream. The flow rate in the receiving stream at the time of stream sampling must be specified.

   3.9 For proposed facilities approximations should be made and analysis performed in accordance with these items and Table 1.

   3.10 The analysis must be performed in accordance with the Standard Methods for the Examination of Water and Wastewater, 13th edition or with the most current later edition or with other generally accepted procedures approved by the Agency. The methods indicated in Table A of the U.S. Environmental Protection Agency National Pollutant Discharge Elimination System Application Form Standard Form Instructions will be considered acceptable to the agency unless noted otherwise in subsequent changes to these instruction forms.

   3.11 Upstream and downstream analyses will not be required for pretreatment facilities. However, if current data is not available regarding receiving treatment works effluent quality, additional data may be requested.

   3.12 Upstream and downstream analyses will not be required if the minimum, 7-day, 10-year low flow of the stream is zero (0) c.f.s. The effluent quality must meet water quality standards.

This Agency is authorized to require this information under Illinois Revised Statutes, 1979, Chapter 111 1/2, Section 1039. Disclosure of this information is required under that Section. Failure to do so may prevent this form from being processed and could result in your application being denied. This form has been approved by the Forms Management Center.

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DIVISION OF WATER POLLUTION CONTROL
PERMIT SECTION
Springfield, Illinois 62706

SCHEDULE N WASTE CHARACTERISTICS

1. Name of Project _____

2. FLOW DATA — EXISTING — PROPOSED-DESIGN

2.1 Average Flow (gpd) _____ _____

2.2 Maximum Daily Flow (gpd) _____ _____

2.3 TEMPERATURE

Time of year	Ave. Intake Temp. F	Avg. Effluent Temp. F	Max. Intake Temp. F	Max. Effluent Temp. F	Max. Temp. Outside Mixing Zone F
SUMMER					
WINTER					

2.4 Minimum 7-day, 10-year flow: _____ cfs _____ MGD.

2.5 Dilution Ratio: _____ : _____

2.6 Stream flow rate at time of sampling _____ cfs _____ MGD.

3. CHEMICAL CONSTITUENT Existing Permitted Conditions ___; Existing conditions ___; Proposed Permitted Conditions _____.

Type of sample: ___grab (time of collection ___); ___composite (Number of samples per day _____)

(see instructions for analyses required)

Constituent	RAW WASTE (mg/l)	TREATED EFFLUENT Avg. (mg/l)	Max. (mg/l)	UPSTREAM (mg/l)	DOWNSTREAM SAMPLES (mg/l)
Ammonia Nitrogen (as N)					
Arsenic (total)					
Barium					
Boron					
BOD_5					
Cadmium					
Carbon Chloroform Extract					
Chloride					
Chromium (total hexavalent)					
Chromium (total tribalent)					
Copper					
Cyanide (total)					
Cyanide (readily released @150°F & pH 4.5)					
Dissolved Oxygen					
Fecal Coliform					

	RAW WASTE (mg/l)	TREATED EFFLUENT Avg. (mg/l) Max.	UPSTREAM (mg/l)	DOWNSTREAM SAMPLES (mg/l)
Fluoride				
Hardness (as $CaCO_3$)				
Iron (total)				
Lead				
Manganese				
MBAS				
Mercury				
Nickel				
Nitrates (asN)				
Oil & Grease (hexane solubles or equivalents)				
Organic Nitrogen (as N)				
pH				
Phenols				
Phosphorous (as P)				
Radioactivity				
Selenium				
Silver				
Sulfate				
Suspended Solids				
Total Dissolved Solids				
Zinc				
Others				

APPENDIX M
CONSTRUCTION SCHEDULE

WARZYN
ENGINEERING INC

APPENDIX M

CONSTRUCTION SCHEDULE

- - - -

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WARZYN ENGINEERING INC

CONSTRUCTION SCHEDULE OUTLINE

A construction schedule for the OMC/Waukegan/Superfund project is presented on the following pages. This schedule differs from that shown in the Conceptual Design document of September 14, 1984 in that it includes more preparatory work in the fall of 1985, shows completion of harbor and Slip 3 dredging in 1986 rather than 1987, and shows total completion of the work in 1988 rather than 1989.

This is a very tight schedule containing very little slack time. It can be met only with full commitment and cooperation from all parties involved.

The crucial part of this construction schedule comprises the work to be performed during 1986. Two critical paths run through this work -- one involving the dredging and handling of contaminated sediments from Slip No. 3 and the inner harbor, and the other involving removal of contaminated materials and the construction of containment cells in the Crescent Ditch, Oval Lagoon, and parking lot areas.

In the fall of 1985, it will be necessary to accomplish preliminary tasks so that the major work effort scheduled for 1986 can start immediately in the spring. The principal 1985 tasks are: 1) the re-routing of buried utilities in the Crescent Ditch, Oval Lagoon and parking lot areas; 2) the construction of foundations for the water treatment plant in the Harbor area and 3) total installation and operation of the water treatment plant in the parking lot area.

In the spring of 1986, work will start immediately on the cofferdam construction in Slip No. 3 and on installation of the Harbor area water treatment plant. The subsequent progression of the work follows a sequence dictated by the inter-relationships of the various tasks.

Initial operation of the water treatment plants in both areas is an essential pre-condition for all following work. Water produced by the operations and casual water from the operation areas must be treated.

Once the water treatment plant is in operation, work in the Harbor area will progress through construction of the batch plant, curing cells, lagoons and cofferdam and then the dredging and handling of the contaminated materials. The schedule calls for these activities to start April 1, 1986 and to extend through November.

In the Crescent Ditch, Oval Lagoon, and parking lot area, the construction of the by-pass sewer is the essential initial task. This can start about April 1, 1986. Once this is done, excavation of contaminated materials and installation of slurry walls around the containment cells can commence. The schedule calls for these activities to be completed by the end of November, 1986, including the placement of final cover over the west containment cell. The schedule indicates that the parking lot containment cell slurry wall will be completed in August of 1986. The sediments from Slip No. 3, which will by then have been dredged, dewatered, fixed and cured, can then be disposed in the parking lot containment cell.

Work in 1987 and 1988 comprises the removal from Lagoon No. 2 of the dried sediments from the inner harbor and diposal of them in the parking lot containment ceil. This work is entirely dependent on the drying time required. This schedule is based on the ability to remove the two feet of dry sediment in five increments at four-month intervals.

The last sediments are scheduled to be disposed of in August of 1988 after which, cleanup work will comprise removal and disposal of the contaminated lagoon liner material in the parking lot containment cell, removal and disposal of the uncontaminated lagoon dike materials off-site, capping and final closure of the parking lot containment cell, and removal of the water treatment plants.

Total completion is scheduled for the end of November, 1988.

TJL/las
[OMC-2-2]

WARZYN
ENGINEERING INC

CONSTRUCTION CONTRACT ORGANIZATION

The construction schedule requires the performance of a portion of the work in the fall of 1985. This portion comprises the rerouting of buried utilities in the Crescent Ditch/Oval Lagoon and Parking Lot areas, the construction of foundations for the water treatment plant in the Harbor area and the total installation and operation of the water treatment plant in the Parking Lot area. It is necessary to accomplish this work in 1985 so that the major work effort scheduled for 1986 can be accomplished in that year.

The overall design schedule calls for completion of the design documents 120 days after notice to proceed following the Concept Design Review. If this notice to proceed is given by March 15, final design documents will be due about July 15, 1985. Allowing one month for COE review and adjustments and six weeks for bidding would indicate a bid opening date of October 1, 1985 and possible contract award on November 1, 1985. This is too late to permit any construction work in the fall of 1985.

To permit the necessary work to be accomplished in 1985, a different approach will be needed. A separate contract for the 1985 portion for the work is indicated. To allow for twelve weeks of working time prior to December 1, work would have to start about September 1. This would necessitate completion of design documents for this part of the work about June 1, 1985, so that a contract could be awarded by August 1, 1985.

Assuming notice to proceed with final design on March 15, 1985, this leaves ten weeks to produce the necessary contract documents and to make other arrangements which will be necessary prior to construction. These other matters include:

1. Negotiations of utility rerouting with North Shore Gas Company
2. Negotiations of utility rerouting with Commonwealth Edition Company
3. Establishment of new utility easements on OMC property as required for 1 and 2, above
4. Establishment of construction easements on OMC property

Further acquisition of property rights or easements on OMC land and on Larsen Marina, National Gypsum and North Shore Sanitary District land will ultimately be required and prudently should be arranged prior to start of any work.

Given notice to proceed with final design on March 15, 1985, Warzyn can produce contract documents for this part of the work by June 1, 1985. The other requirements needed to permit this fall 1985 construction effort are not within Warzyn's scope of work.

If the work is to start in the fall of 1985, prompt action is required to obtain the necessary easements and agreements. Furthermore, contract bidding and award will have to be expedited. If these efforts cannot be achieved, the construction schedule presented herewith cannot be met, no work will be done in the field in 1985, and final completion will be delayed by one year.

TJL/dkp
[OMC-2-6]

