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FINAL
REMEDIAL INVESTIGATION REPORT
FOR THE
BAIER SITE AND McCARL SITE
LEE COUNTY, IOWA

JANUARY 16, 1991

Prepared For:

E.I. du Pont de Nemours & Company
Wilmington, Delaware 19898

VOLUME 3 OF 3

PREPARED BY:

WOODWARD-CLYDE CONSULTANTS
5055 ANTIOCH ROAD
OVERLAND PARK, KANSAS 66203

WCC PROJECT NUMBER 89C75831

APPENDIX E

XRF RAW FIELD DATA

BY JKH DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET CALIBRATION SHEET NO 1 OF 5

[illegible]

BY	DATE 5/7	PROJECT NAME DuPont RI/FS	PROJECT NUMBER 89C7583-1
CHKD. BY	DATE	SUBJECT X-MET CALIBRATION	SHEET NO 2 OF 5

[illegible] DEPENDENTS: [illegible]

1. [illegible] PB: [illegible]

[illegible]

REGRESSION FOR PB

DEFINE INDEPENDENTS:

1. indep: [illegible]

2. indep: [illegible]

3. indep: [illegible]

4. indep: [illegible]

BY [illegible] DATE 5/7 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C 7583-1

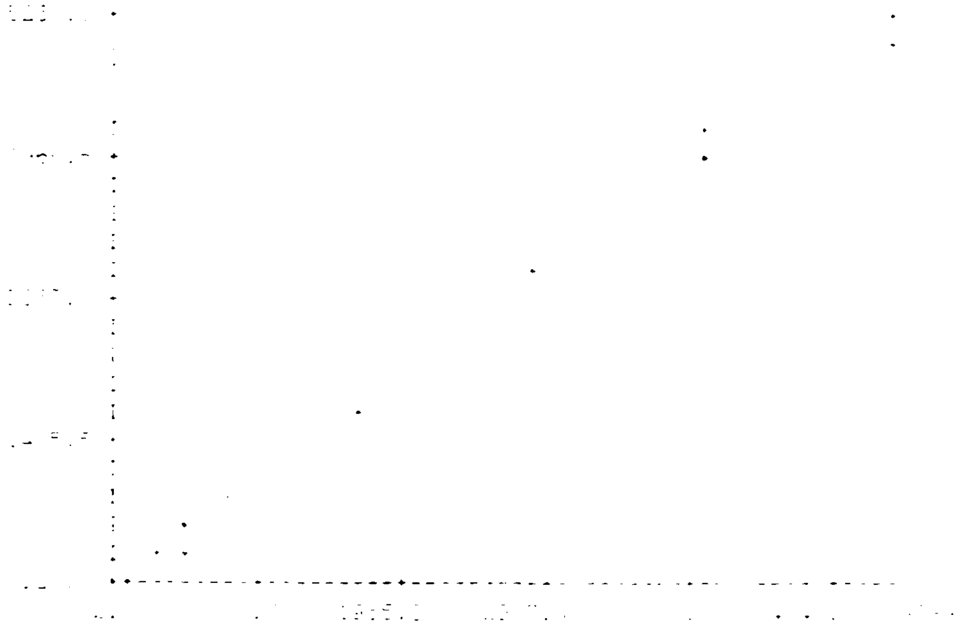
CHKD. BY ______ DATE ______ SUBJECT X-MET CALIBRATION SHEET NO 3 OF 5

[illegible]

BY DATE 5/7 PROJECT NAME DUPONT RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET CALIBRATION SHEET NO 4 OF 5

```
[illegible]

[illegible]
REGRESSION FOR Fe
DEFINE INDEPENDENT...
[illegible] input [illegible]
[illegible] FE*PH

[illegible]
---------------------------------------

RES [illegible]
[illegible]
[illegible]
DELETE POINTS [illegible]

[illegible]
---------------------------------------

RES[illegible]
[illegible]
[illegible]

CALIBRATION PLOT
  RATIO
```



```
DELETE [illegible]
 [illegible]
[illegible]
[illegible]
```

BY DATE 5/7 PROJECT NAME DUPONT RI/FS PROJECT NUMBER 89C 7583 - 1

CHKD. BY ______ DATE ______ SUBJECT X-MET CALIBRATION SHEET NO 5 OF 5

[illegible]

BY JRB DATE 5/7/90 PROJECT NAME DUPONT RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEASUREMENTS SHEET NO 1 OF ______

---

1 [illegible]

[illegible]

[illegible] B-57-2

[illegible]

2 B-B6-1

[illegible]

[illegible] B-B6-1

[illegible]

3 [illegible]

[illegible]

~~PB 189.1~~ 189.1 JRB 5/7/90 B-57-3

[illegible]

BY [illegible] DATE 5/7/90 PROJECT NAME DUPONT RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 2 OF ______

```
[illegible]
[illegible] PROBE [illegible] TYPE [illegible]
[illegible]
ASSAYS:PB [illegible]
```

4 B-57-1 [illegible]

```
INT
CHANNEL INTENSITIES:
[illegible]

CHANNEL INTENSITIES: [illegible]
[illegible]
[illegible]
```

```
[illegible]
[illegible] PROBE [illegible] TYPE [illegible] PB
[illegible]
ASSAYS:PB [illegible]
```

5 B-J2-2 [illegible]

```
[illegible]
CHANNEL INTENSITIES
[illegible]

CHANNEL INTENSITIES: [illegible]
[illegible]    PB    [illegible]    FE
[illegible]
```

```
[illegible]
[illegible] PROBE [illegible] TYPE [illegible]
[illegible]
ASSAYS:PB ....
```

6 BK3-1 [illegible]

```
INT
CHANNEL INTENSITIES:
[illegible]

CHANNEL INTENSITIES: [illegible]
[illegible]    PB    [illegible]    FE
[illegible]

STA
[illegible]
[illegible] PROBE [illegible]
[illegible]
RD'S :PB-?.100

[illegible]
```

BY DATE 5/7/90 PROJECT NAME DUPONT RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 3 OF ______

[illegible]

6' ASSAYS:PB [illegible] B-K3-1

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

5' [illegible] B J2-2

[illegible]

[illegible]

7 [illegible] B-A4-2

[illegible]

CHANNEL INTENSITIES. MODEL 7: DUPONT [illegible]

[illegible]

8 ASSAYS:PB [illegible] B-R5-1

[illegible]

BY DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 4 OF ____

```
 MODEL 1: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASUREMENT PARAMS TYPE [illegible]
10 SECONDS
7'  ASSAYS:PB 113.4

 INT
SITE [illegible]     B-A4-2

 INT
CHANNEL INTENSITIES:
[illegible]

CHANNEL INTENSITIES:   MODEL 1: DUPONT [illegible]
 [illegible]
[illegible]


 MODEL 1: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASUREMENT PARAMS TYPE [illegible]
10 SECONDS
9   ASSAYS:PB 52.[illegible]   B-J2-1

 INT
CHANNEL INTENSITIES:
[illegible]

CHANNEL INTENSITIES:   MODEL 1: DUPONT [illegible]
 [illegible]
[illegible]


 MODEL 1: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASUREMENT PARAMS TYPE [illegible]
10 SECONDS
10  ASSAYS:PB 4.[illegible]   B-P3-1

 INT
CHANNEL INTENSITIES:
[illegible]

CHANNEL INTENSITIES:   MODEL 1: DUPONT [illegible]
 [illegible]
[illegible]


 MODEL 1: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASUREMENT PARAMS TYPE [illegible]
10 SECONDS
11  ASSAYS:PB [illegible]   B-T9-2
```

BY DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 5 OF ______

STA

[illegible]
MEASURING PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
[illegible] PB [illegible]

ASSAYS:PB 347.3

MEASURING TIME [illegible]

MODEL [illegible]
MEASURING PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
12 ASSAYS:PB [illegible] B-N2-3

[illegible]
CHANNEL INTENSITIES:
[illegible]

CHANNEL INTENSITIES: MODEL [illegible]
[illegible] PB [illegible] FE
[illegible]

MODEL [illegible]
MEASURING PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
13 ASSAYS:PB [illegible] B-A4-3

[illegible]
CHANNEL INTENSITIES:
[illegible]

CHANNEL INTENSITIES: MODEL 7: DUPONT #
[illegible] PB [illegible] FE
[illegible]

MODEL [illegible]
MEASURING PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
14 ASSAYS:PB [illegible] B-K2-2

[illegible]
CHANNEL INTENSITIES:
[illegible]

BY ____ DATE 5/7/90 PROJECT NAME DUPONT RI/FS PROJECT NUMBER 89C 7583-

CHKD. BY ____ DATE ____ SUBJECT X-MET FIELD MEAS. SHEET NO 6 OF ____

```
[illegible]
MEASURING: PROBE [illegible]
[illegible]
15 ASSAYS:FE 210.6  B-C2-3

[illegible]
CHANNEL INTENSITIES
[illegible]

CHANNEL INTENSITIES [illegible]
[illegible]
[illegible]


[illegible]
MEASURING: PROBE [illegible]
[illegible]
16 ASSAYS:FE [illegible]  BE2-1

[illegible]
CHANNEL INTENSITIES
[illegible]

CHANNEL INTENSITIES [illegible]
[illegible]
[illegible]


[illegible]
MEASURING: PROBE [illegible] TYPE [illegible]
[illegible]
17 ASSAYS:FE [illegible]  B-T10-1

[illegible]
CHANNEL INTENSITIES
[illegible]

CHANNEL INTENSITIES [illegible]
[illegible]
[illegible]


[illegible]
MEASURING: PROBE [illegible] TYPE [illegible]
[illegible]
18 ASSAYS:FE 252.-  B-P3-2

[illegible]
[illegible]
[illegible]  Fe : 543.0146
P3  [illegible] 7 82a
R [illegible]
```

BY [illegible] DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 7 OF ______

```
MODEL 7: DUPONT [illegible]    DATE: [illegible]    TIME: [illegible]
MEASURING: PROBE 1 TYPE [illegible]
10 SECONDS
ASSAYS:PB 214.7
```

19 B-36-2

```
 INT
CHANNEL INTENSITIES:
[illegible]

CHANNEL INTENSITIES:   MODEL 7: DUPONT [illegible]
  [illegible]     FE      [illegible]      PB
  [illegible]
```

```
MODEL 7: DUPONT [illegible]    DATE: [illegible]    TIME: [illegible]
MEASURING: PROBE 1 TYPE [illegible]
10 SECONDS
ASSAYS:PB 211.1
```

20 B-58-1

```
 INT
CHANNEL INTENSITIES:
[illegible]

CHANNEL INTENSITIES:   MODEL 7: DUPONT [illegible]
  [illegible]     FE      SE      PB
  [illegible]
```

```
MODEL 7: DUPONT [illegible]    DATE: [illegible]    TIME: [illegible]
MEASURING: PROBE 1 TYPE [illegible]
10 SECONDS
ASSAYS:PB [illegible]
```

21 B-58-7

```
 INT
CHANNEL INTENSITIES:
[illegible]

CHANNEL INTENSITIES:   MODEL 7: DUPONT [illegible]
  [illegible]     FE      SE      PB
  [illegible]
```

```
MODEL 7: DUPONT [illegible]    DATE: [illegible]    TIME: [illegible]
MEASURING: PROBE 1 TYPE [illegible]
10 SECONDS
ASSAYS:PB [illegible]
```

22 B-I3-1

```
 INT
CHANNEL INTENSITIES:

CHANNEL INTENSITIES:   MODEL 7: DUPONT [illegible]
  [illegible]     FE      SE      PB
  [illegible]
```

BY DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 8 OF ______

[illegible]
MEASURE
MEASURE
MEASURING PROBE [illegible]
[illegible] SECONDS
[illegible]

MEASURING TIME [illegible]

MEASURING TIME [illegible]

MODEL [illegible]
MEASURING PROBE [illegible]
[illegible] SECONDS
23 ASSAY:PB [illegible] B-Q3-2

[illegible]
CHANNEL INTENSITIES
[illegible]

CHANNEL INTENSITIES: [illegible]
[illegible]
[illegible]

MODEL [illegible]
MEASURING PROBE [illegible]
[illegible] SECONDS
24 ASSAY:PB [illegible] B-K2-1

[illegible]
CHANNEL INTENSITIES
[illegible]

CHANNEL INTENSITIES: [illegible]
[illegible]
[illegible]

MODEL [illegible]
MEASURING PROBE [illegible]
[illegible] SECONDS
25 ASSAY:PB [illegible] B-L2-3

CHANNEL INTENSITIES: [illegible]
[illegible]
[illegible]

600

BY [illegible] DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 9 OF ______

```
[illegible]
[illegible]
[illegible]
ASSAYS:PB 209.5
[illegible]
CHANNEL INTENSITIES:
[illegible]
[illegible]
[illegible]
[illegible]
```

26 B-C7-2

```
[illegible]
[illegible]
[illegible]
ASSAYS:PB [illegible]
[illegible]
CHANNEL INTENSITIES:
[illegible]
CHANNEL INTENSITIES:   MODEL [illegible] DUPONT [illegible]
[illegible]
[illegible]
```

27 B-Q3-1

```
[illegible]
[illegible]
[illegible]
ASSAYS:PB [illegible]
[illegible]
CHANNEL INTENSITIES:
CHANNEL INTENSITIES:   MODEL [illegible] DUPONT [illegible]
[illegible]
[illegible]
```

28 B-C8-1

```
[illegible]
[illegible]
[illegible]
ASSAYS:PB [illegible]
[illegible]
CHANNEL INTENSITIES:   MODEL [illegible] DUPONT [illegible]
[illegible]
[illegible]
```

29 B-D9-3

BY DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 10 OF ______

MODEL 7: DUPONT [illegible] TIME: [illegible]
MEASURING: PROBE [illegible] TYPE [illegible]
120 SECONDS
30 ASSAYS:PB [illegible] B-A4-1
[illegible]

CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
[illegible]

MODEL 7: DUPONT [illegible] TIME: [illegible]
MEASURING: PROBE [illegible]
[illegible] SECONDS
31 ASSAYS:PB [illegible] B-R4-3
[illegible]
CHANNEL INTENSITIES:
[illegible]

CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
CR PB BS FE
[illegible]

MODEL 7: DUPONT [illegible] TIME: [illegible]
MEASURING: PROBE [illegible]
[illegible] SECONDS
32 ASSAYS:PB [illegible] B-D9-1

CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
CR PB BS FE
[illegible]

MODEL 7: DUPONT [illegible] TIME: [illegible]
MEASURING: PROBE [illegible]
[illegible] SECONDS
33 ASSAYS:PB 240.0 B-D9-2

CHANNEL INTENSITIES: MODEL 7: DUPONT WCC
CR PB BS FE
-17.33 -7.914 848.2 549.6

DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C 7583-1

CHKD. BY ______ DATE ______ SUBJECT XMET FIELD MEAS. SHEET NO 11 OF ____

```
    (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 21-50-44
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
34  ASSAYS:PB 128.7  B-F2-1

    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
       CR      PB      BS      FE
     -9.654 -10.23  988.6  291.5

    MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 21-54-30
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
35  ASSAYS:PB 258.5  B-C8-3
    >

    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
       CR      PB      BS      FE
     -13.54 -9.362  341.1  592.7

    (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 21-58-16
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
36  ASSAYS:PB 181.7  B-B2-1

    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
       CR      PB      BS      FE
     -10.44 -5.259  905.2  232.2

    CHANNEL INTENSITIES:

    (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 22-01-12
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
37  ASSAYS:PB 231.0  B-R5-3

    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
       CR      PB      BS      FE
     -16.11 -2.342  642.2  644.8

    (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 22-03-57
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
38  ASSAYS:PB 178.2  B-H2-2

    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
       CR      PB      BS      FE
     -14.18 -12.57  896.5  409.6
```

BY	DATE 5/7/90	PROJECT NAME DuPont RI/FS	PROJECT NUMBER 89-C-7583-1
CHKD. BY	DATE	SUBJECT X-MET FIELD MEAS	SHEET NO 12 OF

```
 MODEL 7: DUPONT WCC   DATE: 07.05.90  TIME: 22-07-09
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
39 ASSAYS:PB 214.5  B-B2-3

CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
   CR      PB      BS      FE
 -15.43 -8.465  871.0  401.9


 MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 22-10-51
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
40 ASSAYS:PB 267.3  B D2-2

CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
   CR      PB      BS      FE
 -19.36 -9.909  854.3  579.9

(MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 22-14-08
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
41 ASSAYS:PB 250.5  B-B6-2


CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC)
   CR      PB      BS      FE
 -13.26 -7.750  842.4  560.7

(MODEL 7: DUPONT WCC   DATE: 07.05.90  TIME: 22-17-20
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
42 ASSAYS:PB 124.0  B-A2-1

CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
   CR      PB      BS      FE
 -10.22 -11.72  885.0  312.7

 MODEL 7: DUPONT WCC   DATE: 07.05.90  TIME: 22-20-25
MEASURING: PROBE 6 TYPE DOPS (A
120 SECONDS
43 ASSAYS:PB [illegible]  B-A3-3

CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
   CR      PB      BS      FE
 [illegible]
```

DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C 7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 13 OF ______

[illegible]

[illegible]

ASSAYS:PB [illegible]

[illegible]

44 ASSAYS:PB [illegible] B-A2-2

CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]

[illegible]

45 ASSAYS:PB [illegible] B-F10-2

CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]

[illegible]

46 [illegible] B-F2-3

CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]

CR PB BS FE

[illegible]

MODEL 7: DUPONT WCC DATE: [illegible]

MEASURING: PROBE 1 TYPE [illegible]

47 ASSAYS:PB [illegible] B-A3-1

CHANNEL INTENSITIES: MODEL 7: [illegible]

CR PB BS FE

[illegible]

MODEL 7: DUPONT WCC DATE: [illegible]

MEASURING: PROBE 1 TYPE [illegible]

[illegible] SECONDS

48 ASSAYS:PB ~~308.0~~ 308.0 B-A2-3

CHANNEL INTENSITIES: MODEL 7: DUPONT WCC

```
  CR       PB       BS       FE
-22.36  -10.36   361.9    720.9
P
```

BY [illegible] DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C 7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 14 OF _____

```
    MEASURING TIME 200
    (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 22-59-27
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
49  ASSAYS:PB 262.0   B-C7-3

    CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC)
       CR      PB      BS      FE
     -19.12 -8.107  836.1   573.0

    (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-02-14
    MEASURING: PROBE 6 TYPE DOPS  A)
    120 SECONDS
50  ASSAYS:PB 233.0   B-F2-2
    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
       CR      PB      BS      FE
     -17.20  -9.365   877.8   548.9
    (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-05-36
    MEASURING: PROBE 6 TYPE DOPS  A)
    60 SECONDS
A1  ASSAYS:PB 140.7

    (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-07-00
    MEASURING: PROBE 6 TYPE DOPS (A)
    60 SECONDS
A2  ASSAYS:PB 196.7

    (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-08-22
    MEASURING: PROBE 6 TYPE DOPS (A)
    60 SECONDS
A3  ASSAYS:PB 309.7
    (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-09-39
    MEASURING: PROBE 6 TYPE DOPS (A)
    60 SECONDS
A4  ASSAYS:PB 493.0

    (MODEL 7: DUPONT WCC   DATE: 07.05.90  TIME: 23-10-54
    MEASURING: PROBE 6 TYPE DOPS (A)
    60 SECONDS
A5  ASSAYS:PB 824.5
    (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-12-15
    MEASURING: PROBE 6 TYPE DOPS (A)
    60 SECONDS
A6  ASSAYS:PB  1015

    (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-13-38
    MEASURING: PROBE 6 TYPE DOPS  A)
    60 SECONDS
A7  ASSAYS:PB  1819
    (MODEL 7: DUPONT WCC   DATE: 07.05.90  TIME: 23-14-57
    MEASURING: PROBE 6 TYPE DOPS (A)
    60 SECONDS
A8  ASSAYS:PB  2988
```

x22p

BY DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 15 OF ____

```
     (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-19-46
     MEASURING: PROBE 6 TYPE DOPS (A)
     60 SECONDS
3A9  ASSAYS:PB  4267
     (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-21-34
     MEASURING: PROBE 6 TYPE DOPS (A)
     60 SECONDS
3A10 ASSAYS:PB  4425
     / STD
     STDEVS:PB 352.3
     (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-27-21
     MEASURING: PROBE 6 TYPE DOPS (A)
     120 SECONDS
51   ASSAYS:PB 223.6   B-E2-2

     CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
        CR      PB      BS      FE
      -15.96 -9.011  954.6  558.4
     (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-31-22
     MEASURING: PROBE 6 TYPE DOPS (A)
     120 SECONDS
52   ASSAYS:PB 170.0   B-T9-3

     CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
        CR      PB      BS      FE
      -13.41 -11.21  904.2  514.6

     (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-34-38
     MEASURING: PROBE 6 TYPE DOPS (A)
     120 SECONDS
53   ASSAYS:PB 257.8   B-C3-2
     CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
        CR      PB      BS      FE
     (-19.37 -8.115  368.3  603.4
     (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-36-44
     MEASURING: PROBE 6 TYPE DOPS (A)
     120 SECONDS
54   ASSAYS:PB 144.5   B-C7-1
     CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
        CR      PB      BS      FE
     (-9.874 -9.327  871.7  345.1
     (MODEL 7: DUPONT WCC)  DATE: 07.05.90  TIME: 23-39-39
     MEASURING: PROBE 6 TYPE DOPS (A)
     120 SECONDS
55   ASSAYS:PB 93.23   B-L2-1

     CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
        CR      PB      BS      FE
      -8.979 -12.34  900.8  255.7
```

BY ~~[illegible]~~ DATE 5/7/90 PROJECT NAME DUPONT RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 16 OF ______

```
   (MODEL 7: DUPONT WCC) DATE: 07.05.90 TIME: 23-41-07
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
56 ASSAYS:PB 275.7  B-A5-2

   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
      CR      PB      BS      FE
    -11.46  5.510  875.0  456.1

   (MODEL 7: DUPONT WCC) DATE: 07.05.90 TIME: 23-43-56
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
57 ASSAYS:PB 269.0  B-D2-3

   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
      CR      PB      BS      FE
    -20.71 -7.802  875.9  765.6

   (MODEL 7: DUPONT WCC) DATE: 07.05.90 TIME: 23-48-38
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
58 ASSAYS:PB 231.0  B-A5-3
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
      CR      PB      BS      FE
    -16.29 -1.941  855.7  372.1
   (MODEL 7: DUPONT WCC) DATE: 07.05.90 TIME: 23-51-14
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
59 ASSAYS:PB 111.5  B-D2-1
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
      CR      PB      BS      FE
    -9.114 -10.35  921.3  227.9
   (MODEL 7: DUPONT WCC) DATE: 07.05.90 TIME: 23-54-10
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
60 ASSAYS:PB 131.5  B-T9-1
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
      CR      PB      BS      FE
    -10.62 -11.39  890.2  348.1
   (MODEL 7: DUPONT WCC) DATE: 07.05.90 TIME: 23-57-06
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
61 ASSAYS:PB 79.76  B-H2-1

   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
      CR      PB      BS      FE
    -7.800 -11.83  903.1  290.6

   (MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 00-00-17
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
62 ASSAYS:PB 282.7  B-Q3-3

   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
      CR      PB      BS      FE
    -20.68 -9.371  850.4  619.2
```

BY GRP DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 17 OF ____

```
   (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 00-03-45
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
63 ASSAYS:PB 180.3   B-L2-2
   CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC
      CR      PB      BS      FE
   ,-12.83 -9.639  367.4  381.4
   (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 00-06-19
   MEASURING: PROBE 6 TYPE DOPS (A)
64 120 SECONDS            — 149.1 GRP   B-T10-2
   ASSAYS:PB
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
      CR      PB      BS      FE
   ,-11.22 -10.55  382.0  378.3
   (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 00-09-38
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
65 ASSAYS:PB 222.2   B-C2-2
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
      CR      PB      BS      FE
   ,-15.60 -4.898  375.0  524.6
   (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 00-11-48
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
66 ASSAYS:PB 220.2  B-M2-1
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
      CR      PB      BS      FE
    -5.556 -0.788  880.3  300.6
   (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 00-18-01
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
67 ASSAYS:PB 240.4  B-E2-3
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
      CR      PB      BS      FE
   ,-17.66 -9.961  873.4  678.5
   (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 00-32-05
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
68 ASSAYS:PB ~~1514  B-N2-4~~
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
      CR      PB      BS      FE
   , 2.473  48.11  347.8  310.5
   (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 00-35-37
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
69 ASSAYS:PB 403.5   B-S6-1
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
      CR      PB      BS      FE
    -6.969  12.72  355.7  291.8
```

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BY [signature] DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 18 OF ____

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    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
69' ASSAYS:PB 396.1  B-56-1

    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
       CR      PB      BS      FE
     -7.323  12.20  357.8  292.4
    (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 00-41-56
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
70  ASSAYS:PB 821.6  B-A5-1

    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
       CR      PB      BS      FE
     -7.784  44.06  861.0  289.2
    (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 00-45-08
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
70' ASSAYS:PB 822.7  B-A5-1
    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
       CR      PB      BS      FE
     -STA18  -1.56  867.1  283.2
    MEASURE
    MEASURING: PROBE 6 TYPE DOPS (A)
    200 SECONDS
    RD'S :PB-21888

    ASSAYS:PB 307.6
     STAND
    STDEVS:PB 10.93

    (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 00-55-26
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
71  ASSAYS:PB 174.4   B M2-2
    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
       CR      PB      BS      FE
     -12.32 -9.286  873.4  396.7

    (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 00-58-17
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
72  ASSAYS:PB 213.2   B-A3-2
    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
       CR      PB      BS      FE
     -14.34 -5.435  367.3  432.0

    (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 01-00-56
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
73  ASSAYS:PB 253.7  B-02-2
    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
       CR      PB      BS      FE
     -18.74 -4.870  875.0  597.1
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BY DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY _______ DATE _________ SUBJECT X-MET FIELD MEAS SHEET NO 19 OF _____

~~MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 01-04-46~~

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   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
74 ASSAYS:PB 199.5  B-R4-7
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
      CR      PB      BS      FE
   -16.24 -9.771  670.4   372.4
   (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 01-07-54
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
75 ASSAYS:PB 180.3   B-02-1
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
      CR      PB      BS      FE
   -3.736 -2.925  877.5   306.5
   (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 01-12-59
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
76 ASSAYS:PB 235.5   B-J2-3
   CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC
      CR      PB      BS      FE
   -16.84 -7.268  343.8   612.3
   MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 01-15-51
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
77 ASSAYS:PB 251.4   B-02-3
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
      CR      PB      BS      FE
   -18.13 -7.302  325.2   557.2
   (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 01-18-31
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
78 ASSAYS:PB 255.9  B-T10-3
   CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC
      CR      PB      BS      FE
   -18.70 -3.940  354.4   632.9
   (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 01-21-07
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
79 ASSAYS:PB 226.1  B-S6-3
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
      CR      PB      BS      FE
   -15.75 -5.529  346.8   545.4
   (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 01-23-49
   MEASURING: PROBE 6 TYPE DOPS (A)
   120 SECONDS
80 ASSAYS:PB 171.9   B-R4-1
   CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
      CR      PB      BS      FE
   -7.370 -4.479  396.9   295.3
```

BY DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 20 OF ____

~~MEASURING: PROBE 6 TYPE DOPS (A)~~
120 SECONDS
81 ASSAYS:PB 204.9 B-G2-1

CHANNEL INTENSITIES: (MODEL 7: DUPONT WCC
CR PB BS FE
-15.26 -11.02 879.7 359.6
(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 01-29-23
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
82 ASSAYS:PB 228.8 B-B6-3
CHANNEL INTENSITIES: (MODEL 7: DUPONT WCC)
CR PB BS FE
-16.37 -9.734 878.4 581.3

(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 01-31-36
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
83 ~~ASSAYS:PB 942.9 B-R5-2~~

CHANNEL INTENSITIES: MODEL 7: DUPONT WCC)
CR PB BS FE
-3.130 34.88 904.0 372.4
MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 01-34-48
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
83 ~~ASSAYS:PB 884.3 B-R5-2~~

CHANNEL INTENSITIES: (MODEL 7: DUPONT WCC)
CR PB BS FE
-4.715 36.10 894.2 374.7

MODEL 7: DUPONT WCC DATE: 08.05.90 TIME: 01-38-03
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
84 ASSAYS:PB 237.3 B-M2-3

CHANNEL INTENSITIES: (MODEL 7: DUPONT WCC)
CR PB BS FE
-17.18 -8.958 857.9 539.9

(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 01-40-37
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
85 ASSAYS:PB 91.67 B-H3-1
CHANNEL INTENSITIES: (MODEL 7: DUPONT WCC)
CR PB BS FE
-6.351 -11.73 896.1 285.3

(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 01-43-15
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
86 ASSAYS:PB 227.6 B-G2-3

Cr Pb BS Fe
-16.34 -9.75 855.79 606.5

BY DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1
CHKD. BY ______ DATE ________ SUBJECT X-MET FIELD MEAS SHEET NO 21 OF ____

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 MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 01-47-45
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
87 ASSAYS:PB 238.4   B-G2-2
CHANNEL INTENSITIES:  MODEL 7: DUPONT WCC
   CR      PB      BS      FE
 -17.02 -9.538  847.0  568.0
(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 01-51-21
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
88 ASSAYS:PB 206.3   B-H3-2
CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
   CR      PB      BS      FE
 -15.00 -11.02  376.7  393.7
(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 01-53-54
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
89 ASSAYS:PB 230.3   B-H2-3
CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
   CR      PB      BS      FE
 -16.59 -9.061  858.1  543.2

(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 01-56-36
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
90 ASSAYS:PB 207.4  B-I3-2
CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
   CR      PB      BS      FE
 -14.79 -9.121  863.3  437.2

> STA
MEASURE
MEASURING: PROBE 6 TYPE DOPS (A)
200 SECONDS
RD'S :PB 1.005
(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 02-03-27
MEASURING: PROBE 6 TYPE DOPS (A)
200 SECONDS
91 ASSAYS:PB 283.7  B-I3-3
CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
   CR      PB      BS      FE
 -23.40 -5.306  818.7  368.8
(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 02-07-30
MEASURING: PROBE 6 TYPE DOPS (A)
200 SECONDS
92 ASSAYS:PB 225.4B-H3-3
CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
   CR      PB      BS      FE
 -16.45 -10.52  868.9  483.8
```

BY ______ DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C 7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 22 OF ______

MODEL 7: DUPONT WCC DATE: 08.05.90 TIME: 02-12-23
~~MEASURING: PROBE 6 TYPE DOPS (A)~~
200 SECONDS
93 ASSAYS:PB 160.2 B-K2-3
CHANNEL INTENSITIES: (MODEL 7: DUPONT WCC)
CR PB BS FE
-12.11 -11.12 873.8 314.5

(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 02-16-26
MEASURING: PROBE 6 TYPE DOPS (A)
200 SECONDS
94 ASSAYS:PB 155.9 B-N2-2

CHANNEL INTENSITIES: MODEL 7: DUPONT WCC
CR PB BS FE
-8.971 -7.122 874.5 293.0

(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 02-20-34
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
95 ASSAYS:PB 213.8 B-P3-3
WHAT?
CHANNEL INTENSITIES: MODEL 7: DUPONT WCC
CR PB BS FE
-15.16 -8.806 857.7 624.9
~~MODEL 7: DUPONT WCC DATE: 08.05.90 TIME: 02-23-47~~
~~MEASURING: PROBE 6 TYPE DOPS (A)~~
~~[illegible] SECONDS~~
~~ASSAYS:PB 228.9~~
(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 02-24-26
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
96 ASSAYS:PB 240.6 B-S8-3

CHANNEL INTENSITIES: (MODEL 7: DUPONT WCC
CR PB BS FE
-17.61 -5.826 843.8 627.5

(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 02-27-17
MEASURING: PROBE 6 TYPE DOPS (A)
~~120 SECONDS~~
97 ~~ASSAYS:PB 1130~~ [illegible]
CHANNEL INTENSITIES: (MODEL 7: DUPONT WCC
CR PB BS FE
-2.364 45.28 833.1 295.2

(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 02-29-59
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
97L ~~ASSAYS:PB 1152~~ M-J4-1
CHANNEL INTENSITIES: (MODEL 7: DUPONT WCC
CR PB BS FE
-1.357 43.93 826.4 290.8

WHAT?

DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C 7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 23 OF ______

```
     (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 02-33-31
     MEASURING: PROBE 6 TYPE DOPS (A)
     120 SECONDS
98   ASSAYS:PB 118.5   M-B12-1
     CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC)
        CR      PB      BS      FE
     -4.865 -6.965  882.0  270.5
     (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 02-36-30
     MEASURING: PROBE 6 TYPE DOPS (A)
     120 SECONDS
99   ASSAYS:PB 245.5   M-B12-3
     CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC
        CR      PB      BS      FE
     -17.46 -7.033  819.8  341.3
     (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 02-39-12
     MEASURING: PROBE 6 TYPE DOPS (A)
     120 SECONDS
50   ASSAYS:PB 254.2   M-L6-2
     CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC
        CR      PB      BS      FE
     --19.33 -5.799  825.3  772.1
     (MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 02-42-07
     MEASURING: PROBE 6 TYPE DOPS (A)
     120 SECONDS
     MEASUREMENT INTERRUPTED
     TRY AGAIN?
3A1  ASSAYS:PB 179.5
     (STD
     STDEVS:PB 16.83
     (MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 02-44-12
     MEASURING: PROBE 6 TYPE DOPS (A)
     60 SECONDS
3A2  ASSAYS:PB 195.7
     (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 02-45-50
     MEASURING: PROBE 6 TYPE DOPS (A)
     60 SECONDS
3A3  ASSAYS:PB 378.1
     (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 02-47-07
     MEASURING: PROBE 6 TYPE DOPS (A)
     60 SECONDS
3A4  ASSAYS:PB 589.2
     (MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 02-48-24
     MEASURING: PROBE 6 TYPE DOPS (A)
     60 SECONDS
3A5  ASSAYS:PB 979.9
     (MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 02-49-54
     MEASURING: PROBE 6 TYPE DOPS (A)
     60 SECONDS
3A6  ASSAYS:PB  1161
     (MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 02-51-10
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BY DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1
CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD RESULTS SHEET NO. 24 OF ______

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~~MEASURING: PROBE 6 TYPE DOPS (A)~~
60 SECONDS
QA7 ASSAYS:PB  1726

(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 02-52-54
MEASURING: PROBE 6 TYPE DOPS (A)
60 SECONDS
QA8 ASSAYS:PB  3087
(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 02-54-12
MEASURING: PROBE 6 TYPE DOPS (A)
60 SECONDS
QA9 ASSAYS:PB  4423

(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 02-55-30
MEASURING: PROBE 6 TYPE DOPS (A)
60 SECONDS
QA10 ASSAYS:PB  5751
(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 02-56-50
MEASURING: PROBE 6 TYPE DOPS (A)
60 SECONDS
101 ASSAYS:PB 122.9      M-B12-2

CHANNEL INTENSITIES:   (MODEL 7: DUPONT WCC)
   CR      PB      BS      FE
 -7.726 -9.286  854.1  380.8
(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 02-59-16
MEASURING: PROBE 6 TYPE DOPS (A)
60 SECONDS
102 ASSAYS:PB 230.0  M-B11-3

CHANNEL INTENSITIES:   (MODEL 7: DUPONT WCC)
   CR      PB      BS      FE
 -15.50 -6.679  805.5  515.4
(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 03-02-22
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
103 ASSAYS:PB 292.1   M-I5-1
CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
   CR      PB      BS      FE
 -6.043  4.042  868.1  272.2
(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 03-05-38
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
104 ASSAYS:PB 0.000   M-L10-1      NOTE: SAMPLE MOIST!

CHANNEL INTENSITIES:   (MODEL 7: DUPONT WCC)
   CR      PB      BS      FE
 -5.173 -14.47  916.7  238.5

(MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 03-08-21
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
105 ASSAYS:PB 216.9   M-K4-3

CHANNEL INTENSITIES:   (MODEL 7: DUPONT WCC)
   CR      PB      BS      FE
 -14.91 -6.987  847.1  605.5
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BY ______ DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 25 OF ______

```
     MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 03-11-27
     MEASURING: PROBE 6 TYPE DOPS  A
     120 SECONDS
106  ASSEYS:PB 284.2 ~~CR     PB     BS     FE~~   284.2   M-E6-3
      -10.33  12.56  322.1  334.2

     CR:
     CHANNEL INTENSITIES:
     MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 03-14-32
     MEASURING: PROBE 6 TYPE DOPS  A
     120 SECONDS
107  ASSAYS:PB 114.0  M-B13-1

     CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC
        CR     PB     BS     FE
      -9.764 -11.65  395.5  221.8
     MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 03-17-21
     MEASURING: PROBE 6 TYPE DOPS  A
     120 SECONDS
108  ASSAYS:PB 107.9  M-K4-2

     CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC
        CR     PB     BS     FE
      -9.291 -9.545  360.8  318.0

     MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 03-19-54
     MEASURING: PROBE 6 TYPE DOPS  A
     120 SECONDS
109  ASSAYS:PB 205.0  M-L9-3
     CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC
        CR     PB     BS     FE
      -14.37 -8.704  355.7  464.6
     MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 03-22-46
     MEASURING: PROBE 6 TYPE DOPS  A
     120 SECONDS
110  ASSAYS:PB 210.8  M-G5-3

     CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC
        CR     PB     BS     FE
      -14.00 -7.291  340.7  479.2

     MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 03-25-30
     MEASURING: PROBE 6 TYPE DOPS  A
111  120 SECONDS
     ASSAYS:PB 219.4     M-J4-2
     CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC
        CR     PB     BS     FE
      -13.34 -8.045  349.5  479.2
```

BY ______ DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1
CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 26 OF ______

```
    (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 03-29-30
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
112 ASSAYS:PB 209.9   M-D13-2

    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
       CR      PB      BS      FE
     -14.52 -6.315  869.2  576.1

    (MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 03-31-07
    MEASURING: PROBE 6 TYPE DOPS (A
    120 SECONDS
113 ASSAYS:PB 170.4   M-D6-3
    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
       CR      PB      BS      FE
     -7.301 -5.227  331.0  576.4

    (MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 03-34-58
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
114 ASSAYS:PB 160.7   M-I5-2

    CHANNEL INTENSITIES:   MODEL 7: DUPONT WCC)
       CR      PB      BS      FE
     -10.40 -8.601  855.9  258.6

    (MODEL 7: DUPONT WCC   DATE: 08.05.90  TIME: 03-38-12
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
115 ASSAYS:PB 150.3   M-L4-2

    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
       CR      PB      BS      FE
     -9.187 -8.216  357.5  352.3

    (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 03-41-38
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
116 ASSAYS:PB 216.5   M-F6-1

    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC
       CR      PB      BS      FE
     -8.289 -1.437  347.6  250.7

    (MODEL 7: DUPONT WCC)  DATE: 08.05.90  TIME: 03-44-55
    MEASURING: PROBE 6 TYPE DOPS (A)
    120 SECONDS
117 ASSAYS:PB 212.2     M-H5-3

    CHANNEL INTENSITIES:  (MODEL 7: DUPONT WCC)
       CR      PB      BS      FE
     -12.77 -4.500  322.4  606.5
```

BY [illegible] DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C 7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 27 OF ____

~~(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: [illegible]~~
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
118 ASSAYS:PB 402.5 M-E6-1

CHANNEL INTENSITIES: (MODEL 7: DUPONT WCC)
CR PB BS FE
-6.537 12.80 827.3 336.5

(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 03-50-45
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
119 ASSAYS:PB 223.9 M-J4-3

CHANNEL INTENSITIES: (MODEL 7: DUPONT WCC)
CR PB BS FE
-15.38 -5.585 342.5 557.7

(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: 03-53-30
MEASURING: PROBE 6 TYPE DOPS (A)
120 SECONDS
120 ASSAYS:PB 225.1 M-D13-3 (outside 3σ - see 120') [illegible] 5/8/90
CHANNEL INTENSITIES: MODEL 7: DUPONT WCC
CR PB BS FE
-14.30 -3.494 309.0 626.3
/ STA
MEASURE
MEASURING: PROBE 6 TYPE DOPS (A)
200 SECONDS
RD'S :PB 3.897

"GAIN" Register at 129 [illegible]
(NOT STABLE)

ASSAYS:PB 309.2

~~(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: [illegible]~~ - [illegible] 5/7/90
~~MEASURING: PROBE 6 TYPE DOPS (A)~~ [illegible] 5/7/90
~~120 SECONDS~~ [illegible] 5/7/90
120' ~~ASSAYS:PB 164.9 M-D13-3~~ [illegible] 5/7/90
~~STD~~ [illegible] 5/7/90
~~STDEVS:PB 3.900~~ [illegible] 5/7/90
~~(MODEL 7: DUPONT WCC) DATE: 08.05.90 TIME: [illegible]~~ [illegible] 5/7/90
~~MEASURING: PROBE 6 TYPE DOPS (A)~~ [illegible] 5/7/90
~~120 SECONDS~~ [illegible] 5/7/90
119' ~~ASSAYS:PB 147.2 M-J4-3~~ [illegible] 5/7/90
/ PRP
PROBE NUMBER: 6
STD
GAIN PARAMETERS
STDEVS:PB 7.586 — 7.586 ~~(Standard Deviation for sample 119')~~ [illegible] 5/7/90

Channel A low limit: 91
Channel A high limit: 101
Channel B low limit: 80
Channel B high limit: 90
TD : -0.0268
Slope: 298.25

BY ____ DATE 5/7/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ____ DATE ____ SUBJECT X-MET FIELD MEAS. SHEET NO 28 OF ____

~~Gain: 131 ?~~

NORMALIZATION PARAMETERS ?
PROBE PARAMETERS ?

~~WHAT?~~ 5/7/90
~~WHAT?~~ 5/7/90
~~3.8P~~ 5/7/90
~~WHAT?~~ 5/7/90

5 min GAIN CONTROL PERIOD 5/7/90
(GAIN STABLE)

PRP
PROBE NUMBER: 6 ?
GAIN PARAMETERS ?

Channel A low limit: [illegible]
Channel A high limit: 101 ?
Channel B low limit: 30 ?
Channel B high limit: 40 ?
T0 : -0.02684 ?
Slope: 298.25 ?
Gain: 131 ?

NORMALIZATION PARAMETERS ?
PROBE PARAMETERS ?

~~WHAT?~~ 5/7/90

STA 5/7/90 8:15 PM (Restandardized with stable gain)
MEASURE
MEASURING: PROBE 6 TYPE DCPS (A)
200 SECONDS
RD'S :PB-3.112

~~ASSAYS:PB 339.2~~ 5/7/90

ASSAYS:PB 339.2

~~WHAT?~~ 5/7/90

STA 5/8/90 7:20 AM
MEASURE
MEASURING: PROBE [illegible] TYPE DCPS A
200 SECONDS
RD'S :PB [illegible]

DP

BY JRP DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 29 OF ______

MODEL [illegible] DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
119' ASSAYS:PB [illegible] M-J4-3
STDEVS:PB [illegible]

CHANNEL INTENSITIES: MODEL [illegible] DUPONT [illegible]
[illegible]

MODEL [illegible] DUPONT [illegible] DATE: [illegible]
MEASURING PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
120' ASSAYS:PB [illegible] M-D13-3

CHANNEL INTENSITIES: MODEL [illegible] DUPONT [illegible]
[illegible]

MODEL [illegible] DUPONT [illegible] DATE: [illegible]
MEASURING PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
21 ASSAYS:PB [illegible] M-L4-3

CHANNEL INTENSITIES: MODEL [illegible] DUPONT [illegible]
[illegible]

MODEL [illegible] DUPONT [illegible] DATE: [illegible]
MEASURING PROBE [illegible] TYPE [illegible]
10 SECONDS
122 ASSAYS:PB [illegible] M-D6-2

CHANNEL INTENSITIES: MODEL [illegible] DUPONT [illegible]
[illegible]

MODEL [illegible] DUPONT [illegible] DATE: [illegible]
MEASURING PROBE [illegible] TYPE [illegible]
10 SECONDS
123 ASSAYS:PB [illegible] M-F6-2

CHANNEL INTENSITIES: MODEL [illegible] DUPONT [illegible]
[illegible]

MODEL [illegible] DUPONT [illegible] DATE: [illegible]
MEASURING PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
124 ASSAYS:PB 55.3 M-C7-1 (Sample moist) JRP 5/7/90
CHANNEL INTENSITIES: MODEL [illegible] DUPONT [illegible]
[illegible]

MODEL [illegible] DUPONT [illegible] DATE: [illegible]
MEASURING PROBE [illegible] TYPE [illegible]

BY DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 30 OF ______

125 [illegible] M-L7-3

[illegible]

126 [illegible] M-L7-1

[illegible]

127 [illegible] S-F10-3

[illegible]

128 ~127.4 B-F10-1 5/8/90

[illegible]

129 [illegible] M-K4-1

[illegible]

130 [illegible] M-B11-2 (SLIGHTLY MOIST) 5/8/90

[illegible]

131 [illegible] M-G13-3

[illegible]

BY ________ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ________ DATE ________ SUBJECT X-MET FIELD MEAS. SHEET NO. 31 OF ________

132 [illegible] M-E6-2

[illegible]

133 [illegible] M-C7-2

[illegible]

134 [illegible] M-G5-2

[illegible]

135 [illegible] M-L7-2

[illegible]

136 [illegible] B-B2-2

[illegible] FE

[illegible]

137 [illegible] B-C2-1

[illegible]

Dep

BY [illegible] DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 32 OF ______

[illegible]

138 [illegible] B-L2-1 (see #55)

[illegible]

139 [illegible] 225.4 M-H5-1

[illegible]

140 [illegible] 1553 m-F13-2

[illegible]

141 [illegible] m-I5-3

[illegible]

[illegible] parameters:

[illegible]

5 min GAIN CONTROL INTERVAL (GAIN STABLE)

[illegible]

DQ

BY [illegible] DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C 7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 33 OF ______

[illegible]

[illegible]

142 [illegible]:PB [illegible] M-H13-1 (Sample moist) 5/8/90

[illegible]

143 [illegible]:PB [illegible] M-L8-3

[illegible]

144 [illegible]:PB 157.2 M-G13-1

[illegible] INTENSITIES:

[illegible]

145 [illegible]:PB [illegible] M-L4-1

[illegible]

146 [illegible]:PB [illegible] M-G5-1

[illegible] INTENSITIES:

[illegible]

BY DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 34 OF ______

```
 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
147 ASSAY8:PB [illegible]  M-I13-3

CHANNEL INTENSITIES:  MODEL 7: DUPONT [illegible]
   CR      PB      BR      FE
 [illegible]

 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
148 ASSAY8:PB [illegible]  M-D6-1

CHANNEL INTENSITIES:  MODEL 7: DUPONT [illegible]
   CR      PB      BR      FE
 [illegible]

 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
149 ASSAY8:PB [illegible]  m-C13-2
CHANNEL INTENSITIES:  MODEL 7: DUPONT [illegible]
   CR      PB      BR      FE
 [illegible]

 MODEL 7: DUPONT NO.  DATE: 05.08.90  TIME: [illegible]
MEASURING: PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
150 ASSAY8:PB [illegible]  M-C13-1

CHANNEL INTENSITIES:  MODEL 7: DUPONT [illegible]
   CR      PB      BR      FE
 [illegible]

 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
151 ASSAY8:PB [illegible]  m-L9-1

CHANNEL INTENSITIES:  MODEL 7: DUPONT [illegible]
   CR      PB      BR      FE
 [illegible]

 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
152 ASSAY8:PB [illegible]  M-L11-3

CHANNEL INTENSITIES:  MODEL 7: DUPONT [illegible]
   CR      PB      BR      FE
 [illegible]
```

BY SLP DATE 5/8/92 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 35 OF ____

```
 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DIRT [illegible]
60 SECONDS
```
QA 1
```
ASSAY:PB 172.3
 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DIRT [illegible]
60 SECONDS
```
QA2
```
ASSAY:PB [illegible]
 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DIRT [illegible]
60 SECONDS
```
QA3
```
ASSAY:PB [illegible]
 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DIRT [illegible]
60 SECONDS
```
QA4
```
ASSAY:PB [illegible]
 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DIRT [illegible]
60 SECONDS
```
AA5
```
ASSAY:PB 470.4
 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DIRT [illegible]
60 SECONDS
```
QA6
```
ASSAY:PB 1259
 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DIRT [illegible]
60 SECONDS
```
QA7
```
ASSAY:PB 1861
 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DIRT [illegible]
60 SECONDS
```
QA8
```
ASSAY:PB 2205
 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DIRT [illegible]
60 SECONDS
```
QA9
```
ASSAY:PB [illegible]
 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DIRT [illegible]
60 SECONDS
```
QA10
```
ASSAY:PB [illegible]
 MODEL 7: DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DIRT [illegible]
60 SECONDS
```
153
```
ASSAY:PB [illegible]
```
M. H5-2
```
 [illegible]  MODEL 7: DUPONT [illegible]
 [illegible]
 [illegible]
```

WOODWARD-CLYDE CONSULTANTS

DAA

BY [illegible] DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C 7583 - 1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 36 OF ______

[illegible]

154 [illegible] M-J12-3

[illegible]

155 [illegible] M-B7-2

[illegible]

156 [illegible] M-J12-1

[illegible]

157 [illegible] M-L8-1

[illegible]

158 [illegible] M-B11-1

[illegible]

159 [illegible] M-B13-3

[illegible]

BY [illegible] DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 37 OF ______

[illegible]

160 [illegible]:FB [illegible] M-H13-3

[illegible]

160' [illegible]:FB [illegible] M-H13-3

[illegible]

5 MIN GAIN CONTROL
(STABLE)

[illegible]

161 [illegible]:FB [illegible] M-I13-2

[illegible]

161' [illegible]:FE [illegible] M-I13-2

DATE 5/3/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 38 OF ______

```
MODEL 7: DUPONT W..  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DUPO..
10 SECONDS
ASSAYS:PB [illegible]     M-B13-2

CHANNEL INTENSITIES:  MODEL 7: DUPONT W..
  CR      FE      BG      PB
  [illegible]
```

162

```
MODEL 7: DUPONT W..  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DUPO..
10 SECONDS
ASSAYS:PB 105.[illegible]     M-F6-3

CHANNEL INTENSITIES:  MODEL 7: DUPONT W..
  CR      FE      BG      PB
  [illegible]
```

163

```
MODEL 7: DUPONT W..  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DUPO..
10 SECONDS
ASSAYS:PB [illegible]     M-C13-3
CHANNEL INTENSITIES:  MODEL 7: DUPONT W..
  CR      FE      BG      PB
  [illegible]
```

164

```
MODEL 7: DUPONT W..  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DUPO..
10 SECONDS
ASSAYS:PB [illegible]     m-L10-2
CHANNEL INTENSITIES:  MODEL 7: DUPONT W..
  CR      FE      BG      PB
  [illegible]
```

165

```
MODEL 7: DUPONT W..  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DUPO..
10 SECONDS
ASSAYS:PB [illegible]     m-F13-1   (MOIST)
CHANNEL INTENSITIES:  MODEL 7: DUPONT W..
  CR      FE      BG      PB
  [illegible]
```

166

```
MODEL 7: DUPONT W..  DATE: [illegible]  TIME: [illegible]
MEASURING: PROBE 1 TYPE DUPO..
10 SECONDS
ASSAYS:PB [illegible]     M-E13-3 (MOIST)
CHANNEL INTENSITIES:  MODEL 7: DUPONT W..
  CR      FE      BG      PB
  [illegible]
```

167

BY	DATE 5/8/90	PROJECT NAME DuPont RI/FS	PROJECT NUMBER 89C7583-1
CHKD. BY	DATE	SUBJECT X-MET FIELD MEAS.	SHEET NO 39 OF

[illegible]

168 [illegible] M-L9-2

[illegible]

169 [illegible] M-L11-2

[illegible]

170 [illegible] 5/8/90

[illegible]

170' [illegible] PB 807 M-IB-1

[illegible]

5MIN GAIN CONTRO
(STABLE)

DLP

BY ~~DLP~~ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 40 OF ______

```
MEASURE
MEASURING PROBE : TYPE DIPS -
ID : [illegible]
ASSAYS:PB [illegible]

ASSAYS:PB [illegible]
STD
[illegible]

MODEL 1: DUPONT ALL   DATE: [illegible]   TIME: [illegible]
MEASURING PROBE : TYPE DIPS -
ID : [illegible]
```

171 ASSAYS:PB [illegible] M-L6-1

```
CHANNEL INTENSITIES:   MODEL 1: DUPONT ALL
  SR      PB      BS      FE
[illegible]

MODEL 1: DUPONT ALL   DATE: [illegible]   TIME: [illegible]
MEASURING PROBE : TYPE DIPS -
ID : [illegible]
```

172 ASSAYS:PB [illegible] M-E13-2

```
CHANNEL INTENSITIES:   MODEL 1: DUPONT ALL
  SR      PB      BS      FE
[illegible]

MODEL 1: DUPONT ALL   DATE: [illegible]   TIME: [illegible]
MEASURING PROBE : TYPE DIPS -
ID : [illegible]
```

173 ASSAYS:PB [illegible] M-J12-2

```
CHANNEL INTENSITIES:   MODEL 1: DUPONT ALL
  SR      PB      BS      FE
[illegible]
MODEL 1: DUPONT ALL   DATE: [illegible]   TIME: [illegible]
MEASURING PROBE : TYPE DIPS -
ID : [illegible]
```

174 ASSAYS:PB [illegible] M-C7-3

```
CHANNEL INTENSITIES:   MODEL 1: DUPONT ALL
  SR      PB      BS      FE
[illegible]

MODEL 1: DUPONT ALL   DATE: [illegible]   TIME: [illegible]
MEASURING PROBE : TYPE DIPS -
ID : [illegible]
```

175 ASSAYS:PB [illegible] M-G13-2

```
CHANNEL INTENSITIES:   MODEL 1: DUPONT ALL
  SR      PB      BS      FE
[illegible]

MODEL 1: DUPONT ALL   DATE: [illegible]   TIME: [illegible]
MEASURING PROBE : TYPE DIPS -
ID : [illegible]
```

176 ASSAYS:PB [illegible] M-B10-1

BY [illegible] DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 41 OF ____

177 [illegible] PB 144.3 M-B9-3

178 [illegible] PB [illegible] M-D13-1

179 [illegible] M-L8-2

180 [illegible] FE [illegible] M-B10-2

181 [illegible] FE [illegible] M-B7-3

182 [illegible] FE [illegible] M-B8-2

Dep

BY ______ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 42 OF ______

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133 [illegible] M-L10-3

134 [illegible] M-L6-3

135 [illegible] M-B7-1

136 [illegible] M-B10-3

137 [illegible] PB [illegible] M-L5-2

138 [illegible] PB [illegible] M-F13-3

BY ~~[illegible]~~ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 43 OF ______

[illegible] [illegible] M-B8-1

[illegible] [illegible] M-LS-1

[illegible] [illegible] M-LS-1

12:15 PM

12:20 PM

1:00 PM

1:05 PM

BY ________ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ________ DATE ________ SUBJECT X-MET FIELD MEAS SHEET NO 44 OF ____

[illegible]

MODEL [illegible] DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
191 [illegible] FB [illegible] M - H13-2

[illegible]

MODEL [illegible]
MEASURING PROBE [illegible]
[illegible] SECONDS
192 [illegible]:FB 127.5 M - B9 - 1

CHANNEL INTENSITIES [illegible] MODEL [illegible] DUPONT [illegible]

MODEL [illegible]
MEASURING PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
193 [illegible]:FB [illegible] M - B8 - 3

CHANNEL INTENSITIES [illegible] MODEL [illegible]

MODEL [illegible]
MEASURING PROBE [illegible]
[illegible] SECONDS
194 [illegible]:FB [illegible] M - L11 - 1

CHANNEL INTENSITIES [illegible] MODEL [illegible]

MODEL [illegible] DUPONT [illegible]
MEASURING PROBE [illegible]
[illegible] SECONDS
195 ASSAYS:FB [illegible] M - B9 - 2
CHANNEL INTENSITIES [illegible]

MODEL [illegible] DATE: [illegible]
MEASURING PROBE [illegible] TYPE [illegible]
[illegible] SECONDS
196 ASSAYS:FB [illegible] B - B3 - 1
CHANNEL INTENSITIES [illegible] MODEL [illegible] DUPONT [illegible]

BY ~~[illegible]~~ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD RESULTS SHEET NO 45 OF ____

197 [illegible] B-B3-2

198 [illegible] B-B3-3

5/8/90

5/8/90

5/8/90

5/8/90

199 S:FE 614.1 B-C3-1

201 AYS:FE 663.2 B-C3-1

200 AYS:PB 2.5.7 B-C3-2

BY ________ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ________ DATE ________ SUBJECT X-MET FIELD MEAS SHEET NO 46 OF ________

[illegible]

9A1 [illegible]

9A2 [illegible]

9A3 [illegible]

9A4 [illegible]

9A5 [illegible]

9A6 [illegible]

9A7 [illegible]

9A8 [illegible]

9A9 [illegible]

9A10 [illegible]

DLP

BY SRB DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X MET FIELD MEAS SHEET NO 47 OF ____

---

201 [illegible] :FE .57.6 B-C3-3

202 [illegible] :FE 545.6 B-C6-1 +

Note: 202 – 202 IX, total 10 measurements, all on same sample without moving it. SRB 5/8/90

202 I [illegible] B-C6-1

202 II [illegible] B: ~~523.0 B-C6~~-1

202 III [illegible] B-C6-1

202 IV [illegible] :FE [illegible] B-C6-1

202 V [illegible] FE [illegible] B-C6-1

202 VI [illegible] FE [illegible] B-C6-1

202 VII [illegible] :FE [illegible] B-C6-1

202 VIII [illegible] :FE [illegible] B-C6-1

WOODWARD-CLYDE CONSULTANTS

BY ~~[illegible]~~ DATE 5/8/90 PROJECT NAME DuPONT RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 48 OF ______

2IX

[illegible]:PB [illegible] B-C6-1 AVERAGE OF LAST 10 = 487.[illegible] σ = ± 29.43

202A :PB 517.2 B-C6-1 (Same sample stirred & remeasured)

202B :PB [illegible] B-C6-1 (Different aliquot 2)

202C :PB 5[illegible] B-C6-1 (Aliquot 3)

202D :PB ~~644.8~~ B-C6-1 (Aliquot 4)

202E PB 555.0 B-C6-1 (Aliquot 5)

202F PB 515.2 B-C6-1 (aliquot 6)

202G :PB 4[illegible] B-C6-1 (aliquot 7)

202H :PB 4[illegible] B-C6-1 (aliquot 8)

202I PB 507.9 B-C6-1 (Aliquot 9)

202J [illegible] B-C6-1 (Aliquot 10)

$\bar{X}$ 522.02
σ ± 52.87

BY ____ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7513-1

CHKD. BY ____ DATE ____ SUBJECT X-met FIELD MEAS SHEET NO 49 OF ____

203 PB B-C6-2

204 B-C6-3

205 S:PB 3756. B-D3-1

205.6

205' PB B-D3-1

206 PB B-D3-2

376.5

206' PB B-D3-2

~~375.0~~

133 5/18/90

WOODWARD-CLYDE CONSULTANTS

BY	DATE 5/8/90	PROJECT NAME DuPont RI/FS	PROJECT NUMBER 89C7583-1
CHKD. BY	DATE	SUBJECT X-MET FIELD MEAS.	SHEET NO 50 OF

207 [illegible] B-D7-1

208 [illegible] B-D7-2

209 [illegible] B-D7-3

210 [illegible] B-D8-1

211 [illegible] B-D8-2

212 [illegible] B-D8-3

BY [illegible] DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 51 OF ______

213
```
[illegible]
[illegible]AYS:PB [illegible]   B-E3-1
[illegible]
[illegible] 628.6 [illegible]
```

214
```
[illegible]
[illegible] :PB 7174   B-E3-2
[illegible]
```

215
```
[illegible]
[illegible] :PB 1409   B-E3-3
[illegible]
[illegible] 306.3 [illegible]
```

216
```
[illegible]
[illegible] PROBE [illegible]
[illegible]YS:PB [illegible]   B-E9-1
[illegible]
```

217
```
[illegible]
[illegible]AYS:PB [illegible]   B-E9-2
[illegible]
```

218
```
[illegible]
[illegible]:PB [illegible]   B-E9-3
[illegible]
```

DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT XMET FIELD MEAS SHEET NO 52 OF ______

[illegible]

219 [illegible] B-E10-1

[illegible]

220 [illegible] B-E10-2

[illegible]

221 [illegible] B-E10-3

[illegible]

221' [illegible] B-E10-3

[illegible]

222 [illegible] B-F3-1

BY 222 DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 53 OF ______

223 ASSAYS:PF 575 B-F3-2

224 SECONDS B-F3-3

225 ASSAYS:PB 785.1 B-F9-1

226 SECONDS S:PB 199.5 B-F9-2

227 SECONDS ASSAYS:PB 212.1 B-F9-3

228 ~~3:PB 3962~~ B-G3-1

22

BY______ DATE ______ PROJECT NAME ______ PROJECT NUMBER ______

CHKD. BY______ DATE ______ SUBJECT______ SHEET NO 54 OF ______

[illegible]

229 AYS:PB 3672 B-G3-2

[illegible]

230 785.9 B-G3-3

[illegible]

231 YS:PB 9693 B-G6-1

[illegible]

232 :PB [illegible] B-G6-2

[illegible]

233 SSAYS:PB 201.1 B-G6-3

[illegible]

234 AYS:PB 145. B-G9-1

[illegible]

Dup

BY [illegible] DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1
CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 55 OF ______

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235 [illegible]:PB [illegible] B-G9-2

236 [illegible]SAYS:PB 225.[illegible] B-G9-3

237 [illegible]:PB 1[illegible]5.[illegible] B-G10-1

MEASURING [illegible]

238 ASSAYS:PB 174.8 B-G10-2

239 ASSAYS:PB 21[illegible] B-G10-3

240 [illegible]SSAYS:PB 227[illegible] B-H6-1

240' [illegible]SSAYS:PB 2030 B-H6-1

DATE 5/3/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 56 OF ______

2[illegible] ASSAYS:PB [illegible] 3-H6-2

242 [illegible]ASSAYS:PB [illegible] B-HG-3

243 ~~ASSAYS:PB~~ 714.7 B-H8-1

BY [illegible] DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 57 OF ______

[illegible]
[illegible]
[illegible] SECONDS
244 ASSAYS:PB [illegible] B-H8-2
CHANNEL INTENSITIES: [illegible]
[illegible]

[illegible]
[illegible]
[illegible] SECONDS
245 ASSAYS:PB [illegible] B-H8-3
CHANNEL INTENSITIES: [illegible]
[illegible]

[illegible]
[illegible]
[illegible]
246 ASSAYS:PB [illegible] B-H9-1
CHANNEL INTENSITIES: [illegible]
[illegible]

[illegible]
[illegible]
[illegible]
247 ASSAYS:PB [illegible] B-H9-2
CHANNEL INTENSITIES: [illegible]
[illegible]

[illegible]
[illegible]
[illegible] SECONDS
248 ASSAYS:PB [illegible] B-H9-3
CHANNEL INTENSITIES: [illegible]
[illegible]

[illegible]
[illegible]
[illegible]
249 ASSAYS:PB [illegible] B-H10-1
CHANNEL INTENSITIES: [illegible]
[illegible]

BY ______ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 53 OF ______

[illegible]

250 [illegible]:FB 212.4 B-H10-2

[illegible]

331 [illegible]:FB [illegible]

[illegible]

GA2 [illegible]RAYS:FB 151.4

± 20.99

BY ______ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 59 OF ______

QA3 [illegible]:FE 228.1

QA4 [illegible]

QA5 [illegible]

QA6 [illegible]

QA7 [illegible]:FE 14[illegible]

QA8 [illegible]

QA9 [illegible] 4083

Keep

BY ______ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 60 OF ______

QA-0 [illegible] FB [illegible]

251 :FB 204.[illegible] B-H1D-3

252 :FB 437.3 B-I4-1

252' [illegible]:FB [illegible] B-I4-1

5/8/90

5/8/90

5/8/90

5/8/90

253 BAYS:FB 172.5 B-I4-2

254 [illegible]FB 20[illegible].7 B-I4-3

255 BAYS:FB •••• B-I5-1

BY ______ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 61 OF ______

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255 (CONT) 730

256 PB 135.4 B-I5-2

257 PB 136.5 B-I5-3

258 PB 124.3 B-J3-1

259 PB [illegible] B-J3-2

260 ASSAYS:PB 127.7 B-J3-3

261 ASSAYS:PB 126 B-K3-2

BY ~~[illegible]~~ DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 62 OF ______

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261 (cont)

[illegible]

261 [illegible]YS:PB 7125 B-K3-2

[illegible]

AL [illegible] :PB [illegible]

262 [illegible]SSAYS:PB 3S[illegible] B-K3-3

[illegible]

263 ASSAYS:PB 3269 B-L3-1

[illegible]

264 [illegible]SAYS:PB [illegible] B-L3-2

[illegible]

DOP

BY DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 63 OF ______

[illegible]

265 ASSAYS:PB 137.2 B-L3-3

[illegible]

[illegible]

266 ASSAYS:PB [illegible] B-03-1

[illegible]

[illegible]

267 ASSAYS:PB 222.0 B-03-2

[illegible]

[illegible]

268 ASSAYS:PB 215.3 B-03-3

[illegible]

[illegible]

269 ASSAYS:PB 136.2 B-N3-1

[illegible]

[illegible]

270 ASSAYS:PB [illegible] B-N3-2

[illegible]

BY	DATE 5/8/90	PROJECT NAME DuPont RI/FS	PROJECT NUMBER 89C7583-1
CHKD. BY	DATE	SUBJECT X-MET FIELD MEAS	SHEET NO 64 OF

271 ASSAYS:PB [illegible] B-N3-3

272 ASSAYS:PB 355.8 B-N10-1

273 ASSAYS:PB [illegible] B-N10-2

274 ASSAYS:PB [illegible] B-N10-3

275 ASSAYS:PB 9955 B-Q4-1

276 ASSAYS:PB 261.7 B-Q4-2

DQ

BY JRB DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 65 OF ______

277 ASSAYS:PB 220.9 B-Q4-3

278 ASSAYS:PB •••• B-Q5-1

279 ASSAYS:PB •••• B-Q5-2 (MOIST)

280 ASSAYS:PB 540E B-Q5-3

281 ASSAYS:PB B-R6-1

547

133

Del

BY [illegible] DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 66 OF ____

282 ASSAYS:FE [illegible] B-R6-2

283 ASSAYS:FE [illegible] B-R6-3

284 ASSAYS:FE [illegible] B-R7-1

237.[illegible]

285 [illegible] B=R7-2

BY DATE 5/8/90 PROJECT NAME DuPont RI/ES PROJECT NUMBER 89C 7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 67 OF ______

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286 ASSAYS:PB 404.3 B-R7-3

287 ASSAYS:PB 95.33 B-S9-1

288 ASSAYS:PB 153.4 B-S9-2

289 ASSAYS:PB 222.1 B-S9-3

290 ASSAYS:PB 111.3 B-S10-1

BY DATE 5/8/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 68 OF ______

[illegible]

[illegible] SECONDS

291 ASSAYS:PB 13[illegible].5 B-S10-2

CHANNEL INTENSITIES [illegible] MODEL [illegible] DUPONT [illegible]

[illegible]

MODEL [illegible] DUPONT [illegible] DATE: [illegible] TIME: [illegible]

MEASURING: [illegible]

[illegible]

292 ASSAYS:PB [illegible]05.5 B-S10-3

900 PM 5/8/90

CHANNEL INTENSITIES [illegible] MODEL [illegible]

[illegible]

PROBE NUMBER: [illegible]

[illegible]

715 AM 5/9/90 JRF

[illegible] STA

MEASURE

MEASURING: PROBE [illegible]

[illegible] SECONDS

RD'S :PB 1.11[illegible]

MODEL [illegible] TIME: [illegible]

MEASURING: PROBE [illegible]

[illegible] SECONDS

MEASUREMENT [illegible]

293 ASSAYS:PB [illegible].19 M-C8-1

CHANNEL INTENSITIES [illegible] MODEL [illegible] DUPONT [illegible]

[illegible]

MODEL [illegible] DATE: [illegible] TIME: [illegible]

MEASURING: [illegible]

[illegible] SECONDS

294 ASSAYS:PB 165.5 M-C8-2

CHANNEL INTENSITIES [illegible]

[illegible]

MODEL [illegible] TIME: [illegible]

MEASURING: [illegible]

[illegible] SECONDS

295 ASSAYS:PB [illegible] M-C8-3

CHANNEL INTENSITIES [illegible] MODEL [illegible]

[illegible]

NQ

BY [illegible] DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ____ DATE ____ SUBJECT X-MET FIELD MEAS SHEET NO 69 OF ____

[illegible]

296 [illegible] M-C9-1

[illegible]

297 [illegible] M-C9-2

[illegible]

298 [illegible] M-C9-3

[illegible]

299 [illegible] M-C10-1

[illegible]

300 [illegible] M-C10-2

[illegible]

BY ~~[illegible]~~ DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 70 OF ______

QA1 ASSAYS:PB [illegible]

QA2 [illegible]:PB [illegible]

QA3 .PB 336.4

QA4 .PB 594.5

QA5 ASSAYS:PB [illegible]

QA6 ASSAYS:PB [illegible]

QA7 ASSAYS:PB [illegible]

QA8 :PB [illegible]

QA9 YS:PB [illegible]

QA10 ASSAYS:PB 5556

29

BY ______ DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 71 OF ______

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301 AYS:PB [illegible] M-C10-3

302 [illegible] M-C11-1

303 [illegible] M-C11-2

304 [illegible] M-C11-3

305 [illegible] M-C12-1

306 [illegible] M-C12-2

KQ

BY ~~JHB~~ DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 72 OF ____

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307 PB 214.2 M-C12-3

308 PB [illegible] M-D7-1

309 156.0 M-D7-2

310 PB [illegible] M-D7-3

311 PB 200.2 M-D8-1

312 PB 156.5 M-D8-2

Dlp

BY JRF DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 73 OF ______

[illegible]

[illegible] SECONDS
313 [illegible]:PB [illegible]4.4 M-D8-3

CHANNEL INTENSITIES: MODEL [illegible]

[illegible]

MODEL [illegible]
MEASURING [illegible]
[illegible] SECONDS
314 [illegible]:PB 489.1 M-D9-1
CHANNEL INTENSITIES: MODEL [illegible]

[illegible]

MODEL [illegible]
MEASURING [illegible]
[illegible] SECONDS
314' ASSAYS:PB 524.1 M-D9-1

MODEL [illegible]
MEASURING [illegible]
[illegible] SECONDS
314'' [illegible]:PB 503.4 M-D9-1

Av. = 505.53

MODEL [illegible]
MEASURING [illegible]
[illegible] SECONDS
315 ASSAYS:PB [illegible] M-D9-2
CHANNEL INTENSITIES: MODEL [illegible]

[illegible]

MODEL [illegible]
MEASURING [illegible]
[illegible] SECONDS
316 ASSAYS:PB 255.5 M-D9-3
CHANNEL INTENSITIES: MODEL [illegible]

[illegible]

MODEL [illegible]
MEASURING [illegible]
[illegible]
317 ASSAYS:PB [illegible].6 M-D10-1

CHANNEL INTENSITIES: MODEL [illegible]

[illegible]

Dlc

BY [illegible] DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 74 OF ______

[illegible]

SECONDS
318 ASSAYS:PB 179.3 M-D10-2
CHANNEL INTENSITIES: [illegible]

MODEL [illegible]
MEASUREMENT [illegible]
SECONDS
319 ASSAYS:PB [illegible] M-D10-3
[illegible]

MODEL [illegible]
MEASUREMENT [illegible]
SECONDS
320 ASSAYS:PB 537.4 M-D11-1
CHANNEL INTENSITIES: [illegible]

MODEL [illegible] DATE: [illegible]
MEASUREMENT [illegible]
SECONDS
320' ASSAYS:PB 474.3 M-D11-1
MODEL [illegible] DATE: [illegible]
MEASUREMENT [illegible]
SECONDS
320'' ASSAYS:PB 497. M-D11-1

Av = 503.07

[illegible]
[illegible] 135

[illegible]

[illegible]
[illegible] 135
STA
MEASURE
MEASUREMENT [illegible]
SECONDS
~~PB 1.5[illegible]~~
MODEL [illegible] DATE: [illegible]
MEASUREMENT [illegible]
20 SECONDS
321 ASSAYS:PB 248.3 M-D11-2
CHANNEL INTENSITIES: [illegible]
[illegible]

WOODWARD-CLYDE CONSULTANTS

x99

BY DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 75 OF ______

322 AYS:PB [illegible] M-D11-3

323 SSAYS:PB 322.5 M-D12-1

324 AYS:PB 178.2 M-D12-2

325 S:PB 221.6 M-D12-3

326 ~~:PB 696.0 M-E7-1~~

SAYS:PB 282.7 M-E7-2 327

N22

BY ~~[illegible]~~ DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1
CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 76 OF ______

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328 [illegible]:PB [illegible].6 M-E7-3

329 [illegible]AYS:PB 206.5 M-E8-1

330 [illegible]AYS:PB 173.7 M-E8-2

331 ASSAYS:PB 212.0 M-E8-3

332 ASSAYS:PB 288.8 M-E9-1

333 YS:PB 202.9 M-E9-2
```

084

BY DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 77 OF ______

334	3:FE [illegible]	M-E9-3
335	FE [illegible]	M-E-10-1
336	3:FE 251.[illegible]	M-E10-2
337	3:FE 132.5	M-E10-3
338	:FE 115.4	M-E11-1
339	SECONDS :FE 223.7	M-E11-2
340	SECONDS ASSAY3:FE 151.6	m-E11-3

BY: DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 78 OF ______

[illegible]

341 ~~PB 966.7~~ M-E12-1

[illegible]

342 M-E12-2

[illegible]

343 M-E12-3

[illegible]

344 M-F7-1

[illegible]

345 M-F7-2

EL INTENSITIES: [illegible]

WOODWARD-CLYDE CONSULTANTS

BY ~~[illegible]~~ DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ____ DATE ____ SUBJECT X-MET FIELD MEAS SHEET NO 79 OF ____

[illegible]

[illegible] FB 13[illegible] M-F7-3

[illegible]

347 ASSAY3:FB 213.[illegible] M-F8-1

[illegible]

349 ASSAY3:FB 1[illegible] M-F8-2

[illegible]

350 [illegible]FB 13[illegible] M-F8-3

[illegible]

GA1 [illegible]FB 179.3

[illegible]

GA2 [illegible]YS:FB 168.[illegible]

[illegible]

GA3 ASSAY3:FB 161.4

DDP

BY ____ DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ____ DATE ____ SUBJECT X-MET FIELD MEAS SHEET NO 80 OF ____

3A4 ASSAYS:PB 610.5

3A5 ASSAYS:PB 384.4

3A6 ASSAYS:PB 1095

3A7 ASSAYS:PB 1592

3A8 ASSAYS:PB 3441

3A9 ASSAYS:PB 4044

3A10 [illegible] :PB 6021

3A10' :PB 5913

351 ASSAYS:PB 145.0 M-F9-1

352 ASSAYS:PB 176.2 M-F9-2

D4

BY ______ DATE 5/9/90 PROJECT NAME Du Pont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 81 OF ______

353 ASSAYS:PB [illegible] M-F9-3

[illegible] ASSAYS:PB [illegible] M-F10-1

[illegible] ASSAYS:PB [illegible] M-F[illegible]-2

356 SECONDS
ASSAYS:PB 224.7 M-F10-3

[illegible] ASSAYS:PB 2263 M-F11-1

358 ASSAYS:PB 516.9 M-F11-2

359 ASSAYS:PB 212.7 M-F11-3

Dlp

BY [illegible] DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 92 OF ______

300 [illegible]3:PB 115.5 M-F12-1

301 [illegible] M-F12-2

302 [illegible]8:PB 258.5 M-F12-3

303 [illegible] M-G6-1

304 [illegible]:PB [illegible] M-G6-2

305 [illegible] M-G6-3

DOP

BY [illegible] DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 83 OF ______

365 SAYS:PB [illegible] M-G7-1

367 AYS:PB 130.[illegible] M-G7-2

368 S:PB 268.[illegible] M-G7-3

369 ASSAYS:PB 622 M-G8-1

SECONDS

370 ASSAYS:PB 121.5 M-G3-2

369' ASSAYS:PB 651.2 M-G8-1.