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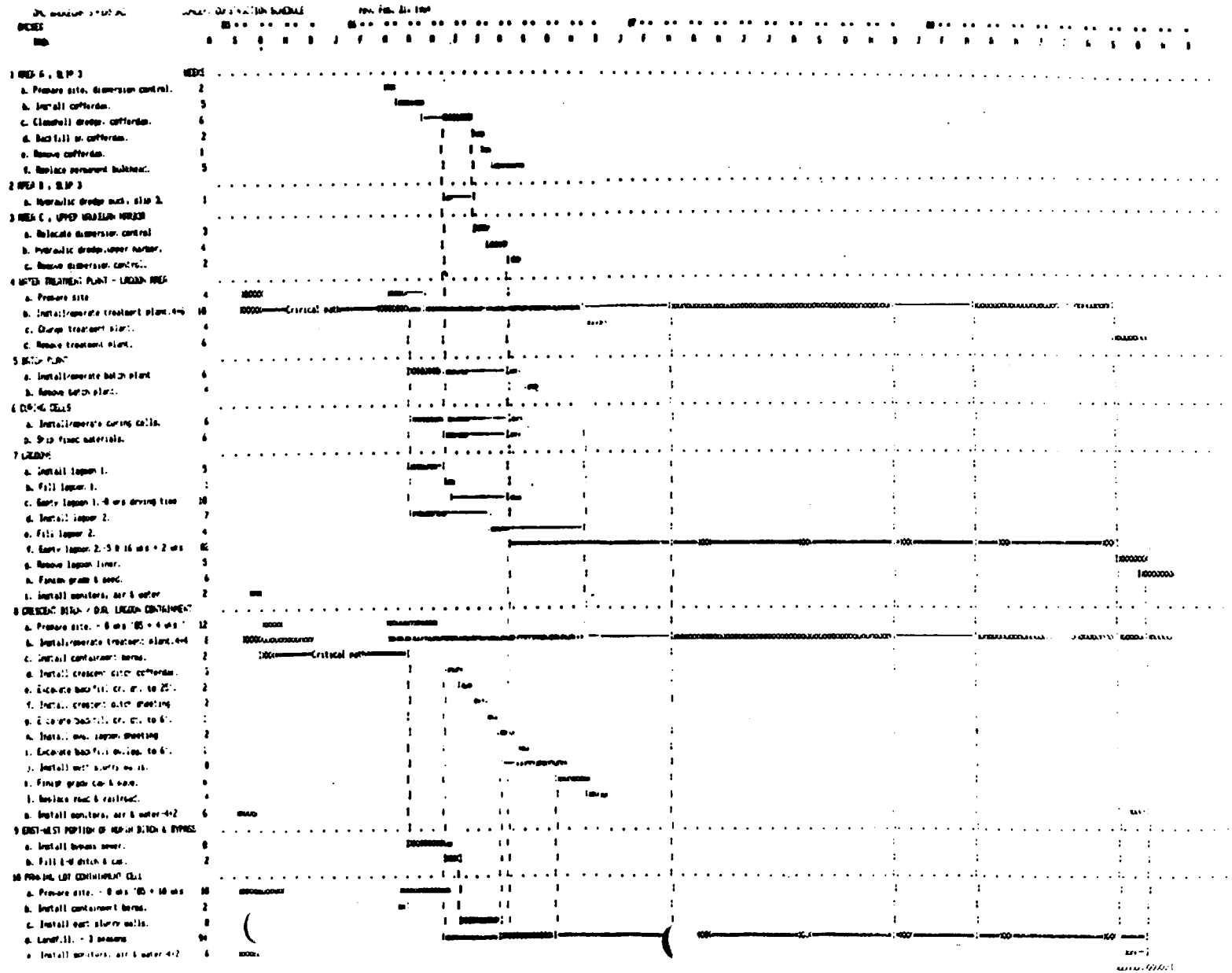
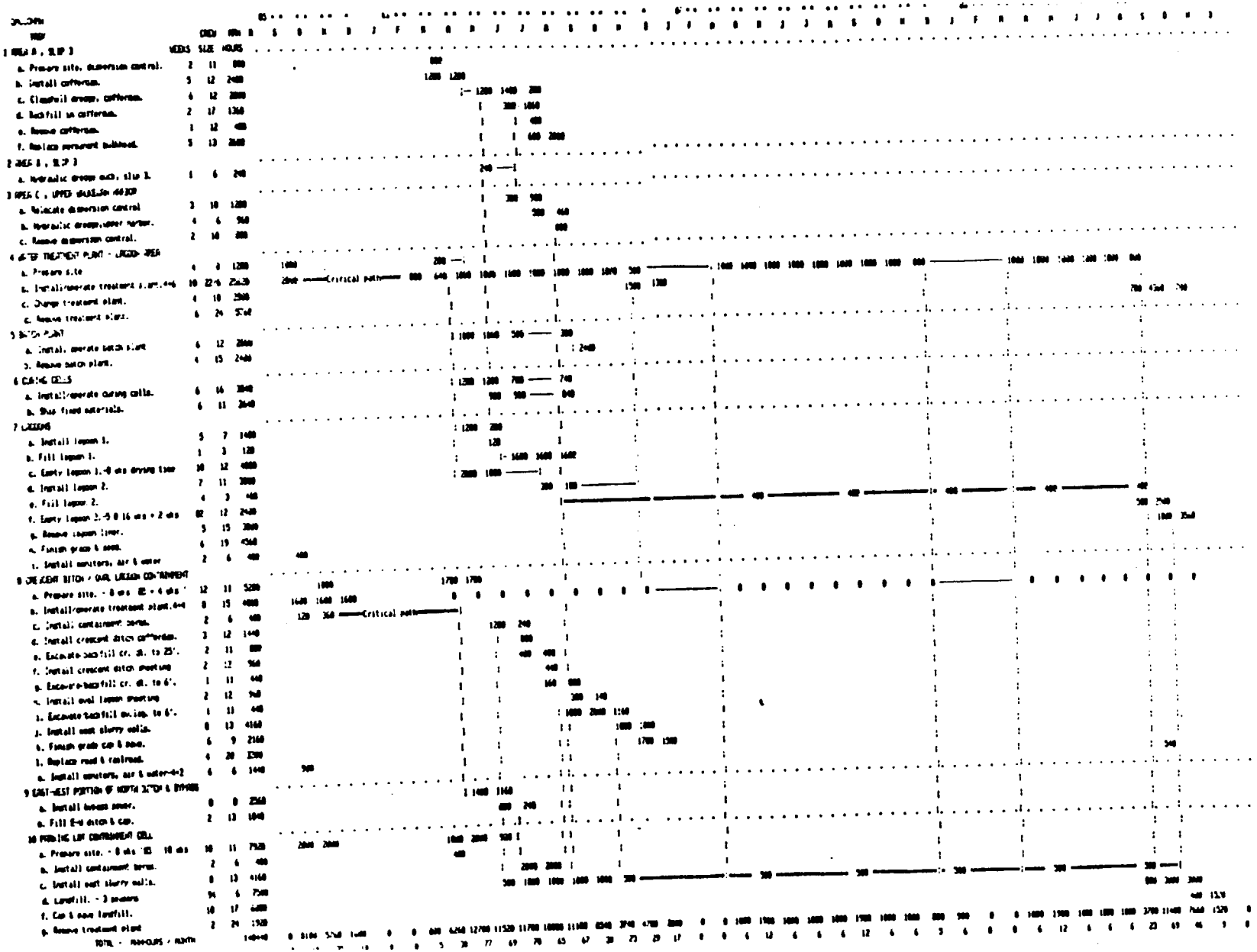
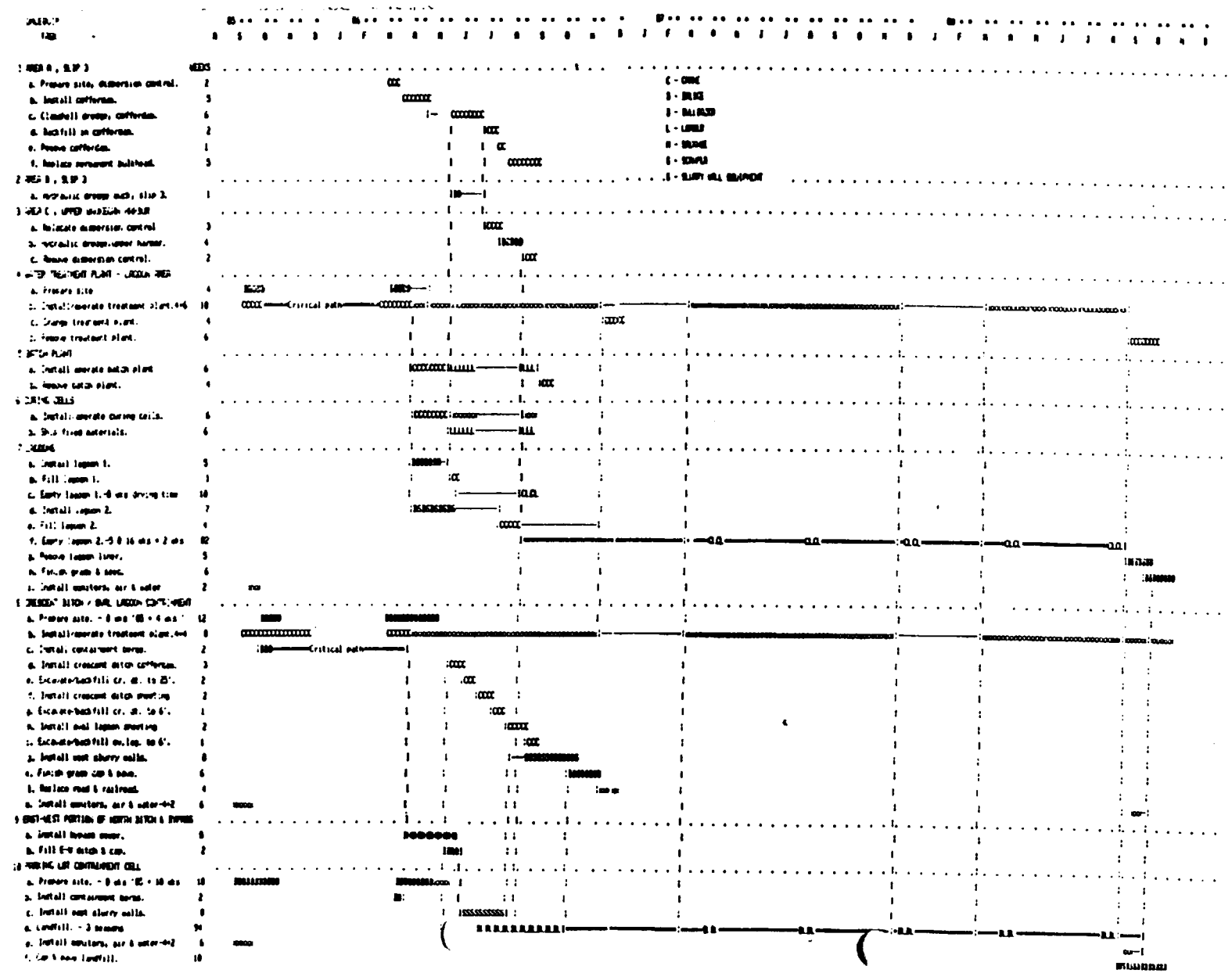
ENGINEERING INC







WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY T. J. Lynch DATE 2/13/85 SUBJECT CMC/Waukegan/Superfund SHEET NO. 1 OF 7
CHKD. BY ____ DATE ____ JOB NO. ____
Construction Schedule:

Activity time:

1. Area A, Slip3

a. Prepare site, dispersion control:

Build sumps for decontamination & truck loading stations -	1 week
Overlay existing pavement for containment & drainage.	+ 1 week
Pump & pipe washwater to treatment plant clearwell.	1 week
Provide fencing & gates.	2 days
Move in guard house / decontamination control / office.	1 day
Mobilize 150 T crane.	1 day
Drive 4 piles for dispersion control - from shore.	2 days
Receive, assemble & install dispersion control device.	1 week.
Total required time	2 weeks.

b. Install cofferdam:

Brace across slip	1 week
Drive piles on land side: 120': 90 piles	+ 1 week
Wales & tie backs	+ 2 weeks.
Drive closure wall across slip - 90' - 70 piles	1 week
Wales & bracing	1 week
Pump & piping to treatment plant (common pipe)	1 week.
Remove bracing across slip	+ 1 week.
Total required time	5 weeks.

c. Clamshell dredge cofferdam:

Quantity = 2000 Yds muck, 3700 Yd sand & clay.

6000 Yds / 2 yd bucket / 18 trips/hr / 40 hrs/wk -	5 weeks
Mobilization & demobilization	1 week
Total required time	6 weeks.

d. Backfill cofferdam:

6000 Yds = 600 Ten Yd trucks.

@ 10 Trucks/hr, 40 hrs/wk	1½ weeks
Total required time	2 weeks.

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY T.J. Lynch DATE 2/13/85 SUBJECT CMC/Waukegan/Superfund SHEET NO. 2 OF 10
CHKD. BY ____ DATE ____ Construction Schedule JOB NO. ____

Continued:

e. Remove cofferdam.
Extract piles across slip. - 70 piles - 2 days.

Total required time 1 week

f. Replace permanent bulkhead.

Drive replacement piles - 60 piles -	1 week
Brace across slip	+ 1 week
Backfill	+ 1 week
Install wale & anchors	+ 1 week
Finish grade & pave	+ 1 week

Total Required Time 5 weeks

NOTE: Quantities used herein are based on those shown in CH2M HILL Concept of September 14, 1984. Difference in quantities shown in Design Analysis are not significant for this purpose.

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY T.J. Lynch DATE 2/13/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 3 OF 12
CHKD. BY ____ DATE ____ JOB NO. ____
Construction Schedule

Activity time:

2. Area B - Slip 3.

a. Hydraulic dredge muck, slip 3.

Quantity: 6,200 Yds @ 40% solids
= 5200 x .4 ÷ 10 = 20,800 Yds @ 10% solids.

@ 3000 gpm = 890 Yds/hr: requires 23 hrs. — 1 week.

3. Area C - Upper Harbor.

a. Relocate dispersion control - remove old — 2 days
reuse piles & anchors - 2 days.
drive 4 new anchor piles - from shore - 2 days.
drive two dolphins - from barge - 4 days.
receive assemble & install new section & relocate old - 2 weeks.

Total required time — 3 weeks

b. Hydraulic dredge upper harbor:

Quantity: 35,700 Yds @ 40% solids.
= 35,700 x 4 ÷ 10 = 142,800 Yds @ 10% solids

@ 3000 gpm = 890 Yds/hr: requires 160 hrs. - 4 weeks — 4 weeks

c. Remove dispersion control:

Remove float & screens -	4 days.
Remove piles & anchors -	2 days
Remove two dolphins -	4 days

Total time required — 2 weeks

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY T.J. Lynch DATE 2/13/85 SUBJECT CMC/Waukegan/Superfund SHEET NO. 9 OF 19
CHKD. BY ____ DATE ____ JOB NO. ____
Construction Schedule:

Activity Times:

4. Water treatment plants:

a.) prepare site

Surface grade, roads, utilities, fencing etc - 4 weeks.

b. Install treatment plant:

Foundations.	2wks.
Clearwell. - concrete - fdn + walls.	- 2wks.
Equipment - install - all skid mount	- + 2wks.
Piping & instrumentation & electrical	+ 4wks.

Total time required 8 weeks

c. Change treatment plant:

Not critical - no down time with proper planning.

Remove surplus piping & equipment 4 weeks.

d) Remove treatment plant:

Remove remaining equipment	2 weeks
Remove foundations & structures	2 weeks
Remove temporary facilities	2 weeks

Total time required 6 weeks

5. Batch Plant:

a. Install batch plant

Foundations -	2 weeks
Equipment -	2 wks
Piping - controls - electrical	2 weeks

Total time required 6 weeks

b. Remove batch plant.

Remove equipment	2 wks
Remove foundations & structures	2 wks

Total time required 4 weeks

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY T.J. Lynch DATE 2/13/86 SUBJECT OMC/Waukegan/Superfund SHEET NO. 5 OF 12
CHKD. BY ____ DATE ____ JOB NO. ____
Construction Schedule

Activity Times:

6. Curing Cells:

a. Install curing cells:

earthwork: dike - 800' @ 9 yds/ft = 7200 Yds.
Liner - 150' x 250' x 20' = 5000 Yds.
@ 500 Yds / day = 24 days.
leachate piping: 800' trench & pipe = 4 days
wearing surface: 150' x 200' x 0.5' = 700 Yds
@ 200 Yds / day = 4 days
division walls: 400 ft. = 12 days
Total time required = 6 weeks.

b. Ship final materials:

Quantity: Area A + Area B dredging
6000 + 5200 = 11,200 Yds.
@ 75 yds / hr from batch plant
= 11200 / 75 = 150 hours

Total time required = 4 weeks

Time to match excavating & batching - 6 weeks

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY T.J. Lynch DATE 2/19/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 6 OF 17
CHKD. BY ____ DATE ____ Construction Schedule JOB NO. ____

Activity times:

7. Lagoons:

a. Install Lagoon 1:

earthwork: Dike 1200' @ 21 Yd/Ft. = 26,200 Yds.
Liner: 200' x 400' x 3.5' = 10,400 Yds.
@ 2000 Yds/day (2 scrapers) = 18 days.
leachate piping: 1200' trench & pipe = 5 days.

Total time required = 5 weeks.

b. Fill Lagoon 1:

See task 2 a - dredge slip 3 — 1 week

c. Empty Lagoon 1:

Drying time - 2 months
Excavating time: 6000 Yds @ 100 Yds/hr = 60 hrs.

Total time required 8 + 2 = 10 weeks

d. Install lagoon 2:

earthwork: dikes: 2000' @ 21 Yd/Ft. = 42,000 Yds.
Liner: 400' x 800' x 3.5' = 41,500 Yds.
@ 4000 Yds/day (4 scrapers) = 21 days.
leachate piping: 2800' trench & pipe = 12 days.

Total time required = 7 weeks.

e. Fill lagoon 2:

See task 3 b - dredge upper harbor. — 4 weeks

f. Empty lagoon 2:

Dredged quantity = 142,000 Cu Yds.
Capacity = 94,000 Cu Yds - 48,000 Yds water decanted during filling - depth = 8' @ 26% solids.
Dredged quantity = 35,700 Yds @ 40% Solids = 3' deep.
Orig. quantity = 23,800 Yds @ 60% Solids = 2' deep.
Excavate in 5 layers @ 5000 Yds ea. @ 4 mo. intervals.

Total time required: 5 x 16 + 2 = 82 weeks in two seasons.

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY T.J. Lynch DATE 2/19/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 7 OF 19
CHKD. BY ____ DATE ____ JOB NO. ____
Construction Schedule

Activity Times:
Continued

g. Remove lagoon liner:

Quantity: Lagoons 1+2 = 10,400 + 41,500 = 51,900 Yds.
@ 300 yds/hr. (20 trips - 15 Yd scraper) = 173 hrs. =
+ 5000 Yds curing cell liner = 17
Total time required = 5 weeks

h. Finish grade & seed:

Quantity. berms - Lagoons & curing cells.
25,200 + 42,000 + 7,200 = 74,400 Yds.
Load & ship off site.
@ 300 Yds/hr = 248 hrs.

Total time required = 6 weeks

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY T.J. Lynch DATE 2/27/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 8 OF 19
CHKD. BY ____ DATE ____ JOB NO. ____
Construction Schedule

Activity Times:

8. Crescent Ditch / Coal Lagoon Containment.

a. Prepare site.
First season - 1985. - utility relocations.
Gas main, 1000'; storm sewers, 1700'
Sanitary, electric, misc. - allow 8 weeks.
Second season - 1986 -
Fencing, decontamination, office - allow 4 weeks

b. Install/Operate treating plant.
First season - 1985 - Foundations - allow 4 weeks.
Second season - 1986 - Equipment/piping - allow 4 weeks

c. Install containment berms.
6000 ft at 1 yd/ft. = 5000 Yds.
@ 100'/hr = 50 hrs - 2 weeks

d. Install crescent ditch cofferdam.
Drive piles : 600' = 500 piles - 6 days.
Wales/bracing + 6 days.
Pump, sump, piping + 3 days

Total time required - 3 weeks

e. Excavate/backfill cr. dt. to 25'.
Quantity = 300' x 15' x 20' = 3300 Yds out
= 300' x 15' x 25' = 4000 Yds in
7300 Yds @ 100 Yds/hr = 73 hrs - 2 weeks

f. Install crescent ditch sheeting.
Drive piles : 600' = 500 piles - 6 days.
No wales or bracing.
Pump, sump, piping 3 days

Total time required 2 weeks

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BY T.J.Lynch DATE 2/27/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 9 OF 19
CHKD. BY ____ DATE ____ Construction Schedule JOB NO. ____

Activity Times:

8. Crescent Ditch / Oval Lagoon Containment.

g. Excavate/backfill crescent ditch to 6'

Quantity: 300' x 15' x 6' = 1000 Yds out
300' x 16' x 11' = 2000 Yds in
3000 Yds @ 100 Yds/hr. = 30 hrs - 1 week

h. Install Oval Lagoon sheeting.

Drive piles: 600' = 500 piles - 6 days.
Pump, sump, piping - 3 days

Total time required 2 weeks

i. Excavate/backfill oval lagoon to 6'.

Quantity: 300' x 20' x 6' = 1300 Yds out
300 x 20 x 11 = 2400 Yds in
3700 Yds @ 100 Yds/hr = 37 hrs - 1 week

j. Install west slurry walls.

2500 ft @ 100 ft/day = 25 days - allow 8 weeks

k. Finish grade, pave & cap.

Grading: 300' x 800' = 240,000 ft² = 5½ acres - 1 wk.
Cap. 240,000 ft² x 3' = 27,000 Yds clay.
@ 300 Yds/hr = 90 hrs 3 wks.
Pave 240,000 ft² = 27,000 ft Yds.
@ 300 ft Yds/hr = 90 hrs. 3 wks.
Pave & Cap ~ overlap 1 wk.

Total Time required 6 weeks

l. Replace road & railroad.

500' track + 500' road - 4 weeks

m. Install monitors, air & water:

22 + 9 = 31 water monitors
9 air monitors.
initial installation - 1985 4 weeks.
final installation - 1988 2 weeks.

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BY T.J. Lynch DATE 2/27/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 10 OF 19
CHKD. BY ____ DATE ____ JOB NO. ____
Construction Schedule

Activity Times:

9. East-West portion of North Ditch & Bypass.

a. Install bypass sewer.

Quantity: 2900 Lf. 36x66 oval RCP.
@ 100 ft/day = 29 days.
11 manholes @ 1/day ea = 11 days — 8 weeks

b. Fill E-W. ditch & cap.

Quantity: 2000 Lf. x 20' x 2' = 3000 Yds gen. fill.
+ 3000 Yds Clay
+ 1500 Yds Topsoil
7500 Yds @ 100 Yds/hr = 75 hrs - 2 weeks,

10. Parking Lot Containment Cell.

a. Prepare site:

Same as 8 a. 1985 — 8 weeks
1986 — 4 weeks

b. Install containment berms - Same as 8 c — 2 weeks

c. Install east slurry walls - Same as 8 j. — 8 weeks.

d. Landfill. from 7c - 7 f & 7 g 7+82+5 = — 94 weeks

e. Install monitors, air & water. Same as 8 m, 4+2 = 6 weeks

f. Cap & pave landfill: Same as 8 k - 6 weeks.
+ place revetments 4 weeks - 10 weeks

g. Remove treatment plant. — 2 weeks

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MADISON, WISCONSIN

BY T.J. Lynch DATE 2/27/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 11 OF 12
CHKD. BY ____ DATE ____ JOB NO. ____
Construction Schedule

Personnel Requirements:

		Man Weeks
1. Area A, Slip 3.		
a. Prepare site; dispersion control.	- 2 weeks.	
General work crew: 2 carp. + 3 lab.	- 5	
Piping, mech, elect. - average	- 2	
Crane: Operator, oiler, riggers	- 4	
average work crew	- 11.	22
b. Install cofferdam:	- 5 weeks	
Crane operator, oiler, riggers	- 4	
Pile drivers, welders - average	- 2	
Piping, mech. elect. - average	- 2	
General work, carp, laborers	- 4	
average work crew	- 12	60
c. Clamshell dredge cofferdam.	- 6 weeks	
Crane operator, oiler, riggers	4	
Truck drivers, 15/hr, 20 min cycle	- 5	
Decontamination station	- 3	
average work crew	- 12	72
d. Backfill cofferdam.	- 2 weeks	
Crane operator, oiler, riggers	4	
Truck drivers, 10/hr., 1 hr. cycle	- 10	
Clean-up crew	3	
average work crew	17	34
e. Remove cofferdam.	- 1 week	
Crane operator, oiler, riggers	4	
Pile drivers	2	
Truck drivers	2	
Clean-up crew	4	
average work crew	12	12

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BY T.J. Lynch DATE 2/27/86 SUBJECT OMC/Waukegan/Superfund SHEET NO. 12 OF 19
CHKD. BY ____ DATE ____ Construction Schedule JOB NO. ____

Personnel Requirements.