BY [illegible] DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 84 OF ______

```
[illegible]

9TA
MODE[illegible]
[illegible]
[illegible]
[illegible]B 0.312
MODEL 7: DUPONT [illegible]
MEASURING TIME [illegible]
[illegible] SECONDS
371 ASSAYS:PB 215.7 M-G8-3
CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
[illegible]
MODEL 7: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING [illegible]
[illegible] SECONDS
372 ASSAYS:PB 147.6 M-G9-1
CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
[illegible] FE
[illegible]
MODEL 7: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING [illegible]
[illegible]
373 [illegible]AYS:PB [illegible] M-G9-2
CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
[illegible]
MODEL 7: [illegible] DATE: [illegible] TIME: [illegible]
MEASURING [illegible] TYPE [illegible]
[illegible] SECONDS
374 ASSAYS:PB 233.0 M-G9-3
CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
[illegible] FE
[illegible]
MODEL 7: [illegible] DATE: [illegible] TIME: [illegible]
MEASURING [illegible]
[illegible]
375 [illegible]S:PB [illegible] M-G10-1
CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
[illegible]
```

BY ~~[illegible]~~ DATE 5/9/90 PROJECT NAME Du Pont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 85 OF ______

375 ASSAYS:PB 474.7 M-G10-1

[illegible]

376 [illegible]PB 226.7 M-G10-2

[illegible]

377 [illegible]S:PB 196.[illegible] M-G10-3

[illegible]

378 [illegible]SAYS:PB 67.74 M-G11-1

[illegible]

379 ASSAYS:PB 3[illegible].67 M-G11-2

[illegible]

380 [illegible]SSAYS:PB 156.1 M-G11-3

[illegible]

381 [illegible]AYS:PB 32.25 M-G12-1

[illegible]

BY DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 8907583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 86 OF ______

382 YS:FE 161. M-G12-2

383 ASSAYS:FE 165.3 M-G12-3

384 ASSAYS:FE 132.1 M-H6-1

385 ASSAYS:FE 140.6 M-K11-1

SECONDS

386 ASSAYS:FE 155.3 M-K11-2

387 ASSAYS:FE 167.4 M-K11-3

388 ASSAYS:FE 169.3 M-H6-2

DDP

BY DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1
CHKD. BY DATE SUBJECT 6-MET FIELD MEAS SHEET NO 87 OF

389 [illegible]S:FB 195.2 M-H6-3

[illegible] M-H7-1

FB [illegible].39[illegible]

391 [illegible]S:FB 194.[illegible] M-H7-2

200sec [illegible] 5/9/90
392 A[illegible]A:B:FB 193.3 m-H7-3

BY	DATE 3/9/90	PROJECT NAME DuPont RI/FS	PROJECT NUMBER 89C7583-1
CHKD. BY	DATE	SUBJECT X-MET FIELD MEAS	SHEET NO 83 OF

393 SSAYS:PB 633.7 M-H8-1

394 237.7 M-H8-2

395 PB 2?0.9 M-H8-3

396 ~~SAYS:PB 644.9~~ M-H9-1

397 ASSAYS:PB 22?.? M-H9-2

398 YS:PB ? 1.? M-H9-3

399 ASSAYS:PB 545.5 M-H10-1

229

~~BY~~ DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 89 OF ______

399' ~~SAPB 526.4~~ M-H10-1

P60 SBA1S:PE [illegible] M-H10-2

GA1 :PE 177

GA2 :PE 2 3.[illegible]

GA3 PE 322.5

GA4 S:PB 553.[illegible]

GA5 :PE 347

WOODWARD-CLYDE CONSULTANTS

D99

BY: DATE 5-?-?? PROJECT NAME DuPont RI/FS PROJECT NUMBER 84C7383-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 10 OF ______

[illegible]

6A6 [illegible]YS:PB [illegible]

[illegible]

6A7 [illegible]YS:PB 1679

[illegible]

6A8 [illegible]YS:PB [illegible]

[illegible]

6A9 [illegible]YS:PB 405

[illegible]

6AK [illegible]S:PB 5153

[illegible]

401 ASSAYS:PB 193.[illegible] M-H10-3

[illegible]

402 ~~[illegible]~~ (WET)

[illegible]

403 [illegible]S:PB [illegible] M-H11-2

[illegible]

404 [illegible]:PB 15[illegible] M-H11-3

BY DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 91 OF ____

[illegible]
[illegible] SECONDS
405 ASSAYS:PB 144.6 M-H12-1

[illegible]

406 [illegible] PB [illegible] BAIER BARE SPOT

[illegible]

407 ASSAYS:PB [illegible] M-H12-2 (UNGROUND/WET) - NOT SIEVED
also see page 97

[illegible]

408 ASSAYS:PB [illegible] M-H12-3

[illegible]

409 ASSAYS:PB [illegible] M-I6-1

[illegible]

410 ASSAYS:PB [illegible] M-I6-2

[illegible]

411 ~~ASSAYS:PB [illegible]~~ M-I6-3 — 212.6 Dee 5/9/90

[illegible]

DCP

BY GEC DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1
CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 92 OF ______

[illegible]

412 [illegible] YS:PB [illegible] M-I7-1

[illegible]

413 [illegible]:PB [illegible] M-I7-2

[illegible]

414 [illegible] PB [illegible] M-I7-3

[illegible]

415 ASSAYS:PB [illegible] M-I8-1

[illegible]

416 [illegible]:PB [illegible] M-I8-2

[illegible]

[illegible] M-I8-3

417 [illegible]

RQ

DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 93 OF ______

GRID EXTENSION

418 [illegible] B-N1-1-

419 [illegible] B-S5-2

420 [illegible] M-J3-1

421 [illegible] M-M5-1

422 [illegible] B-S5-1

BY ~~[illegible]~~ DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 94 OF ______

```
[illegible]
[illegible]
[illegible]

[illegible]

NORMALIZATION PARAMETERS

[illegible]
[illegible]
[illegible]

[illegible]
NORMALIZATION PARAMETERS
[illegible]
 [illegible]
[illegible]
MEASURING PROBE  TYPE [illegible]
[illegible] SETTINGS
[illegible] PB [illegible]
 MODEL [illegible] DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING PROBE  TYPE [illegible]
[illegible] SETTINGS
ASSAYS:PB 500.5

 CHANNEL INTENSITIES  [illegible]
 [illegible]
 [illegible]

 MODEL [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING PROBE [illegible]
 [illegible] SETTINGS
ASSAYS:PB 571.6
 MODEL [illegible] DUPONT [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING PROBE  TYPE [illegible]
 [illegible] SETTINGS
ASSAYS:PB [illegible]
 CHANNEL INTENSITIES  MODEL [illegible] DUPONT [illegible]
 [illegible]
 [illegible]

 MODEL [illegible]  DATE: [illegible]  TIME: [illegible]
MEASURING PROBE [illegible]
[illegible] SETTINGS
ASSAYS:PB [illegible]
 CHANNEL INTENSITIES  MODEL [illegible] DUPONT [illegible]
 [illegible]
 [illegible]
```

23 M-I9-1

423' M-I9-1

424 M-I9-2

425 M-I9-3

BY Dc37 DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 95 OF ______

426 [illegible] 3:PB [illegible] M-I10-1

[illegible] ASSAY:PB [illegible] M-I10-2

[illegible] ASSAY:PB [illegible] M-I10-3

[illegible] ASSAY:PB 2038 M-I11-1

[illegible] ~~ASSAY:PB 501.9~~ M-I11-2

430' ASSAY:PB [illegible] M-I11-2

431 ASSAY:PB 221.7 M-I11-3

BY [illegible] DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 96 OF ______

---

432 ASSAYS:FB 2566 m-I12-1

432' [illegible]:FB [illegible] m-I12-1

433 ASSAYS:FB m-I12-2

434 [illegible]YS:FB m-I12-3

435 ASSAYS:FB [illegible] m-J5-1

436 [illegible]:FB [illegible] m-J5-2

437 [illegible]:FB [illegible] m-J5-3

DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 97 OF ______

```
[illegible]
[illegible]
     SECONDS
ASSAYS:PB 2254
```

[illegible] ~~ASSAYS:PB 2254~~ M-J6-1

```
CHANNEL INTENSITIES:   MODEL 1: DUPONT #
    [illegible]
    [illegible]

[illegible]
[illegible]
     SECONDS
ASSAYS:PB [illegible]
```

[illegible] M-J6-2

```
CHANNEL INTENSITIES:   MODEL 1: DUPONT #
    [illegible]              PB
    [illegible]

[illegible]
[illegible]
     SECONDS
ASSAYS:PB [illegible]
```

[illegible] M-J6-3

```
CHANNEL INTENSITIES:   MODEL 1: DUPONT #
    [illegible]       PB              FE
    [illegible]
```

~~[illegible]~~ 5/9/90

~~[illegible]~~ 5/9/90

~~[illegible]~~ 5/9/90

```
[illegible]
[illegible]
[illegible]

[illegible]

gain control parameters:
[illegible]                          gain [illegible]
[illegible]

[illegible]                STA
[illegible]
[illegible]
[illegible]
RD'S (PB-[illegible]
```

DDP

BY ______ DATE 5/9/90 PROJECT NAME DUPONT RI/FS PROJECT NUMBER 89C 7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 98 OF ______

[illegible]

[illegible]1 ASSAYS:PB [illegible] M-J7-1

CHANNEL INTENSITIES: [illegible]

[illegible]

437' [illegible]

Sep 91

ASSAYS:PB [illegible] M-H12-2 [illegible]

CHANNEL INTENSITIES: [illegible]

[illegible]

442 ~~443~~ ASSAYS:PB 719.2 M-J7-2

gll 5/9/90

CHANNEL INTENSITIES: [illegible]

[illegible]

443 [illegible]S:PB 1007 M-J7-3

CHANNEL INTENSITIES: [illegible]

[illegible]

444 ASSAYS:PB [illegible] M-J8-1

CHANNEL INTENSITIES: [illegible]

[illegible]

445 ASSAYS:PB M-J8-2

CHANNEL INTENSITIES: [illegible]

[illegible]

KJD

By ~~GGT~~ DATE 5/9/90 PROJECT NAME DUPONT RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ________ SUBJECT X-MET FIELD MEAS SHEET NO 91 OF ______

[illegible]

440 ASSAYS:PB 2787. M-J8-3

CHANNEL INTENSITIES: [illegible]
ZR PB [illegible] FE
[illegible]

MODEL 1: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
[illegible] PROBE [illegible]
[illegible]

[illegible] ASSAYS:PB 574.0 M-J9-1

CHANNEL INTENSITIES: [illegible]
[illegible]
[illegible]

MODEL 1: DUPONT [illegible] DATE: [illegible]
[illegible] PROBE [illegible]
[illegible]

[illegible] [illegible]:PB [illegible] M-J9-2

CHANNEL INTENSITIES: MODEL 1: DUPONT [illegible]
[illegible]
[illegible]

MODEL 1: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
TEMPERATURE PROBE [illegible]
[illegible] SECONDS

448 ASSAYS:PB 454.1 M-J9-2

MODEL 1: DUPONT [illegible] DATE: [illegible]
TEMPERATURE PROBE [illegible]
[illegible] SECONDS

[illegible] ASSAYS:PB 169.. M-J9-3

CHANNEL INTENSITIES: MODEL 1: DUPONT [illegible]
ZR [illegible] FE
[illegible]

MODEL 1: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
TEMPERATURE PROBE [illegible]
[illegible] SECONDS

450 ASSAYS:PB 5745 M-J10-1

CHANNEL INTENSITIES: MODEL 1: DUPONT
[illegible]
[illegible]

WOODWARD-CLYDE CONSULTANTS

BY [illegible] DATE 5/9/92 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 00 OF ______

```
[illegible] parameters:
[illegible]
[illegible]          135     [illegible]

Channel A low limit:  [illegible]

[illegible] parameters:
[illegible]
[illegible]          135     [illegible]

Channel [illegible] low limit:  [illegible]

[illegible] parameters:
[illegible]
[illegible]          135     [illegible]

[illegible]

Basic control parameters:
[illegible]
[illegible]          135     [illegible]

[illegible]
NORMALIZATION PARAMETERS:
[illegible]
```

```
 MODEL 7: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASURING: PROBE [illegible] TIPS  A
   SECONDS
ASSAYS:PB [illegible]
```

2A1

```
 MODEL 7: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASURING: PROBE [illegible] TIPS  A
   SECONDS
ASSAYS:PB [illegible]
```

2A2

```
 MODEL 7: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASURING: PROBE [illegible]  A
   SECONDS
ASSAYS:PB [illegible]
```

2A3

```
 MODEL 7: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASURING: PROBE [illegible]  A
   SECONDS
ASSAYS:PB [illegible]
```

2A4

```
 MODEL 7: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASURING: PROBE [illegible]  A
   SECONDS
ASSAYS:PB [illegible]
```

2A5

KJD

BY JLB DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 8967583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 101 OF ____

```
     [illegible]
6A6  ASSAYS:PE  1104

     MODEL 7: DUPONT  [illegible]  DATE: [illegible]  TIME: [illegible]
     MEASURING PROBE  [illegible]
       SECONDS
2A7  ASSAYS:PE  2144

     MODEL 7: DUPONT  [illegible]  DATE: [illegible]  TIME: [illegible]
     MEASURING PROBE  [illegible]
       SECONDS
2A8  ASSAYS:PE  1051

     MODEL 7: DUPONT  [illegible]  DATE: [illegible]  TIME: [illegible]
     MEASURING PROBE  [illegible]
       SECONDS
2A9  ASSAYS:PE  4740

     MODEL 7: DUPONT  [illegible]  DATE: [illegible]  TIME: [illegible]
     MEASURING PROBE  [illegible]
       SECONDS
3A10 ASSAYS:PE  5577

     MODEL 7: DUPONT  [illegible]  DATE: [illegible]  TIME: [illegible]
     MEASURING PROBE  [illegible]
       SECONDS
25   ASSAYS:PE_ 2179.  M-J 10-2

     CHANNEL INTENSITIES:  MODEL 7: DUPONT  [illegible]
       [illegible]
       [illegible]

     MODEL 7: DUPONT  [illegible]  DATE: [illegible]  TIME: [illegible]
     MEASURING PROBE  [illegible]
       SECONDS
25   ASSAYS:PE  4020  M-J 10-3

     CHANNEL INTENSITIES:  MODEL 7: DUPONT  [illegible]
       [illegible]   PE   [illegible]   FE
       [illegible]

     MODEL 7: DUPONT  [illegible]  DATE: [illegible]  TIME: [illegible]
     MEASURING PROBE  [illegible]
       SECONDS
453  ASSAYS:PE  7170  M-J 11-1

     CHANNEL INTENSITIES:  MODEL 7: DUPONT  [illegible]
       [illegible]
       [illegible]
```

KWD

BY ______ DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-INET FIELD MEAS SHEET NO. 02 OF ______

GRID EXTENSION

[illegible] [illegible] B-N5-1

[illegible]

455 [illegible] B-N1-2

[illegible]

456 [illegible] M-J13-1

[illegible]

457 [illegible] M-J13-2

[illegible]

458 [illegible] M-I14-2

[illegible]

459 [illegible] M-I14-1

[illegible]

KJD

BY SGG DATE 5/9/90 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7583-1

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS. SHEET NO 103 OF ______

[illegible]

SECONDS
460 ASSAYS:PB .... ~~M-JH-2~~

[illegible]
PB
383.[illegible]

[illegible]

SECONDS M-
~~ASSAYS:PB~~ ~~.5764~~ J H-3

[illegible]
PB

[illegible]

STA

[illegible]

462 ASSAYS:PB M-K5-1

[illegible]

WOODWARD-CLYDE CONSULTANTS

K30

BY Ra	DATE 5/9/90	PROJECT NAME DuPont RI/FS	PROJECT NUMBER 89C7583-1
CHKD. BY	DATE	SUBJECT X-MET FIELD MEAS	SHEET NO 104 OF

[illegible]

463 ASSAYS:FB [illegible] M-K5-2

[illegible]

[illegible]

464 [illegible] M-K5-3

[illegible]

[illegible]

465 [illegible] M-K6-1

[illegible]

[illegible]

466 [illegible] M-K6-2

[illegible]

[illegible]

467 ASSAYS:FB [illegible] M-K6-3

[illegible]

[illegible]

468 [illegible] M-K7-1

[illegible]

KUD

BY [illegible] DATE 5/9/92 PROJECT NAME DuPont RI/FS PROJECT NUMBER 89C7553-

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 105 OF ______

MEASURING: PROBE 1 TYPE DIFF A
[illegible] SECONDS
469 ASSAYS:PB 134.[illegible] M-L5-3
CHANNEL INTENSITIES: MODEL 7: DUPONT
CR PB SB FE
[illegible]

MODEL 7: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING: PROBE 1 TYPE DIFF A
[illegible] SECONDS
[illegible] ~~ASSAYS:PB 562.4~~ M-E13-1
CHANNEL INTENSITIES: MODEL 7: DUPONT
CR PB SB FE
[illegible]

MODEL 7: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING: PROBE 1 TYPE DIFF A
[illegible] SECONDS
ASSAYS:PB [illegible] B-D3-3
CHANNEL INTENSITIES: MODEL 7: DUPONT
CR PB SB FE
[illegible]

MODEL 7: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING: PROBE 1 TYPE DIFF A
[illegible] SECONDS
ASSAYS:PB 136.7 M-K7-2
CHANNEL INTENSITIES: MODEL 7: DUPONT
CR PB SB FE
[illegible]

MODEL 7: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING: PROBE 1 TYPE DIFF A
[illegible] SECONDS
473 ASSAYS:PB 231.7 M-K7-3
CHANNEL INTENSITIES: MODEL 7: DUPONT
CR PB SB FE
[illegible]

MODEL 7: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING: PROBE 1 TYPE DIFF A
[illegible] SECONDS
474 ASSAYS:PB 4[illegible] MK8-1
CHANNEL INTENSITIES: MODEL 7: DUPONT
CR PB SB FE
[illegible]

KJD

BY CJG DATE 2/9/92 PROJECT NAME DuPont RI/FS PROJECT NUMBER 8907583

CHKD. BY ________ DATE __________ SUBJECT X-MET FIELD MEAS SHEET NO 106 OF ______

```
MEASURING PROBE [illegible] TYPE DIFS A
[illegible] RESULTS
475 ASSAYS:PB 251.5   M-K8-2

CHANNEL INTENSITIES:   MODEL 7: DUPONT [illegible]
  IR      PB      SR      FE
 [illegible]

 MODEL 7: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASURING PROBE [illegible] TYPE DIFS A
[illegible] RESULTS
476 ASSAYS:PB [illegible]   M-K8-3

CHANNEL INTENSITIES:   MODEL 7: DUPONT [illegible]
  IR      PB      SR      FE
 [illegible]

 MODEL 7: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASURING PROBE [illegible] TYPE DIFS A
[illegible] RESULTS
477 ASSAYS:PB [illegible]   M-K9-1

CHANNEL INTENSITIES:   MODEL 7: DUPONT [illegible]
  IR      PB      SR      FE
 [illegible]

 MODEL 7: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASURING PROBE [illegible] TYPE DIFS A
[illegible] RESULTS
478 ASSAYS:PB 314.4   M-K9-2 -

CHANNEL INTENSITIES:   MODEL 7: DUPONT [illegible]
  IR      PB      PB      FE
 [illegible]

 MODEL 7: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASURING PROBE [illegible] TYPE DIFS A
[illegible] RESULTS
479 ASSAYS:PB [illegible]   M-K9-3

CHANNEL INTENSITIES:   MODEL 7: DUPONT [illegible]
  [illegible]      [illegible]      SR      FE
 [illegible]

 MODEL 7: DUPONT [illegible]   DATE: [illegible]   TIME: [illegible]
MEASURING PROBE [illegible] TYPE DIFS A
[illegible] RESULTS
480 ASSAYS:PB [illegible]   M-K10-1

CHANNEL INTENSITIES:   MODEL 7: DUPONT [illegible]
  [illegible]      [illegible]      [illegible]      FE
 [illegible]
```

KJD

BY [illegible] DATE 5/9/90 PROJECT NAME Dupont RI/FS PROJECT NUMBER 8907583

CHKD. BY ______ DATE ______ SUBJECT X-MET FIELD MEAS SHEET NO 107 OF ______

MODEL 7: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING: PROBE 7 TYPE DOPS [illegible]
[illegible] SECONDS
481 ~~ASSAYS:PB 13958.~~ ~~m-K10-2~~

CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
CR PB BS FE
[illegible] [illegible] [illegible] [illegible]

MODEL 7: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING: PROBE 7 TYPE DOPS [illegible]
~~[illegible] SECONDS~~
482 ~~ASSAYS:PB 124.5~~ m-K10-3.

CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
CR PB BS FE
[illegible] [illegible] [illegible] [illegible]

MODEL 7: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING: PROBE 7 TYPE DOPS [illegible]
[illegible] SECONDS
483 ASSAYS:PB [illegible] m-K11-3

CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
CR PB BS FE
[illegible] [illegible] [illegible] [illegible]

MODEL 7: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING: PROBE 7 TYPE DOPS [illegible]
[illegible] SECONDS
484 ASSAYS:PB [illegible] m-K11-2

CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
CR PB BS FE
[illegible] [illegible] [illegible] [illegible]

MODEL 7: DUPONT [illegible] DATE: [illegible] TIME: [illegible]
MEASURING: PROBE 7 TYPE DOPS [illegible]
[illegible] SECONDS
485 ASSAYS:PB [illegible] m-K11-11

CHANNEL INTENSITIES: MODEL 7: DUPONT [illegible]
CR PB BS FE
[illegible] [illegible] [illegible] [illegible]

MEASURE STA
MEASURE
MEASURING: PROBE [illegible]
[illegible] SECONDS
RD'S :PB-[illegible]

APPENDIX F

SOIL GAS ANALYSES RAW FIELD DATA

89C75831 File 4.4

PES

Plains Environmental Services
P.O. Box 6288
Salina, Kansas 67401-0288
(913)827-4545

environmental consulting and analytical services

MAY 14 1990
RECEIVED

May 12, 1990

Woodward-Clyde Consultants
5055 Antioch Road
Overland Park, KS 66203

Re: Project No. 89C75831

Attn: David C. Convy

Dear Mr. Convy:

This letter provides a discussion of occurrences which ultimately led to an alternate approach to the soil gas survey proposed as part of the remedial investigation/ feasibility study (RI/FS) for the Baier site and McCarl site in Lee County, Iowa.

Plains Environmental Services (PES), subcontractor for the soil gas survey, started the soil gas investigation on 1 May 1990, at the McCarl site. During sample collection at the first several sample locations, it became apparent that the subsurface material, a silty clay, was causing excessive soil vapor purge times. Due to the shallow sampling depths (3') and long purge times (>3 min.), a concern regarding the integrity of the vapor samples was raised by PES and the contractor, Woodward-Clyde Consultants (WCC). The main concern centered around the potential of surface air being drawn down around the probe annulus during the vacuum purge, and therefore, diluting the sampled vapors.

PES discussed an alternate technique with WCC personnel which consisted of collecting soil samples followed by headspace analysis. An area of known contamination (H9) was sampled using both soil gas and soil headspace techniques. Only the soil headspace technique resulted in significant detection from the analysis. The recommendation by PES and WCC to the USEPA Region VII to change from soil gas to soil sampling followed by headspace analysis was made and verbally authorized by late Tuesday afternoon of 1 May 1990. Mr. Lynn R. Newcomer of PES and Mr. Terry Hagen of Jacobs Engineering Group, Lenexa, Kansas, also discussed the alternate approach by telephone on the same afternoon. The general consensus was that the headspace approach would provide more reliable data for this study.

The change in sampling and analysis scheme, while allowing the project to continue on schedule, did increase the cost estimate proposed for this phase of the project. The cost increased from $125 per sample to $150 per sample as noted in the attached 1990 Rate Sheet. These rates represent standard charges for services performed by PES.

Following is a presentation of the method used by PES to analyze soil samples by the headspace technique:

HEADSPACE ANALYSIS OF SOIL SAMPLES FOR VOLATILE ORGANIC COMPOUNDS BY GAS CHROMATOGRAPHY

1. Soil samples are collected at a discrete depth using a one-inch sampling tube which connects to the end of the probe rod.
2. A five gram sample (4.9 - 5.1 g) was quickly transferred to a 40-mL VOA vial and accurately weighed to the nearest 0.1 g.
3. Deionized water was added to the vial to a pre-marked line so that one-half of the vial contents consisted of headspace. The vial was immediately capped to minimize loss of volatile components. (The use of water helps to control the headspace volume and also to increase soil surface exposure for desorbing volatile components.)
4. The vial was shaken vigorously and placed in an oven at 60 C for 30 minutes.
5. A 1-cc aliquot was withdrawn from the vial by inserting the needle of a 1-cc syringe through the vial septum.
6. The sample was injected directly into the gas chromatograph for analysis.
7. The final concentration (ug/g or mg/Kg) in the soil was calculated as follows:

$$\frac{\text{Headspace conc. (ug/L)} \times 0.021 \text{ L (headspace vol.)}}{5.0 \text{ g (used actual wt. of soil sample)}}$$

Note: This method only measures the amount of volatile compounds that are thermally desorbed from the soil and aqueous mixture/solution at 60 C.

PLAINS ENVIRONMENTAL SERVICES

Lynn R. Newcomer

Lynn R. Newcomer
President

89C75831 File 6.2.2.3

PES

Plains Environmental Services
P.O. Box 6288
Salina, Kansas 67401-0288
(913)827-4545

environmental consulting and
analytical services

[illegible]
RECEIVED

PRIVILEGED AND CONFIDENTIAL

LABORATORY REPORT

CLIENT: Woodward-Clyde Consultants
5055 Antioch Road
Overland Park, KS 66203

DATE REPORTED: 05-07-90

PROJECT NO.: 89C75831

Attn: David C. Convy

SAMPLE DESCRIPTION: M-D7-HS
DATE SAMPLED AND ANALYZED: 05-01-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-D9-HS
DATE SAMPLED AND ANALYZED: 05-01-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-C8-HS
DATE SAMPLED AND ANALYZED: 05-01-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-C10-HS
DATE SAMPLED AND ANALYZED: 05-01-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-C10-HSB
DATE SAMPLED AND ANALYZED: 05-01-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-B9-HS
DATE SAMPLED AND ANALYZED: 05-01-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-B7-HS
DATE SAMPLED AND ANALYZED: 05-01-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-B11-HS
DATE SAMPLED AND ANALYZED: 05-01-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-B11-HSB
DATE SAMPLED AND ANALYZED: 05-01-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-B13-HSB
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-B13-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-C12-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-D13-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	2.28	mg/Kg	0.01
Ethylbenzene	15.8	mg/Kg	0.01
Xylene, Total	199.	mg/Kg	0.01

SAMPLE DESCRIPTION: M-D11-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-F13-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-E12-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-G12-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-F11-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-H9-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	6.36	mg/Kg	0.01
Ethylbenzene	14.4	mg/Kg	0.01
Xylene, Total	48.8	mg/Kg	0.01

SAMPLE DESCRIPTION: M-E10-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-F9-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-E8-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-E8-HSD
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-G8-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-H13-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-I12-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-H11-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-G10-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-K12-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-J11-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-I10-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-I10-HSB
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-K10-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-L11-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-L9-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-K8-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-J9-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-H7-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-I8-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-J5-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-K4-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-L5-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-K6-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-L7-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-J7-HS
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	0.03	mg/Kg	0.01
Ethylbenzene	0.02	mg/Kg	0.01
Xylene, Total	0.54	mg/Kg	0.01

SAMPLE DESCRIPTION: M-J7-HSD
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	0.05	mg/Kg	0.01
Ethylbenzene	0.14	mg/Kg	0.01
Xylene, Total	1.74	mg/Kg	0.01

SAMPLE DESCRIPTION: M-J7-HSB
DATE SAMPLED AND ANALYZED: 05-02-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-F7-HSB
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-F7-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-G6-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-E6-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-H5-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-I6-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-C14-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-E14-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-E10-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-G10-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-D9-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-C8-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-D7-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-C6-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-B3-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-A2-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-A4-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-D3-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	0.02	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	0.85	mg/Kg	0.01

SAMPLE DESCRIPTION: B-E2-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-F3-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	0.11	mg/Kg	0.01
Ethylbenzene	1.64	mg/Kg	0.01
Xylene, Total	5.84	mg/Kg	0.01

SAMPLE DESCRIPTION: B-C2-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-C2-HSD
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-C2-HSB
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-F9-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-H9-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-G6-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-G2-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-H3-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-I4-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-J3-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-K2-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-N3-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-02-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-Q4-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-R5-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	7.84	mg/Kg	0.01
Ethylbenzene	39.3	mg/Kg	0.01
Xylene, Total	137.	mg/Kg	0.01

SAMPLE DESCRIPTION: B-R5-HSD1
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	11.3	mg/Kg	0.01
Ethylbenzene	51.9	mg/Kg	0.01
Xylene, Total	179.	mg/Kg	0.01

SAMPLE DESCRIPTION: B-R5-HSD2
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	6.38	mg/Kg	0.01
Ethylbenzene	28.1	mg/Kg	0.01
Xylene, Total	89.7	mg/Kg	0.01

SAMPLE DESCRIPTION: B-S6-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-T9-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-S10-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-S8-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-R7-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	0.58	mg/Kg	0.01
Ethylbenzene	1.63	mg/Kg	0.01
Xylene, Total	47.1	mg/Kg	0.01

SAMPLE DESCRIPTION: B-P3-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-T5-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-T7-HS
DATE SAMPLED AND ANALYZED: 05-03-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-T7-HSB
DATE SAMPLED: 05-03-90 DATE ANALYZED: 05-04-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-F1-HS
DATE SAMPLED: 05-03-90 DATE ANALYZED: 05-04-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-D1-HS
DATE SAMPLED: 05-03-90 DATE ANALYZED: 05-04-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-N9-HS
DATE SAMPLED: 05-03-90 DATE ANALYZED: 05-04-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-L3-HS
DATE SAMPLED: 05-03-90 DATE ANALYZED: 05-04-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: B-M2-HS
DATE SAMPLED: 05-03-90 DATE ANALYZED: 05-04-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-B14-HS
DATE SAMPLED: 05-03-90 DATE ANALYZED: 05-04-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

SAMPLE DESCRIPTION: M-B14-HSB
DATE SAMPLED: 05-03-90 DATE ANALYZED: 05-04-90

ANALYSES	RESULTS	UNITS	D.L.
Toluene	ND	mg/Kg	0.01
Ethylbenzene	ND	mg/Kg	0.01
Xylene, Total	ND	mg/Kg	0.01

D.L. = reporting limit
ND = not detected
mg/Kg = milligrams per kilogram

All results represent headspace analysis of soil samples analyzed on-site by Plains Environmental Services using GC/FID.