		Man Weeks
1. Area A, Slip 3 – Continued.		
f. Replace permanent bulkhead	– 5 weeks.	
Crane, operator, oiler, riggers	4	
Piledrivers, welders. – average	2	
Truckdrivers - backfill - average	2	
General work, - anchors - average	2	
Clean-up crew	3	
average work crew	13	65
2. Area B - Slip 3		
a. Hydraulic dredge muck, Slip 3.	– 1 week.	
Dredge crew.	4	
Shore crew	2	
average work crew	6	6
3. Area C - Upper Harbor:		
a. Relocate dispersion control.	– 3 weeks.	
Crane - operator - oiler - riggers	4	
Pile drivers – average	1	
General work -	2	
Clean-up crew	3	
average work crew	10	3
b. Hydraulic dredge upper harbor	– 4 weeks.	
Dredge crew	4	
Shore crew	2	
average work crew	6	24
c. Remove dispersion control.	– 2 weeks	
Crane - operator, oiler, riggers	4	
Piledrivers – average	1	
General work -	2	
Clean-up crew	3	
average work crew	10	20

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BY T.J. Lynch DATE 2/27/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 13 OF 19
CHKD. BY ____ DATE ____ Construction Schedule JOB NO. ____

Personnel Requirements:

			Man Weeks
4. Water Treatment Plants:			
a. Prepare site		4 weeks.	
Dozer, grader operators	2		
Truck drivers	2		
General work, fencing etc.	4		
average work crew	8		32
b. Install treatment plant.		8 weeks.	
Crane, oiler, riggers	- 4		
Carpenters, laborers, Concrete wk	- 6		
Piping, mech. elect.	- 12		
average work crew	22		176
Plant operation:		92 weeks	
3 shifts, 2 men/shift.			
average work crew	6		552
c. Change treatment plant.		4 weeks.	
Crane, oiler, riggers	4		
Piping, mech, elect.	10		
Clean-up crew	4		
average work crew	18		72
d. Remove treatment plant.		6 weeks	
Crane, oiler, riggers	4		
Piping, mech, elect.	10		
General work	4		
Clean-up crew	6		
average work crew	24		144

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BY T.J.Lynch DATE 2/28/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 14 OF 19
CHKD. BY ____ DATE ____ JOB NO. ____
Construction Schedule

Personnel Requirements:

			Man-Weeks
5. Batch Plant:			
a. Install batch plant.		6 weeks	
Crane - oiler - riggers	4		
Carpenters - laborers - Gen. Wk.	4		
Piping, mech. elect.	4		
average work crew		12	72
b. Remove batch plant		4 weeks	
Crane - oiler - riggers	4		
Piping, mech, elect.	4		
General work	4		
Clean-up crew	3		
average work crew		15	60
6. Curing Cells:			
a. Install curing cells.		6 weeks	
Dozer, grader operators, laborers	4		
Truck drivers	5		
Piping	3		
Carpenters, Laborers - Conc wk	4		
average work crew		16	96
b. Ship fixed materials		6 weeks	
End loader operators, helpers -	4		
Truck drivers -	4		
Clean-up crew -	3		
average work crew		11	66

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BY T.J.Lynch DATE 2/28/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 15 OF 19
CHKD. BY ____ DATE ____ JOB NO. ____
Construction Schedule

Personnel Requirements:

		Man Weeks
7. Lagoons:		
a. Install lagoon 1.	5 weeks	
Dozer, scraper, grader - operators, helpers	4	
Piping	3	
average work crew	7	35
b. Fill lagoon 1.	1 week	
Crane, laborers	3	
average work crew	3	3
c. Empty lagoon 1.	10 weeks	
Crane, laborers	3	
End loaders	2	
Truck drivers	4	
Clean-up crew	3	
average work crew	12	120
d. Install lagoon 2.	7 weeks	
Dozer, scraper, grader - operators, helpers	8	
Piping	3	
average work crew	11	77
e. Fill lagoon 2.	4 weeks	
Crane, laborers	3	
average work crew	3	12
f. Empty lagoon 2.	10 weeks	
Crane, laborers	3	
End loaders	2	
Truck drivers	4	
Clean-up crew	3	
average work crew	12	120

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BY T.J. Lynch DATE 2/28/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 16 OF 19
CHKD. BY ____ DATE ____ JOB NO. ____
Construction Schedule

Personnel Requirements:

		Man Weeks
7. Lagoons continued.		
g. Remove lagoon liner:	5 weeks.	
Dozer, scraper, loader, operator + helpers	6	
Truck drivers	4	
End loaders	2	
Clean-up crew	3	
average work crew	15	75
h. Finish grade & seed.	6 weeks.	
Dozer, scraper, loader, operator + helpers	6	
Truck drivers	8	
End loaders	2	
Clean-up crew	3	
average work crew	19	114
8. Crescent ditch / Oval lagoon containment.		
a. Prepare site:	12 weeks.	
General work crew - 2 emp + 3 lab.	5	
Piping - utility relocations; backhoe	6	
average work crew	11	132
b. Install / Operate Treatment Plant:	8 weeks	
Crane, oiler, riggers	3	
Carpenter, laborers, Concrete work	6	
Piping, mech, elect	6	
average work crew	15	120
Plant operation:	92 weeks.	
use operators from other plant.		
average work crew	0	0
c. Install containment berms	2 weeks	
Dozer, grader, helpers	4	
Truck drivers	2	
average work crew	6	12

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CHKD. BY ____ DATE ____ JOB NO. ____

Construction Schedule

Personnel Requirements:

			Man Weeks
d.	Install crescent ditch cofferdam.	3 weeks	
	Crane operator, oiler, riggers -	4	
	Pile drivers, welders - average -	2	
	Piping, mech, elect.	2	
	General wk, carp, ~~elect~~ laborers	4	
	average work crew	12	36
e.	Excavate/backfill cr. dt. to 25'	2 weeks	
	Crane/back hoe, operator, laborers	4	
	Truck drivers	4	
	Clean-up crew	3	
	average work crew	11	22
f.	Install crescent ditch sheeting.	2 weeks	
	Crane operator, oiler, riggers	4	
	Pile drivers, welders, average	2	
	Piping, mech, elect.	2	
	General wk. carp. laborers	4	
	average work crew	12	24
g.	Excavate/backfill crescent ditch to 6'	1 week	
	Crane/back hoe, operator, laborers	4	
	Truck drivers	4	
	Clean-up crew	3	
	average work crew	11	11
h.	Install Oval lagoon sheeting.	2 weeks.	
	Crane operator, oiler, riggers	4	
	Pile drivers, welders, average	2	
	Piping, mech. elect.	2	
	General work, carp. laborers	4	
	average work crew	12	24

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY T.J. Lynch DATE 2/28/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 18 OF 2
CHKD. BY ____ DATE ____ Construction Schedule JOB NO. ____

Personnel Requirements

			Man Weeks
i.	Excavate/backfill Oval lagoon to 6'	1 week	
	Crane/backhoe, operator, laborers	4	
	Truck drivers	4	
	Clean-up crew	3	
	average work crew	11	11
j.	Install west slurry walls.	8 weeks	
	Back hoe, dozer, grader, loader + helpers	6	
	Truck drivers	4	
	Clean-up crew	3	
	average work crew	13	104
k.	Finish grade, pave & cap.	6 weeks	
	Dozer, grader, paver, helpers	4	
	Truck drivers	2	
	Clean-up crew	3	
	average work crew	9	54
l.	Replace road & railroad	4 weeks,	
	R.R. section gang	12	
	Dozer, grader + helpers	4	
	Utility work crew	4	
	average work crew	20	80
m.	Install monitors, air & water.	6 weeks.	
	Drilling crew	2	
	Finishing crew	2	
	Clean-up crew	2	
	average work crew	6	36

WARZYN ENGINEERING, INC.
MADISON, WISCONSIN

BY T.J. Lynch DATE 2/28/85 SUBJECT OMC/Waukegan/Superfund SHEET NO. 19 OF ?
CHKD. BY ____ DATE ____ JOB NO. ____
Construction Schedule

Personnel Requirements:

			Man Weeks
9.	East-West portion of North Ditch & By pass - ~~5 weeks~~		
	a. Install By-Pass Sewer - 8 weeks		
	Back hoe operator + laborers 4		
	End loader/compactor + laborers 4		
	average work crew	8	64
	b. Fill E-W. ditch & cap.	2 weeks	
	~~Back~~ Dozer/Grader + Laborers 4		
	Truck drivers 6		
	Clean-up crew 3		
	average work crew	13	26
10.	Parking lot Containment Cell.		
	a. Prepare site - see 8a.	12 weeks.	
	average work crew	11	132
	b. Install containment berms - see 8c	2 weeks	
	average work crew	6	12
	c. Install east slurry walls - see 8j.	8 weeks	
	average work crew	13	104
	d. Land fill.	25 weeks	
	Dozer/loader, operator + laborers 3		
	Clean-up crew 3		
	average work crew	6	150
	e. Install monitors - Same as 8m.	6 weeks	
	Included in 8m		
	average work crew	0	0
	f. Cap & pave land fill	10 weeks	
	Cap - same as 8k - 9		
	Runtrucks: Comm, loader, riggers 4		
	Truck drivers 4		
	average work crew	17	170
	g. Remove treatment plant	2 weeks	
	Same as 4d.		
	average work crew	24	48
		Σ	3543 Man Weeks

= 141,720 Man hours
@ $25/hr = $3,543,000
= ~ 25%

APPENDIX N
SITE DESCRIPTION & PRELIMINARY SHEET PILE/ FOUNDATION RECOMMENDATIONS

WARZYN
ENGINEERING INC

February 21, 1985
C 11837

MEMORANDUM

To: Project Staff

From: Richard H. Weber, P.E.
Geotechnical Engineer

Re: Geotechnical Design Memorandum #1
Site Description and Preliminary
Sheet Pile/Foundation Recommendations
Outboard Marine Corporation
Waukegan Harbor Superfund Project
Contract No. DACW 45-85-C-0023

INTRODUCTION

It has become evident that the proposed subsurface investigation at the OMC site to further delineate subsurface conditions and to obtain soil samples for testing of index and physical properties will not be completed, and probably not even started, by Concept Review scheduled to begin March 12, 1985. As such, the purpose of this memorandum is to summarize the subsurface conditions and limited laboratory soil test results from the previous investigations. A list of references is attached.

SUBSURFACE CONDITIONS

A. North Ditch Area

The North Ditch area is comprised of the Crescent Ditch, Oval Lagoon, East-West Ditch, the areas adjacent to these features and the OMC Plant No. 2 employee parking lot. The ground surface is relatively flat and lies near Elevation 585 (USGS datum). The ditch inverts are near Elevation 580. The general subsurface conditions consist of 20 to 32 feet of granular deposits overlying cohesive glacial till. The Crescent Ditch and Oval Lagoon have 1- to 2-feet of soft organic silt (muck) overlying the granular deposits.

The granular deposits primarily consist of brown fine to medium sand with trace silt (SP) and gray very fine to fine sand with trace to little silt (SP-SM). Occasional 0.5- to 1.5-foot thick layers of well-graded gravel with some sand are present between the sand and till. In the vicinity of the Crescent Ditch and Oval Lagoon at the west end of the site, the granular deposits average approximately 23-feet thick while at the east end of the site, the granular deposits average approximately 30-feet thick. SPT N-values in the granular deposits varied from 2 to 117 BPF and averaged approximately 27 indicating the sand is generally medium dense. Sieve analyses indicate the sand contains from 0 to 23 percent fines (material passing No. 200 sieve) and typically averages 5 to 10 percent. Two laboratory permeability tests on

remolded sand samples indicate a permeability of approximately 4 x 10^{-3} cm/sec while several field baildown tests of groundwater monitoring wells indicate a permeability on the order of 2 x 10^{-3} cm/sec.

The glacial till was generally classified as gray silt with little to some clay, sand and trace to little gravel (ML). The till extended to the maximum depths penetrated by the borings. SPT N-values in the till varied from 14 to 178 BPF and averaged approximately 65. Pocket penetrometer readings varied from 2.5 to 4.5+ TSF and generally exceeded 4.5 TSF indicating the till is hard. Several Atterberg limit tests resulted in an average liquid limit of 19 and plastic limit of 16. Sieve analyses indicate the till contains from 72 to 99 percent fines and averages approximately 90 percent passing the No. 200 sieve.

Water levels in the Crescent Ditch, Oval Lagoon, East-West Ditch and Lake Michigan were aerometrically surveyed in August of 1984 to be near Elevation 581.7. Groundwater levels recorded during drilling and in monitoring wells of previous investigations were in the range of Elevation 583 to 581. Groundwater levels are anticipated to fluctuate with the general level of Lake Michigan and storm runoff in the Ditches and Lagoon.

B. Vacant OMC Property

The vacant OMC property is located between OMC's Plant No. 2 and 1, to the north and south, and between Seahorse Drive and Upper Waukegan Harbor, to the east and west. The area is currently used by OMC for parking semi-trailers and by Larsen Marine for storing boat cribs. The area has been the site of a coke plant among other things, and old foundations are rumored to still exist. Rail gantry foundations have been identified along the Upper Harbor bulkhead. The ground surface is relatively flat near Elevation 585 except for relatively large fill piles along the Harbor bulkhead which extend to a maximum Elevation 612. The fill piles apparently consist of sand dredgings. The general subsurface conditions consist of 23 to 32 feet of granular deposits overlying cohesive glacial till.

The granular deposits primarily consist of black very fine to medium sand with little to some silt (SP-SM, SM). Upper layers included coal, coke, gravel, concrete and wood. Several borings encountered dark liquid in the samples with strong petroleum-like odors. SPT N-values in the granular deposits varied from 2 to 87 BPF and averaged approximately 22. Based on the average N-value, the sand is typically medium dense. Moisture content tests indicate a range from 13 to 53 percent with an average of approximately 24 percent (weight of water divided by dry weight of solids). Sieve analyses indicate the sand contains from 3 to 19 percent fines and averages approximately 10 percent.

The till stratum was visually classified as both low plasticity silt (ML) and clay (CL). A typical description is gray silt with little to some clay, sand and trace to little gravel (similar to till in the North Ditch area). The till extended to the maximum depths penetrated by the borings. SPT N-values in the till varied from 18 to 146 BPF and averaged approximately 60. Pocket penetrometer readings exceeded 4.5 TSF indicating the till is hard. Moisture

content tests indicate a range from 9 to 19 percent with an average of approximately 14 percent. Density test results indicate a range in dry density from 113 to 133 PCF with an average of 124 PCF. Sieve analyses indicate the till contains from 59 to 96 percent fines and averages approximately 80 percent passing the No. 200 sieve.

Groundwater levels recorded during drilling were in the range of Elevation 583 to 582. Groundwater levels are anticipated to fluctuate with the general level of Lake Michigan and the Upper Harbor.

C. Upper Waukegan Harbor

The Upper Harbor, for purposes of this memorandum, consists of the Harbor beginning at the north side of OMC Plant No. 1 and extending north to include Slip No. 3. Water depths in the Harbor generally vary from 14 to 25 feet with some shallower depths as little as 9 feet at the southwest corner of Slip No. 3. The harbor sediments typically consist of organic silt (muck) underlain by granular deposits that are underlain by glacial till. The Upper Harbor is bordered by approximately 20- to 25-foot long steel sheetpiling that apparently extends into the granular deposits above the till.

The upper sediments were visually described as black organic clayey silt with trace to some sand (muck)(OL). The muck was typically 1 to 7 feet thick. SPT N-values of the muck were essentially 0 BPF since the drill rods and split spoon sampler sank through the muck under their own weight. The muck is therefore considered very soft and contains an average of 50 percent solids. Pocket penetrometer readings were impractical and unfeasible. Moisture content tests indicate a range from 90 to 190 percent with an average of approximately 140 percent. A loss on ignition tests indicated 22.5 percent organics by combustion. Density test results indicate an average muck dry density of about 28 PCF. Sieve analyses indicate the muck contains from 40 to 68 percent fines and averages approximately 56 percent.

The granular deposits primarily consist of gray fine to medium sand with little to some silt, trace gravel and occasional thin lenses of organic materials (SP-SM, SM). SPT N-values in the sand varied from 0 to 72 BPF and averaged approximately 19 indicating the sand is typically medium dense. Moisture content tests indicate a range from 10 to 24 percent with an average of approximately 20 percent. Sieve analyses indicates the sand contains from 0.2 to 29 percent fines and averages approximately 11 percent.

The glacial till stratum was classified as both low plasticity silt (ML) and clay (CL). A typical description is gray silty clay with little sand and trace gravel. The till extended to the maximum depths penetrated by the borings. SPT N-values in the till varied from 21 to 144 BPF and averaged approximately 58. Pocket penetrometer readings varied from 2.5 to 4.5+ TSF and averaged approximately 4.5 TSF indicating the till is hard. Atterberg limits test results indicate an average liquid limit of 23 and plastic limit of 16. Sieve analyses indicate the till contains from 74 to 95 percent fines with an average of approximately 81 percent.

The level of the Upper Harbor was surveyed in August of 1984 to be Elevation 581.8. The Harbor water level apparently normally ranges from Elevation 578 to 580. Recent levels indicate Lake Michigan is currently at a high stage. Harbor water level changes as much as 4 feet can apparently occur within a few hours during a seiche.

RECOMMENDATIONS

The previous section included discussion of general subsurface conditions and index properties of the soil strata. Detailed boring logs and test results are available in the investigation reports listed in the attached references. The following paragraphs contain recommended soil parameters for the design of sheetpile walls and foundations.

A. Sheetpile Walls

Temporary sheetpile walls are currently anticipated for remedial activities in Slip No. 3, the Crescent Ditch and the Oval Lagoon. In Slip No. 3, the soil strata consists of organic silt (muck) overlying sand overlying glacial till. In the vicinity of the Crescent Ditch and Oval Lagoon, the soil strata consists of sand overlying glacial till. The granular deposits and till inside and outside the harbor had similar index properties. Therefore, the following soil parameters are recommended for sheetpile wall design based on the index test results and correlations of SPT N-values and pocket penetrometer readings with strength.

Stratum	USCS	Wet Density (PCF)	Cohesion (PSF)	Friction Angle (DEG)
Muck	OL	68	0	0
Sand	SP-SM	120	0	35
Till	ML	140	4500	0

B. Foundations

Temporary foundations are currently anticipated for the water treatment plant facilities at both the North Ditch and vacant OMC property, and batch plant at the vacant OMC property. Relatively light loading conditions are anticipated for column loads, wall loads and areal tank loads. As such, conventional shallow spread foundations established in the medium dense sand stratum are considered suitable to support the loads.

Spread foundations for structures having a service life of only several months and not exposed to frost conditions (e.g. batch plant) can be established at or just below the ground surface and proportioned using an allowable bearing pressure of 5000 PSF. Spread foundations having a longer service life and exposed to seasonal frost conditions should be established at least 42 inches below grade and can also be proportioned using an allowable bearing pressure of 5000 PSF. To avoid disproportionately narrow foundations, minimum widths of 30 inches and 18 inches are recommended for individual column foundations and wall footings, respectively. Total settlements of 1 inch or less are anticipated and should essentially occur as the load is applied due to the granular nature of the soil.

Fluid loadings in tanks bearing at grade should be limited to an allowable soil bearing pressure of 3000 PSF. Areal loads can be distributed over large concrete mat foundations or the tanks placed directly on the levelled and proof-rolled subgrade. Total settlements of 1 inch or less are anticipated.

The preceding recommendations are contingent upon standard care being exercised during construction to check that subgrade conditions are consistent with expectations. Subgrade observation by a qualified geotechnical engineer is recommended to check the adequacy of bearing conditions. If encountered, unsuitable soil or fill material should be removed and replaced with compacted granular fill.

Water treatment facilities along the bulkhead at the OMC vacant property can potentially make use of reportedly existing rail gantry foundations below the dredge fill piles. Details and conditions of the foundations are presently unknown. For preliminary design purposes, the gantry foundations can be assumed capable of supporting 3000 PSF bearing pressures. However, investigation of the foundations with test pits are recommended prior to construction.

RHW/cac
[cac-6-37]

Encls: References

cc: Warzyn Project Staff (TJL, RAJ, DJD, LAB, WWW, MNS, RHW, LDA, BAW, MWR, DAW, SGW)
Donohue Project Staff (6 copies submitted)

WARZYN
ENGINEERING INC

REFERENCES

(In Chronological Order)

1. Hydrogeologic Investigation, Outboard Marine Corporation, Waukegan, Illinois, for JRB Associates by Warzyn Engineering Inc., September 20, 1979, Job No. C 8342. The investigation was performed in the general vicinity of the North Ditch. The report includes the results of 9 SPT soil borings, 15 groundwater monitoring wells, 15 baildown permeability tests, 18 sieve analysis tests, 4 hydrometer analysis tests and 4 Atterberg limits tests.

2. Subsurface Investigation, North Ditch Area, Outboard Marine Corporation, Waukegan, Illinois, for Mason & Hanger - Silas Mason Co. Inc. by Warzyn Engineering Inc., July 29, 1980, Job No. C 9177. The majority of the investigation was performed in the general vicinity of the North Ditch with several additional borings on the vacant OMC property adjacent to Waukegan Harbor. The report includes the results of 39 deep SPT soil borings, 5 shallow SPT soil borings, 20 shallow sediment cores, 7 groundwater monitoring wells and 7 baildown permeability tests.

3. Outboard Marine Corporation, Waukegan Harbor Borings, Waukegan, Illinois, for Mason & Hanger - Silas Mason Co. Inc. by Warzyn Engineering Inc., August 5, 1980, Job No. C 9291. The investigation was performed in Waukegan Harbor from Slip No. 3 to the Harbor entrance. The report includes the results of 6 SPT soil borings, 5 sieve analysis tests, 4 hydrometer analysis tests, 1 natural moisture content test, 1 loss on ignition test and 2 Atterberg limits tests.

4. An Engineering Study for the Removal and Disposition of PCB Contamination in the Waukegan Harbor and North Ditch at Waukegan, Illinois, Final Report (including Appendices), for U.S. EPA by Mason & Hanger - Silas Mason Co. Inc., January 1981. First Addendum, May 1981. Second Addendum, March 1982.

5. Sand Sample Collection, Waukegan Harbor Slip No. 3, Waukegan, Illinois, for Mason & Hanger - Silas Mason Co. Inc., by Warzyn Engineering Inc., January 6, 1981, Job No. C 9560. The investigation was performed in Slip No. 3 of Waukegan Harbor. The report includes the results of 6 SPT soil borings, 9 sieve analysis tests and 9 natural moisture content tests.