PLAINS ENVIRONMENTAL SERVICES

Lynn R Newcomer

Lynn R. Newcomer
President

Field Log Sheet

1 of 6

SSIC7553-1

Site ID: Dupont - McCool	Sampler: LRN + CMH
Date: 05/01/90	Analyst: CMH + LRN

Sample ID	Time	Depth (ft)	PES No.	Purge Vol. (L)	Comments
std	1119	—	C01	—	BTX
std	1134	—	C02	—	EB4
M-D7-SGB	1142	—	C03	0.5	1 Rod
m-D7-SG	1157	0.3	C04	0.5	4 min
m-C8-SG	1209	0.3	C05	0.5	2 min
m-G7-SG	1224	0.3	C06	0.5	6 min
m-G9-SG	1253	0.3	C07	0.5	21 min
m-G11-SG	1303	0.3	C08	0.5	3 min 30 secs.
m-J9-SG	1320	0.3	C09	0.5	Bad Injection
m-J9-SG	1327	0.3	C10	0.5	2 minutes
m-J9-HS	1347	0.3	C11	—	Soil Sample
m-H9-SG-1	1434	0.3	C12	0.5	36 min.
———	1454	0.3	C13	0.5	Bad Injection
m-119 SG 2	1508	0.3	C14	0.5	1 min
m-119-HS	1516	0.3	C15	—	Soil Sample

Field Log Sheet 2 of 6

Site ID: DuPont - McCool   Sampler: LRN + CMH

Date: 05/01/90   Analyst: LRN + CMH

Sample ID	Time	Depth (ft)	PES No.	Sample Time ~~Purge~~ ~~Vol.~~ (L)	Sample Weight ~~Comments~~ (g)	
std			C16		BTX	
M-D7-HS	1835	03	C17	1805	4.9g	
M-D9-HS	1846	03	C18	1815	4.9g	
M-C8-HS	1901	03	C19	1829	5.0g	
M-C12-HS	1916	03	C20	1840	5.0g	
M-C10 HSB	1927	—	C21	1846	—	~~C22~~ ~~Bad Inject~~
M-B9-HS	1946	03	C22 ~~C22~~	1805	4.9g	
M-B7-HS	1956	03	C23	1919	5.0g	
M-B11-HS	2005	03	C24	1928	4.9g	BTX std.
std	2045	~~t~~	C26	—	—	
M-B11-HSB Blank	2027	—	C25	—		
std	2014	—	C25	—	BTX STD	

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Field Log Sheet

Site ID: DuPont - McLaren Sampler: LRN + CMH

Date: 05/02/90 Analyst: LRN + CMH

	Sample ID	Time	Depth (ft)	PES No.	Sample Time ~~Purge Vol.~~ (L)	Sample Weight ~~Comments~~ (g)	
	std	1039	—	C27	—	—	BTX
	M-B13 HSB	1053	—	C28	—	—	
	M-B13-HS	1103	0.3	C29	0910	5.0g	
	M-C12 HS	1113	03	C30	0935	5.0g	
.5cc	M-D13-HS	1124	03	C31	0950	5.0g *	~~Dilution~~ D.F
	M-D11-HS	1155	0.3	C32	1119	5.1g	
	M-F13-HS	1205	03	C33	1135	5.0g	
	M-E12-HS	1215	03	C34	1146	5.1g	
	M-G12-HS	1227	03	C35	1156	5.1g	
	M-F11-HS	1245	03	C36	1209	5.0g	
.5cc	M-H9-HS	1306	03	C37	1235	5.0g *	DF 2X
	M-~~H9-HSD~~	—	~~03~~	—	~~1225~~	~~4.9g~~	
	std	1425	—	C38	—	—	BTX
	M-E10-HS	1447	03	C39	1410	5.0g	
	M-F9-HS	1457	03	C40	1422	5.1g	
	M-E8-HS	1515	03	C41	1445	4.9g	
	M-E8 HSD	1526	03	C42	1445	5.0g	
	M-G8 HS	1535	03	C43	1458	5.0g	
	M-H13-HS	1547	03	C44	1515	5.0g	
	M-I12 HS	1557	03	C45	1526	5.0g	
	M-H11-HS	1607	03	C46	1535	4.9g	
	M-G10-HS	1618	03	C47	1550	5.0g	
	M-K12-HS	1640	03	C48 ~~C50~~	1600 ~~1554~~	5.0g	
	M-J11-HS	1652	03	C49 ~~C51~~	1612 ~~1644~~	5.1g	
	M-I10-HS	1703	03	C50 ~~C52~~	1626	4.9g	
	std	1713	—	C51 ~~C53~~	—	—	BTX
	M-I10 HSB	1724	—	C52 ~~C54~~	—	—	

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Field Log Sheet

Site ID: Du Pont · McCarl
Sampler: LKN, CMH
Date: 05/02/90
Analyst: LKN, CMH

	Sample ID	Time	Depth (ft)	PES No.	Sample Time ~~Purge Vol.~~ (L)	Sample Weight ~~Comments~~ (g)	
	M-K10-HS	1736	03	C53 ~~C55~~	1637	5.1g	
	M-L11-HS	1746	03	C54 ~~C56~~	1655	4.9g	
	M-~~L4~~ L9-HS	1757	03	C55 ~~C57~~	1715	4.9g	
	M-K8-HS	1808	03	C56	1730	5.0g	
	M-J9-HS	1818	03	C57	1740	5.0g	
	M-H7-HS	1828	03	C58	1751	4.9g	
	M-I8-HS	1838	03	C59	1757	5.0g	
	M-J5-HS	1846	03	C60	1809	4.9g	
	M-K4-HS	1900	03	C61	1820	4.9g	
	M-L5-HS	1910	03	C62	1830	5.0g ~~5.0g~~	
	std	1921	—	C63	—	—	
	M-K6-HS	1930	03	C64	1855	5.1g	
	M-L7-HS	1939	03	C65	1906	5.0g	
5cc.	M-J7-HS	1951	03	C66	1917	4.9g	d.f. 2x
5cc.	M-J7-HSA	2037	03	C67	1917	4.9g	d.f. 2x
	M-J7-HSB	2120	—	C68	—	—	
	std	2207	—	C69	—	—	ETX

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Field Log Sheet

Site ID: Dupont - McCarl + BAIER Sampler: LRN - CMH

Date: 05/03/90 Analyst: CMH + LRN

	Sample ID	Time	Depth (ft)	PES No.	Sample Time ~~Purge~~ ~~Vol.~~ (L)	Sample Weight ~~Comments~~ (g)	
	std	940	—	C70	—	—	BTX
	M-F7-HSB	958	—	C71	—	—	
	M-F7-HS	1011	03	C72	0850	5.0g	
	M-G6-HS	1021	03	C73	0904	5.0g	
	M-E6-HS	1031	03	C74	0916	4.9g	
	M-H5-HS	1055	03	C75	0928	4.9g	
	M-I6-HS	1156	03	C76	0945	4.9g	
	M-C14-HS	1209	03	C77	1006	5.0g	
	M-E14-HS	1220	03	C78	1030	4.9g	
BAIER SITE	B-E10-HS	1242	03	C79	1210	5.0g	
	B-G10 HS	1300	03	C80	1228	4.9g	
	B-D9-HS	1313	03	C81	1241	5.0g	
	std	1325	—	C82	—	—	BTX
	B-C8-HS	1336	03	C83	1255	5.0g	
	B-C7-HS	1347	03	C84	1308	5.0g	
	B-C6 HS	1357	03	C85	1316	4.9g	
	B-B3-HS	1404	03	C86	1335	5.0g	
	B-A2-HS	1419	03	C87	1348	5.0g	
	B-A4-HS	1430	03	C88	1359	5.0g	
	B-D3 HS	1443	03	C89	1412	5.0g	
	B-E2-HS	1511	03	C90	1426	4.9g	
	B-F3-HS	1521	03	C91	1435	5.0g *	
	B-C2-HS	1547	03	C92	1448	5.0g	
	B-C2-HSD	1558	03	C93	1448	5.0g	
	B-C2-HSB	1608	—	C94	—	—	
	std	1620	—	C95	—	—	BTX

Field Log Sheet

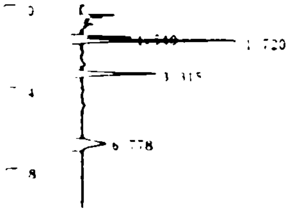
6 of 6

Site ID: DuPont Baier
Sampler: LRN + CMH
Date: 05/03/90
Analyst: CMH + LRN

	Sample ID	Time	Depth (ft)	PES No.	Sample Time ~~Purge Vol.~~ (L)	Sample Weight ~~Comments~~ (g)	
	B-F9-HS	1634	03	C96	15[illegible]	5.0g	
	B-H9-HS	1645	03	C97	1518	4.9g	
	B-G6-HS	1657	03	C98	1527	5.1g	
	B-G2-HS	1706	03	C99	1545	5.1g	
	B-H3-HS	1718	03	C100	1605	5.0g	
	B-I4-HS	1740	03	C101	1622	5.0g	
	B-J3-HS	1756	03	C102	1643	5.1g	
	B-K2-HS	1816	03	C103	1655	5.0g	
	B-N3-HS	1828	03	C104	1706	5.0g	
	B-O2-HS	1850	03	C105	1716	5.0g	
	std	1900	—	C106	—	—	std C107
Changed Std	B-Q4-HS	1952	03	~~C107~~ C110 (cic)	1820	5.0g	std C108 std C109
5cc	B-R5-HS	2002	03	C111	1834	4.9g *	d.f.=2x
5cc	B-R5-HSD1	2027	03	C112 (cic)	1834	5.1g *	df =2x
WCCDP1 C14 (B-R5-HSD2)	B-S6 HS	2053 2116	03	~~C14~~ C15	~~1834~~ 1849	~~5.1~~ * 4.9g	df =2x
	B-T4-HS	2155	03	C16	1858	5.0g	
	B-S10-HS	2204	03	C17	1910	5.0g	
	B-S8 HS	2216	03	C18	1921	4.9g	
	B-R7-HS	2226	03	C19	1932	4.9g *	
	B-R3-HS	2323	03	C20	1942	5.1g	
	B-T5-HS	2334	03	C21	1950	4.9g	
	B-T7-HS	2343	03	C22	1959	4.9g	
	std	2354/0007	—	C23	—	—	std C24
05/04/90	B-T7-HSD	0015	—	C25	—	—	
	B-F1-HS	0025	03	C26	2015	4.9g	
	B-D1-HS	0034	03	C27	2023	4.9g	
	B-N9-HS	0044	03	C28	2154	5.0g	
	B-L3-HS	0053	03	C29	2035	5.0g	
C33 0132 - BTX	B-M2-HS	0103	03	C30	2043	4.9g	
	M-B14-HS	0112	05	C31	2210	5.0g	
	M-B14-HSD	0122		C32			

Headspace Chromatograms

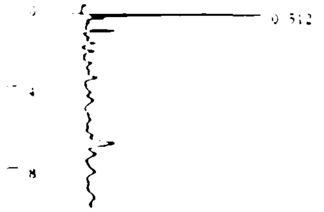
```
C-R4A CHROMATOPAC    CH=1    REPORT No.=6    CHROMATOGRAM=2 WCCOPT C16     90.05.01  17:41:15
```



BTX STD

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT     MK   IDNO         CONC              NAME
 1   13     1.54           731         129
     14     1.72          2364         410     V        1             3.5529     BENZENE
     24     3.315         1726         196              2             4.0687     TOLUENE
     31     6.778          963          60     V        4             4.6426     P-XYLENE
                    -----------   --------                   --------------
          TOTAL           5784         794                          12.2643
```

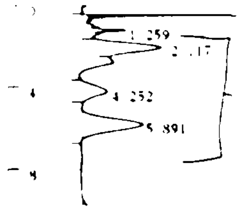
```
C-R4A CHROMATOPAC    CH=1    REPORT No.=7    CHROMATOGRAM=2 WCCOPT C17     90.05.01  18:35:31
```



m-D7-HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT     MK   IDNO         CONC              NAME
 1    1     0.512         1478         461
                      ---------   --------                ---  ---------
          TOTAL           1478         461                           0
```

```
C-R4A CHROMATOPAC    CH=1    REPORT No.=8    CHROMATOGRAM=2 WCCOPT C18     90.05.01  18:46:23
```



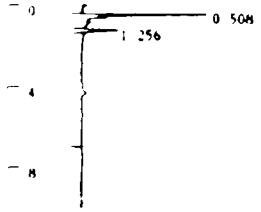
peaks from C15 run

m-D9-HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT     MK   IDNO         CONC              NAME
 1    2     0.51          1343         412
     10     1.259          767         100     V
     18     2.117         4370         161     V
     20     4.252         2282          68
     21     5.891         6657         165
                    -----------   --------                --      -----
          TOTAL          15418         905                          0
```

peaks from C15 run

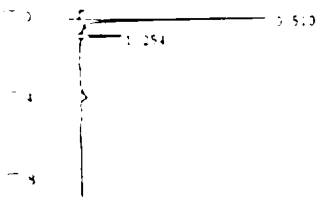
```
C-R4A CHROMATOPAC    CH=1    REPORT No.=9    CHROMATOGRAM=2 WCCOPT C19     90.05.01  19:01:31
```



m-C8-HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT     MK   IDNO         CONC              NAME
 1    2     0.508         1283         328
      5     1.256          519          91   S
                    -----------   --------                -----------
          TOTAL           1802         419                          0
```

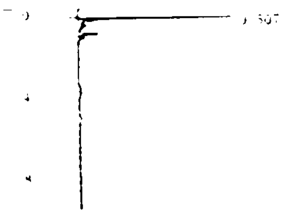
```
C-R4A CHROMATOPAC   CH=1   REPORT No =10   CHROMATOGRAM=2 RECEIPT 20    90 05 01  19 17 16
```



m- C10 - HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT    MK  IDNO       CONC          NAME
 1    2    0.51        1587        498
      6    1.254        621        109
                    ---------  --------                ---  ---  ---
        TOTAL          2208        606                      0
```

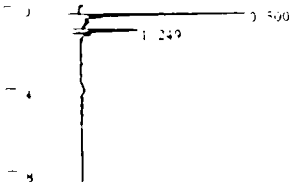
```
C-R4A CHROMATOPAC   CH=1   REPORT No =11   CHROMATOGRAM=2 RECEIPT 21    90 05 01  19 27 22
```



m - C10 - HSB

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT    MK  IDNO       CONC          NAME
 1    1    0.507       1096        408
                    ---------  --------                -----
        TOTAL          1096        408                      0
```

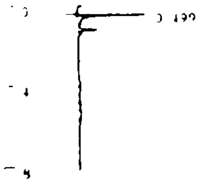
```
C-R4A CHROMATOPAC   CH=1   REPORT No =12   CHROMATOGRAM=2 RECEIPT 22    90 05 01  19 46 00
```



m- 39- HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT    MK  IDNO       CONC          NAME
 1    3    0.5         1380        444
      8    1.249        962        149
                    ---------  --------                ---
        TOTAL          2342        593                      0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =13   CHROMATOGRAM=2 RECEIPT 23    90 05 01  19 56 22
```

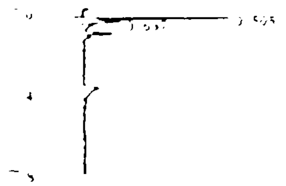


m- 37 - HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT    MK  IDNO       CONC          NAME
 1    3    0.499        589        182
                    ---------  --------                -
        TOTAL           589        182                      0
```

```
R4A CHROMATOPAC   CH=1   REPORT No =14   CHROMATOGRAM=2 ACCEPT =24   90 05 01  20 05 25
```

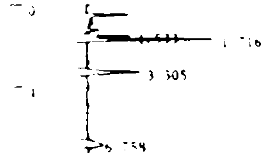
m- B11 - HS



```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT     MK  IDNO        CONC              NAME
 1     3     0 505          1377          385
       4     0 637           592           93    V
                        ---- --    ------                  - ---- -----
          TOTAL             1968          468                       0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =15   CHROMATOGRAM=2 ACCEPT =25   90 05 01  20 14 28
```

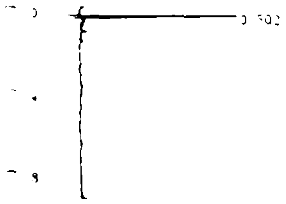
BT X
std



```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT     MK  IDNO        CONC              NAME
 1    11     1 533           696          115    V
       2     1 716          1992          333    V      1         2 9935     BENZENE
      13     3 305          1291          142           2         3 3446     TOLUENE
      14     6 758           534           37           4         2 5714     P XYLENE
                        ---- --   - ------               - --  -------
          TOTAL             4513          627                     8 6096
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =16   CHROMATOGRAM=2 ACCEPT =25   90 05 01  20 27 35
```

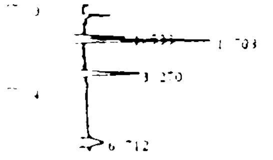
m - B11 - HS 3



```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT     MK  IDNO        CONC              NAME
 1     3     0 502          1311          418
                       --- -----  --------                - - -    -
          TOTAL             1311          418                      0
```

```
R4A CHROMATOPAC   CH=1   REPORT No =17   CHROMATOGRAM=2 ACCEPT =26   90 05 01  20 44 56
```

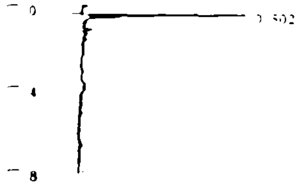
BT X
std



```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT     MK  IDNO        CONC              NAME
 1     8     1 533           635          108
       9     1 703          2032          337    SV     1         3 0533     BENZENE
      12     3 27           1306          145    V      2         3 0805     TOLUENE
      15     6 712           591           39    V      4         2 8475     P XYLENE
                      -----------    -------                       - ---
          TOTAL             4564          629                     8 9813
```

Headspace
Chromatogram

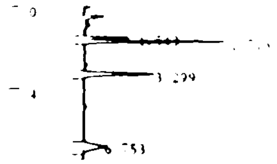
```
C R4A CHROMATOPAC    CH=1    REPORT No =7    CHROMATOGRAM=2 @COPY 128    90 05 02  10 52 45
```



m-313-HS3
Blank

```
** CALCULATION REPORT **
CH PKNO    TIME          AREA        HEIGHT    MK   IDNO        CONC              NAME
 1    2    0.502         1422          437
                                       ---
         TOTAL           1422          437                         0
```

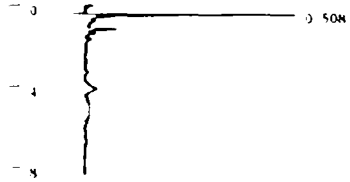
```
C R4A CHROMATOPAC    CH=1    REPORT No =8    CHROMATOGRAM=2 @COPY 127    90 05 02  10 39 27
```



BTX
std

```
** CALCULATION REPORT **
CH PKNO    TIME          AREA        HEIGHT    MK   IDNO        CONC              NAME
 1    4    1.543          740          121
      5    1.713         2318          374     V      1        3.2545    BENZENE
      6    3.299         1713          184            2        3.5714    TOLUENE
      9    6.753          863           53            4        3.4804    P-XYLENE
                         ----          ---                      -------
         TOTAL           5634          732                     10.3063
```

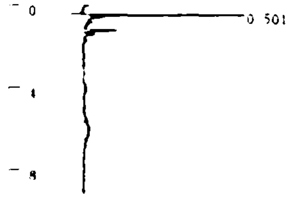
```
C R4A CHROMATOPAC    CH=1    REPORT No =9    CHROMATOGRAM=2 @COPY 129    90 05 02  11 03 35
```



m-313-HS

```
** CALCULATION REPORT **
CH PKNO    TIME          AREA        HEIGHT    MK   IDNO        CONC              NAME
 1    2    0.508         1869          560
                        -----        -- ---                     -----
         TOTAL           1869          560                         0
```

```
C R4A CHROMATOPAC    CH=1    REPORT No =10   CHROMATOGRAM=2 @COPY 130    90 05 02  11 13 37
```

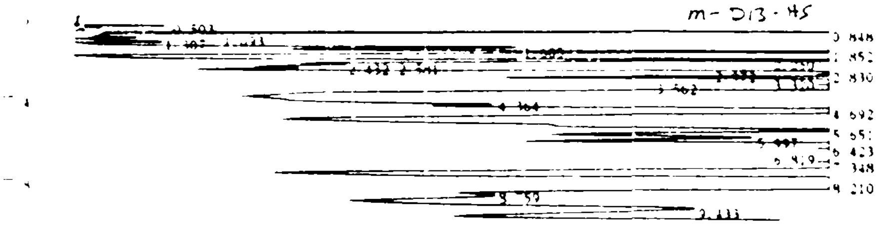


m-C12-HS

```
** CALCULATION REPORT **
CH PKNO    TIME          AREA        HEIGHT    MK   IDNO        CONC              NAME
 1    2    0.501         1352          431
                    --- ------     - ------                 ------ -----
         TOTAL           1352          431                         0
```

```
R4A CHROMATOPAC   CH=1   REPORT No =11   CHROMATOGRAM=2 @CCOPT C31   90 05 02  11 21 38
```

m- D13-HS

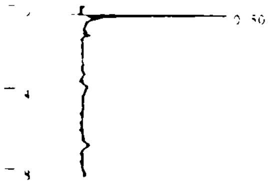


```
** CALCULATION REPORT **
CH PKNO    TIME        AREA     HEIGHT   MK  IDNO      CONC        NAME
 1    2    0.503        662       235
      5    0.848       7594      2153   SV
      7    1.093        538       134   TV
      8    1.307       1171       217
      9    1.605      10087      1153   V
     10    1.852      21393      2650   V
     11    2.25       27825      3690
     12    2.432       4931       653   V
     13    2.581       3627       513   V
     14    2.83       28340      2882   V
     15    2.972      16284      2121   V
     16    3.32      129991     13158   V     2      271.0312   TOLUENE x2 ≈ 2.28 mg/kg
     17    3.562      72167      6132   V
     18    4.364      14659       554   V
     19    4.692      54932      2728   V
     20    5.651      46163      1925   V
     21    5.997      21720      1398   V
     22    6.423      93286      6377   V     3      376.1279   ETHYLBENZENE = 15.8
     23    6.819     821229     48815   V     4     3311.1945   P-XYLENE = 139
     24    7.348      48662      2904   V
     25    8.21      352460     17895   S     5     1421.1197   O-XYLENE = 59.7
     26    8.759       1759       144   T
     27    9.433      16023       741   T
                  ----------  -------               ---------
         TOTAL      1795491    119371               5379.4731
```

DF = 2X

```
R4A CHROMATOPAC   CH=1   REPORT No =12   CHROMATOGRAM=2 @CCOPT C32   90 05 02  11 55 16
```

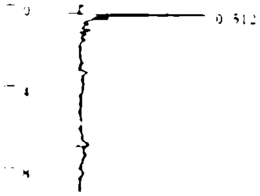
m - D11 - HS



```
** CALCULATION REPORT **

CH PKNO    TIME        AREA     HEIGHT   MK  IDNO      CONC        NAME
 1    6    0.504       1317       391
                  ----------  -------               ---------
         TOTAL         1317       391                       0
```

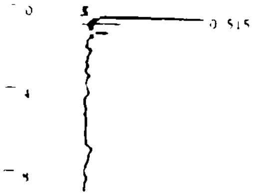
```
R4A CHROMATOPAC   CH=1   REPORT No =13   CHROMATOGRAM=2 @CCOPT C33   90 05 02  12 05 10
```

m- F13-HS



```
** CALCULATION REPORT **
CH PKNO    TIME        AREA     HEIGHT   MK  IDNO      CONC        NAME
 1    3    0.512       1401       337
                  ----------  -------               ---------
         TOTAL         1401       337                       0
```

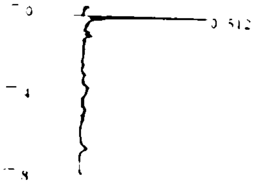
C-R4A CHROMATOPAC CH=1 REPORT No =14 CHROMATOGRAM=2 WCCOPT 034 90 05 02 12 15 17



m- E12 - HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT   MK  IDNO       CONC         NAME
 1    8    0.515       1455         326   V
                      ------     -------
       TOTAL           1455         326                    0
```

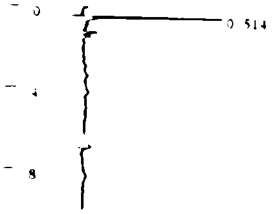
C-R4A CHROMATOPAC CH=1 REPORT No =15 CHROMATOGRAM=2 WCCOPT 035 90 05 02 12 27 26



m- G12 - HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT   MK  IDNO       CONC         NAME
 1    2    0.512       1195         332
                  -----------   --------             -------  -----
       TOTAL           1195         332                  0
```

C-R4A CHROMATOPAC CH=1 REPORT No =16 CHROMATOGRAM=2 WCCOPT 036 90 05 02 12 46 09

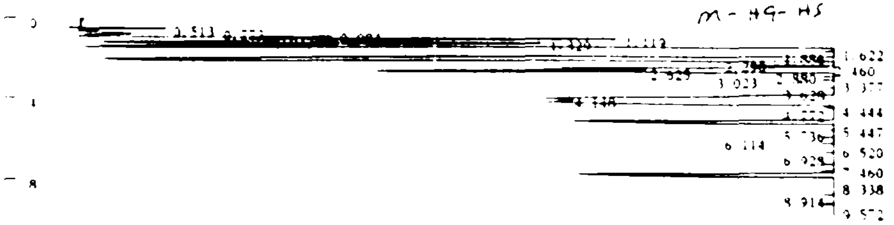


m- F11 - HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT   MK  IDNO       CONC         NAME
 1    3    0.514       1224         373
                   ---------   ---------             -------------
       TOTAL           1224         373                  0
```

C R4A CHROMATOPAC CH=1 REPORT No =17 CHROMATOGRAM=2 @CCOPT 137 90 05 02 13 06 36

m-49-HS

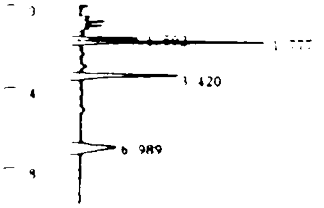


** CALCULATION REPORT **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME	
1	3	0 513	605	226	V				
	5	0 773	523	124	V				
	7	0 984	2669	644	V				
	8	1 043	795	448	V				
	9	1 119	5801	1394	V				DF = 2x
	10	1 329	6303	1183	V				
	11	1 622	59162	6863					
	12	1 886	104913	13094	V				
	13	2 29	109679	14850					
	14	2 46	13256	1795	V				
	15	2 625	9886	1284	V				
	16	2 88	57014	5874	V				
	17	3 023	32673	4107	V				
	18	3 377	418862	43025	V	—	757	Tol	6 36 ug/kg
	19	3 628	150303	11561	V				
	20	4 148	7640	756	V				
	21	4 444	21550	1834	V				
	22	4 772	164239	8098	V				
	23	5 447	44321	2663	V				
	24	5 736	47199	2932	V				
	25	6 114	37757	2467	V	3	~~[illegible]~~	~~ETHYLBENZENE~~	
	26	6 52	424017	27217	V	4	1310 ~~1700 [illegible]~~	~~P-XYLENE~~ ethylbz	14.4
	27	6 928	1069284	62952	V	4	4311 3535	P-XYLENE	36.2
	28	7 46	77163	4505	V		1498	o-xyl	12.6
	29	8 338	536548	26536					
	30	8 914	13317	836	V				
	31	9 572	40728	1885					
	TOTAL		3455204	249154			6173 227		

C R4A CHROMATOPAC CH=1 REPORT No =18 CHROMATOGRAM=2 @CCOPT 138 90 05 02 14 25 21

BTX
STD

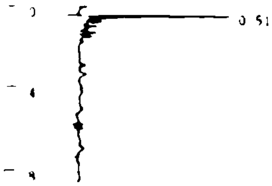


** CALCULATION REPORT **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	14	1 592	946	151	V		1 56	Bz
	15	1 777	2743	488	V		4 15	Tol
	26	3 42	2293	256	SV		4 35	m,p-xyl
	35	6 989	1559	94	V			
	TOTAL		7441	989			0	

C R4A CHROMATOPAC CH=1 REPORT No =19 CHROMATOGRAM=2 @CCOPT 139 90 05 02 14 47 30

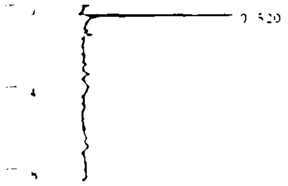
m-E10-HS



** CALCULATION REPORT **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	3	0 514	1362	403				
	TOTAL		1362	403			0	

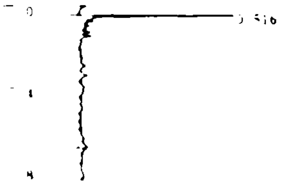
```
C-R4A CHROMATOPAC   CH=1   REPORT No.=20   CHROMATOGRAM=2 #CCDPT C40     90 05 02  14 57 08
```



m-F9-HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA        HEIGHT    MK  IDNO       CONC            NAME
 1     6    0.52        1082         383
                    -----------   ------                 -------- ---
        TOTAL               1082         383                   0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No.=21   CHROMATOGRAM=2 #CCDPT C41     90 05 02  15 15 16
```



m-E8-HS

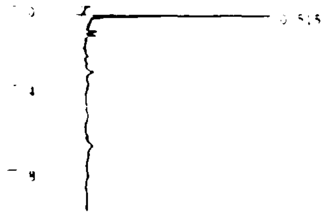
```
** CALCULATION REPORT **
CH PKNO    TIME        AREA        HEIGHT    MK  IDNO       CONC            NAME
 1     3    0.516       1300         412
                    ----------   --------                -------- -----
        TOTAL               1300         412                   0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No.=22   CHROMATOGRAM=2 #CCDPT C42     90 05 02  15 25 49
```

m-~~E8~~-HSD

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA        HEIGHT    MK  IDNO       CONC            NAME
 1     4    0.515       1231         412
                    - ----       ------                  ---   
        TOTAL               1231         412                   0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No.=23   CHROMATOGRAM=2 #CCDPT C43     90 05 02  15 36 00
```

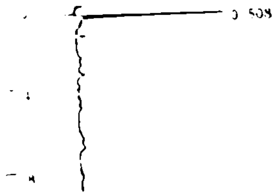


m-G8-HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA        HEIGHT    MK  IDNO       CONC            NAME
 1     2    0.515       1606         491
                         -      --------                -------------- -
        TOTAL               1606         491                   0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =24   CHROMATOGRAM=2 #CCOPT 044     90 05 02  15 46 53
```

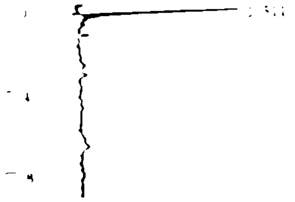
m-H13-HS



```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT    MK  IDNO       CONC          NAME
 1    3    0 508         1240         391
                    ----------    --------              --------------
                                                              0
         TOTAL           1240         391
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =25   CHROMATOGRAM=2 #CCOPT 045     90 05 02  15 57 24
```

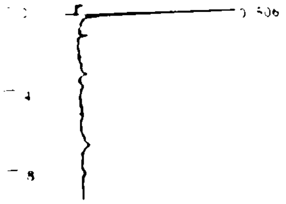
m-I12-HS



```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT    MK  IDNO       CONC          NAME
 1    2    0 511         1383         433
                    ----------    --------              --------------
                                                              0
         TOTAL           1383         433
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =26   CHROMATOGRAM=2 #CCOPT 046     90 05 02  16 07 46
```

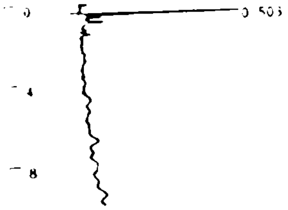
m-H11-HS



```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT    MK  IDNO       CONC          NAME
 1    4    0 506         1376         424
                    ----------    --------              --------------
                                                              0
         TOTAL           1376         424
```

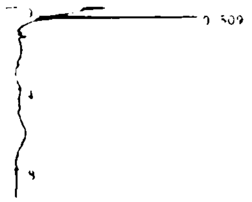
```
C-R4A CHROMATOPAC   CH=1   REPORT No =27   CHROMATOGRAM=2 #CCOPT 047     90 05 02  16 18 33
```

m-G10-HS



```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT    MK  IDNO       CONC          NAME
 1    3    0 503         1283         406
                    ----------    --------              --------------
                                                              0
         TOTAL           1283         406
```

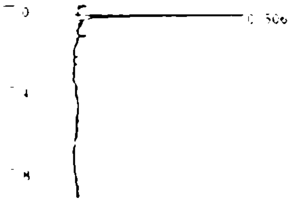
```
C-R4A CHROMATOPAC   CH=1   REPORT No.=28   CHROMATOGRAM=2 #CCCPT 048   90 05 02 16 40 05
```



m- K12-HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT   MK  IDNO      CONC          NAME
 1    2    0.509       1153        396
                     --------   -------               ------------
           TOTAL       1153        396                     0
```

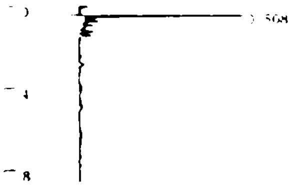
```
C-R4A CHROMATOPAC   CH=1   REPORT No.=29   CHROMATOGRAM=2 #CCCPT 049   90 05 02 16 52 36
```



m- J11- HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT   MK  IDNO      CONC          NAME
 1    3    0.506       1546        440    S
                     --------   -------               ------------
           TOTAL       1546        440                     0
```

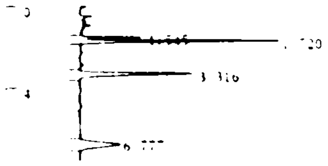
```
C-R4A CHROMATOPAC   CH=1   REPORT No.=30   CHROMATOGRAM=2 #CCCPT 050   90 05 02 17 03 30
```



m- I10- HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT   MK  IDNO      CONC          NAME
 1    4    0.508       1350        438
                     --------   -------               ------------
           TOTAL       1350        438                     0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No.=31   CHROMATOGRAM=2 #CCCPT 051   90 05 02 17 13 19
```

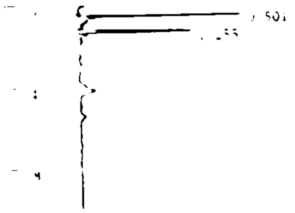


BTX
STD

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT   MK  IDNO      CONC          NAME
 1   14    1.545        919        162    V
     15    1.72        3006        530    V    1         4.2197    BENZENE
     21    3.316       2738        303         2         5.7081    TOLUENE
     22    6.777       1721        105         4         6.4403    P-XYLENE
                     --------   -------               ------------
           TOTAL       8383       1099                    16.3681
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =32   CHROMATOGRAM=2 @ACCEPT 052   90 05 02  17 24 42
```

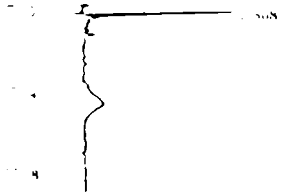
m- I.O-HSB



```
** CALCULATION REPORT **
CH PKNO    TIME         AREA      HEIGHT   MK  IDNO      CONC          NAME
 1    5    0.501        1247       432
     13    1.255        1519       292
                   ----------  --------            -------------
        TOTAL           2765       724                   0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =33   CHROMATOGRAM=2 @ACCEPT 053   90 05 02  17 35 58
```

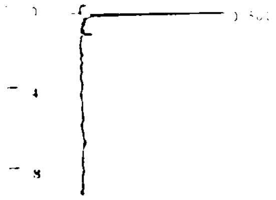
m- K.O-HS



```
** CALCULATION REPORT **
CH PKNO    TIME         AREA      HEIGHT   MK  IDNO      CONC          NAME
 1    3    0.508        1288       402
                   ----------  --------            -------------
        TOTAL           1288       402                   0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =34   CHROMATOGRAM=2 @ACCEPT 054   90 05 02  17 46 13
```

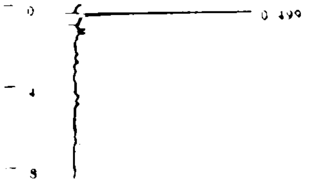
m- L11- HS



```
** CALCULATION REPORT **


CH PKNO    TIME         AREA      HEIGHT   MK  IDNO      CONC          NAME
 1    3    0.501        1312       390  S
                   ----------  --------            -------------
        TOTAL           1312       390                   0
```

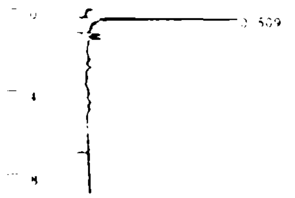
```
C-R4A CHROMATOPAC   CH=1   REPORT No =35   CHROMATOGRAM=2 @ACCEPT 055   90 05 02  17 57 12
```

m- L9- HS



```
** CALCULATION REPORT **
CH PKNO    TIME         AREA      HEIGHT   MK  IDNO      CONC          NAME
 1    3    0.499        1640       475  S
                   ----------  --------            -------------
        TOTAL           1640       475                   0
```

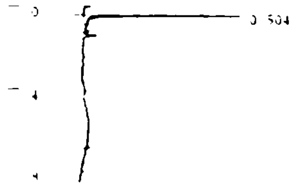
```
[illegible]
```



m-K8-HS

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT   MK  IDNO      CONC          NAME
 1    4    0 509        1775          409  S
                    ----------    -------              --------------
          TOTAL         1775          409                    0
```

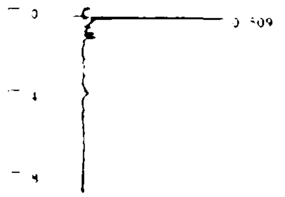
```
C-R4A CHROMATOPAC   CH=1   REPORT No =37   CHROMATOGRAM=2 @CCDPT 057    90 05 02  18 18 27
```



m-J9-HS

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT   MK  IDNO      CONC          NAME
 1    3    0 504        1319          418
                    ----------    -------              --------------
          TOTAL         1319          418                    0
```

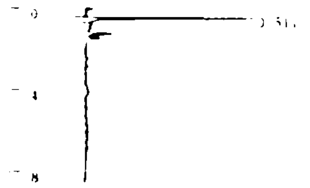
```
C-R4A CHROMATOPAC   CH=1   REPORT No =38   CHROMATOGRAM=2 @CCDPT 058    90 05 02  18 28 22
```



m-H7-HS

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT   MK  IDNO      CONC          NAME
 1    4    0 509        1184          375
                    ----------    -------              --------------
          TOTAL         1184          375                    0
```

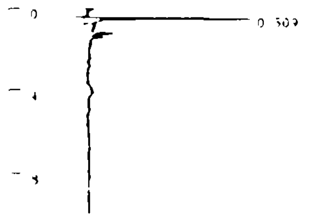
```
C-R4A CHROMATOPAC   CH=1   REPORT No =39   CHROMATOGRAM=2 @CCDPT 059    90 05 02  18 38 22
```



m-I3-HS

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT   MK  IDNO      CONC          NAME
 1    6    0 511        1521          448  S
                    ----------    -------              --------------
          TOTAL         1521          448                    0
```

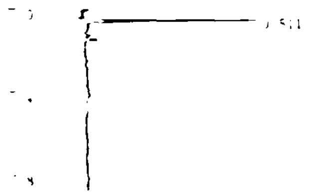
```
C-R4A CHROMATOPAC   CH=1   REPORT No =40   CHROMATOGRAM=2 @CCDPT 060    90 05 02  18 47 57
```



m-J5-HS

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT   MK  IDNO      CONC          NAME
 1    3    0 509        1509          434  S
                    ----------    -------              --------------
          TOTAL         1509          434
```

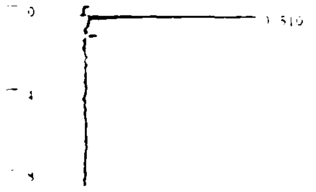
```
C-R4A CHROMATOPAC  CH=1  REPORT No =41  CHROMATOGRAM=2 ACCEPT [illegible]  90 05 02  19 [illegible] 29
```



m - K4 - HS