6. Sediment and Shore Sample Collection, Waukegan Harbor Slip No. 3, Waukegan, Illinois, for Mason & Hanger - Silas Mason Co. Inc. by Warzyn Engineering Inc., May 26, 1981, Job No. C 9729. The investigation was performed in and adjacent to Slip No. 3 of Waukegan Harbor. The report includes the results of 6 SPT soil borings, 3 sieve analysis tests, 3 hydrometer analysis tests, 3 natural moisture content tests and 3 density tests.

7. Soil Boring Investigation, North Ditch Area, Outboard Marine Corporation, Waukegan, Illinois, for Roy F. Weston, Inc. by Warzyn Engineering Inc., December 23, 1981, Job No. C 10191. The investigation was performed in the vicinity of the North Ditch. The report includes the results of 20 SPT soil borings, 6 sieve analysis tests, 2 remolded laboratory permeability tests and 3 standard Proctor tests.

WARZYN ENGINEERING INC

8. Site Selection Study, Waukegan Harbor, Illinois, Confined Disposal Facility, for and by U.S. Army Corps of Engineers, Chicago District, April, 1984. The investigation was performed in the vacant OMC property adjacent to Waukegan Harbor. The report includes the results of 5 SPT soil borings, 37 sieve analysis tests, 35 hydrometer analysis tests, 33 natural moisture content tests, 22 loss on ignition tests, 9 density tests and 36 specific gravity tests.

9. Topographic Maps, for CH2M Hill by Aerometric Engineering Inc., August 9, 1984.

10. Conceptual Design, OMC Hazardous Waste Site, Waukegan, Illinois, for U.S. EPA by CH2M Hill, September 14, 1984.

APPENDIX P
VALUE ENGINEERING

WARZYN
ENGINEERING INC

A1 T-1

PROJECT TRANSMITTAL RECORD

1. SECURITY CLASSIFICATION: UNCLASSIFIED

2. SHIPMENT NO:

3. TITLE/FILE IDENTIFICATION
PROJECT: OMC-Waukegan Harbor
LOCATION: Waukegan, IL (Cont #DACW45-85-C-0023)

4. AS OF DATE: YEAR | MONTH | DAY

5. DATE OF SHIPMENT: YEAR | MONTH | DAY

6. AUTHORITY FOR SHIPMENT
Project Design Criteria

7. METHOD OF SHIPMENT
- [ ] FIRST CLASS
- [ ] PARCEL POST
- [ ] FIRST CLASS-REGISTERED
- [ ] COURIER
- [ ] FIRST CLASS-CERTIFIED
- [x] PRIORITY MAIL

8. REQUIREMENT CONTROL SYMBOL (AR 335-15)
MROED-E

8. NO. BOXES

10. NO. ITEMS

9. SHIPPED FROM:
Commander, Omaha District/MROED-E
US Army Corps of Engineers
6014 US Post Office & Courthouse
Omaha, NE 68102

12. TYPE OF MEDIA
- [ ] MAGNETIC TAPE
- [ ] HARD COPY
- [ ] PUNCHED CARDS
- [ ]

13. FOR MAGNETIC TAPE SHIPMENTS
- [ ] TAPE HAS HEADER LABEL.
- [ ] DATA WRITTEN BEYOND END OF REEL REFLECTIVE SPOT
- TAPE MARK [ ] PRECEDES [ ] FOLLOWS HEADER LABEL
- RECORDS ARE [ ] PACKED [ ] FIXED [ ] VARIABLE-LENGTH
- PARITY IS [ ] ODD [ ] EVEN
- TAPE IS [ ] SEVEN [ ] NINE CHANNEL
- RECORDING MODE IS [ ] NRZI [ ] EBCDIC [ ] BINARY

DENSITY	NO. OF TAPE MARKS	NO. CHARACTERS PER RECORD	NO. RECORDS PER BLOCK

10. REASON TO CONTACT/PHONE (if necessary)
Robert F. Smart, (402) 221-4500

11. TYPED NAME AND TITLE OF SENDER
Robert F. Smart, PROJECT MANAGER

12. SIGNATURE OF SENDER
Robert F. Smart

17. TYPE COMPUTER AND RECORDING DEVICE

13. REMARKS
Enclosed for your information and use in design development are Region V EPA comments on the Value Engineering Review, dated 10 January 1985, for the subject project. Further clarification of some items may be required at the Concept (30%) Review Conference.

REMARKS (Cont'd).

14. When checked here, acknowledgment of receipt is requested. Sign and return one copy of this transmittal to address above.

15. SHIPPED TO:
Warzyn Engineering, Inc.
1409 Emil Street
P.O. Box 9538
Madison, Wisconsin 53715

16. SIGNATURE OF RECEIVER

17. DATE RECEIVED

FORM 200

F-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

REPLY TO THE ATTENTION OF

FEB 21 1985

Mr. Robert Smart
U.S. Army Corps of Engineers
Omaha District, MROED-E
6014 U.S. Post Office
and Courthouse
Omaha, Nebraska 68102

Dear Mr. Smart:

The purpose of this letter is to transmit our comments concerning the January 10, 1985, Value Engineering Review, prepared by Warzyn, concerning the OMC hazardous waste site, Waukegan, Illinois. These comments were previously transmitted verbally. Overall, this was a very useful report. The number preceeding our comment refers to the item number in Warzyn's report.

A.1.b. We understand that since the preparation of the report, some detailed information regarding the existing sheet pile was received from the Corps of Engineers, Chicago District. However, the effects that the pile driving, dredging, and cofferdam installation and removal will have on the stability of the existing sheet pile walls will need to be addressed as part of the design process. The existing bulkheads should be as strong when the project is completed, as they are currently.

A.1.c. Our goal is to assure the public that the most highly contaminated material is removed for off-site disposal and that volatility is minimized. We feel that of the two alternatives presented, the first alternative (increased cofferdam size preceded by hydraulic dredging of loose sediments) is the better choice for this project. Dewatering of the entire slip would cause a large disruption of both commercial and recreational use of the harbor, and might also result in an increase in the volatilization of PCB's. Therefore, we are opposed to this idea. During the design phase, there are a number of items that need to be specifically addressed concerning the larger cofferdam.

1. The areas and volumes of materials to be hydraulically dredged need to be defined.

2. The effects that the increased cofferdam size (105' versus 85') will have on the sizes and numbers of piles necessary, the penetration depths of those piles, and the stability of the bulkheads need to be addressed. (See also A.1.b.).

3. Off shore precautions will still be necessary during truck loading.

A.2. We accept the comment regarding permeability of the clay liners and caps.

A.3. Our conceptual design does not intend to use the 1,500 gpm water treatment plant for the life of the project. A 1,500 gpm plant would be on-line during the actual dredging, while a 200 gpm plant could be utilized after dredging.

The U.S. EPA agrees that a mechanically assisted sludge dewatering system would be beneficial. Accelerated dewatering would reduce variability while speeding the project along. However, we do not feel that this should warrant a full blown value engineering review. We believe that this item should be part of the lagoon design development process.

A.4. The U.S. EPA is opposed to providing temporary boating facilities due to a possible inconsistency with the National Contingency Plan. Additionally, Larsen Marina has previously indicated that no alternative launching sites are available in the Waukegan area. The project should be designed to minimize any impacts on harbor usage.

B.3. The U.S. EPA agrees that the use of soil cement should be evaluated during design. Because this layer is merely serving as protection to the lower clay zone, it may prove to be more practical and feasible to use a granular material above the clay.

B.5. The U.S. EPA believes that existing technological reports should be fully utilized to investigate the suitability of the slurry material for the site. This item should be further evaluated during the design development process.

B.7. Performance criteria and monitoring for sediment control should be designed to assure that any impact on the Waukegan water supply would be detected. This includes

both the normal water intake and the emergency water intake. Monitoring data should be made available to the Lake County Health Department and Waukegan Water District, through the U.S. EPA Project Manager.

C All of the items listed in this section, though not specifically addressed by this VE review, need to be carefully evaluated during the design process. Of particular concern are items 5, 7, 11, 12, 13, 14, and 18.

We hope these comments are beneficial. If you have any comments or questions concerning these issues please contact me.

Sincerely,

Daniel M. Caplice

Daniel M. Caplice
Remedial Project Manager

cc: Jack Braun, 5HE-12

VALUE ENGINEERING REVIEW
HAZARDOUS WASTE CONTAINMENT/CLEANUP
OMC - WAUKEGAN HARBOR
WAUKEGAN, ILLINOIS

C 11837

F-6

WARZYN
ENGINEERING INC

Engineers & Scientists • Environmental • Geological • Civil • Structural • Geotechnical • Chemical/Materials Testing • Soil Borings • Surveying

1400 EMIL STREET, P.O. BOX 9636, MADISON, WIS. 53715 • TEL. (608) 257-4848 WIS. TOLL FREE NO. 800-362-6006

January 10, 1985
C 11837

Mr. Robert Smart
Omaha Corps of Engineers
6014 Post Office and Courthouse
Omaha, NE 68102

Re: Value Engineering Review

Dear Mr. Smart:

In accordance with our contract requirements, Appendix A, 6K, the required Value Engineering Review is attached for your review and consideration.

This Value Engineering Review has been accomplished by a specially formed team led by Mr. Bruce Weber, President of Warzyn Engineering Inc. The other team members are Mr. David Horsefield, Consulting Engineer, and Mr. Lawrence Andersen, Manager of Warzyn's Madison Division. This team represents many years of experience in engineering design and construction.

Four items have been recommended for Value Engineering study:

1. Cofferdam in Slip No. 3;
2. Permeability requirements for clay liners and caps;
3. Dewatering of sediment lagoons; and
4. Temporary boating facilities.

Prompt revision of the first of these items is needed to permit the design work to progress on schedule.

After your review, please contact me to discuss these matters.

Sincerely,

WARZYN ENGINEERING INC.

Thomas J. Lynch/las

Thomas J. Lynch, P.E.
Project Manager

TJL/las
[las-36-5]

C 11837

VALUE ENGINEERING REVIEW
HAZARDOUS WASTE CONTAINMENT/CLEANUP
OMC - WAUKEGAN HARBOR
WAUKEGAN, ILLINOIS

INTRODUCTION

The Value Engineering Review is based on the design concepts and criteria as presented in the Conceptual Design document of September 14, 1984 and the outline presented in Appendix A, dated August 21, 1984. Reference has also been made to various background data, principally the engineering study prepared by Mason & Hanger, dated January, 1981.

FORMAT

The following pages present potential items for Value Engineering consideration in three categories:

1. Items for which Value Engineering Study is recommended;
2. Items which were considered in some detail but for which further study is not recommended;
3. Items which were not considered in any significant detail.

SCOPE

The Value Engineering Review has studied parameteric data, criteria and methodology presented in the Conceptual Design document with a principal focus on:

1. Developing a more cost-effective design; and
2. Minimizing construction problems.

Specific details and cost estimates normally associated with a Value Engineering Study are beyond the scope of the current effort.

WARZYN ENGINEERING INC

To accomplish the review objectives, comments were solicited from members of the design team. Concurrently, an independent review was conducted by the Value Engineering Team. A meeting was then held to discuss all comments and formalize recommendations included in this report.

REVIEW FINDINGS

A. Recommended Items for Value Engineering Study

1. Construction of 85-Foot Diameter Cofferdam in Slip No. 3

Potential implementation and utilization problems exist with the proposed cofferdam concept, which lead the Value Engineering Review team to conclude that further study is warranted.

a. Sheet Pile Driving Problems

The concept calls for excavation five feet into the underlying clay glacial till. This would required an estimated ten feet of sheet pile penetration into the till.

Recent experience in driving piles into this same till stratum on the other side of the harbor entrance indicates that driving these sheet piles would be very difficult, expensive and probably impractical.

b. Stability of Existing Sheet Pile Bulkheads

No data is available to define the existing sheet pile walls. The sheet piles apparently extend into the sand layer above the glacial till but not into the till itself.

Lack of pile tip elevation information on the existing sheet piling makes it difficult to assess the affect of the proposed dredging on the stability of

the existing sheet piling. Furthermore, the effect of cofferdam installation on fill deposits behind the existing bulkhead has not been addressed, nor have the impacts of pile extraction on toe stability.

c. Clamshell Dredging of Sediments

The unconsolidated sediments consist of approximately 40% solids and 60% water. Clamshell dredging will dispense contaminated solids throughout the water in Slip No. 3 and will require an expensive cleanup operation to remove them. In addition, onshore-containment facilities will be required to control spillage during truck loading.

Alternatives to the 85-foot circular cofferdam are available which seem to warrant further study. These are:

1. The loose sediments could be hydraulically dredged before the cofferdam is constructed. The dredged material could be taken to Lagoon No. 1 for partial dewatering prior to fixing. Then the circular cofferdam could be made larger, about 105 feet in diameter so that the 85-foot diameter deep excavation could be safely made with nominal penetration of the sheet piles into the glacial till.

2. The existing sheet piles could be reinforced at the existing dredge line, either with a tremie-poured concrete apron or with short "stub" sheet piles, to sufficiently increase its strength so that it could be used as part of the cofferdam. Then, with a sheet pile closure across the slip and adequate shoring, the end of Slip No. 3 could be dewatered to below the sediment level. The highly contaminated material could be removed in the dry, possibly eliminating the need for fixation.

The Value Engineering team believes that either of these alternatives would be more practical to implementat and likely be less costly.

2. Permeability for Clay Liners and Caps

This requirement is attainable. However, the practical difference between 10^{-7} and 10^{-8} cm/sec is considered insignificant during the life of

temporary facilities and inconsistent with other aspects (i.e., slurry wall and base) of permanent containment areas. The more stringent requirements are expected to result in significant additional costs to secure suitable borrow materials and achieve specified compaction.

The Value Engineering team believes that this extra expenditure is not justified by existing documentation.

3. Dewatering of Sediment Lagoons

The proposed construction schedule anticipates approximately more than one year to dewater sediments in the lagoons and transport the materials to the containment area. This prolongs the project and necessitates continued operation of the 1,500-GPM water treatment plant. As a result of this schedule, cost escalation must be factored into the construction estimate, construction administration and testing costs increase, and greater contingencies are factored into contractor's bids.

The Value Engineering team believes that dewatering of the dredged spoil, some of which will be sand, can be accelerated by a combination of vacuum-assisted underdrains, water-ponding consolidation and conventional well point dewatering. Dewatering by means of electro-osmosis may also be feasible. This action is expected to affect a cost savings and significantly reduce the construction schedule.

4. Temporary Boating Facilities in Slip No. 3

The construction of temporary boat docks and boat launching facilities may prove impractical, due to lack of space, and not be very cost effective.

Temporary facilities would have to be located outside Slip No. 3 and/or the upper harbor area, which may not be feasible. The Value Engineering team believes this design parameter should be studied to determine the feasibility of providing other facilities on a short-term rental basis through the Port District.

B. Items Considered But Not Recommended for Value Engineering Study

1. Clay Lined Curing Cell

Is a curing cell really needed? Why not move the contaminated materials directly from the batch plant to transport? It was concluded that the curing cell is required to ensure stability of fixing and avoid spillage during transport.

2. Containment Cell with Clay Cap and Underdrain System

It would seem that the drain system could be replaced with a synthetic liner to better accomplish the purpose. It was concluded that this is a design development decision.

3. Lagoons with Soil Cement Liners

Is soil cement liner needed? Since excavation will contact liner only while lowest layer is being removed, a layer of gravel would seem ample. It was concluded that this is a design development decision.

4. Data on Extent of Contamination

Is sufficient data available? Many borings have been made, but limits of contamination are not exactly defined. It was concluded that sufficient data is available.

5. Is Bentonite Slurry Wall Suitable?

Based upon existng technology, it was concluded that the slurry wall is suitable.

6. Is 10^{-7} cm/sec Permeability Attainable with Slurry Wall?

It was concluded that this requirement is reasonable.

7. Will Sediment Control Device Work?

It was concluded that the sediment control device will limit but not entirely prevent sediment dispersion and that this is its intended purpose. Contract specifications will be developed to define performance criteria for monitoring.

C. Items Not Considered in Any Significant Detail

1. Suitability of braced excavation in crescent ditch.
2. Routing of by-pass sewer along north ditch.
3. Indicated rates of dredging and batching (1,500 yds/day).
4. Vehicle/equipment/personnel decontamination problems.
5. Effect of work on harbor use.
6. Effect of work on OMC plant operation.
7. Effect of work on local traffic.
8. Effect of dewatering neighboring structures and facilities.
9. Durability/suitability of soil cement liner in curing cells.
10. Adequacy of available space/alternative spaces.
11. Compatibility of slurry walls with PCB's.
12. What is the best fixing agent.
13. Are trucks the best means of transport.

14. Would a moveable batch plant be beneficial?

15. Is three compartments in the curing cell correct?

16. Are various quantities and rates correct?

17. Is the construction schedule correct?

18. What material will be used to control volitization?

Respectfully Submitted,

WARZYN ENGINEERING INC.

Bruce A. Weber, P.E.
Chairman, Value Engineering Review Team

TJL/BAW/las
[las-36-5]

WARZYN ENGINEERING INC

APPENDIX Q
UNRESOLVED ITEMS OR CRITERIA REQUIRED TO COMPLETE FINAL DESIGN

WARZYN
ENGINEERING INC

APPENDIX Q

UNRESOLVED ITEMS OR CRITERIA REQUIRED TO COMPLETE FINAL DESIGN

- - - -

A. SITE DATA

1. On-Site Survey

Needed to validate, fill in gaps and resolve discrepancies in existing site data.

2. Soil Borings and Laboratory Testing

Needed to provide basis for design of facilities for remedial activities, i.e., foundations, sheet pile walls, slurry walls, construction dewatering, etc.

B. DREDGING

1. Dredging Rates and Dredging Equipment

Further evaluation will be needed to establish specification requirements for dredging equipment and to more accurately predict dredging rates.

2. Dredge Spoil Drying Time

Further evaluation is needed to establish criteria for the required degree of dryness and to more accurately predict drying time.

C. WORK AREA BOUNDARIES:

Construction space requirements are shown on the concept drawings. A decision must be reached regarding the form in which legal occupancy of these spaces

will be realized, both for temporary uses for construction purposes and for permanent use as containment cells. Involved are the properties of Larsen Marine, National Gypsum and OMC.

D. TRAFFIC RESTRICTIONS

1. Boat and Ship Traffic

During dredging operations, boat and ship traffic will be restricted as follows:

a. During dredging in Slip 3, all traffic in Slip 3 will be suspended. This will extend from approximately March 1, 1986 to July 1, 1986. This will have a substantial impact on the Larsen Marine operation.

b. During dredging in the inner harbor, waterborne traffic will be restricted to craft able to negotiate the labyrinth through the dispersion control device. This will extend from approximately July 1 to September 1, 1986. This will have some impact on the Larsen Marine operation. It will preclude the use of the inner harbor by large ships thereby impacting National Gypsum and Falcon Marine.

Binding agreements will be needed with the effected parties and with the Port District

2. Street Traffic

The heavy truck traffic associated with transport of materials to off-site disposal and between on-site areas will severely impact local traffic in the area; particularly the flow of employee traffic to and from the OMC plant. Positive traffic control, lights and/or flagmen, will be needed at the truck entry and crossing points on Sea Horse Drive.

Agreement with the City will be needed to effect these controls.

E. LOCATION OF OFF-SITE LANDFILL

The shipping distance to off-site disposal is a very significant cost element. The Concept estimate has been based on shipping to the CECOS site in southern Ohio. This assumption must be either validated or revised.

F. OMC PLANT WATER INTAKE

During dredging activities in Slip No. 3 and in the inner harbor, a replacement must be provided for the water supply to the OMC plant now taken from Slip No. 3. Three alternatives have been investigated; taking water from a nearby City watermain and providing a temporary piped supply from Slip No. 1, either pumped or gravity flow.

To evaluate these alternatives, there are several problems which must be addressed:

1. This design effort is outside the scope of the design contract. A contract change order is needed.

2. Design criteria and data are needed from OMC:

   a. Size, type of material, condition, location and elevation of existing intake structure and piping.

   b. Details of water use and distribution system; water use, daily and monthly peak and average flows; pressure requirements; details of the internal pumping and piping system.

G. NORTH DITCH BY-PASS SEWER

The north ditch by-pass sewer will carry water coming from an existing 36-inch culvert at the northwest corner of the OMC plant building and will pick up drainage from the plant roofs and from the yard areas north of the plant. Completion of the design of this sewer will require the development of some additional information and the further assessment of some factors.

1. The source of flow into the existing 36-inch culvert has not been defined nor has its detail of construction.

2. The portion of the plant roof area contributing to this sewer has not been defined.

3. The health hazards associated with laying the pipe in the north ditch in a partially submerged condition in contaminated water have not been completely assessed.

H. UTILITIES

1. Relocations

Initial contacts have been made with Commonwealth Edison Co. and with North Shore Gas Company. Both of these companies have existing utility lines which cross the proposed containment cells and will have to be relocated. Final arrangements will have to be made for performance of the relocations and payment for them and for appropriate rearrangement of the necessary easements on OMC property.

2. Service

a. Electric power services will be required at three locations: the end of Slip No. 3, the lagoon area, and the north ditch area. Arrangements will be made with Commonwealth Edison Co. to provide this service.

b. Clean water supply will be needed for the decontamination stations, laboratories and offices. Arrangements will be made to provide this from City water supply.

I. TRANSPORT

Whether or not manifesting will be required for trucks carrying contaminated materials the short distance on Sea Horse Drive between work areas is not yet resolved.

J. WATER TREATMENT PLANTS

1. Effluent Quality

Criteria is established at 1 PPB for PCB content in effluent. No other effluent quality requirements have yet been established.

2. Chemical Feed Rates

Conflicting requirements are given in the project data base for alum and polymer dosages.

Source	Alum	Polymer
M & H, 10/80	45 PPM	15 PPM
CH2M HILL, 8/83	800 PPM	40 PPM

This disparity has yet to be resolved.

K. LAGOON LINER SYSTEM

1. Synthetic Liner

Use of a multi-liner, synthetic liner system in lieu of the double clay layer system offers potential of superior quality at lower cost. This will be further investigated during final design.

2. Protective Cover for Liner

Use of a granular blanket in lieu of the soil-cement layer for protection of the liner offers potential for significant cost savings. This will be further investigated during final design.

L. GROUNDWATER MONITORING

Monitoring of groundwater for PCB content is to be performed. No other parameters have been specified as yet.

M. CONTAINMENT AREA SECURITY

Removal of construction fencing from around the two containment areas has not been decided upon. Limitations on access to and use of these areas have not been established. Marking/posting of boundaries has not been addressed.

N. LAGOON AREA: EXISTING CONTAMINATION

Existing borings in the lagoon area (old foundry area) clearly show the presence of foreign materials in the samples. Apparently, no attempt has been made to identify these materials.