```
** CALCULATION REPORT **
CH PKNO   TIME        AREA      HEIGHT   MK  IDNO      CONC           NAME
 1    4   0.511       1582        458
                  ---------  ---------           ------------
          TOTAL       1582        458                   0
```

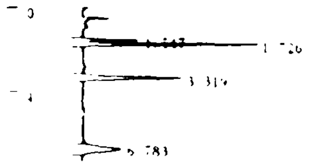
```
C-R4A CHROMATOPAC  CH=1  REPORT No =42  CHROMATOGRAM=2 ACCEPT 062  90 05 02  19 10 37
```



m - L5 - HS

```
** CALCULATION REPORT **
CH PKNO   TIME        AREA      HEIGHT   MK  IDNO      CONC           NAME
 1    4   0.51        1476        459
                  ---------  ---------           ------------
          TOTAL       1476        459                   0
```

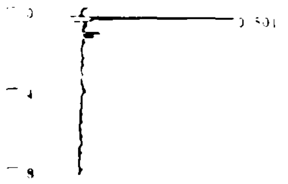
```
C-R4A CHROMATOPAC  CH=1  REPORT No =43  CHROMATOGRAM=2 ACCEPT 063  90 05 02  19 21 13
```



BTX
STD

```
** CALCULATION REPORT **
CH PKNO   TIME        AREA      HEIGHT   MK  IDNO      CONC           NAME
 1    6   1.547        845        144
      7   1.726       2735        466    V     1        3.8401     BENZENE
     14   3.319       2323        258          2        4.8424     TOLUENE
     17   6.783       1682        100    V     4        6.7802     P-XYLENE
                  ---------  ---------           ------------
          TOTAL       7584        968                  15.4627
```

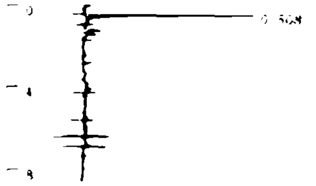
```
C-R4A CHROMATOPAC  CH=1  REPORT No =44  CHROMATOGRAM=2 ACCEPT 064  90 05 02  19 30 27
```



m - K6 - HS

```
** CALCULATION REPORT **
CH PKNO   TIME        AREA      HEIGHT   MK  IDNO      CONC           NAME
 1    3   0.501       1370        407    S
                  ---------  ---------           ------------
          TOTAL       1370        407                   0
```

```
C-R4A CHROMATOPAC  CH=1  REPORT No =45  CHROMATOGRAM=2 ACCEPT 065  90 05 02  19 39 57
```

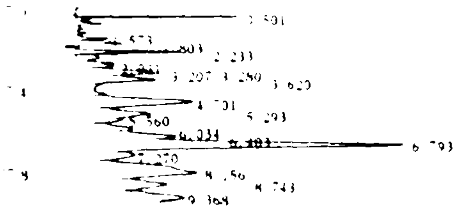


m - L7 - HS

```
** CALCULATION REPORT **
CH PKNO   TIME        AREA      HEIGHT   MK  IDNO      CONC           NAME
 1    4   0.508       1365        453
                  ---------  ---------           ------------
          TOTAL  [illegible]      453
```

C-R4A CHROMATOPAC CH=1 REPORT No.=46 CHROMATOGRAM=2 WCCIPT 56 90 05 02 19 51 26

m - J7 - HS

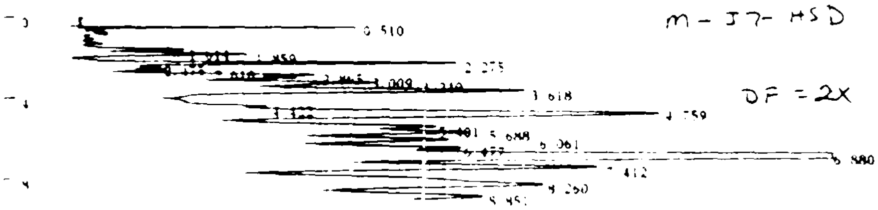


DF = 2X

```
** CALCULATION REPORT **
CH PKNO     TIME        AREA      HEIGHT   MK  IDNO      CONC          NAME
 1   1      0.501        139       430
    12      1.573        557        80     V
    14      1.803       1098       116     V
    16      2.233       1904       269
    23      2.931        563        71     V
    24      3.207       1076       163     V     2    ~~3.166~~       ~~TOLUENE~~
    25      3.28        1730       173     V     2     3.6077        TOLUENE      0.03 ug/Kg
    26      3.62        2562       166     V
    30      4.701       5302       251     V
    31      5.293       2430       133     V
    32      5.56         622        57     V
    33      6.034       1064        77     V
    34      6.403       3090       187     V     3    17 ~~[illegible]~~  ETHYLBENZENE   0.02 ug/kg
    35      6.793      14263       787     V     4    46 ~~[illegible]~~  P-XYLENE       0.40
    36      7.27        1972        67     V
    37      8.156       6026       197           5    6.8 ~~[illegible]~~ O-XYLENE      0.14 ug/kg
    38      8.743       1553        90     V
    39      9.368        824        53
                       ------    ------              ------------
         TOTAL         46874      3366                100.1124
```

C-R4A CHROMATOPAC CH=1 REPORT No.=47 CHROMATOGRAM=2 WCCIPT 67 90 05 02 20 37 54

m - J7 - HSD

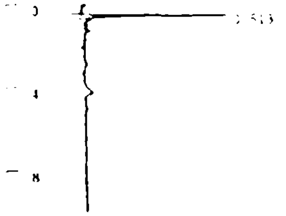


DF = 2X

```
** CALCULATION REPORT **
CH PKNO     TIME        AREA      HEIGHT   MK  IDNO      CONC          NAME
 1   2      0.51        2032       739
     9      1.614       2343       271     V
    10      1.859       3814       434     V
    11      2.275       7028       971
    12      2.475       1292       169     V
    13      2.61        1218       173     V
    14      2.865       5194       549     V
    15      3.009       4177       487     V
    16      3.24        9637       682     V     2    6.19 ~~[illegible]~~   TOLUENE        0.05
    17      3.618      16737      1046     V
    18      4.422       4301       292     V
    19      4.759      28404      1309     V
    20      5.401      11325       667     V
    21      5.688      11734       726     V
    22      6.061      10957       646     V
    23      6.477      10071       644     V     3    15.59 ~~10.9003~~  ETHYLBENZENE   0.14
    24      6.88       56077      3112     V     4    142.5 ~~120.1033~~ P-XYLENE       1.22
    25      7.412      16304       931     V
    26      8.26       17593       629           5    49.6 ~~[illegible]~~  O-XYLENE       0.42
    27      8.851       3614       257
                       ------    ------              ------------
         TOTAL        223843     14733               157.7374
```

C-R4A CHROMATOPAC CH=1 REPORT No 48 CHROMATOGRAM=2 RECEIPT 68 90 05 02 11 20 36

m-37-#5B



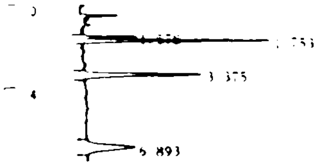
** CALCULATION REPORT **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	2	0.513	1337	380	S			
		TOTAL	1337	380			0	

C-R4A CHROMATOPAC CH=1 REPORT No 49 CHROMATOGRAM=2 RECEIPT 69 90 05 02 12 07 35

BTX

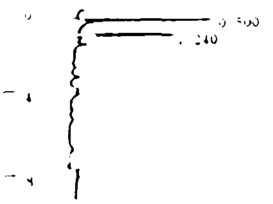
STD



** CALCULATION REPORT **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	12	1.578	856	144				
	13	1.753	3038	495	V	1	3.95 ~~[illegible]~~	BENZENE
	24	3.375	2826	310			5.149	Tol
	25	6.893	2143	125		4	5.98 ~~[illegible]~~	P-XYLENE
		TOTAL	8863	1074			12.9053	

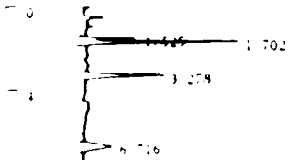
```
C-R4A CHROMATOPAC [illegible]
```



m - F7 - HS3

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT    MK  IDNO       %          NAME
 1    2    0.5          [illegible]   342
      3    1.24         1463          254

           TOTAL        2634          596                     0
```

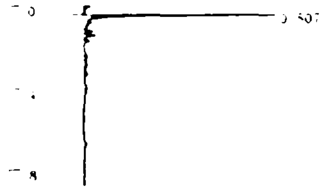
```
C-R4A CHROMATOPAC   CH=1   REPORT No =10   CHROMATOGRAM=2 #CCRPT.070     90 05 03  09 40 21
```



BTX
STD

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT    MK  IDNO       %          NAME
 1    3    0.525         773          130
      4    1.702        2502          404     V    1        3.2498     BENZENE
      5    3.278        1887          206          2        3.4124     TOLUENE
      6    6.716        1015           58          4        2.8333     P-XYLENE
                        ----         ----                   ------
           TOTAL        6177          807                   9.4956
```

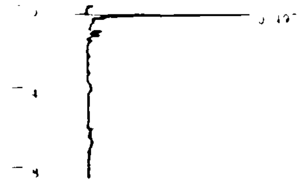
```
C-R4A CHROMATOPAC   CH=1   REPORT No =11   CHROMATOGRAM=2 #CCRPT.072     90 05 03  10 12 02
```



m- F7- HS

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT    MK  IDNO       CONC       NAME
 1    1    0.507        1654          509
                        ----------  -------              ------------
           TOTAL        1654          509                     0
```

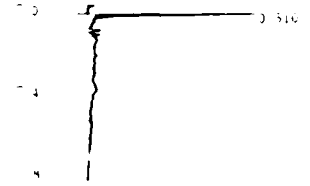
```
C-R4A CHROMATOPAC   CH=1   REPORT No =12   CHROMATOGRAM=2 #CCRPT.073     90 05 03  10 22 06
```



m- G6- HS

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT    MK  IDNO       CONC       NAME
 1    2    0.497        1719          431
                        ----------  -------                -----
           TOTAL        1719          431                     0
```

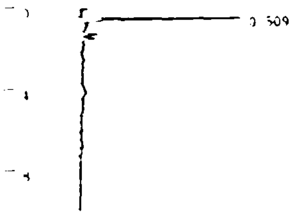
```
C-R4A CHROMATOPAC   CH=1   REPORT No =13   CHROMATOGRAM=2 #CCRPT.074     90 05 03  10 31 55
```



m- E6- HS

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA        HEIGHT    MK  IDNO       CONC       NAME
 1    1    0.51         [illegible]   444
                                    -------                ----
           TOTAL        [illegible]   444                     0
```

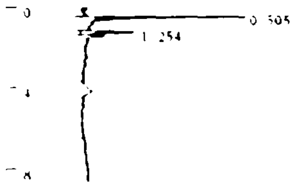
```
C-R4A CHROMATOPAC   CH=1   REPORT No =[illegible]   CHROMATOGRAM=2 [illegible]   [illegible]
```



m- H5-HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA       HEIGHT    MK  IDNO       CONC            NAME
 1    2    0 509       1901         422
                    -- ---       ------                -- - - - ---
        TOTAL          1901         422                         0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =15   CHROMATOGRAM=2 ACCEPT 776   90 05 03  11 56 26
```



m - I6-HS

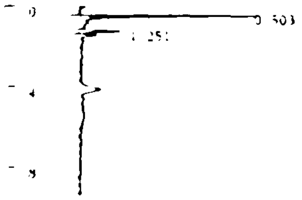
```
** CALCULATION REPORT **

CH PKNO    TIME        AREA       HEIGHT    MK  IDNO       CONC            NAME
 1    3    0 505       1595         426
      6    1 254        716         125
                 -----------  -------              - - -
        TOTAL          2312         551                         0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =16   CHROMATOGRAM=2 ACCEPT 777   90 05 03  12 09 42
```

m- C14-HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA       HEIGHT    MK  IDNO       CONC            NAME
 1    3    0 51        1637         384
                 -- -------       ------                        -
        TOTAL          1637         384                         0
```

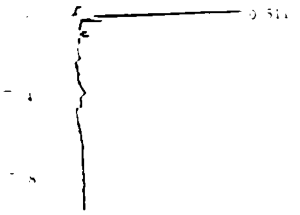
```
C-R4A CHROMATOPAC   CH=1   REPORT No =17   CHROMATOGRAM=2 ACCEPT 7[illegible]   90 05 03  12 20 23
```



m - E14 - HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA       HEIGHT    MK  IDNO       CONC            NAME
 1    4    0 503       1747         472     V
      9    1 251        639         104     V
                 -   ---       ------              -  ------- -
        TOTAL          2386         575                         0
```

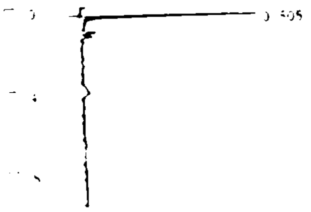
```
[illegible] CHROMATOPAC [illegible] REPORT No [illegible] CHROMATOGRAM [illegible]
```



B-?.0-HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT    MK  IDNO       CONC          NAME
 1    2    0 511       1760        447
                                 ------               ----------
         TOTAL         1760        447                    0
```

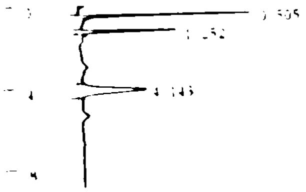
```
C-R4A CHROMATOPAC   CH=1   REPORT No =19   CHROMATOGRAM=2 ACCEPT 080    90 05 03  13 00 53
```



B-6.0-HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT    MK  IDNO       CONC          NAME
 1    3    0 505       1592        469
                   ----------  ---- ---               ----------
         TOTAL         1592        469                    0
```

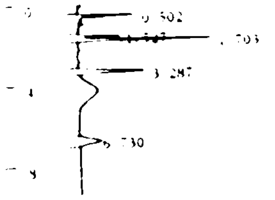
```
C-R4A CHROMATOPAC   CH=1   REPORT No =20   CHROMATOGRAM=2 ACCEPT 081    90 05 03  13 13 48
```



B-D9-HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT    MK  IDNO       CONC          NAME
 1    1    0 505       1431        447
      2    1 252       1465        255
     12    4 143       2602        106
                                 --- ---               ---
         TOTAL         5499        808                    0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =21   CHROMATOGRAM=2 ACCEPT 082    90 05 03  13 25 29
```



BTK

STD

RF

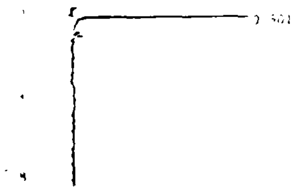
B/~~[illegible]~~

T/2.2×10⁶

x/y/3.3×10⁶

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT    MK  IDNO       CONC          NAME
 1    4    0 502        633        147
      8    1 527        663        112
      9    1 703       2122        354     V     1     3.15 ~~[illegible]~~   BENZENE Ø
     11    3 287       1534        172     V     2     3.41 ~~[illegible]~~   TOLUENE
     22    6 73         951         57     V     4     3.30 ~~[illegible]~~   P-XYLENE
                     ------      ------               ----------
         TOTAL         5902        542                 9 1846
```

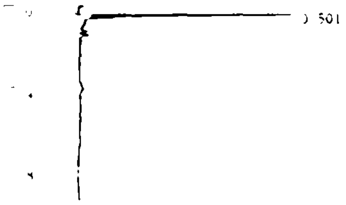
```
R4A CHROMATOPAC   CH=1   REPORT No =22   CHROMATOGRAM=2 ACCEPT 83    90 05 03  13 [illegible] 25
```



B - C8 - HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT    MK  IDNO        CONC             NAME
 1    2      0 501          1537         471
                                      -------                  -----------
          TOTAL             1537         471                         0
```

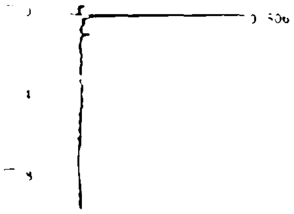
```
R4A CHROMATOPAC   CH=1   REPORT No =23   CHROMATOGRAM=2 ACCEPT 84    90 05 03  13 46 33
```



B ~ D7 - HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT    MK  IDNO        CONC             NAME
 1    2      0 501          1988         565
                         ---------   -------                  ----------
          TOTAL             1988         565                         0
```

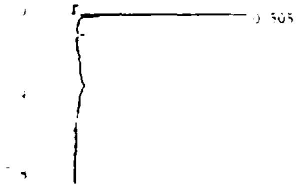
```
R4A CHROMATOPAC   CH=1   REPORT No =24   CHROMATOGRAM=2 ACCEPT 85    90 05 03  13 57 28
```



3 - C6 - HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT    MK  IDNO        CONC             NAME
 1    2      0 506          1519         440
                         ---------   -------                  ----------
          TOTAL             1519         440                         0
```

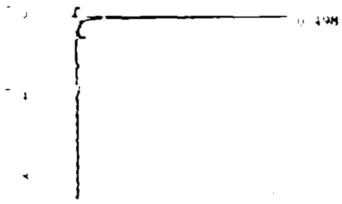
```
R4A CHROMATOPAC   CH=1   REPORT No =25   CHROMATOGRAM=2 ACCEPT 86    90 05 03  14 09 28
```



3 - B3 - HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT    MK  IDNO        CONC             NAME
 1    2      0 505          1361         455
                         ---------   -------                  ----------
          TOTAL             1361         455                         0
```

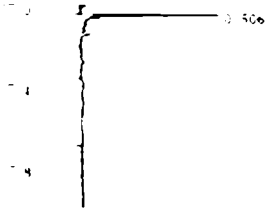
```
R4A CHROMATOPAC   CH=1   REPORT No =26   CHROMATOGRAM=2 ACCEPT 87    90 05 03  14 [illegible] 32
```



B - A - 2 - HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT    MK  IDNO        CONC             NAME
```

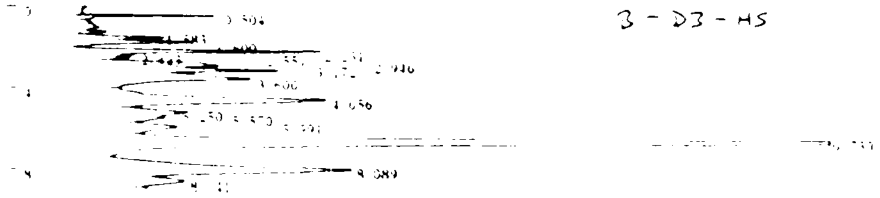
```
R4A CHROMATOPAC   CH=1   REPORT No.=27   CHROMATOGRAM=2 @CCEPT 388   90.05.03  14:30:
```



B-A4-HS

```
** CALCULATION REPORT **
CH PKNO   TIME       AREA     HEIGHT   MK  IDNO      CONC          NAME
 1    2   0.506      1474       368
                   --------   ------              -----------
       TOTAL         1474       368                    0
```

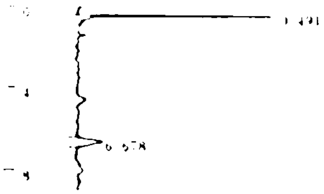
```
R4A CHROMATOPAC   CH=1   REPORT No.=28   CHROMATOGRAM=2 @CCEPT 389   90.05.03  14:43:2
```



3 - D3 - HS

```
** CALCULATION REPORT **
CH PKNO   TIME       AREA     HEIGHT   MK  IDNO      CONC          NAME
 1    4   0.504      1256       349   SV
     11   1.583      1971       211   V
     12   1.8        2667       292   V
     13   2.231      5354       630
     14   2.423       846       125   V
     15   2.551       913       115   V
     16   2.946      6029       345   V
     17   3.172 1994 ~~[illegible]~~  499   V     2  4.44 ~~[illegible]~~  TOLUENE   0.02
     18   3.6       10044       421   V
     19   4.656     14859       608   V
     20   5.25       4548       217   V
     21   5.57       2140       164   V
     22   5.991      4649       192   V
     23   6.73  42892 ~~[illegible]~~ 1365 V     4   ~~[illegible]~~  P-XYLENE  0.64
     24   8.089     14302       603         5    39.932     O-XYLENE  0.21
     25   8.641      2294       126   V
                   --------   ------              -----------
       TOTAL       121480      7263                 172.5981
```

```
R4A CHROMATOPAC   CH=1   REPORT No.=29   CHROMATOGRAM=2 @CCEPT 390   90.05.03  15:11:36
```

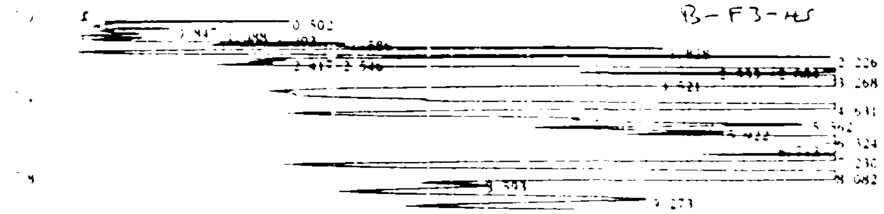


3 - E2 - HS

```
** CALCULATION REPORT **
CH PKNO   TIME       AREA     HEIGHT   MK  IDNO      CONC          NAME
 1    3   0.491      1757       519   TS
     14   6.678       996        65         4      2.7794    P-XYLENE
                   --------   ------              -----------
       TOTAL         2753       583                 2.7794
```

```
R4A CHROMATOPAC   CH=1   REPORT No.=30   CHROMATOGRAM=1 [illegible]   90/05/03 15:22:11
```

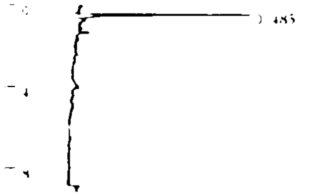
B-F3-HS



```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT   MK  IDNO     CONC        NAME
 1    2    0.502       1953        552    V
      5    0.847       1045        224    V
      7    1.088        810        143    V
      8    1.293        864        147    V
      9    1.586       6357        687    V
     10    1.828      13133       1525    V
     11    2.226      16402       1943
     12    2.417       3593        481    V
     13    2.546       3103        433    V
     14    2.804      22477       2225    V
     15    2.933      17990       2054    V
     16    3.268   1902 [illegible] 2860  V    2      77.1436   TOLUENE      0.11
     17    3.521      73708       5429    V
     18    4.631      64233       2791    V
     19    5.562      42957       3545    V
     20    5.922      23045       1301    V
     21    6.324   10949 [illegible] 7825 V    3     351.1324   ETHYLBENZENE 1.64
     22    6.713   27300 [illegible] 16347 V   4     797.3145   P-XYLENE     4.05
     23    7.123      39599       2233    V
     24    8.082     120635       5883         5   42 [illegible]   O-XYLENE     1.79
     25    8.593       5950        391    V
     26    9.273      14926        697
                   ----------  --------           -----------
          TOTAL      929977      57717             1565.3028
```

```
R4A CHROMATOPAC   CH=1   REPORT No.=31   CHROMATOGRAM=1 [illegible]   90/05/03 15:47:49
```

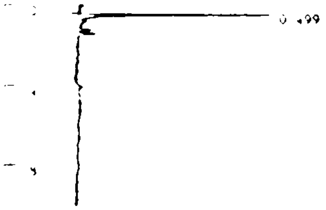
B-C2-HS



```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT   MK  IDNO     CONC        NAME
 1    2    0.485       1776        462    S
                   ----------  --------
          TOTAL        1776        462                  0
```

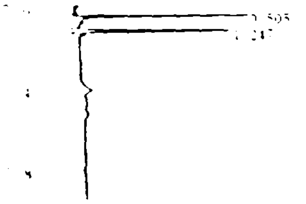
```
R4A CHROMATOPAC   CH=1   REPORT No.=32   CHROMATOGRAM=1 [illegible]   90/05/03 15:58:13
```

B-C2-HSD



```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT   MK  IDNO     CONC        NAME
 1    1    0.499       1925        512
                   ----------  --------
          TOTAL        1925        512                  0
```

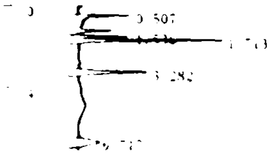
```
C-R4A CHROMATOPAC  CH=1  REPORT No.=33  CHROMATOGRAM=1  ACCOUNT  ..      90 05 03  ..
```



B-C2-HSB

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA       HEIGHT    MK  IDNO      CONC          NAME
1    1     0.505       1391        447
     3     1.247       2194        400
                       ----      ------                  --------
           TOTAL       3585        848                    0
```

```
C-R4A CHROMATOPAC  CH=1  REPORT No.=34  CHROMATOGRAM=1  ACCOUNT 195     90 05 03  16 20 17
```

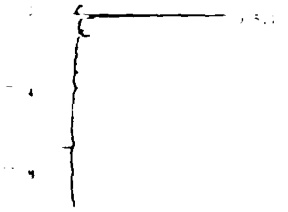


BTX
STD

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA       HEIGHT    MK  IDNO      CONC          NAME
1    1     0.507        563        126
     5     1.536        700        125
     6     1.713       2255        379     V    1                      BENZENE
     7     3.282       1613        177          2                      TOLUENE
    12     6.717        877         55     V    4                      XYLENE
                                  -----                  --------
           TOTAL       6007        861                    8.2936
```

Handwritten in CONC column: 3.35 ~~[illegible]~~ (BENZENE); 1.55 ~~[illegible]~~ (TOLUENE); 3.05 ~~[illegible]~~ (XYLENE)

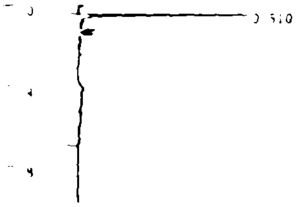
```
C-R4A CHROMATOPAC  CH=1  REPORT No.=35  CHROMATOGRAM=2  ACCOUNT 196     90 05 03  16 34 30
```



B-F9-HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA       HEIGHT    MK  IDNO      CONC          NAME
1    3     0.511       1604        402
                                  -----
           TOTAL       1604        402                    0
```

```
C-R4A CHROMATOPAC  CH=1  REPORT No.=36  CHROMATOGRAM=1  ACCOUNT 197     90 05 03  16 45 52
```

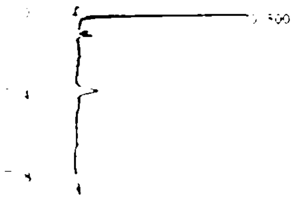


B-H9-HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA       HEIGHT    MK  IDNO      CONC          NAME
1    2     0.51        1537        454
                       ----      ------                  --------
           TOTAL       1537        454                    0
```

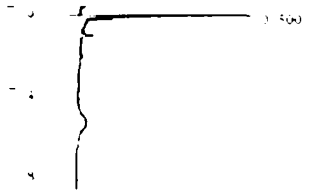
Shimadzu

```
C-R1A CHROMATOPAC  [illegible]  REPORT No. 37  CHROMATOGRAM=2 [illegible]
```



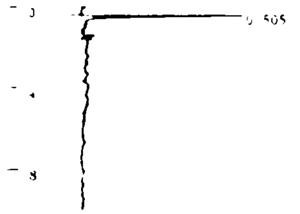
B-66-HS

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA       HEIGHT    MK  IDNO        CONC           NAME
 1    2    0.5          1645        459
                        ----       ---
        TOTAL           1645        459

C-R1A CHROMATOPAC   CH=1   REPORT No. 38   CHROMATOGRAM=2 ACCEPT   90.05.03  17:07:13
```



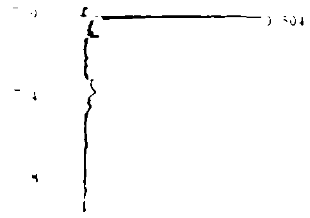
B-G2-HS

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA       HEIGHT    MK  IDNO        CONC           NAME
 1    1    0.5          1909        453
                    --- ----     ------
        TOTAL           1909        453
                                                          700
C-R1A CHROMATOPAC   CH=1   REPORT No. 39   CHROMATOGRAM=2 ACCEPT   90.05.03  17:18:26
```



B-H3-HS

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA       HEIGHT    MK  IDNO        CONC           NAME
 1    2    0.505        1572        430
                    --- ----   --- ---
        TOT             1572        430
                                                          01
C-R1A CHROMATOPAC   CH=1   REPORT No. 40   CHROMATOGRAM=2 ACCEPT   90.05.03  17:40:38
```



B-I4-HS

```
** CALCULATION REPORT **
CH PKNO    TIME         AREA       HEIGHT    MK  IDNO        CONC           NAME
 1    1    0.504        1728        474
                  ----- ----   -------
        TOTAL           1728        474
```

```
C-R4A CHROMATOPAC     CH=1    REPORT No.=41    CHROMATOGRAM=1 ACQ-OPT       90 05 03  17 56 06
```

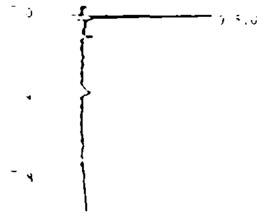
102

B-J3-HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA         HEIGHT     MK  IDNO         CONC                NAME
 1     3    0.499          1409           400
                          -----        ------                        ----
            TOTAL          1409           400                      0
```

```
C-R4A CHROMATOPAC     CH=1    REPORT No.=42    CHROMATOGRAM=1 ACQ-OPT       90 05 03  18 16 55
```

103

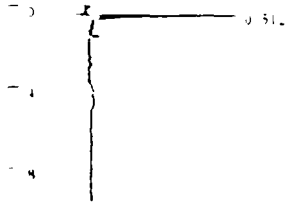


B-K2-HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA         HEIGHT     MK  IDNO         CONC                NAME


 1     3    0.51          1407           348  S
                          -----        ------                  ----
            TOTAL          1407           348                      0
```

```
C-R4A CHROMATOPAC     CH=1    REPORT No.=43    CHROMATOGRAM=1 ACQ-OPT       90 05 03  18 28 38
```

104

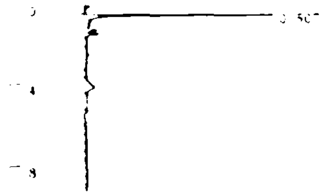


B-N3-HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA         HEIGHT     MK  IDNO         CONC                NAME
 1     4    0.512          1428           401
                          -----        ------                  ----
            TOTAL          1428           401                      0
```

```
C-R4A CHROMATOPAC     CH=1    REPORT No.=44    CHROMATOGRAM=1 ACQ-OPT       90 05 03  18 50 08
```

105

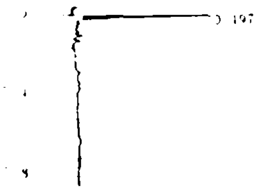


B-O2-HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA         HEIGHT     MK  IDNO         CONC                NAME
 1     2    0.507          1763           499  S
                          -----        ------                  ----
            TOTAL          1763           499                      0
```

```
C-R4A CHROMATOPAC  CH=1  REPORT No.=49  CHROMATOGRAM=1 ACCEPT
```

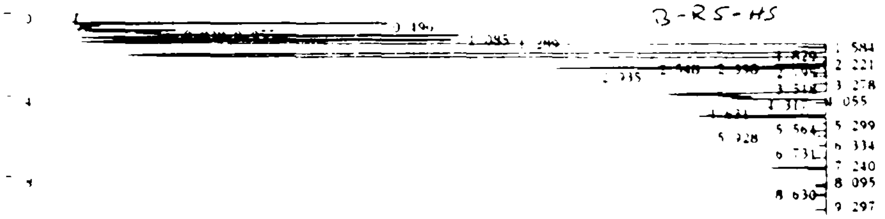
3-Q4-HS



```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT    MK  IDNO     CONC          NAME
 1    4    0.497       1480         369
                       ----      ------
        TOTAL          1480         369
```

```
C-R4A CHROMATOPAC  CH=1  REPORT No.=50  CHROMATOGRAM=1 ACCEPT      90/05/03  20:02:50
```

3-R5-HS



```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT    MK  IDNO     CONC          NAME
 1    2    0.496       2354         829
      6    0.838        960         255    V
      7    0.955        790         207    V
      8    1.085       4435         997    V
      9    1.289       4723         973    V
     10    1.584      39807        4708
     11    1.829     101486       15584    V
     12    2.221      97811       13166
     13    2.398      19033        2567    V
     14    2.548      12858        1816    V
     15    2.795      85895        9066    V
     16    2.935      59123        7090    V
     17    3.278     392290       37664    V    2   915 ~~[illegible]~~   TOLUENE       7.84
     18    3.518     219731       18701    V
     19    4.055      12061        1002    V
     20    4.317      22739        1984    V
     21    4.631     177323        8968    V
     22    5.299      50167        3337    V
     23    5.564      77736        4649    V
     24    5.928      51711        3777    V
     25    6.334    1119268       71220    V    3   4590 ~~[illegible]~~  ETHYLBENZENE  37.3

     26    6.731    2940917      175602    V    4   12060 ~~[illegible]~~ M-XYLENE      ~~St. T~~ 103
     27    7.24      133795        8101    V
     28    8.095     379643       49529    S    5   4017 ~~[illegible]~~  O-XYLENE      34.4
     29    8.63        5523         466    T
     30    9.297      18521        2278    T
                    -------      ------              ------------
        TOTAL       6660724      442534              14780.4736
```

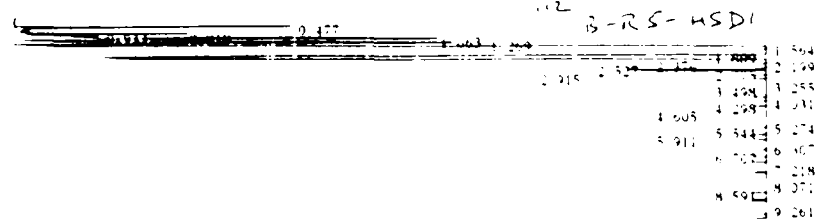
DF = 2K

Shimadzu

C-R4A CHROMATOPAC CH=1 REPORT No.=51 CHROMATOGRAM=1 [illegible] 90.05.03 20:27:22

12

B-RS-HSD1



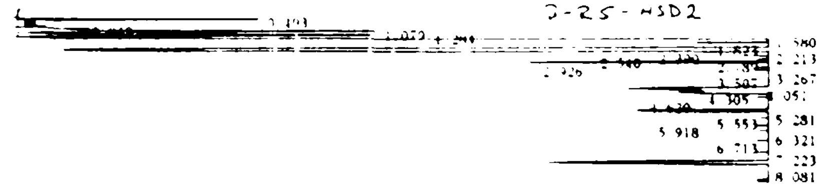
** CALCULATION REPORT **

PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME	
3	0.477	2830	736	V				
6	0.818	1367	449	V				
7	0.933	708	206	V				
8	1.063	4671	1105	V				
9	1.269	5342	1135	V				
10	1.564	49418	5871					
11	1.809	129523	17759	V				
12	2.199	127008	17485	V				
13	2.376	27749	3452	V				
14	2.527	17226	2465	V				
15	2.775	116280	12406	V				
16	2.915	79510	9545	V				
17	3.255	590637	58776	V	2	~~[illegible]~~	TOLUENE	/3
18	3.498	233377	24961	V				
19	4.031	14190	1314	V				
20	4.298	33741	2579	V				
21	4.605	250732	11838	V				
22	5.274	64933	4021	V				
23	5.544	85947	5298	V				
24	5.911	58451	4522	V				
25	6.307	1535584	99364	V	3	~~[illegible]~~	ETHYLBENZENE	519
26	6.707	3092360	236547	V	4	~~[illegible]~~	P-XYLENE	135
27	7.218	138413	8406	V				
28	8.071	1299060	65533	S	5	3626.375	O-XYLENE	479
29	8.591	4986	404	T				
30	9.261	48233	2307	T				
	TOTAL	8948302	598483			20128.8632		

DF=2X

C-R4A CHROMATOPAC CH=1 REPORT No.=52 CHROMATOGRAM=2 [illegible] 90.05.03 20:53:45

B-RS-HSD2

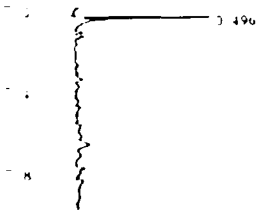


** CALCULATION REPORT **

PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME	
4	0.493	1704	641					
5	0.949	597	182					
7	1.079	4047	937	V				
8	1.284	4326	917	V				
9	1.58	41238	4907					
10	1.823	106572	14723	V				
11	2.213	104985	14406					
12	2.39	23452	2908	V				
13	2.54	13954	2121	V				
14	2.789	97981	10065	V				
15	2.926	60813	7860	V				
16	3.267	332344	30077	V	2	~~[illegible]~~	TOLUENE	6.38
17	3.507	252817	19692	SV				
18	4.051	630	85	T				
19	4.305	25565	2212	V				
20	4.62	187843	9308	V				
21	5.281	53443	3306	V				
22	5.553	70883	4203	V				
23	5.918	48360	3505	V				
24	6.321	831232	53346	V	3	2320.7[illegible]	ETHYLBENZENE	28.1
25	6.713	2057786	123297	V	4	5745.33[illegible]	P-XYLENE	69.5
26	7.223	92711	5593	V				
27	8.081	597638	30700		5	1668.505[illegible]	O-XYLENE	20.2
	TOTAL	5010926	344991			10335.6[illegible]		

DF=2X

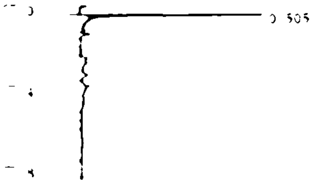
```
C-R4A CHROMATOPAC   CH=1   REPORT No =53   CHROMATOGRAM=2 [illegible]   90 05 03   21 [illegible]
```



B - S6-HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT    MK  IDNO       CONC            NAME
 1     3    0 496         1509          361
                     ---------   --------                  ----- ----
       TOTAL              1509          361                       0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =54   CHROMATOGRAM=2 #CCOP1 [illegible]   90 05 03   21 55 37
```

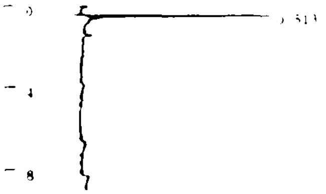


B-T9-HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT    MK  IDNO       CONC            NAME
 1     3    0 505         1498          484
                   -----------   --------           --------------
       TOTAL              1498          484                       0
```

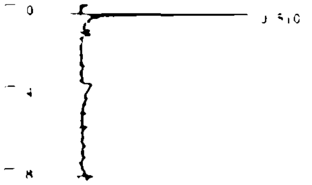
```
C-R4A CHROMATOPAC   CH=1   REPORT No =55   CHROMATOGRAM=2 #CCOP1 [illegible]   90 05 03   22 04 59
```

B - S10 - HS



```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT    MK  IDNO       CONC            NAME
 1     5    0 513         1372          483   V
                          ----        -----              ---- ---- - --
       TOTAL              1372          483                       0
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =56   CHROMATOGRAM=2 #CCOP1 C18   90 05 03   22 16 37
```

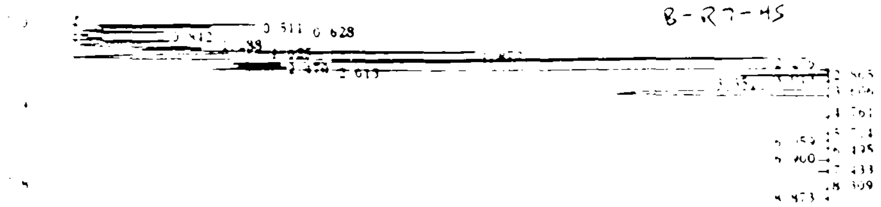


B- S8 - HS

```
** CALCULATION REPORT **
CH PKNO     TIME          AREA        HEIGHT    MK  IDNO       CONC            NAME
 1     5    0 51          1437          452
                     --   ----        -- ---              -- --- ---
       TOTAL              1437          452                       0
```

P4A CHROMATOPAC CH=1 REPORT No =57 CHROMATOGRAM=1 #CCDPI C19 90 05 03 22 26 19

B-R7-HS

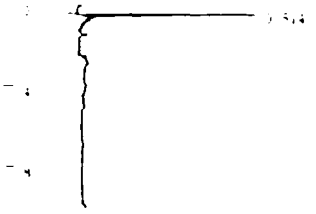


** CALCULATION REPORT **

CH PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME	
3	0.511	2708	485					
4	0.628	2549	363	V				
[illegible]	0.842	1016	236	V				
10	1.288	1531	245	V				
11	1.625	2743	321					
12	1.872	8115	1040	V				
13	2.276	12941	1678					
14	2.47	1950	299	V				
15	2.613	1432	240	V				
16	2.865	23179	2678					
17	3.013	22067	2513	V				
18	3.35	58197	4031	V	2	~~2.6295~~	TOLUENE	0.58
19	3.606	141302	12795	V				
20	4.761	224452	8868	V				
21	5.73	222273	8398	V				
22	6.159	101292	6388	V		335	[illegible]	1.67
23	6.495	52493 ~~[illegible]~~	17728	V				
24	6.9	2004857 ~~[illegible]~~	109108	V	4	5252.3896	P-XYLENE	36.2
25	7.433	267745	14760	V				
26	8.309	617396	29880				o-xyl	10.9
27	8.873	37022	2182	V				
TOTAL		3901290	223235			5357.6098		

P4A CHROMATOPAC CH=1 REPORT No =58 CHROMATOGRAM=2 #CCDPI C20 90 05 03 23 23 15

B-73-HS

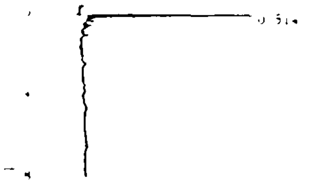


** CALCULATION REPORT **

CH PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
3	0.514	1445	477	V			
TOTAL		1445	477				

P4A CHROMATOPAC CH=1 REPORT No =59 CHROMATOGRAM=2 #CCDPI C21 90 05 03 23 34 03

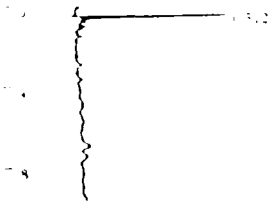
B-T5-HS



** CALCULATION REPORT **

CH PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
3	0.514	1235	449				
TOTAL		1235	449				

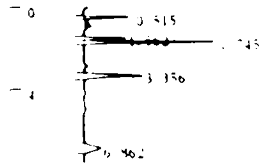
```
C-R4A CHROMATOPAC   CH=1   REPORT No =460   CHROMATOGRAM=2 @ACCUPT 022     90 05 03  23 43 25
```



B-T7-HS

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT    MK  IDNO       CONC          NAME
 1    3    0.512        1156       404
                    --------  --------              -------------
        TOTAL           1156       404                      0
```

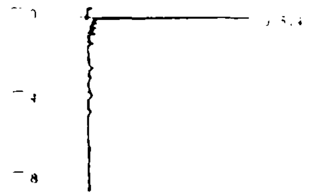
```
C-R4A CHROMATOPAC   CH=1   REPORT No =462   CHROMATOGRAM=2 @ACCUPT 024     90 05 04  00 06 55
```



BTX
STD

```
** CALCULATION REPORT **
CH PKNO    TIME        AREA      HEIGHT    MK  IDNO       CONC          NAME
 1    3    0.515         644       123
      9    1.562         623       108
     10    1.745        2038       349    V     1          2.6476    BENZENE
     13    3.356        1370       154          2          2.4768    TOLUENE
     19    6.962         774        48    V     4          2.1596    P-XYLENE
                    --------  --------              -------------
        TOTAL           5448       783                     7.284
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =463   CHROMATOGRAM=2 @ACCUPT 025     90 05 04  00 15 24
```



B-T7-HSD

```
** CALCULATION REPORT **

CH PKNO    TIME        AREA      HEIGHT    MK  IDNO       CONC          NAME
 1    3    0.514        1343       447
                    --------  --------              -------------
        TOTAL           1343       447                      0
```

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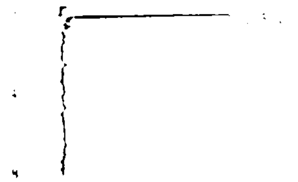
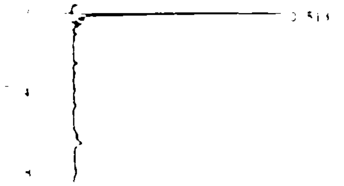
```
[illegible] CHROMATOPAC  [illegible]  REPORT No [illegible]64  [illegible]  [illegible] 25 14
```



B- F1-HS

```
** CALCULATION REPORT **
CH PKNO    TIME          AREA        HEIGHT    MK  IDNO        CONC             NAME
1    4     0.51[illegible]       1446         474
                                    ------
           TOTAL         1446         474
```

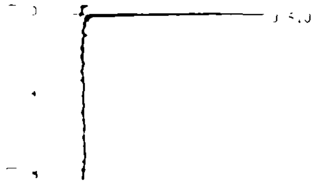
```
C-R4A CHROMATOPAC   CH=1   REPORT No =65   CHROMATOGRAM=1 [illegible] 127    90 05 04   00 34 39
```



B-D1-HS

```
** CALCULATION REPORT **
CH PKNO    TIME          AREA        HEIGHT    MK  IDNO        CONC             NAME
1    4     0.513         1987         565 S
                         ----       ------
           TOTAL         1987         565
```

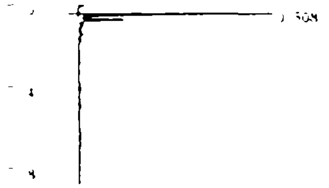
```
C-R4A CHROMATOPAC   CH=1   REPORT No =66   CHROMATOGRAM=1 [illegible]    90 05 04   00 44 28
```



B-N9-HS

```
** CALCULATION REPORT **
CH PKNO    TIME          AREA        HEIGHT    MK  IDNO        CONC             NAME
1    3     0.51          1388         478
                  -----------   -------
           TOTAL         1388         478                        0
```

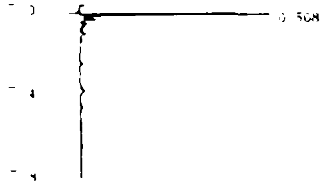
```
C-R4A CHROMATOPAC   CH=1   REPORT No =67   CHROMATOGRAM=2 [illegible]    90 05 04   00 53 57
```



B-L3-HS

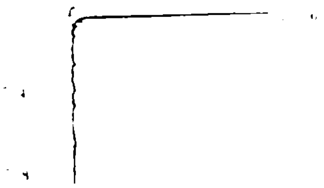
```
** CALCULATION REPORT **
CH PKNO    TIME          AREA        HEIGHT    MK  IDNO        CONC             NAME
1    2     0.508         1566         523
                  -----------   -------
           TOTAL         1566         523
```

```
C-R4A CHROMATOPAC   CH=1   REPORT No =68   CHROMATOGRAM=2 [illegible]    90 05 04   01 03 38
```



B-M2-HS

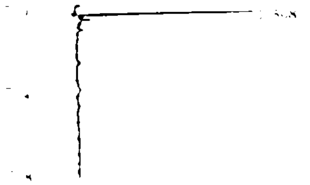
```
** CALCULATION REPORT **
CH PKNO    TIME          AREA        HEIGHT    MK  IDNO        CONC             NAME
1    2     0.508         1655         514
                                    ------
           TOTAL         1655         514
```



m - B 4 - HS

```
** CALCULATION REPORT **
CH PKNO   TIME       AREA      HEIGHT   MK  IDNO      CONC          NAME
 1    3   0.506      597        527
                               ----
          TOTAL      597        527
```

```
R1A CHROMATOGRAM      REPORT No. 70   CHROMATOGRAM=2 ACCEPT 132    90 05 04  01 22 32
```

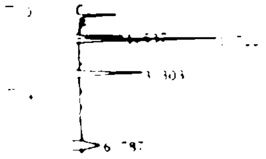


m - B 14 - HS B

```
** CALCULATION REPORT **

CH PKNO   TIME       AREA      HEIGHT   MK  IDNO      CONC          NAME
 1    4   0.508      1376       470
                                --
          TOTAL      1376       470                      0
```

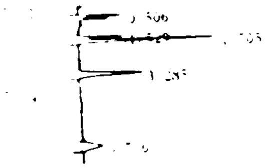
```
R1A CHROMATOGRAM      REPORT No. 71   CHROMATOGRAM=2 ACCEPT 133    90 05 04  01 32 ..
```



BTX
STD

```
** CALCULATION REPORT **
CH PKNO   TIME       AREA      HEIGHT   MK  IDNO      CONC          NAME
 1   11   1.537      654        116
     12   1.722      2078       364   V     1        2.6991    BENZENE
     14   3.303      1486       168         2        2.6863    TOLUENE
     15   6.787      663        46    S     4        1.8519    P-XYLENE
                                ---              ------ ------
          TOTAL      4881       693                  7.2373
```

```
R1A CHROMATOGRAM      REPORT No. 148   CHROMATOGRAM=2 ACCEPT ~~[illegible]~~ 105    90 05 03  .. .. ..
```



BTX
STD

```
** CALCULATION REPORT **
CH PKNO   TIME       AREA      HEIGHT   MK  IDNO      CONC          NAME
 1    3   0.506                 114
      6   1.5                   118
      2   1.7        2240       357   V     1        2.917     BENZENE
      4   3.285      1634       171   SV    2        2.9539    TOLUENE
     13   6.7        739        50    SV    4        2.310     P-XYLENE
                                ------           ------ ----
          TOTAL      6010       810                  8.1026
```

APPENDIX G

APPENDIX G

USEPA DATA FROM BAIER SITE GRIDS ON FEDLER PROPERTY

SOIL SAMPLE ANALYTICAL RESULTS (MG/KG)
DUPONT COUNTY ROAD X-23 SITE

Sample No.	Location	Depth (ft.)	Date Collected	Aluminum	Arsenic	Barium	Beryllium	Cobalt	Chromium	Copper
DSX22034	H-11	0-1	6/27/90	7200	5.1	210	ND (1.2)	15	11	ND (6.2)
DSX22035	H-11	1-2	6/27/90	15000	12	130	ND (1.2)	13	19	13
DSX22036	H-11	2-3	6/27/90	18000	14	160	ND (1.2)	ND (12)	21	17
DSX22037	I-11	0-1	6/27/90	8800	5.8	240	ND (1.2)	15	13	ND (6.2)
DSX22038	I-11	1-2	6/27/90	13000	8.5	140	ND (1.2)	18	18	10
DSX22039	I-11	2-3	6/27/90	16000	10	170	ND (1.2)	ND (12)	20	17
DSX22040	J-11	0-1	6/27/90	7700	7	260	ND (1.2)	18	11	ND (6.2)
DSX22040D	J-11	0-1	6/27/90	9000	7.4	210	ND (1.2)	16	12	ND (6.1)
DSX22041	J-11	1-2	6/27/90	15000	10	140	ND (1.2)	14	19	12
DSX22042	J-11	2-3	6/27/90	17000	12	160	ND (1.3)	ND (13)	22	17
DSX22043	K-11	0-1	6/27/90	15000	8.1	130	ND (1.2)	ND (12)	18	12
DSX22044	K-11	1-2	6/27/90	8400	6.2	220	ND (1.2)	17	12	ND (6.2)
DSX22045	K-11	2-3	6/27/90	19000	14	160	ND (1.3)	ND (13)	22	18
DSX22046	L-11	0-1	6/27/90	8900	6	280	ND (1.2)	18	13	ND (6)
DSX22047	L-11	1-2	6/27/90	13000	11	120	ND (1.2)	ND (12)	18	12
DSX22048	L-11	2-3	6/27/90	18000	12	140	ND (1.3)	ND (12)	22	18

J - The associated numerical value is an estimated quantity.

ND - Not Detected

JE1\C:LOTUS\TB4TH905

SOIL SAMPLE ANALYTICAL RESULTS (MG/KG)
DUPONT COUNTY ROAD X-23 SITE

Sample No.	Iron	Manganese	Nickel	Lead	Selenium	Vanadium	Zinc
DSX22034	11000	2300	16	19	ND (1.2)	23	47
DSX22035	22000	600	18	11	ND (1.2)	36	59
DSX22036	27000	270	20	14	ND (1.2)	38	71
DSX22037	12000	2500	14	34	ND (1.2)	25	61
DSX22038	20000	950	16	18	ND (1.2)	36	54
DSX22039	23000	150	17	11	ND (1.2)	29	60
DSX22040	12000	2800	15	38	ND (1.2)	24	49
DSX22040D	13000	2200	18	22	ND (1.2)	27	49
DSX22041	22000	770	15	19	ND (1.2)	39	58
DSX22042	25000	240	19	11	ND (1.2)	37	68
DSX22043	22000	350	12	12	ND (1.2)	33	57
DSX22044	12000	2700	16	16	ND (1.2)	25	51
DSX22045	26000	4100	19	17	ND (1.2)	34	69
DSX22046	13000	1600	18	20	ND (1.2)	26	53
DSX22047	21000	3300	14	16	ND (1.2)	35	54
DSX22048	26000	4200	16	15	ND (1.2)	36	69

J - The associated numerical value is an estimated quantity.

ND - Not Detected

JE1\C:LOTUS\TB4TH905

SOIL SAMPLE ANALYTICAL RESULTS (MG/KG)
DUPONT COUNTY ROAD X-23 SITE

Sample No.	Location	Depth (ft.)	Date Collected	Aluminum	Arsenic	Barium	Beryllium	Cobalt	Chromium	Copper
DSX22049	M-11	0-1	6/27/90	8100	5	290	ND (1.2)	18	12	ND (6)
DSX22050	M-11	1-2	6/27/90	14000	12	110	ND (1.3)	ND (13)	18	13
DSX22051	M-11	2-3	6/27/90	17000	15	120	ND (1.3)	ND (13)	21	18
DSX22052	N-11	0-1	6/28/90	6500	5.7	280	ND (1.2)	17	10	ND (6.1)
DSX22053	N-11	1-2	6/28/90	18000	8.2	130	ND (10)	14	21	ND (6.1)
DSX22054	N-11	2-3	6/28/90	19000	11	130	ND (1.3)	ND (13)	22	16
DSX22055	O-11	0-1	6/28/90	8000	6.9	370	ND (1.2)	30	11	ND (6.2)
DSX22056	O-11	1-2	6/28/90	12000	8.8	100	ND (1.2)	ND (12)	17	6.7
DSX22057	O-11	2-3	6/28/90	16000	14	140	ND (1.3)	13	20	16
DSX22058	P-11	0-1	6/28/90	9300	5.3	270	ND (1.2)	21	14	ND (6)
DSX22059	P-11	1-2	6/28/90	18000	8.5	150	ND (1.3)	ND (13)	22	ND (6)
DSX22060	P-11	2-3	6/28/90	17000	12	130	ND (1.3)	13	21	16
DSX22061	Q-11	0-1	6/28/90	8500	6.4	220	ND (1.4)	14	12	ND (6.8)
DSX22062	Q-11	1-2	6/28/90	21000	11	130	ND (1.3)	ND (13)	23	18
DSX22063	Q-11	2-3	6/28/90	21000	11	140	ND (1.3)	ND (14)	24	19
DSX22063D	Q-11	2-3	6/28/90	18000	10	110	ND (1.3)	ND (13)	21	19

J - The associated numerical value is an estimated quantity.

ND - Not Detected

JE1\C:LOTUS\TB4TH905

SOIL SAMPLE ANALYTICAL RESULTS (MG/KG)
DUPONT COUNTY ROAD X-23 SITE

Sample No.	Iron	Manganese	Nickel	Lead	Selenium	Vanadium	Zinc
DSX22049	12000	1400	15	32	ND (1.2)	25	85
DSX22050	22000	3400	15	15	ND (1.2)	32	57
DSX22051	28000	4100	16	15	ND (1.2)	34	65
DSX22052	11000	1300	10	32	ND (1.2)	22	65
DSX22053	24000	590	17	11J	ND (1.2)	46	63
DSX22054	28000	220	23	17J	ND (1.2)	40	74
DSX22055	14000	5000	21	48J	ND (1.2)	29	66
DSX22056	20000	500	15	20J	ND (1.2)	36	50
DSX22057	27000	460	19	23J	ND (1.2)	38	70
DSX22058	14000	3100	18	33J	ND (1.2)	30	62
DSX22059	23000	500	16	7.7J	ND (1.2)	44	63
DSX22060	28000	490	25	24J	ND (1.2)	37	73
DSX22061	12000	2100	16	43	ND (1.4)	27	70
DSX22062	26000	170	23	14	ND (1.3)	38	73
DSX22063	29000	330	24	14	ND (1.6)	48	76
DSX22063D	25000	170	16	13	ND (1.3)	37	71

J - The associated numerical value is an estimated quantity.
ND - Not Detected

JE1\C:LOTUS\TB4TH905

SOIL SAMPLE ANALYTICAL RESULTS (MG/KG)
DUPONT COUNTY ROAD X-23 SITE

Sample No.	Location	Depth (ft.)	Date Collected	Aluminum	Arsenic	Barium	Beryllium	Cobalt	Chromium	Copper
DSX22064	R-11	0-1	6/28/90	15000	9.7	140	ND (1.3)	14	20	13
DSX22065	R-11	1-2	6/28/90	16000	9.3	140	ND (1.3)	ND (13)	20	13
DSX22066	R-11	2-3	6/28/90	20000	14	200	ND (1.3)	ND (13)	23	18
DSX22067	S-11	0-1	6/28/90	10000	6.1	150	ND (1.2)	18	13	ND (6.1)
DSX22068	S-11	1-2	6/28/90	15000	17	130	ND (1.3)	ND (13)	18	13
DSX22069	S-11	2-3	6/28/90	16000	10	110	ND (1.2)	ND (12)	19	17
DSX22070	T-11	0-1	6/28/90	8300	6	190	ND (1.2)	16	12	ND (6.2)
DSX22071	T-11	1-2	6/28/90	16000	12	130	ND (1.2)	ND (12)	21	12
DSX22072	T-11	2-3	6/28/90	20000	12	130	ND (1.3)	ND (13)	24	22
DSX22073	I-12	0-1	7/10/90	12000	5.9	170	ND (1.2)	13	14	ND (6.2)
DSX22074	I-12	1-2	7/10/90	19000	9.1	170	ND (1.2)	ND (12)	22	ND (15)
DSX22075	I-12	2-3	7/10/90	19000	8	180	ND (1.3)	ND (13)	22	19
DSX22076	J-12	0-1	7/10/90	10000	6	180	ND (1.3)	20	14	ND (6.3)
DSX22077	J-12	1-2	7/10/90	16000	12	160	ND (1.3)	ND (13)	21	ND (16)
DSX22078	J-12	2-3	7/10/90	15000	12	160	ND (1.3)	ND (13)	19	19

J - The associated numerical value is an estimated quantity.
ND - Not Detected

SOIL SAMPLE ANALYTICAL RESULTS (MG/KG)
DUPONT COUNTY ROAD X-23 SITE

Sample No.	Iron	Manganese	Nickel	Lead	Selenium	Vanadium	Zinc
DSX22064	22000	600	14	13	ND (1.3)	40	58
DSX22065	22000	460	15	14	ND (1.3)	41	58
DSX22066	26000	160	22	13	ND (1.3)	39	69
DSX22067	14000	2000	13	20	ND (1.2)	32	45
DSX22068	23000	340	20	20	ND (1.7)	38	59
DSX22069	26000	190	21	12	ND (1.2)	35	69
DSX22070	13000	2100	16	20	ND (1.2)	27	54
DSX22071	22000	470	24	13	ND (1.2)	42	57
DSX22072	30000	240	23	14	ND (1.3)	43	74
DSX22073	14000	2000	16	27	ND (1.2)	31	45
DSX22074	24000	4200	21	21	ND (1.2)	32	67
DSX22075	24000	4400	20	21	ND (1.3)	35	71
DSX22076	14000	2000	18	18	ND (1.3)	29	47
DSX22077	25000	4000	12	24	ND (1.3)	34	61
DSX22078	25000	4000	18	13	1.5J	32	62

J – The associated numerical value is an estimated quantity.
ND – Not Detected

SOIL SAMPLE ANALYTICAL RESULTS (MG/KG)
DUPONT COUNTY ROAD X-23 SITE

Sample No.	Location	Depth (ft.)	Date Collected	Aluminum	Arsenic	Barium	Beryllium	Cobalt	Chromium	Copper
DSX22079	K-12	0-1	7/10/90	8600	5.5	240	ND (1.2)	16	11	ND (6.2)
DSX22080	K-12	1-2	7/10/90	18000	12	140	ND (1.2)	14	23	ND (14)
DSX22081	K-12	2-3	7/10/90	20000	15	180	ND (1.3)	ND (13)	25	21
DSX22082	L-12	0-1	7/10/90	10000	5.4	200	ND (1.2)	14	14	ND (6.2)
DSX22083	L-12	1-2	7/10/90	19000	9.9	180	ND (1.3)	ND (13)	22	ND (16)
DSX22084	L-12	2-3	7/10/90	2000	10	200	ND (1.3)	ND (13)	28	21
DSX22085	M-12	0-1	7/10/90	10000	6.5	220	ND (1.2)	14	14	ND (5.9)
DSX22086	M-12	1-2	7/10/90	18000	11	140	ND (1.2)	ND (12)	21	ND (9.8)
DSX22087	M-12	2-3	7/10/90	20000	14	260	ND (1.2)	ND (12)	24	20
DSX22088	N-12	0-1	7/11/90	13000	7.4	220	ND (1.2)	19	17	ND (6.1)
DSX22089	N-12	1-2	7/11/90	24000	12	160	ND (1.3)	ND (13)	27	19
DSX22090	N-12	2-3	7/11/90	21000	12	170	ND (1.3)	ND (13)	28	21
DSX22091	O-12	0-1	7/11/90	13000	7.3	240	ND (1.2)	16	18	ND (6.1)
DSX22092	O-12	1-2	7/11/90	24000	13	170	ND (1.3)	ND (13)	27	20
DSX22093	O-12	2-3	7/11/90	16000	15	190	ND (1.3)	ND (13)	20	16

J - The associated numerical value is an estimated quantity.
ND - Not Detected

JE1\C:LOTUS\TB4TH905

SOIL SAMPLE ANALYTICAL RESULTS (MG/KG)
DUPONT COUNTY ROAD X-23 SITE

Sample No.	Iron	Manganese	Nickel	Lead	Selenium	Vanadium	Zinc
DSX22079	12000	2700	15	20	ND (1.2)	26	44
DSX22080	24000	430	17	23J	ND (1.2)	43	64
DSX22081	28000	300	20	24	ND (1.3)	46	73
DSX22082	14000	2100	14	23	ND (1.2)	29	53
DSX22083	24000	190	19	23	ND (1.3)	36	72
DSX22084	26000	270	27	23	ND (1.3)	36	80
DSX22085	13000	2400	17	34J	ND (1.2)	28	49
DSX22086	23000	270	17	28	ND (1.2)	42	61
DSX22087	28000	400	22	22	ND (1.2)	42	72
DSX22088	16000	2300	13	31	ND (1.2)	35	49
DSX22089	30000	310	21	13	ND (1.3)	50	77
DSX22090	29000	290	26	20	ND (1.3)	46	77
DSX22091	16000	2600	11	29	ND (1.2)	38	55
DSX22092	30000	180	16	24	ND (1.3)	50	73
DSX22093	25000	190J	16	20J	ND (1.3)	32	67

J - The associated numerical value is an estimated quantity.
ND - Not Detected

JE1\C:LOTUS\TB4TH905

SOIL SAMPLE ANALYTICAL RESULTS (MG/KG)
DUPONT COUNTY ROAD X-23 SITE

Sample No.	Location	Depth (ft.)	Date Collected	Aluminum	Arsenic	Barium	Beryllium	Cobalt	Chromium	Copper
DSX22094	P-12	0-1	7/11/90	9400	9	130	ND (1.2)	13	14	ND (6.2)
DSX22095	P-12	1-2	7/11/90	16000	16	160	ND (1.3)	ND (13)	19	ND (12)
DSX22096	P-12	2-3	7/11/90	16000	13	180	ND (1.3)	14	21	16
DSX22097	Q-12	0-1	7/11/90	9300	7.4	160	ND (1.2)	16	13	ND (6.1)
DSX22098	Q-12	1-2	7/11/90	14000	14	160	ND (1.2)	ND (12)	18	ND (11)
DSX22099	Q-12	2-3	7/11/90	17000	13	190	ND (1.3)	16	21	16
DSX22100	R-12	0-1	7/11/90	14000	7.7	130	ND (1.4)	ND (14)	18	ND (7)
DSX22101	R-12	1-2	7/11/90	23000	15	190	ND (1.3)	ND (13)	27	17
DSX22102	R-12	2-3	7/11/90	19000	15	190	ND (1.3)	ND (13)	22	16
DSX22103	S-12	0-1	7/11/90	10000	10	170	ND (1.3)	14	13	ND (6.3)
DSX22104	S-12	1-2	7/11/90	20000	11	160	ND (1.3)	ND (13)	24	ND (11)
DSX22105	S-12	2-3	7/11/90	20000	15	200	ND (1.3)	17	24	17
DSX22106	A-5	0-1	7/11/90	9900	4.3	480	ND (1.3)	18	30	ND (6.7)
DSX22107	A-5 (I)	0-1	7/12/90	7300	6	120	ND (1.3)	ND (13)	13	ND (6.6)

J - The associated numerical value is an estimated quantity.
ND - Not Detected

JE1\C:LOTUS\TB4TH905

SOIL SAMPLE ANALYTICAL RESULTS (MG/KG)
DUPONT COUNTY ROAD X-23 SITE

Sample No.	Iron	Manganese	Nickel	Lead	Selenium	Vanadium	Zinc
DSX22094	15000	1000J	ND (9.9)	19J	1.4J	28	42
DSX22095	25000	250J	17	19J	ND (1.3)	33	67
DSX22096	26000	400J	20	17J	ND (1.3)	39	72
DSX22097	15000	1400J	12	24J	ND (1.2)	30	42
DSX22098	23000	330J	17	16J	2.6J	32	56
DSX22099	27000	520J	14	16J	ND (1.3)	36	72
DSX22100	19000	680J	16	15J	ND (1.4)	41	52
DSX22101	30000	240J	20	16J	ND (1.3)	46	83
DSX22102	25000	290J	18	18J	ND (1.3)	34	78
DSX22103	16000	1800J	11	24J	ND (1.3)	29	42
DSX22104	26000	370J	16	21J	ND (1.7)	48	66
DSX22105	28000	840J	25	18J	ND (1.3)	40	82
DSX22106	13000	1000J	ND (10)	600J	ND (1.3)	27	390
DSX22107	11000	640J	ND (10)	62J	ND (1.3)	21	63

J - The associated numerical value is an estimated quantity.
ND - Not Detected

JE1\C:LOTUS\TB4TH905

89C75831 File 4.7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 7
25 FUNSTON ROAD
KANSAS CITY KANSAS 66115

DATE: 8/27/90

MEMORANDUM

SUBJECT: Data Transmittal for Activity #: DSX22,
Site Description: Dupont County Rd X-23

FROM: Andrea Jirka
Chief, Laboratory Branch, ENSV

TO: Robert Morby
Chief, Superfund Branch, WSTM

ATTN: P. Roemerman

Attached is the data transmittal for the above referenced site. These data have met all quality assurance requirements unless indicated otherwise in a data package. This should be considered a ✓ Partial or ___ Complete data transmittal (completes transmittal of ________________). If you have any questions or comments, please contact Dee Simmons at 236-3881.

Attachments

cc: Data Files

NOTE: Please see Mary Gerken, SPFD-WSTM, if you want an electronic copy of the data.

DATA REPORTING / QUALIFICATION CODES

U - The material was analyzed for, but was not detected. The associated numerical value is the sample detection limit.

J - The associated numerical value is an estimated quantity (explanation attached).

I - The data are invalid (compound may or may not be present). Resampling and/or reanalysis is necessary for verification.

N - Sample not analyzed.

CODES FOR FLASH POINT DATA

L - The sample did not ignite or "flash". This is the highest temperature at which the sample was tested. It is possible that the material may be ignitable at higher temperatures.

K - The sample did ignite or "flash" at the lowest temperature tested. This is usually the ambient temperature at the time of the test. It is possible that the material may be ignitable at even lower temperatures.

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont Co. Rd.
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX:SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : M33

UNITS: MG/KG
CASE: 14180
DATE: 07/18/90
BASIS: WET/~~DRY WT~~

SAMPLES	DSX22034	DSX22035	DSX22036	DSX22037
ALUMINUM	7200	15000	18000	8800
ANTIMONY	12 U	15 U	15 U	15 U
ARSENIC	5.1	12	14	5.8
BARIUM	210	130	160	240
BERYLLIUM	1.0 U	1.2 U	1.2 U	1.3 U
CADMIUM	1.0 U	1.2 U	1.2 U	1.3 U
CALCIUM	2400	1200 U	1800	2600
CHROMIUM	11	19	21	13
COBALT	15	13	12 U	15
COPPER	5.0 U	13	17	6.3 U
IRON	11000	22000	27000	12000
LEAD	19	11	14	34
MAGNESIUM	1400	3300	4100	1600
MANGANESE	2300	600	270	2500
MERCURY	0.10 U	0.12 U	0.12 U	0.13 U
NICKEL	16	18	20	14
POTASSIUM	1000 U	1200 U	1200 U	1300 U
SELENIUM	1.0 U	1.2 U	1.2 U	1.3 U
SILVER	2.0 U	2.5 U	2.5 U	2.5 U
SODIUM	1000 U	1200 U	1200 U	1300 U
THALLIUM	2.0 U	2.5 U	2.5 U	2.5 U
VANADIUM	23	36	38	25
ZINC	47	59	71	61
CYANIDE	N	N	N	N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont Co. Rd.
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX: SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : M33

UNITS: MG/KG
CASE: 14180
DATE: 07/18/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22038	DSX22039	DSX22040	DSX22040D
ALUMINUM	13000	16000	7700	9000
ANTIMONY	15 U	15 U	15 U	15 U
ARSENIC	8.5	10	7.0	7.4
BARIUM	140	170	260	210
BERYLLIUM	1.2 U	1.2 U	1.2 U	1.2 U
CADMIUM	1.2 U	1.2 U	1.2 U	1.2 U
CALCIUM	1200 U	2000	1900	1800
CHROMIUM	18	20	11	12
COBALT	18	12 U	18	16
COPPER	10	17	6.2 U	6.1 U
IRON	20000	23000	12000	13000
LEAD	18	11	38	22
MAGNESIUM	3000	3800	1400	1600
MANGANESE	950	150	2800	2200
MERCURY	0.12 U	0.12 U	0.12 U	0.12 U
NICKEL	16	17	15	18
POTASSIUM	1200 U	1200 U	1200 U	1200 U
SELENIUM	1.2 U	1.2 U	1.2 U	1.2 U
SILVER	2.4 U	2.5 U	2.5 U	2.4 U
SODIUM	1200 U	1200 U	1200 U	1200 U
THALLIUM	2.4 U	2.5 U	2.5 U	2.4 U
VANADIUM	36	29	24	27
ZINC	54	60	49	49
CYANIDE	N	N	N	N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont Co. Rd.
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX:SEDIMENT
METHOD: CS0788A
REVIEWER: ____________
DATA FILE : M33

UNITS: MG/KG
CASE: 14180
DATE: 07/18/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22041		DSX22042		DSX22043		DSX22044	
ALUMINUM	15000		17000		15000		8400	
ANTIMONY	14	U	15	U	15	U	15	U
ARSENIC	10		12		8.1		6.2	
BARIUM	140		160		130		220	
BERYLLIUM	1.2	U	1.3	U	1.2	U	1.2	U
CADMIUM	1.2	U	1.3	U	1.2	U	1.2	U
CALCIUM	1200		2000		1500		1600	
CHROMIUM	19		22		18		12	
COBALT	14		13	U	12	U	17	
COPPER	12		17		12		6.2	U
IRON	22000		25000		22000		12000	
LEAD	19		11		13		20	
MAGNESIUM	3300		4000		3400		1500	
MANGANESE	770		240		350		2700	
MERCURY	0.12	U	0.13	U	0.12	U	0.12	U
NICKEL	15		19		12		16	
POTASSIUM	1300		1300	U	1200	U	1200	U
SELENIUM	1.2	U	1.3	U	1.2	U	1.2	U
SILVER	2.4	U	2.5	U	2.4	U	2.5	U
SODIUM	1200	U	1300	U	1200	U	1200	U
THALLIUM	2.4	U	2.5	U	2.4	U	2.5	U
VANADIUM	39		37		33		25	
ZINC	58		68		57		51	
CYANIDE		N		N		N		N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont Co. Rd.
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX: SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : M33

UNITS: MG/KG
CASE: 14180
DATE: 07/18/90
BASIS: WET~~/DRY WT~~

SAMPLES	DSX22045	DSX22046	DSX22047	DSX22048
LUMINUM	19000	8900	13000	18000
ANTIMONY	15 U	14 U	15 U	15 U
RSENIC	14	6.0	11	12
ARIUM	160	280	120	140
BERYLLIUM	1.3 U	1.2 U	1.2 U	1.3 U
ADMIUM	1.3 U	1.2 U	1.2 U	1.3 U
ALCIUM	2100	1600	1300	2100
CHROMIUM	22	13	18	22
COBALT	13 U	18	12 U	13 U
OPPER	18	6.0 U	12	18
RON	26000	13000	21000	26000
LEAD	17	20	16	15
AGNESIUM	4100	1600	3300	4200
ANGANESE	200	3300	440	230
MERCURY	0.13 U	0.12 U	0.12 U	0.13 U
NICKEL	19	18	14	16
OTASSIUM	1300 U	1200 U	1200 U	1300 U
ELENIUM	1.3 U	1.2 U	1.2 U	1.3 U
SILVER	2.5 U	2.4 U	2.5 U	2.5 U
ODIUM	1300 U	1200 U	1200 U	1300 U
HALLIUM	2.5 U	2.4 U	2.5 U	2.5 U
VANADIUM	34	26	35	36
INC	69	53	54	69
YANIDE	N	N	N	N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont Co. Rd.
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX: SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : M33