O. POST-DREDGING/EXCAVATING SAMPLING

The SSQMP calls for sampling to be taken after dredging and excavation and for the samples to be tested for PCB content. No criteria has been established for action and no action has been determined.

TJL/las
[OMC-2-1]

WARZYN ENGINEERING INC

APPENDIX R
LIST OF SPECIFICATIONS

WARZYN
ENGINEERING INC

CORP OF ENGINEERS
MASTER LIST OF SPECIFICATIONS

OMC HAZARDOUS WASTE
CONTAINMENT/CLEANUP
WAUKEGAN, ILLINOIS

C 11837

DIVISION 1

GENERAL REQUIREMENTS

1A	SPECIAL CLAUSES
1B	WARRANTY OF CONSTRUCTION (Standard form will be inserted by the Corps when specifications are assembled.)
1C	ENVIRONMENT PROTECTION
1D	SPECIAL SAFETY REQUIREMENTS

DIVISION 2

SITE WORK

02050	DEMOLITION
02072	REMOVAL AND DISPOSITION OF MATERIAL AND EQUIPMENT FROM EXISTING BUILDINGS
CEGS-02100	CLEARING AND GRUBBING
CEGS-02201	EXCAVATION, FILLING AND BACKFILLING FOR UTILITIES SYSTEMS
02210	GRADING
CEGS-02221	EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS
CE-807.02	SUBBASE COURSE
CE-02696	STABILIZED-AGGREGATE BASE COURSE
OD 807.08	GRANULAR FILTER COURSE
CEGS-02360	STEEL H-PILES
CEGS-02363	CAST-IN-PLACE CONCRETE PILES, STEEL CASING (Pipe piles, without concrete)
02410	SUBDRAINAGE SYSTEM
02501	STORM-DRAINAGE SYSTEM
OD-02440	TRAFFIC SIGNS
OD-806.09	BARBED-WIRE AND WOVEN-WIRE FENCE AND GATES

CEGS-02444	CHAIN LINK SECURITY FENCE AND GATES
CE-2631	CONCRETE [SIDEWALKS,][STRAIGHT CURB,] [CURB AND GUTTER][AND ENTRANCES]
02475	SODDING
02480	SEEDING
0D-806.11	PRECAST CONCRETE WHEEL STOPS
0D-806.12	BUMPER AND GUARD POSTS
807.12	BITUMINOUS INTERMEDIATE AND SURFACE COURSES (Central-Plant-Hot-Mix)
02558	BITUMINOUS TACK COAT
02559	BITUMINOUS PRIME COAT
CE-820	PAVEMENT MARKINGS, ROADS AND PARKING AREAS
CEGS-02711	GAS DISTRIBUTION SYSTEM
02713	WATER LINES
CEGS-15302	SEWER; SANITARY, GRAVITY
02724	FORCE MAINS; SEWER
CEGS-02850	RAILROADS

DIVISION 3

CONCRETE

CEGS-03300	CONCRETE FOR BUILDING CONSTRUCTION
CEGS-03301	CONCRETE FOR BUILDING CONSTRUCTION (Minor Requirements)
03303	CONCRETE (Abbreviated)

DIVISION 5

METALS

CEGS-05120	STRUCTURAL STEEL
05500	MISCELLANEOUS METAL

DIVISION 6

WOOD AND PLASTICS

06100	ROUGH CARPENTRY

DIVISION 9

FINISHES

09910	PAINTING, GENERAL

DIVISION 11

EQUIPMENT

CE-504.01	PUMPS; WATER, CENTRIFUGAL
11303	GUIDE MOUNTED SEWAGE LIFT STATION
11310	PUMPS; SEWAGE AND SLUDGE
CEGS-11375	AIR-SUPPLY AND AIR-DIFFUSION EQUIPMENT FOR SEWAGE TREATMENT PLANTS

DIVISION 13

SPECIAL CONSTRUCTION

CE-505	ELEVATED STEEL WATER TANKS
CE-506	STEEL STANDPIPES AND GROUND STORAGE RESERVOIRS
13600	METAL BUILDINGS

DIVISION 15

MECHANICAL

OD-15047	IDENTIFICATION OF PIPING

DIVISION 16

ELECTRICAL

16401	ELECTRICAL DISTRIBUTION SYSTEM, AERIAL
16402	ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND
16415	ELECTRICAL WORK, INTERIOR

WARZYN ENGINEERING INC.
LIST OF SPECIFICATIONS

OMC HAZARDOUS WASTE
CONTAINMENT/CLEANUP
WAUKEGAN, ILLINOIS

C 11837

DIVISION 1

GENERAL CONDITIONS AND SUPPLEMENTARY CONDITIONS

01010	SUMMARY OF WORK
01011	CONTRACTS
01017	CONTRACTOR USE OF PREMISES
01018	PARTIAL OWNER OCCUPANCY
01019	PHYSICAL CONDITIONS
01031	GRADES, LINES, LEVELS
01050	COORDINATION
01070	CUTTING AND PATCHING
01090	ABBREVIATIONS, SYMBOLS AND DEFINITIONS
01100	ALTERNATIVES
01200	PROJECT MEETINGS
01310	CONSTRUCTION SCHEDULE
01340	SHOP DRAWINGS, PRODUCT DATA AND SAMPLES
01370	SCHEDULE OF VALUES
01400	QUALITY CONTROL
01500	TEMPORARY FACILITIES AND CONTROLS
01710	CLEANING
01720	PROJECT RECORD DOCUMENTS
	WARRANTY AND GUARANTEE

DIVISION 2

SITE WORK

DREDGING

GROUNDWATER MONITORING WELLS

- Installation
- Abandonment

SOIL-BENTONITE SLURRY WALL

PRESSURE VENTS

AIR MONITORING STATIONS

SHEETPILES

TIEBACKS

SYNTHETIC MEMBRANE

GEOTEXTILE

OFF-SITE DISPOSAL

RIPRAP

TRENCHING, BACKFILL AND COMPACTION

DONOHUE & ASSOCIATES INC.
LIST OF SPECIFICATIONS

OMC HAZARDOUS WASTE
CONTAINMENT/CLEANUP
WAUKEGAN, ILLINOIS

C 11837

DIVISION 1

GENERAL REQUIREMENTS

AA0	01000	GENERAL PROVISIONS (Civil)
DM3	01000A	GENERAL PROVISIONS (Illinois)
AA1	01010	SUMMARY OF WORK
AA5	01041	PROJECT COORDINATION
AA7	01050	FIELD ENGINEERING (Civil)
AA8	01060	REGULATORY REQUIREMENTS (Civil)
AB2	01300	SUBMITTALS (Civil)
AB3	01310	CONSTRUCTION PROGRESS SCHEDULES
AB9	01410	TESTING LABORATORY SERVICES
AC0	01500	TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS
AC1	01500A	CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS (Single Contract)
AC2	01560	PROTECTION OF THE ENVIRONMENT
AC7	01656B	DISINFECTION OF POTABLE WATER MAINS (Civil)
AC9	01663A	TESTING SEWER SYSTEMS (Civil)
AD2	01669	TESTING PIPING SYSTEMS
AD3	01669A	HYDROSTATIC TESTS FOR PRESSURE MAINS (Civil, Generic)
AD4	01710	CLEANING

DIVISION 2

SITE WORK

AE2	02220	STRUCTURE EXCAVATION AND BACKFILLING
DH4	02221	TRENCHING, BACKFILLING, AND COMPACTING
DM7	02221B	TRENCHING, BACKFILLING, AND COMPACTING (Illinois)
AE3	02271	RIPRAP
DNO	02601B	MANHOLES, INLETS, AND CATCH BASINS (Illinois)
AF7	02612	REINFORCED CONCRETE PIPE
AGO	02618	CORRUGATED METAL PIPE (Civil)
AG1	02622	PLASTIC SEWER PIPE
AG3	02700	GENERAL UTILITY SYSTEMS (Wisconsin, Standard Specification)
DN1	02713	WATER SYSTEMS (Illinois)
DN2	02722A	GRAVITY SEWER PIPES (Illinois)

DIVISION 5

METALS

AJ8	05500	METAL FABRICATIONS

DIVISION 6

WOOD AND PLASTICS

AK5	06520	WEIRS, SCUM BAFFLES, AND TROUGHS

DIVISION 9

FINISHES

AN1	09900	PAINTING, STAINING, AND COATINGS

DIVISION 11

EQUIPMENT

AQ3	11310	PUMPS
AQ4	11311	CENTRIFUGAL PUMP
ARO	11317	PORTABLE SEWAGE PUMPING EQUIPMENT (Submersible)
DJ9	11317A	SUBMERSIBLE PUMPING EQUIPMENT
AR2	11319	PORTABLE SEWAGE PUMPING EQUIPMENT
AS1	11336	SAND FILTRATION EQUIPMENT
AS2	11352	POLYMER MIXING AND STORAGE EQUIPMENT
AS3	11353	CHEMICAL MIXING EQUIPMENT
AT6	11372	AIR COMPRESSOR EQUIPMENT
AX3	11600	LABORATORY EQUIPMENT AND SUPPLIES

ADDITIONAL SPECIFICATIONS SECTIONS TO BE DEVELOPED FOR WHICH NO DONOHUE STANDARD EXISTS:

1. HOPPER
2. TRUCK TRANSPORT - ON/OFF SITE
3. "BATCH" PLANT - FIXATION PROCESS
4. CRANE - DRAGLINE
5. MOBIL HOME - TEMPORARY OFFICE, WORK AREA, ETC.
6. SOLIDS - PUMP
7. PORTABLE STEAM CLEANER
8. CARBON ABSORBTION SYSTEM/EQUIPMENT
9. OIL SKIMMING EQUIPMENT
10. DECONTAMINATION PROCEDURES

DIVISION 13

SPECIAL CONSTRUCTION

AZ2	13621	SAMPLING EQUIPMENT
AZ3	13622	AIR FLOW MONITORING SYSTEM
AZ4	13623	FLOW METER (Magnetic)
BA5	13690	PACKAGE SYSTEM I&C PANELS

DIVISION 15

MECHANICAL

BC6	15065	FIBERGLASS REINFORCED PLASTIC PIPE
BQ6	15067	ALUMINUM PIPE
BC9	15072	WELDED STEEL PIPE
BD2	15076	HOSE, NOZZLES, NON-METALLIC TUBING, AND QUICK-CONNECT COUPLINGS
BD3	15090	PIPE HANGERS, SUPPORTS, AND ANCHORS
BD4	15092	WALL PIPES, SLEEVES, AND SEALS
DA1	15100	VALVES
BD6	15103	BUTTERFLY VALVES
BE0	15111	CHECK VALVES
BE1	15117	ECCENTRIC PLUG VALVES
BE4	15121	PRESSURE REGULATING VALVES
BE5	15122	PRESSURE RELIEF VALVES
BE6	15126	AIR RELIEF VALVE
BF1	15311	COMPRESSED AIR PIPING SYSTEM
BF4	15341	CHEMICAL WASTE DRAINAGE SYSTEM
BF5	15370	PROCESS PIPING SYSTEMS

DIVISION 16

ELECTRICAL

BI6	16100	BASIC MATERIALS AND METHODS (Used for Small Projects, Includes Most 16100 Series Sections)
BL8	16480	MOTOR CONTROL CENTER (MCC)
BO5	16930	INSTRUMENT AND CONTROL PANEL CONSTRUCTION
BO6	16931	MINIATURE ELECTRONIC PANEL INSTRUMENTS
BP2	16937	ELECTRONIC CIRCULAR CHART RECORDER