UNITS: MG/KG
CASE: 14180
DATE: 07/18/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22049	DSX22050	DSX22051	DSX22052
ALUMINUM	8100	14000	17000	6500
ANTIMONY	14 U	15 U	15 U	15 U
ARSENIC	5.0	12	15	5.7
BARIUM	290	110	120	280
BERYLLIUM	1.2 U	1.3 U	1.3 U	1.2 U
CADMIUM	1.2 U	1.3 U	1.3 U	2.2
CALCIUM	1500	1600	2100	1300
CHROMIUM	12	18	21	10
COBALT	18	13 U	13 U	17
COPPER	6.0 U	13	18	6.1 U
IRON	12000	22000	28000	11000
LEAD	32	15	15	32
MAGNESIUM	1400	3400	4100	1300
MANGANESE	2600	250	160	2800
MERCURY	1.2	0.13 U	0.13 U	0.12 U
NICKEL	15	15	16	10
POTASSIUM	1200 U	1300 U	1300 U	1200 U
SELENIUM	1.2 U	1.3 U	1.3 U	1.2 U
SILVER	2.4 U	2.5 U	2.5 U	2.4 U
SODIUM	1200 U	1300 U	1300 U	1200 U
THALLIUM	2.4 U	2.5 U	2.5 U	2.4 U
VANADIUM	25	32	34	22
ZINC	85	57	65	65
CYANIDE	N	N	N	N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont Co. Rd.
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX:SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : N33

UNITS: MG/KG
CASE: 14180
DATE: 07/18/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22053	DSX22054	DSX22055	DSX22056
ALUMINUM	18000	19000	8000	12000
ANTIMONY	12 U	15 U	15 U	14 U
ARSENIC	8.2	11	6.9	8.8
BARIUM	130	130	370	100
BERYLLIUM	1.0 U	1.3 U	1.2 U	1.2 U
CADMIUM	1.0 U	1.3 U	1.2 U	1.2 U
CALCIUM	1300	2000	1700	1200 U
CHROMIUM	21	22	11	17
COBALT	14	13 U	30	12 U
COPPER	11	16	6.2 U	6.7
IRON	24000	28000	14000	20000
LEAD	11 J	17 J	48 J	20 J
MAGNESIUM	3700	4500	1500	2900
MANGANESE	590	220	5000	500
MERCURY	0.10 U	0.13 U	0.12 U	0.12 U
NICKEL	17	23	21	15
POTASSIUM	1500	1300	1200 U	1200 U
SELENIUM	1.0 U	1.3 U	1.2 U	1.2 U
SILVER	2.0 U	2.5 U	2.5 U	2.4 U
SODIUM	1000 U	1300 U	1200 U	1200 U
THALLIUM	2.0 U	2.5 U	2.5 U	2.4 U
VANADIUM	46	40	29	36
ZINC	63	74	66	50
CYANIDE	N	N	N	N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont Co. Rd.
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX: SEDIMENT
METHOD: CS0788A
REVIEWER:
DATA FILE : N33

UNITS: MG/KG
CASE: 14180
DATE: 07/20/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22057	DSX22058	DSX22059	DSX22060
ALUMINUM	16000	9300	18000	17000
ANTIMONY	15 U	14 U	15 U	15 U
ARSENIC	14	5.3	8.5	12
BARIUM	140	270	150	130
BERYLLIUM	1.3 U	1.2 U	1.3 U	1.3 U
CADMIUM	1.3 U	1.2 U	1.3 U	1.3 U
CALCIUM	1800	2700	1500	2000
CHROMIUM	20	14	22	21
COBALT	13	21	13 U	13
COPPER	16	6.0 U	11	16
IRON	27000	14000	23000	28000
LEAD	23 J	33 J	7.7 J	24 J
MAGNESIUM	3800	2300	3600	4200
MANGANESE	460	3100	500	490
MERCURY	0.13 U	0.12 U	0.13 U	0.13 U
NICKEL	19	18	16	25
POTASSIUM	1300 U	1200 U	1600	1300 U
SELENIUM	1.3 U	1.2 U	1.3 U	1.3 U
SILVER	2.5 U	2.4 U	2.5 U	2.6 U
SODIUM	1300 U	1200 U	1300 U	1300 U
THALLIUM	2.5 U	2.4 U	2.5 U	2.6 U
VANADIUM	38	30	44	37
ZINC	70	62	63	73
CYANIDE	N	N	N	N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont Co. Rd.
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX:SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : M34

UNITS: MG/KG
CASE: 14180
DATE: 07/19/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22061		DSX22062		DSX22063		DSX22063D	
ALUMINUM	8500		21000		21000		18000	
ANTIMONY	16	U	15	U	16	U	16	U
ARSENIC	6.4		11		11		10	
BARIUM	220		130		140		110	
BERYLLIUM	1.4	U	1.3	U	1.4	U	1.3	U
CADMIUM	1.4	U	1.3	U	1.4	U	1.3	U
CALCIUM	2200		2000		2200		2200	
CHROMIUM	12		23		24		21	
COBALT	14		13	U	14	U	13	U
COPPER	6.8	U	18		19		19	
IRON	12000		26000		29000		25000	
LEAD	43		14		14		13	
MAGNESIUM	1700		4500		4600		4300	
MANGANESE	2100		170		330		170	
MERCURY	0.14	U	0.13	U	0.14	U	0.13	U
NICKEL	16		23		24		16	
POTASSIUM	1400	U	1300	U	1400	U	1300	U
SELENIUM	1.4	U	1.3	U	1.6	U	1.3	U
SILVER	2.7	U	2.5	U	2.7	U	2.7	U
SODIUM	1400	U	1300	U	1400	U	1300	U
THALLIUM	2.7	U	2.5	U	2.7	U	2.7	U
VANADIUM	27		38		48		37	
ZINC	70		73		76		71	
CYANIDE		N		N		N		N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont Co. Rd.
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2
MATRIX:SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : M34
UNITS: MG/KG
CASE: 14180
DATE: 07/19/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22064	DSX22065	DSX22066	DSX22067
ALUMINUM	15000	16000	20000	10000
ANTIMONY	15 U	16 U	15 U	15 U
ARSENIC	9.7	9.3	14	6.1
BARIUM	140	140	200	150
BERYLLIUM	1.3 U	1.3 U	1.3 U	1.2 U
CADMIUM	1.3 U	1.3 U	1.3 U	1.2 U
CALCIUM	1600	1600	2200	1600
CHROMIUM	20	20	23	13
COBALT	14	13 U	13 U	18
COPPER	13	13	18	6.1 U
IRON	22000	22000	26000	14000
LEAD	13	14	13	20
MAGNESIUM	3500	3500	4300	1800
MANGANESE	600	460	160	2000
MERCURY	0.13 U	0.13 U	0.13 U	0.12 U
NICKEL	14	15	22	13
POTASSIUM	1300 U	1300 U	1300 U	1200 U
SELENIUM	1.3 U	1.3 U	1.3 U	1.2 U
SILVER	2.6 U	2.6 U	2.6 U	2.4 U
SODIUM	1300 U	1300 U	1300 U	1200 U
THALLIUM	2.6 U	2.6 U	2.6 U	2.4 U
VANADIUM	40	41	39	32
ZINC	58	58	69	45
CYANIDE	N	N	N	N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont Co. Rd.
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX:SEDIMENT
METHOD: CS0788A
REVIEWER:
DATA FILE : M34

UNITS: MG/KG
CASE: 14180
DATE: 07/19/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22068	DSX22069	DSX22070	DSX22071
ALUMINUM	15000	16000	8300	16000
ANTIMONY	15 U	15 U	15 U	15 U
ARSENIC	17	10	6.0	12
BARIUM	130	110	190	130
BERYLLIUM	1.3 U	1.2 U	1.2 U	1.2 U
CADMIUM	1.3 U	1.2 U	1.2 U	1.2 U
CALCIUM	1400	2200	1700	2100
CHROMIUM	18	19	12	21
COBALT	13 U	12 U	16	12 U
COPPER	13	17	6.2 U	12
IRON	23000	26000	13000	22000
LEAD	20	12	20	13
MAGNESIUM	3600	4000	1600	3700
MANGANESE	340	190	2100	470
MERCURY	0.13 U	0.12 U	0.12 U	0.12 U
NICKEL	20	21	16	24
POTASSIUM	1300 U	1200 U	1200 U	1200 U
SELENIUM	1.7 U	1.2 U	1.2 U	1.2 U
SILVER	2.5 U	2.5 U	2.5 U	2.5 U
SODIUM	1300 U	1200 U	1200 U	1200 U
THALLIUM	2.5 U	2.5 U	2.5 U	2.5 U
VANADIUM	38	35	27	42
ZINC	59	69	54	57
CYANIDE	N	N	N	N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont Co. Rd.
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX:SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : M34

UNITS: MG/KG
CASE: 14180
DATE: 07/19/90
BASIS: WET/~~DRY WT~~

SAMPLES	DSX22072	
ALUMINUM	20000	
ANTIMONY	15	U
ARSENIC	12	
BARIUM	130	
BERYLLIUM	1.3	U
CADMIUM	1.3	U
CALCIUM	2400	
CHROMIUM	24	
COBALT	13	U
COPPER	22	
IRON	30000	
LEAD	14	
MAGNESIUM	4700	
MANGANESE	240	
MERCURY	0.13	U
NICKEL	23	
POTASSIUM	1300	U
SELENIUM	1.3	U
SILVER	2.5	U
SODIUM	1300	U
THALLIUM	2.5	U
VANADIUM	43	
ZINC	74	
CYANIDE		N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont County Road
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX: SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : M44

UNITS: MG/KG
CASE: 14180
DATE: 07/31/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22073	DSX22074	DSX22075	DSX22076
ALUMINUM	12000	19000	19000	10000
ANTIMONY	15 U	15 U	15 U	15 U
ARSENIC	5.9	9.1	8.0	6.0
BARIUM	170	170	180	180
BERYLLIUM	1.2 U	1.2 U	1.3 U	1.3 U
CADMIUM	1.2 U	1.2 U	1.3 U	1.3 U
CALCIUM	1800	1900	2100	1500
CHROMIUM	14	22	22	14
COBALT	13	12 U	13 U	20
COPPER	6.2 U	15 U	19	6.3 U
IRON	14000	24000	24000	14000
LEAD	27	21	21	18
MAGNESIUM	2000	4200	4400	2000
MANGANESE	1600	180	130	1900
MERCURY	0.12 U	0.12 U	0.13 U	0.13 U
NICKEL	16	21	20	18
POTASSIUM	1300	1300	1300	1500
SELENIUM	1.2 U	1.2 U	1.3 U	1.3 U
SILVER	2.5 U	2.4 U	2.5 U	2.5 U
SODIUM	1200 U	1200 U	1300 U	1300 U
THALLIUM	2.5 U	2.4 U	2.5 U	2.5 U
VANADIUM	31	32	35	29
ZINC	45	67	71	47
CYANIDE	N	N	N	N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont County Road
LAB: SILVER
SAMPLE PREP: ________
ANALYST/ENTRY: DEW
REVIEW LEVEL: 2
MATRIX:SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : M44
UNITS: MG/KG
CASE: 14180
DATE: 07/31/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22077		DSX22078		DSX22079		DSX22080	
ALUMINUM	16000		15000		8600		18000	
ANTIMONY	15	U	15	U	15	U	15	U
ARSENIC	12		12		5.5		12	
BARIUM	160		160		240		140	
BERYLLIUM	1.3	U	1.3	U	1.2	U	1.2	U
CADMIUM	1.3	U	1.3	U	1.2	U	1.2	U
CALCIUM	1900		2000		2100		2000	
CHROMIUM	21		19		11		23	
COBALT	13	U	13	U	16		14	
COPPER	16	U	19		6.2	U	14	U
IRON	25000		25000		12000		24000	
LEAD	24		13		20		23	J
MAGNESIUM	4000		4000		1500		4000	
MANGANESE	150		240		2700		430	
MERCURY	0.13	U	0.13	U	0.12	U	0.12	U
NICKEL	12		18		15		17	
POTASSIUM	1300	U	1300	U	1200	U	1500	
SELENIUM	1.3	U	1.5	J	1.2	U	1.2	U
SILVER	2.6	U	2.5	U	2.5	U	2.5	U
SODIUM	1300	U	1300	U	1200	U	1200	U
THALLIUM	2.6	U	2.5	U	2.5	U	2.5	U
VANADIUM	34		32		26		43	
ZINC	61		62		44		64	
CYANIDE		N		N		N		N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont County Road
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX:SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : M44

UNITS: MG/KG
CASE: 14180
DATE: 07/31/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22081	DSX22082	DSX22083	DSX22084
ALUMINUM	20000	10000	19000	20000
ANTIMONY	15 U	15 U	15 U	15 U
ARSENIC	15	5.4	9.9	10
BARIUM	180	200	180	200
BERYLLIUM	1.3 U	1.2 U	1.3 U	1.3 U
CADMIUM	1.3 U	1.2 U	1.3 U	1.3 U
CALCIUM	2200	2100	2000	2300
CHROMIUM	25	14	22	28
COBALT	13 U	14	13 U	13 U
COPPER	21	6.2 U	16 U	21
IRON	28000	14000	24000	26000
LEAD	24	23	23	23
MAGNESIUM	4500	1900	4300	4600
MANGANESE	300	2100	190	270
MERCURY	0.13 U	0.12 U	0.13 U	0.13 U
NICKEL	20	14	19	27
POTASSIUM	1500	1200 U	1300 U	1300 U
SELENIUM	1.3 U	1.2 U	1.3 U	1.3 U
SILVER	2.5 U	2.5 U	2.5 U	2.6 U
SODIUM	1300 U	1200 U	1300 U	1300 U
THALLIUM	2.5 U	2.5 U	2.5 U	2.6 U
VANADIUM	46	29	36	36
ZINC	73	53	72	80
CYANIDE	N	N	N	N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont County Road		MATRIX:SEDIMENT	UNITS: MG/KG
LAB: SILVER		METHOD: CS0788A	CASE: 14180
SAMPLE PREP: ________	ANALYST/ENTRY: DEW	REVIEWER: ________	DATE: 07/31/90
REVIEW LEVEL: 2		DATA FILE : M44	BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22085	DSX22086	DSX22087	DSX22088
ALUMINUM	10000	18000	20000	13000
ANTIMONY	14 U	15 U	15 U	15 U
ARSENIC	6.5	11	14	7.4
BARIUM	220	140	260	220
BERYLLIUM	1.2 U	1.2 U	1.2 U	1.2 U
CADMIUM	1.2 U	1.2 U	1.2 U	1.2 U
CALCIUM	1600	1400	2100	1500
CHROMIUM	14	21	24	17
COBALT	14	12 U	12 U	19
COPPER	5.9 U	9.8 U	20	6.1 U
IRON	13000	23000	28000	16000
LEAD	34 J	28	22	31
MAGNESIUM	1800	3800	4500	2300
MANGANESE	2400	270	400	2300
MERCURY	0.12 U	0.12 U	0.12 U	0.12 U
NICKEL	17	17	22	13
POTASSIUM	1200 U	1500	1300	1200
SELENIUM	1.2 U	1.2 U	1.2 U	1.2 U
SILVER	2.4 U	2.4 U	2.5 U	2.4 U
SODIUM	1200 U	1200 U	1200 U	1200 U
THALLIUM	2.4 U	2.4 U	2.5 U	2.4 U
VANADIUM	28	42	42	35
ZINC	49	61	72	49
CYANIDE	N	N	N	N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont County Road	MATRIX:SEDIMENT	UNITS: MG/KG
LAB: SILVER	METHOD: CS0788A	CASE: 14180
SAMPLE PREP: ________ ANALYST/ENTRY: DEW	REVIEWER: ________	DATE: 07/31/90
REVIEW LEVEL: 2	DATA FILE : M44	BASIS: WET/~~DRY WT~~

SAMPLES	DSX22089		DSX22090		DSX22091		DSX22092	
LUMINUM	24000		21000		13000		24000	
ANTIMONY	15	U	15	U	15	U	15	U
RSENIC	12		12		7.3		13	
ARIUM	160		170		240		170	
ERYLLIUM	1.3	U	1.3	U	1.2	U	1.3	U
CADMIUM	1.3	U	1.3	U	1.2	U	1.3	U
ALCIUM	1800		2200		1600		2000	
HROMIUM	27		28		18		27	
COBALT	13	U	13	U	16		13	U
OPPER	19		21		6.1	U	20	
RON	30000		29000		16000		30000	
LEAD	13		20		29	J E.W.	24	
MAGNESIUM	5100		4800		2200		5000	
ANGANESE	310		290		2600		180	
ERCURY	0.13	U	0.13	U	0.12	U	0.13	U
NICKEL	21		26		11		16	
OTASSIUM	1600		1400		1200		1500	
ELENIUM	1.3	U	1.3	U	1.2	U	1.3	U
SILVER	2.5	U	2.5	U	2.4	U	2.5	U
ODIUM	1300	U	1300	U	1200	U	1300	U
HALLIUM	2.5	U	2.5	U	2.4	U	2.5	U
VANADIUM	50		46		38		50	
ZINC	77		77		55		73	
YANIDE		N		N		N		N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont County Road
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2
MATRIX:SEDIMENT
METHOD: CS0788A
REVIEWER: ✓
DATA FILE : M43
UNITS: MG/KG
CASE: 14180
DATE: 07/30/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22093		DSX22094		DSX22095		DSX22096	
LUMINUM	16000		9400		16000		16000	
ANTIMONY	15	U	15	U	16	U	15	U
RSENIC	15		9.0		16		13	
ARIUM	190		130		160		180	
BERYLLIUM	1.3	U	1.2	U	1.3	U	1.3	U
ADMIUM	1.3	U	1.2	U	1.3	U	1.3	U
ALCIUM	2100		2200		2200		2300	
HROMIUM	20		14		19		21	
COBALT	13	U	13		13	U	14	
OPPER	16		6.2	U	12	U	16	
RON	25000		15000		25000		26000	
LEAD	20	J	19	J	19	J	17	J
AGNESIUM	4000		2200		3900		4200	
ANGANESE	190	J	1000	J	250	J	400	J
MERCURY	0.13	U	0.12	U	0.13	U	0.13	U
NICKEL	16		9.9	U	17		20	
OTASSIUM	1300	U	1200	U	1300	U	1300	
ELENIUM	1.3	U	1.4	J	1.3	U	1.3	U
SILVER	2.5	U	2.5	U	2.6	U	2.5	U
ODIUM	1300	U	1200	U	1300	U	1300	U
HALLIUM	2.5	U	2.5	U	2.6	U	2.5	U
VANADIUM	32		28		33		39	
INC	67		42		67		72	
YANIDE		N		N		N		N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont County Road
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX:SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : M43

UNITS: MG/KG
CASE: 14180
DATE: 07/30/90
BASIS: WET/[✓ DRY] WT

SAMPLES	DSX22097		DSX22098		DSX22099		DSX22100	
ALUMINUM	9300		14000		17000		14000	
ANTIMONY	15	U	15	U	15	U	17	U
ARSENIC	7.4		14		13		7.7	
BARIUM	160		160		190		130	
BERYLLIUM	1.2	U	1.2	U	1.3	U	1.4	U
CADMIUM	1.2	U	1.2	U	1.3	U	1.4	U
CALCIUM	2100		1900		2300		1600	
CHROMIUM	13		18		21		18	
COBALT	16		12	U	16		14	U
COPPER	6.1	U	11	U	16		7.0	U
IRON	15000		23000		27000		19000	
LEAD	24	J	16	J	16	J	15	J
MAGNESIUM	2000		3500		4200		2900	
MANGANESE	1400	J	330	J	520	J	680	J
MERCURY	0.12	U	0.12	U	0.13	U	0.14	U
NICKEL	12		17		14		16	
POTASSIUM	1200	U	1200	U	1300	U	1400	U
SELENIUM	1.2	U	2.6	J	1.3	U	1.4	U
SILVER	2.4	U	2.5	U	2.6	U	2.8	U
SODIUM	1200	U	1200	U	1300	U	1400	U
THALLIUM	2.4	U	2.5	U	2.6	U	2.8	U
VANADIUM	30		32		36		41	
ZINC	42		56		72		52	
CYANIDE		N		N		N		N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont County Road
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX: SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : M43

UNITS: MG/KG
CASE: 14180
DATE: 07/30/90
BASIS: WET/[✓ DRY WT]

SAMPLES	DSX22101	DSX22102	DSX22103	DSX22104
ALUMINUM	23000	19000	10000	20000
ANTIMONY	16 U	15 U	15 U	16 U
ARSENIC	15	15	10	11
ARIUM	190	190	170	160
BERYLLIUM	1.3 U	1.3 U	1.3 U	1.3 U
CADMIUM	1.3 U	1.3 U	1.3 U	1.3 U
CALCIUM	2100	2200	1400	1600
CHROMIUM	27	22	13	24
COBALT	13 U	13 U	14	13 U
COPPER	17	16	6.3 U	11 U
IRON	30000	25000	16000	26000
LEAD	16 J	18 J	24 J	21 J
MAGNESIUM	4900	4300	2200	4200
MANGANESE	240 J	290 J	1800 J	370 J
MERCURY	0.13 U	0.13 U	0.13 U	0.13 U
NICKEL	20	18	11	16
POTASSIUM	1400	1300 U	1300 U	1600
SELENIUM	1.3 U	1.3 U	1.3 U	1.7 J
SILVER	2.6 U	2.6 U	2.5 U	2.6 U
SODIUM	1300 U	1300 U	1300 U	1300 U
THALLIUM	2.6 U	2.6 U	2.5 U	2.6 U
VANADIUM	46	34	29	48
ZINC	83	78	42	66
CYANIDE	N	N	N	N

ANALYSIS TYPE: METALS, TOTAL

TITLE: DuPont County Road
LAB: SILVER
SAMPLE PREP: ________ ANALYST/ENTRY: DEW
REVIEW LEVEL: 2

MATRIX:SEDIMENT
METHOD: CS0788A
REVIEWER: ________
DATA FILE : m43

UNITS: MG/KG
CASE: 14180
DATE: 07/31/90
BASIS: WET~~/DRY WT~~

SAMPLES	DSX22105	DSX22106	DSX22107
ALUMINUM	20000	9900	7300
ANTIMONY	16 U	15 U	16 U
ARSENIC	15	4.3	6.0
BARIUM	200	480	120
BERYLLIUM	1.3 U	1.3 U	1.3 U
CADMIUM	1.3 U	8.0	1.3 U
CALCIUM	2200	1300 U	1300 U
CHROMIUM	24	30	13
COBALT	17	18	13 U
COPPER	17	6.7 U	6.6 U
IRON	28000	13000	11000
LEAD	18 J	600 J	62 J
MAGNESIUM	4700	1600	1300 U
MANGANESE	840 J	1000 J	640 J
MERCURY	0.13 U	0.13 U	0.13 U
NICKEL	25	10 U	10 U
POTASSIUM	1500	1300 U	1300 U
SELENIUM	1.3 U	1.3 U	1.3 U
SILVER	2.6 U	2.5 U	2.6 U
SODIUM	1300 U	1300 U	1300 U
THALLIUM	2.6 U	2.5 U	2.6 U
VANADIUM	40	27	21
ZINC	82	390	63
CYANIDE	N	N	N

U.S. ENVIRONMENTAL PROTECTION AGENCY

ENVIRONMENTAL SERVICES ASSISTANCE TEAM -- Zone II

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NSI Technology Services Corp.

The Bionetics Corp.

ESAT Region VII
NSI Technology Services
25 Funston Road
Kansas City, KS 66115
(913) 236-3881

TO: Debra Morey
Data Review Task Monitor
THRU: Harold Brown, Ph.D.
ESAT Deputy Project Officer, EPA

FROM: D. Eric Woodland
ESAT Data Reviewer
THRU: Ronald A. Ross
ESAT Team Manager

DATE: July 19, 1990
SUBJECT: Review of inorganic data for DuPont County Rd.

TID# 07-9003-329
ASSIGNMENT# 533A
ICF ACCT# 26-329-02
NSI S.O.# 4633-3292

These data were reviewed primarily according to the "Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses," July 1988 revision with changes given in the Region VII Inorganic Data Review Training Manual and EPA memoranda.

The following comments and attached data sheets are a result of the ESAT review, according to EPA policies, of the following data from the contract laboratory.

CASE NO.: 14180
SITE: DuPont Co. Rd.
REVIEWER: D. Eric Woodland

LABORATORY: SILVER
METHOD NO.: CS0788A
EPA ACTIVITY NO.: DSX22
MATRIX: SOIL

TOTAL METALS		TOTAL METALS	
SMO Sample No.	EPA Sample No.	SMO Sample No.	EPA Sample No.
MGG121	DSX22034	MGG814	DSX22043
MGG122	DSX22035	MGG815	DSX22044
MGG123	DSX22036	MGG816	DSX22045
MGG124	DSX22037	MGG817	DSX22046
MGG125	DSX22038	MGG818	DSX22047
MGG809	DSX22039	MGG819	DSX22048
MGG810	DSX22040	MGG820	DSX22049
MGG811	DSX22040D	MGG821	DSX22050
MGG812	DSX22041	MGG822	DSX22051
MGG813	DSX22042	MGG823	DSX22052

GENERAL

This data review assignment covers TWENTY SOIL samples analyzed for TOTAL METALS for case number 14180. There was one field duplicate and no field blanks or performance samples included with this assignment.

1. Technical Holding Times / Preservation

Technical holding times are not defined for soil samples.

2. Initial and Continuing Calibration

All percent recoveries were within control limits.

3. Blanks

Several analytes were detected in the blanks. Corresponding sample results were qualified according to the blank rule using five times the highest blank value. Sample results requiring modification are reported as non-detect on the attached data sheets.

TOTAL METALS
(SOIL)

Analyte	5 x Highest Blank (mg/kg)	Qualified Samples
Al	55	None qualified
Ca	67	None qualified
Cu	3.6	DSX22040,-040D,-044,-049 and -052
Fe	51	None qualified
Mg	69	None qualified
Tl	2.4	DSX22034,-035,-036,-038,-039,-041, -043,-047,-048,-049,-050,-051 & -052

4. ICP Interference Check

Recoveries of solution AB analytes were within control limits.

5. Laboratory Control Standard (LCS)

LCS results were within established control limits.

6. Duplicates

The RPDs for all analytes were within control limits.

7. Matrix Spike Sample

Sb and Se were out of range for matrix spike recovery. All results for these samples were non-detect, so no coding was necessary.

8. ICP Serial Dilution

All results were within limits.

9. Furnace Atomic Absorption

The analytical scheme was followed for Furnace AA analysis. MSA correlation coefficients were acceptable.

10. Summary

Several results for Cu and Tl were qualified according to the blank rule. No other sample results were coded.

This data package is acceptable in terms of requirements for accuracy, precision, and completeness as described in SOP 9561M00.

U.S. ENVIRONMENTAL PROTECTION AGENCY

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(913) 236-3881

TO: Debra Morey
Data Review Task Monitor
THRU: Harold Brown, Ph.D.
ESAT Deputy Project Officer, EPA

FROM: D. Eric Woodland
ESAT Data Reviewer
THRU: Ronald A. Ross
ESAT Team Manager

DATE: July 19, 1990
SUBJECT: Review of inorganic data for DuPont County Rd.

TID# 07-9003-329
ASSIGNMENT# 533B
ICF ACCT# 26-329-02
NSI S.O.# 4633-3292

These data were reviewed primarily according to the "Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses," July 1988 revision with changes given in the Region VII Inorganic Data Review Training Manual and EPA memoranda.

The following comments and attached data sheets are a result of the ESAT review, according to EPA policies, of the following data from the contract laboratory.

CASE NO.: 14180
SITE: DuPont Co. Rd.
REVIEWER: D. Eric Woodland

LABORATORY: SILVER
METHOD NO.: CS0788A
EPA ACTIVITY NO.: DSX22
MATRIX: SOIL

TOTAL METALS

SMO Sample No.	EPA Sample No.
MGG824	DSX22053
MGG825	DSX22054
MGG826	DSX22055
MGG827	DSX22056
MGG828	DSX22057
MGG829	DSX22058
MGG830	DSX22059
MGG831	DSX22060

GENERAL

This data review assignment covers EIGHT SOIL samples analyzed for TOTAL METALS for case number 14180. There were no field duplicates, field blanks or performance samples included with this assignment.

1. Technical Holding Times / Preservation

Technical holding times are not defined for soil samples.

2. Initial and Continuing Calibration

All percent recoveries were within control limits.

3. Blanks

Several analytes were detected in the blanks. Corresponding sample results were qualified according to the blank rule using five times the highest blank value. Sample results requiring modification are reported as non-detect on the attached data sheets.

TOTAL METALS
(SOIL)

Analyte	5 x Highest Blank (mg/kg)	Qualified Samples
Al	55	None qualified
As	2.4	None qualified
Fe	18	None qualified
Pb	1.8	None qualified
Mn	5.2	None qualified

4. ICP Interference Check

Recoveries of solution AB analytes were within control limits.

5. Laboratory Control Standard (LCS)

LCS results were within established control limits.

6. Duplicates

The RPDs for all analytes were within control limits.

7. Matrix Spike Sample

Sb and Pb were out of range for matrix spike recovery. All Sb results for these samples were non-detect, so no coding was necessary. All Pb results were J coded.

8. ICP Serial Dilution

All results were within limits.

9. Furnace Atomic Absorption

The analytical scheme was followed for Furnace AA analysis. MSA correlation coefficients were acceptable.

10. Summary

All sample results for Pb were J coded because of the matrix spike recovery. No other sample results were coded.

This data package is acceptable in terms of requirements for accuracy, precision, and completeness as described in SOP 9561M00.

U.S. ENVIRONMENTAL PROTECTION AGENCY

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Data Review Task Monitor
THRU: Harold Brown, Ph.D.
ESAT Deputy Project Officer, EPA

FROM: D. Eric Woodland
ESAT Data Reviewer
THRU: Ronald A. Ross
ESAT Team Manager

DATE: July 19, 1990
SUBJECT: Review of inorganic data for DuPont County Road.

TID# 07-9003-329
ASSIGNMENT# 534
ICF ACCT# 26-329-02
NSI S.O.# 4633-3292

These data were reviewed primarily according to the "Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses," July 1988 revision with changes given in the Region VII Inorganic Data Review Training Manual and EPA memoranda.

The following comments and attached data sheets are a result of the ESAT review, according to EPA policies, of the following data from the contract laboratory.

CASE NO.: 14180
SITE: DuPont Co. Rd.
REVIEWER: D. Eric Woodland

LABORATORY: SILVER
METHOD NO.: CS0788A
EPA ACTIVITY NO.: DSX22
MATRIX: SOIL

SMO Sample No.	EPA Sample No.	SMO Sample No.	EPA Sample No.
MGH603	DSX22061	MGH610	DSX22067
MGH604	DSX22062	MGH611	DSX22068
MGH605	DSX22063	MGH612	DSX22069
MGH606	DSX22063D	MGH613	DSX22070
MGH607	DSX22064	MGH614	DSX22071
MGH608	DSX22065	MGH615	DSX22072
MGH609	DSX22066		

GENERAL

This data review assignment covers THIRTEEN SOIL samples analyzed for TOTAL METALS for case number 14180. There was one field duplicate and no field blanks or performance samples included with this assignment.

1. Technical Holding Times / Preservation

Technical holding times were observed for all analytes.

2. Initial and Continuing Calibration

All percent recoveries were within control limits.

3. Blanks

Fe and Se were detected in the blanks. DSX22062,-063,-063D, -067 to 070 and -072 were qualified for Se. No Fe results were qualified.

4. ICP Interference Check

Recoveries of solution AB analytes were within control limits.

5. Laboratory Control Standard (LCS)

LCS results were within established control limits.

6. Duplicates

The RPDs for all analytes were within control limits.

7. Matrix Spike Sample

The percent recovery for Sb and Se were outside control limits. All results for these analytes were non-detect or qualified by the blank rule, so no results were qualified by the matrix spike recoveries.

8. ICP Serial Dilution

All results were within limits.

9. Furnace Atomic Absorption

The analytical scheme was followed for Furnace AA analysis. Some MSA correlation coefficient were outside the control limit. These results were qualified by the blank rule, so no further coding was performed.

10. Summary

Several results were qualified by the blank rule for Se. No other coding was necessary.

This data package is acceptable in terms of requirements for accuracy, precision, and completeness as described in SOP 9561M00.

U.S. ENVIRONMENTAL PROTECTION AGENCY

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TO: Debra Morey
Data Review Task Monitor
THRU: Harold Brown, Ph.D.
ESAT Deputy Project Officer, EPA

FROM: D. Eric Woodland
ESAT Data Reviewer
THRU: Ronald A. Ross
ESAT Team Manager

DATE: July 31, 1990
SUBJECT: Review of inorganic data for DuPont County Road.

TID# 07-9003-329
ASSIGNMENT# 544
ICF ACCT# 26-329-02
NSI S.O.# 4633-3292

These data were reviewed primarily according to the "Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses," July 1988 revision with changes given in the Region VII Inorganic Data Review Training Manual and EPA memoranda.

The following comments and attached data sheets are a result of the ESAT review, according to EPA policies, of the following data from the contract laboratory.

CASE NO.: 14180
SITE: DuPont County Road
REVIEWER: D. Eric Woodland
LABORATORY: SILVER
METHOD NO.: CS0788A
EPA ACTIVITY NO.: DSX22
MATRIX: SOIL

TOTAL METALS

SMO Sample No.	EPA Sample No.	SMO Sample No.	EPA Sample No.
MGG848	DSX22073	MGG858	DSX22083
MGG849	DSX22074	MGG859	DSX22084
MGG850	DSX22075	MGG860	DSX22085
MGG851	DSX22076	MGG861	DSX22086
MGG852	DSX22077	MGG862	DSX22087
MGG853	DSX22078	MGG863	DSX22088
MGG854	DSX22079	MGG864	DSX22089
MGG855	DSX22080	MGG865	DSX22090
MGG856	DSX22081	MGG866	DSX22091
MGG857	DSX22082	MGG867	DSX22092

GENERAL

This data review assignment covers TWENTY SOIL samples analyzed for TOTAL METALS for case number 14180. There were no field blanks, field duplicates or performance samples included with this assignment.

1. Technical Holding Times / Preservation

Technical holding times have not been established for soil samples.

2. Initial and Continuing Calibration

All percent recoveries were within control limits.

3. Blanks

Several analytes were detected in the blanks. Corresponding sample results were qualified according to the blank rule using five times the highest blank value. Results reported less than the CRDL by the lab were first raised to the CRDL and coded U in accordance with EPA reporting procedures. Sample results requiring modification are reported as non-detect on the attached data sheets.

TOTAL METALS
(WATER)

Analyte	5 X Highest Blank (ug/L)	Qualified Samples
Sb	39	None qualified
As	2.8	None qualified
Be	1.3	None qualified
Cr	7.4	None qualified
Cu	17	DSX22074,-077,-080,-083 and -086
Pb	1.9	None qualified
K	950	None qualified
Ag	5.0	None qualified
Zn	5.3	None qualified

4. ICP Interference Check

Recoveries of solution AB analytes were within control limits.

5. Laboratory Control Standard (LCS)

LCS results were within established control limits.

6. Duplicates

The RPDs were all within established control limits.

7. Matrix Spike Sample

Sb and Se were out of range for matrix spike recovery. DSX22078 was qualified for Se.

8. ICP Serial Dilution

All results were within limits.

9. Furnace Atomic Absorption

MSA correlation coefficients were out of control limits for DSX22080 and -085 for Pb. Both of these results were J coded.

10. Summary

Some Cu results were qualified by the blank rule. Some results for Pb were qualified by MSA outliers. DSX22078 was J coded for Se by matrix spike recovery outliers.

U.S. ENVIRONMENTAL PROTECTION AGENCY

ENVIRONMENTAL SERVICES ASSISTANCE TEAM -- Zone II

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THRU: Harold Brown, Ph.D.
ESAT Deputy Project Officer, EPA

FROM: D. Eric Woodland
ESAT Data Reviewer
THRU: Ronald A. Ross
ESAT Team Manager

DATE: July 31, 1990
SUBJECT: Review of inorganic data for DuPont County Road.

TID# 07-9003-329
ASSIGNMENT# 543
ICF ACCT# 26-329-02
NSI S.O.# 4633-3292

These data were reviewed primarily according to the "Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses," July 1988 revision with changes given in the Region VII Inorganic Data Review Training Manual and EPA memoranda.

The following comments and attached data sheets are a result of the ESAT review, according to EPA policies, of the following data from the contract laboratory.

CASE NO.: 14180
SITE: DuPont County Road
REVIEWER: D. Eric Woodland

LABORATORY: SILVER
METHOD NO.: CS0788A
EPA ACTIVITY NO.: DSX22
MATRIX: SOIL

TOTAL METALS

SMO Sample No.	EPA Sample No.	SMO Sample No.	EPA Sample No.
MGG868	DSX22093	MGG876	DSX22101
MGG869	DSX22094	MGG877	DSX22102
MGG870	DSX22095	MGG878	DSX22103
MGG871	DSX22096	MGG879	DSX22104
MGG872	DSX22097	MGG880	DSX22105
MGG873	DSX22098	MGG881	DSX22106
MGG874	DSX22099	MGG882	DSX22107
MGG875	DSX22100		

GENERAL

This data review assignment covers FIFTEEN SOIL samples analyzed for TOTAL METALS for case number 14180. There were no field blanks, field duplicates or performance samples included with this assignment.

1. Technical Holding Times / Preservation

Technical holding times have not been established for soil samples.

2. Initial and Continuing Calibration

All percent recoveries were within control limits.

3. Blanks

Several analytes were detected in the blanks. Corresponding sample results were qualified according to the blank rule using five times the highest blank value. Results reported less than the CRDL by the lab were first raised to the CRDL and coded U in accordance with EPA reporting procedures. Sample results requiring modification are reported as non-detect on the attached data sheets.

TOTAL METALS
(WATER)

Analyte	5 X Highest Blank (ug/L)	Qualified Samples
Al	56	None qualified
Ca	66	None qualified
Cr	7.0	None qualified
Cu	15	DSX22095, -098, -104 and -106
Fe	47	None qualified
Mg	80	None qualified
K	950	None qualified
Ag	4.3	None qualified
Zn	7.1	None qualified

4. ICP Interference Check

Recoveries of solution AB analytes were within control limits.

5. Laboratory Control Standard (LCS)

LCS results were within established control limits.

6. Duplicates

The RPD for Pb exceeded control limits. All sample results were J coded.

7. Matrix Spike Sample

Sb, Mn and Se were out of range for matrix spike recovery. All samples had data qualified for Mn and DSX33094,-098 and -104 were qualified for Se.

8. ICP Serial Dilution

All results were within limits.

9. Furnace Atomic Absorption

MSA correlation coefficients were out of control limits for DSX22093 and -107 for Se. Both results were less than the CRDL, so no coding was necessary.

10. Summary

Some Cu results were qualified by the blank rule. All results for Mn and some results for Se were qualified for matrix spike recovery outliers. All Pb results were coded J for a duplicate precision outlier.

APPENDIX H

RISK ASSESSMENT

BASELINE RISK ASSESSMENT

FOR THE

BAIER SITE AND MCCARL SITE
LEE COUNTY, IOWA

JANUARY 16, 1991

PREPARED FOR:

E. I. du Pont de Nemours & Company
Wilmington, Delaware 19898

PREPARED BY:

WOODWARD-CLYDE CONSULTANTS
5055 ANTIOCH ROAD
OVERLAND PARK, KANSAS 66203

WCC PROJECT 89C7583-1

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0.0 EXECUTIVE SUMMARY

A baseline risk assessment (RA) was performed to evaluate the potential risks to human health posed by soil and ground water contamination at the McCarl and Baier sites. The term baseline refers to the fact that the evaluation of risks is made for the sites in their unremediated state. The results of the RA were used in evaluating potential remedial alternatives for the sites, including the no-action scenario.

The RA was performed using guidance provided in the Risk Assessment Guidance for Superfund, Volume I; Human Health Evaluation manual (Part A) (USEPA, 1989). Other relevant guidance documents used include the Superfund Exposure Assessment Manual (USEPA, 1988) and the Exposure Factors Handbook (USEPA, 1989). Environmental data and site information obtained during the remedial investigation were used in the RA. In addition, the RA made use of recent toxicology literature and USEPA data bases, including the Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST).

An ecological assessment was also performed as a companion to the RA. The purpose of this assessment was to qualitatively evaluate the potential effects of the site contaminants on environmental receptors at the sites. An executive summary is presented in Appendix G which contains the ecological assessment report.

Two major classes of contaminants were identified in soils and ground water at both sites during the remedial investigation. The contaminants, including metals and volatile organic compounds (VOCs), were detected in discrete areas of each site that were apparently associated with past waste disposal activities. However, surficial soils at both sites were found to contain only metals. This is consistent with the fate and transport characteristics of VOCs since these compound would volatilize from surface soils over an extended period of time. Ground water at both sites was generally found to contain only metals (both primary and secondary drinking water metals) although a single monitoring well on the Baier site was found to contain VOCs. This suggests the presence of a localized source of VOCs in Baier ground water.

An analysis of potential exposure pathways at the sites indicated that surface soil is the medium with the greatest potential for human exposures. Thus, persons entering either site could be exposed to contaminant metals through incidental ingestion of soil or through dermal contact with surface soils. The evaluation of potential exposures also revealed that the potential for fugitive dust emission at either site is low. Therefore, the exposure pathway linking soil contaminants and human populations through fugitive dust appears incomplete.

The ground water ingestion pathway does not appear to be complete because the characteristics of the water-bearing units are not capable of supplying sufficient drinking water. Therefore, the potential for health risks was not evaluated under conditions of current site use. However, a hypothetical scenario for ground water ingestion was evaluated as a potential future use of ground water at the Baier and McCarl sites. Although some ground water may appear at the surface via seeps, the extent and rate of seepage is not sufficient to create a potential for human exposures. Moreover, the seepages do not result in ponding of water. Thus, exposure to surface water was not considered a complete pathway at the sites.

The RA evaluated potential exposures and health risks for several groups of persons who may enter the site as a result of certain recreational or occupational activities. Because of the rural nature of the site, it was assumed that hunters (both adult and juvenile) may enter the site at various times of the year. Persons involved in collecting wild edibles such as mushrooms and/or berries were also accounted for in the exposure scenarios. Under this scenario, it was assumed that both an adult or child could be assumed to take part in the activity. Persons who might pass through the sites while hiking were evaluated in the exposure assessment. Finally, the assumption was made that a farmer might enter the sites from surrounding farmland to cut back brush or trees, etc. These exposure scenarios represent the range of activities and receptors that may likely enter the sites under current land use conditions. Future use evaluations were limited to hypothetical ground water ingestion because these two sites are located several miles from a small town and thus represent very remote sites that may or may not be developed for residential use.

The RA focused on two separate groups of contaminant metals for the Baier and McCarl sites, respectively. The contaminants of concern selected for the Baier site included arsenic, chromium, cadmium, lead, and selenium. The selection of these contaminants was based on the results of soil sampling activities conducted by Woodward-Clyde Consultants pursuant to the Removal Action Work Plan (Woodward-Clyde Consultants, October 1989) and corroborated by the RI. The contaminants of concern selected for the McCarl site included the five selected for the Baier site plus barium, copper, manganese, and zinc.

Exposure point concentrations were developed using data obtained from surficial soil samples. Potential health risks were evaluated for two levels of exposure: a representative level (i.e., the arithmetic contaminant mean) and a reasonable maximum exposure (RME; i.e., the upper 95th confidence limit of the arithmetic mean used as a worst-case level of exposure).

Characterization of potential cancer risks posed by both sites indicated that the estimated risks were in the range of 10^{-9} to 10^{-7} for all exposure scenarios except the farmer at the Baier site. The estimated cancer risks for this scenario were on the order of 10^{-6} at the RME level of exposure. Thus, all of the potential cancer risks estimated for both sites were at or below the USEPA advisory range of 10^{-6} to 10^{-4}. Estimated cancer risks for the hypothetical future ground water use scenario were on the order of 10^{-5}. However, this level of risk corresponds to potential risks associated with background levels of arsenic in ground water.

In general, the potential for non-carcinogenic (i.e., toxic) health hazards does not exist at either site (including future ground water use).

However, potential exposures of young children to lead in wastes on the Baier site may warrant concern. The evaluation of potential health hazards posed by lead was performed by estimating blood lead levels that may result from exposure to lead in soil.

Exposure of a young child (e.g. 6 years of age) to areas of lead contamination on the Baier site resulted in estimated blood levels in excess of the USEPA advisory range for blood lead at both the representative and RME levels of exposure. It is noted, however, that exposure point concentrations developed for lead in Baier soils were based on sampling from waste disposal areas only and therefore are not representative of exposure to all of the Baier site soils.

The results of the RA indicate that both the Baier and McCarl sites possess little potential for risks to human health, with the possible exception of the effects of lead on young children because of the following facts:

- The remote nature of the sites;
- The fact that DuPont owns the McCarl site and, therefore, controls site use; and
- The low likelihood that either site will ever be used for residential purposes.

It is concluded that both sites will not pose significant human health risks in the foreseeable future based on this assessment. Should site remediation occur, potential future risks will be further reduced.

1.0 INTRODUCTION

A baseline risk assessment (RA) was performed in order to evaluate the potential health risks posed by the Baier and McCarl sites in the absence of remedial action. The RA focussed on potential health risks posed by contaminants found in site soils as a result of past disposal activities. The term "health risks" refers to potential carcinogenic effects (i.e., cancer risks) and non-carcinogenic health hazards (i.e., toxic effects) that may result from exposure to contaminants. The RA focussed on potential health risks posed by metal contaminants found in site soils as a result of past disposal activities.

An ecological assessment was also performed for both sites and is presented as another appendix. This assessment qualitatively evaluates potential effects of the sites on plant and animal wildlife and examines potential interactions between site contaminants and various ecosystems.

Fundamentally, the RA is comprised of the following steps:

- Identification of contaminants of concern;
- Assessment of potential chemical exposures;
- Assessment of existing toxicology information; and
- Characterization of potential health risks.

One of the goals of the RA is to evaluate potential chemical releases from the sites and to estimate the magnitude of potential chemical exposure for persons on or near the sites. A second goal is to estimate the magnitude of the health risks associated with various levels of potential exposure. In accomplishing these goals, conclusions are drawn regarding the impact of the sites on human health.

The RA and ecological assessment were performed using guidance provided in the Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual (Part A) (USEPA, 1989a) and Risk Assessment Guidance for Superfund Volume II, Environmental Evaluation Manual (USEPA, 1989b), respectively. Other relevant guidance documents used to prepare the RA include the Superfund Exposure Assessment Manual (SEAM; USEPA, 1988) and the Exposure Factors Handbook (USEPA, 1989).

The conclusions of the RA are fundamental in evaluating the necessity for remedial action at the sites. Under circumstances where remediation is indicated, the risk assessment process can be used to develop health-based cleanup goals as part of the feasibility study.

2.0 IDENTIFICATION OF CONTAMINANTS OF CONCERN

The initial step in the RA is the identification of site-specific contaminants that may pose health risks. The contaminants selected in this part of the RA are included in the risk characterization step in which a quantitative evaluation of potential health risks is performed.

2.1 RESULTS OF SAMPLING ACTIVITIES CONDUCTED AT THE BAIER AND MCCARL SITES

The RA makes use of environmental data obtained during the remedial investigation. Specifically, the RA focuses on the results of sampling of environmental media where the potential for human exposures to contaminants is greatest. Thus, contaminant concentrations in surface soil, ground water, surface water, etc. are of greatest importance in assessment potential human health risks.

The results of soil and ground water sampling activities at both sites have been summarized and discussed in Section 4.0 (Analytical Results) of the Remedial Investigation report. These results indicate that volatile organic compounds were present in quantities ranging from non-detectable to 4,000 mg/kg in some subsurface soil samples, but not in surface soils. Metals were the only apparent contaminants in site surficial soils. Metals also appear as the only contaminants detected in monitoring wells placed on the Baier and McCarl sites, although significant concentrations of volatile organic compounds were detected in a single well on the Baier site. However, the presence of metal contaminants in ground water is less frequent than in soil.

It is noted that contaminant concentrations in surficial soils at the Baier site were obtained from sampling activities pursuant to preparation of a Removal Action Work Plan prepared by Woodward-Clyde Consultants (October 1989). The results of chemical analyses on individual soil samples are presented in that document although contaminant means developed from these data are presented here.

2.2 DISTRIBUTION OF SOIL CONTAMINANT DATA

The distribution of the contaminant data is important in the selection of an appropriate mean to represent the concentrations of individual contaminants. For purposes of this RA, the arithmetic mean was selected for calculation of contaminant concentrations. The arithmetic mean was chosen on the basis of the following statistical criteria:

- The arithmetic means of contaminants were similar to the geometric means indicating the data to be normally distributed;
- The coefficients of variation were low for several contaminants thus supporting a normal distribution;
- Rankit plots of contaminant data were linear which is indicative of normally distributed data; and
- Frequency distributions (i.e., histograms) plotted using contaminant data indicated skewed normal distributions as opposed to logarithmic distributions.

Although data for all contaminants did not uniformly meet all of these criteria, risk assessment guidance suggests that either the arithmetic or geometric be selected and applied to all contaminant data. The use of the arithmetic mean in this RA is conservative because it will be used to develop exposure point concentrations for contaminant data that may, in fact, not exhibit a normal distribution. Moreover, because the arithmetic mean is sensitive to data points that are outliers, the use will result in overestimation of chemical exposures. The potential for overestimation using the arithmetic mean is also high when the data are skewed as in the case of several contaminants at the sites.

2.3 CONTAMINANTS INCLUDED IN THE RISK ASSESSMENT

All of the contaminant metals found in surficial soils at the Baier site were included in the risk assessment for that site. These metals include arsenic, cadmium, chromium, lead, and selenium. The arithmetic means and upper 95th confidence limits of the means are presented in Table 2-1.

A larger set of contaminant metals was selected for the McCarl site. In addition to those metals selected for the Baier site, barium, copper, manganese, and zinc were also included. The rationale for inclusion of these metals is based on their high concentrations detected on-site. The arithmetic means and upper 95th confidence limits of the means for the McCarl site metals are also presented in Table 2-1.

It is noted that the contaminant means presented in Table 2-1 are also used as exposure point concentrations in estimating potential exposures at the sites.

2.4 CONTAMINANTS EXCLUDED FROM THE RISK ASSESSMENT

A group of metals found in site soils at the Baier and McCarl sites were excluded from the RA. The rationale for their exclusion is based on the following:

- Metals are naturally occurring and are found in the environment at concentrations characterized as background;
- The RA is intended to evaluate incremental health risks associated with contaminants not attributed to background; and
- Metals at the sites are present at concentrations that are within their respective background ranges.

The metals that were excluded from the RA along with their concentrations and background ranges are presented in Table 2-2.

It is noted that the exclusion of these metals is not expected to significantly affect the results of the RA since many of these contaminants are also of low toxicologic significance.

TABLE 2-1

CONTAMINANTS OF CONCERN IN SURFICIAL SOILS AT THE BAIER AND MCCARL SITES

BAIER SITE[1]

Metal	Arithmetic Mean[2]	Upper 95th Percent Confidence Limit
Arsenic	6.6	20.1
Cadmium	117	373
Chromium	612	1,847
Lead	14,026	42,397
Selenium	18.4	58.6
McCARL SITE		
Arsenic	6.7	12.8
Barium	2,686	6,500
Cadmium	43.2	206
Chromium	105.6	280
Copper	135	662
Lead	1,314	3,192
Manganese	1,312	2,210
Selenium	11.4	76.1
Zinc	1,950	4,470

Notes:

[1] Soil samples from baier site taken at 0 to 6-inch interval; samples taken from McCarl site taken at 0 to 12-inch interval.

[2] Concentrations have units of mg/kg.

TABLE 2-2

CONCENTRATIONS AND BACKGROUND RANGES OF METALS EXCLUDED FROM THE RISK ASSESSMENT[1]

Metals[2]	Arithmetic Mean[3]	National Background Range[3]	National Background Mean[3]
Aluminum	9,439	10,000 - 300,000	71,000
Antimony	14.7	0.2 - 150	6
Beryllium	0.7	0.1 - 40	6
Calcium	8,590	7,000 - 500,000	13,700
Cobalt	15.9	1 - 40	8
Iron	20,733	7,000 - 550,000	38,000
Magnesium	2,354	600 - 6,000	5,000
Mercury	0.07	0.01 - 0.3	0.03
Nickel	28.5	5 - 500	40
Potassium	933	400 - 30,000	8,300
Silver	0.7	0.01 - 5	0.05
Sodium	118	750 - 7,500	6,300
Thallium	0.24	0.1 - 0.5	0.2
Vanadium	31.7	20 - 500	100

Notes:

[1] Taken from Koranda et al. (1981) and Schacklette and Boerngen (1984).

[2] Metals listed in this table are for McCarl site only.

[3] Concentrations have units of mg/kg.

3.0 EXPOSURE ASSESSMENT

An exposure assessment estimates the magnitude of potential contaminant exposures for various receptor populations. The goals of the exposure assessment include the following:

- Identification of potential receptor populations;
- Identification of potentially complete exposure pathways;
- Evaluation of potential exposure parameters;
- Estimation of exposure point concentrations; and
- Estimation of daily intake factors.

The evaluation of potential exposures is based on conservative exposure assumptions. This approach ensures that estimated exposure levels will be most probably greater than actual levels and that any resulting evaluation of the site will be health protective. At the same time, exposure scenarios which are considered unlikely are not evaluated since they do not reflect realistic exposure conditions.

In developing exposure scenarios, the Baier and McCarl sites were treated similarly. This approach was used because of the similarities between the two sites, and their similar predicted future land use patterns. The sites are located within one mile of each other and share the following characteristics:

- The sites are small (less than 5 acres each);
- The sites are located in remote rural areas;
- Human activity is infrequent;
- There is no farming or grazing on the sites;
- There are no schools, towns, or municipal water supplies immediately adjacent to or near the sites;
- The sites are vegetated, containing both wooded areas and cleared areas covered by secondary plant growth, with little exposed surface soil;

- Both sites can support hunting activities;
- The types of contaminants found at both sites (VOCs and metals) are similar;
- The geology, hydrology, and soil characteristics of both sites are similar; and
- Both sites are fenced to reduce access by potential receptors.

The two major differences between the sites are topography and neighboring residences. The Baier site is a wooded site among gently rolling hills, while the McCarl site is relatively flat. Two farmhouses are located within two hundred yards of the McCarl site and are separated from the site by a fence. There are no residences near the Baier site. These differences are minor and do not justify different exposure assumptions for the two sites.

3.1 IDENTIFICATION OF POTENTIAL RECEPTOR POPULATIONS

Potential receptors include human populations as well as plant and animal populations and environmental receptors (e.g. rivers, ponds, and lakes) that may interact with contaminants. Potential human receptor populations are addressed in this section whereas plant, animal, and other environmental receptors are discussed in the Ecological Assessment.

Human receptors include all individuals who may come into contact with contaminants both on-site and off-site. The local demographics of the Baier and McCarl sites indicate that there are a limited number of potential human receptors, consisting of farm workers and occasional recreational users. The potential receptor populations are limited by the rural nature and low population density of the region. In addition, local site information indicates the following:

- There are no sensitive populations (e.g. young children, pregnant women, elderly, or chronically ill individuals) in the vicinity of the Baier site which could be exposed to contaminants. A small elderly population lives near the McCarl site, but exposure is unlikely since the site is fenced; and

- An on-site resident scenario is highly unlikely, given the low projected growth rate and lack of neighboring population centers.

Given the nature of the potential receptor populations, six scenarios were selected to represent the types of activities that may occur on-site. Moreover, these scenarios also represent hypothetical and future uses of the sites, and therefore, can be used to develop health-based cleanup goals that can be used to guide potential remediation. Briefly, the six scenarios evaluated for these sites are:

- hunter (adult);
- hunter (juvenile);
- farmer;
- hiker gathering edibles (e.g. mushrooms);
- hiker (child); and
- hiker (adult).

These receptors, characterized by distinct activities that influence their exposure conditions are assumed to visit the sites at various times throughout the year. The exposure conditions will be discussed in greater detail in the following sections of the RA.

3.2 EVALUATION OF POTENTIAL EXPOSURE PATHWAYS

An exposure pathway is the mechanism by which a receptor may come into contact with a contaminant. As defined in the RAG (USEPA, 1989), there are four major elements which characterize an exposure pathway. These elements consist of the following:

- A source and mechanism of contaminant release;
- A medium for contaminant transport to potential receptors;
- A point of potential receptor contact with the medium (e.g. exposure point); and

- A route of exposure (e.g. ingestion) for the receptors to come into contact with the contaminants.

All four elements must be present for an exposure pathway to be complete and the potential for a health risk to exist. The absence of any one of these elements constitutes an incomplete pathway and the potential for health risks does not exist. Thus, the evaluation of potential exposure pathways is necessary to focus on only those pathways which could potentially impact on human health.

Several individual elements of the potential exposure pathways have already been discussed. The potential sources of contaminants were outlined in this RA in Section 2.0, Contaminants of Concern. Potential mechanisms of contaminant release and transport were discussed in this RI report in Section 5.0, Contaminant Fate and Transport. Fate and transport specifically refers to processes that govern the mobility and degradation of contaminants. These processes are dependent upon physicochemical factors, such as solubility, volatility, hydrophobicity, etc. Receptors were defined in Section 4.1, Identification of Potential Receptor Populations.

Identification of potential contaminant transport media (e.g. ground water, surface water, air and soil), exposure points and exposure routes are required to evaluate the complete exposure pathways. The various transport media will be discussed individually in the following sections:

3.2.1 SURFACE SOILS

The surface soil profiles for both the Baier and McCarl sites are similar, consisting of oxidized silty clay loess. The potential for contaminant exposures is greatest for soil layers comprising the 0- to 1-foot soil horizon (e.g. surface soils); and, therefore, contaminants in these soils may have the greatest impact on human health.

The contaminants of concern from the surface soil consist of metals only. Residual VOC concentrations in surficial soils are not significant because these compounds volatilize from surficial soils. Moreover, disposal activities have not occurred at the site for over 30 years and any VOCs originally in the site surficial soils have been dissipated by the passage of numerous half-lives for volatilization.

Ingestion of contaminated soils and dermal contact could represent potentially complete exposure pathways for all receptors evaluated in this RA.

3.2.2 GROUND WATER

The generalized subsurface profiles for both the Baier and McCarl sites are similar, consisting of approximately 50 feet of weathered glacial till underlain by approximately 150-200 feet of unweathered till. The bedrock consists of Mississippian limestone at approximately 200-250 feet. The till consists of clay and fine sand, with occasional, discontinuous water-bearing zones of sand. These water-bearing zones provide a very low yield water supply (less than 1 gpm), and are generally inadequate for either irrigation or domestic water supplies. Typical domestic wells in the surrounding area utilize deep aquifers in the bedrock. However, it should be noted that some older, hand-dug domestic wells in the county draw on water from the weathered till. The large reservoir capacity of hand-dug wells, due to their large diameter, allows them to function minimally as a domestic water supply, despite the low refill rate. These wells are not thought to be at risk of contamination for the following reasons:

- There are no shallow, hand-dug wells in the vicinity of either site;
- There is no hydrologic communication between off-site wells and the water-bearing units of the weathered till on either site.

The likelihood of future wells screened in the glacial till is low for the following reasons:

- The small shaft diameter and corresponding low volume reservoir capacity result in a low-yield water for wells in the till and therefore are inadequate for domestic purposes;

- Economically, it is more feasible to drill a well to the bedrock than to hand-dig a well in the till;
- The ground water quality from the till is poor compared to water from the bedrock water-bearing unit; and
- Future residents would be more likely to hook up to the local rural water district than drill a well.

Irrigation may potentially release subsurface contaminants to the surface soil, air, and water. However, irrigation wells require a high yield water supply (greater than those of domestic wells) and thus, would not be feasibly screened in any of the water-bearing zones in the till. Since these are the only water-bearing zones that contain VOCs, potential release of VOCs via irrigation would not occur.

Numerous sampling wells were placed on both the Baier and McCarl sites to sample water quality from water-bearing zones in the till. An upper zone was sampled from the weathered till at 50 feet, and a lower zone was sampled from the unweathered till at 120 feet. Contaminant VOCs were found in two shallow wells at the Baier site, MW-F and MW-J (Tables 4.2-1(G) and 4.2-1(2) in the RI). There are several reasons for the apparent minimal contaminant migration into the water-bearing zones.

- The thickness of the till acts to impede downward movement and therefore impedes downward migration;
- The high clay content of the till effectively immobilizes metals such as arsenic via electrostatic attraction (i.e., adsorption) and virtually stops downward migration; and
- The water-bearing zones are located in discontinuous sand lenses which may not be hydrologically linked, thus limiting lateral contaminant migration.

It is unlikely that contaminants from either site pose a significant risk to private wells which are screened in the ground water in the bedrock. This conclusion is based on the observation that very little, if any, contaminant migration has occurred. No contaminants were found in the deep ground water sampling zone, and an additional 100 feet of highly impermeable till separates this zone from the underlying bedrock. Thus, ground water does not appear to be a complete exposure pathway under any realistic exposure scenario, and as such would not be associated with adverse health effects.

3.2.3 SURFACE WATER

Surface water does not appear to be a medium for potential contaminant exposure at either the Baier or the McCarl sites. Both sites share the following surface water characteristics:

- There are no standing bodies of water, ponds, etc., on either site;
- There are no permanent streams on either site;
- The drainage pathways from the sites do not feed any ponds, lakes, or municipal water supplies.

Some ground water seepage may occur along the drainage pathways at the Baier site. However, these seeps do not appear to offer a source of potential contamination for the following reasons:

- The rate of seepage is very low;
- No ponding occurs;
- The most likely contaminants to be found in the ground water would be VOCs, which would volatilize upon atmospheric exposure; and
- Field investigation with an HNu was unable to detect any atmospheric VOCs at the sources of the seeps.

3.2.4 AIRBORNE CONTAMINANTS

Airborne contaminants can be derived from two possible sources:

- Direct volatilization of contaminants in the soil and surface water; and
- Fugitive dust emissions from soil containing adsorbed contaminants.

Volatilization of VOCs occurs via off-gassing from surface soils. This does not appear to be a complete exposure pathway for any of the exposure scenarios for the following reasons:

- VOCs are not present in detectable amounts at the soil/air interface because previous off-gassing has removed most available VOCs from the surface soils;
- Intrusive activities (e.g. digging) which might release VOCs from subsurface soils are not expected to occur under any of the exposure scenarios; and
- Assuming that the atmosphere functions as an infinite reservoir, the concentrations of VOCs at the point of release would be further reduced by dilution upon release.

Exposure to fugitive dust also represents an incomplete exposure pathway because of the lack of dust-generating sources on both the Baier or McCarl sites. Potential dust emissions are limited by the following factors:

- There is a lack of exposed surface soil due to rocks, leaf litter, and vegetative cover;
- The sites are located in a non-arid climatic region where the surface soil moisture content retards dust formation;
- Surrounding vegetation provides a wind-break for the sites;
- Disposal pits are protected from wind erosion by their low-lying topography.

3.2.5 FOOD CHAIN CONSIDERATIONS

Potential exposure to contaminants at the site could occur through ingestion of contaminated plant or animal life found at the site. Current use of the site does not include farming and it is not anticipated as a future use of the site. Therefore, it is unlikely that exposure could occur through the ingestion of contaminated food crops. Other sources of edible materials that may be found on-site such as raspberries and mushrooms also are not expected to result in human exposure through the food chain. As previously stated, the areas containing wastes or areas where the soil has been disturbed by grading, etc. do not support the growth of mushrooms. Raspberries are found growing on the periphery of the site away from the waste disposal areas. Therefore, the potential for uptake of contaminants by these plants is expected to be limited.

However, small game (e.g. rabbits) could ingest potential contaminants through ingestion of soil or plants. This possibility suggests that contaminants could enter the human food chain if small game were hunted at the site and subsequently eaten. Among the contaminants on-site, only metals exhibit the potential for entry into the human food chain. A significant body of scientific literature indicates that uptake of metals into plants may occur. The plants in turn may be consumed by small game. Volatile organic compounds are found at sufficient depth to preclude direct exposure to small animals. Moreover, it is not likely that organic compounds characterized by high degrees of hydrophobicity (e.g. ethylbenzene, xylene, toluene) would sequester into the water transport system of plants.

Ingestion of small game which had consumed plants containing metals appears to be the major food chain factor at the site. Because of this assumption, it is important to address the disposition of metals in mammals. A significant number of studies have been performed to characterize the absorption, distribution, and excretion of metals, including arsenic, cadmium, chromium, lead, and selenium. The results of these studies indicate the following:

- Metals such as cadmium and chromium are poorly absorbed by the mammalian gastrointestinal tract;
- Metals such as arsenic and selenium are efficiently excreted by mammals and do not bioaccumulate;
- Bioaccumulation of metals in mammals occurs primarily in non-edible tissues; and
- Metals are often tightly bound to certain macromolecules and subcellular components, and hence, are not bioavailable.

These findings indicate that biomagnification in the human food chain is a remote possibility.

The following summary is derived mainly from Venugopal and Luckey (1978) and Friberg et al. (1986). The absorption of arsenic and selenium is dependent upon the chemical form of the respective elements. Soluble forms of both elements are well absorbed from the gastrointestinal tracts of mammals although selenium is poorly absorbed by ruminants (e.g. sheep and cows). However, both metals are quickly removed from the blood and efficiently excreted by the kidney. Thus, accumulation would not occur at low dosages or following sub-toxic acute exposure. Under exposure conditions in which accumulation may occur, the majority of arsenic is found in hair, skin, gastrointestinal tract, epididymis, thyroid gland, lens of the eye, and skeleton. Similarly, selenium accumulates in kidney, liver, skeleton, nails, and hair. Both elements are believed to be tightly bound to sulfhydryl groups (i.e., sulfur-containing compounds) in cells and do not exist in the free state.

Cadmium and chromium are poorly absorbed by mammalian gastrointestinal tracts. Absorption of cadmium is on the order of 2 to 5 percent, and absorption of chromium is less than 1 percent of the respective ingested doses. Cadmium is poorly excreted but exhibits high affinity blinding to sulfhydryl proteins in liver and secondarily in kidney, thus rendering it biologically unavailable even if ingested. Accumulation of chromium initially occurs in heart, pancreas, lungs, brain, spleen, liver, and testes; however, these organs are subsequently cleared by efficient excretion processes. Long-term accumulation of chromium in mammals occurs in the reticuloendothelial system, liver, spleen, and bone marrow. Another factor that appears to decrease the bioavailability of chromium is the formation of insoluble chemical complexes in the duodenum of the mammalian gastrointestinal tract which are subsequently excreted.

The absorption of lead ranges from 1 to 15 percent of the ingested dose, with the higher end of the range observed in younger animals. Lead is distributed to several soft tissues including liver, kidney, intestine, and brain but in a transient fashion. During subsequent redistribution, lead is incorporated into mineralized tissues (e.g. bone, skeleton, and teeth).

Lead that is not absorbed in the gastrointestinal tract is excreted in the feces.

These factors collectively suggest that it is unlikely that significant accumulation of metals occurs in edible portions (e.g. muscle) of small mammals. In addition, remedial activities forthcoming at the site make it further unlikely that contamination of the human food chain will occur.

3.2.6 POTENTIAL ROUTES OF EXPOSURE AND EXPOSURE SCENARIOS

An important component of the RA is the evaluation of potential routes of contaminant uptake for receptor populations. The three major routes of potential exposure typically include dermal absorption, ingestion of contaminated material, and inhalation of airborne contaminants. However, as discussed in Sections 3.1.1 through 3.1.4, only the dermal and soil ingestion pathways may be complete at the Baier and McCarl sites.

In order to fully characterize exposure scenarios, exposure routes must be evaluated for each potential receptor population. The viability of particular exposure routes is determined by the activities of the receptor and not all receptors are exposed by the same routes. Exposure scenarios are then used in the RA to estimate the degree of contaminant exposure and the associated health risks.

The potential exposure scenarios are discussed in the following sections.

3.2.6.1 <u>Hunter (Adult)</u>

The Baier and McCarl sites consist of wooded and open areas that could provide adequate cover for a number of different species of game animals. Both sites are fenced, and the Baier site is posted, thus restricting access. However, it is possible that hunters could enter the sites in pursuit of game at certain times of the year. Most hunting scenarios would be expected to be of a transient nature, due to the small size of the sites. A worst-case scenario would consist of a deer hunter establishing a hunting blind on-site during deer season. Exposure of hunters to contaminants could occur via incidental soil ingestion or dermal contact with soil.

3.2.6.2 Hunter (Juvenile)

This group of receptors represents a hypothetical scenario in which an individual hunts on-site on a regular basis throughout the Iowa rabbit season. Exposure to contaminants would be expected to occur through the same routes as for the adult hunter (i.e., via incidental soil ingestion and dermal soil contact).

3.2.6.3 Farmer

This scenario was designed to estimate exposure to any farmer who might enter the site even though it is not utilized as farmland. Potential activities for this receptor include periodic fence repair, cutting back brush and dead trees, cutting firewood, and general property maintenance. Potential contaminant exposure would be expected to occur via dermal contact or incidental ingestion of contaminated soils. The nature of the activities associated with the farmer scenario potentially places the farmer in greater contact with soil than any other receptor group.

3.2.6.4 Hiker Gathering Edibles

A hypothetical scenario has been included to account for the possibility that hikers may enter the site to gather edibles such as berries or mushrooms. Potential contaminant exposure could occur via dermal contact or ingestion of contaminated soil.

Potential exposure via gathering activities would likely be limited by the following factors:

- Raspberries are the primary source of berries on site. However, these plants are sparsely distributed and tend to be found at the site peripheries near fence rows;

- Mushrooms are highly sensitive to disruptive activities and environmental contaminants. It is unlikely that any mushrooms would be found in areas where grading or dumping activities had occurred;
- The sloping terrain of the Baier site would limit many gathering activities.

3.2.6.5 Hiker (Child)

This hypothetical scenario is designed to include the possibility that a child may accompany the adult hiker (Section 4.2.5.4) during visits to the site(s). Soil ingestion and dermal contact are the most likely routes of potential contaminant exposure.

3.2.6.6 Hiker (Year-round)

This scenario is designed to include adults who may be walking through the site. This is an unlikely scenario, given that there are no known hiking trails in the immediate vicinity, both sites have restricted access, and neither site contains unique features which would attract trespassers. As in the other hiker scenarios, potential contaminant exposure would be expected to occur via dermal contact or incidental ingestion of soil.

3.2.7 RECEPTOR GROUPS EXCLUDED IN THE EXPOSURE SCENARIOS

Residential receptors were excluded from the exposure scenarios developed in this RA. The rationale for excluding this potential exposure scenario includes:

- The sites are located in a very rural area with a low population density and projected low growth; and
- There are no towns or communities in the immediate vicinity of either site.

The exposure scenarios that are evaluated in this EA are summarized in Table 3-1.

3.2.8 FUTURE USE SCENARIOS

Consideration of future use scenarios in this RA is limited to a hypothetical ground water ingestion scenario by residents near the McCarl and Baier sites. The details regarding this scenario are presented in Section 5.5 of this RA.

Other potential future use scenarios for either site cannot be forecast because of the remote and rural nature of the sites. It is not possible to predict changes in land use or demographics that may occur decades into the future, especially for remote sites that have not even undergone development beyond that of farming. The use of the McCarl site for future agricultural or residential use is clearly precluded by the fact that DuPont owns the site. The purchase of the Baier site by DuPont might ultimately restrict potential future uses of that site as well.

Although future uses represent a source of uncertainty with regard to future risks posed by any site, this uncertainty is minimal for the Baier and McCarl sites because they are restricted with regard to access and development and located in areas of low receptor density.

3.3 EVALUATION OF POTENTIAL EXPOSURE PARAMETERS

Those parameters which define contaminant exposure are quantified in order to calculate daily contaminant intakes and potential health risks. Parameters which are typically quantified include the frequency and duration of exposure, quantity of soil ingested, surface area of exposed skin, and body weight. The extent of contaminant exposure can be estimated by incorporating these numerical values into exposure algorithms for dermal soil contact and soil ingestion. Algorithms used for estimation of exposure are given in Attachment I, and the exposure parameters for each exposure scenario have been summarized by pathway in Tables I-1 and I-2.

Several variables used in the exposure algorithms have been assigned values common to all exposure scenarios. These include:

- An assumed life span of 75 years (i.e., 2.74×10^4 days);
- An assumed body weight of 70 kg for adults, 60 kg for juveniles, and 43 kg for children;
- A soil adherence factor of 1.45 mg/cm^2; and
- Exposure periods for adults and children are assumed to be 30 and 12 years, respectively.

The 75-year life span was obtained from the Exposure Factors Handbook (1989). The soil adherence factor is used to estimate the adherent properties of soil to human skin. The assumption has been made that site soils resemble potting soil; therefore, the value given in the SEAM (1988) for potting soil has been used. All other variables have been developed on a scenario-specific basis and are discussed in Sections 3.3.1 through 3.3.6.

3.3.1 HUNTER (ADULT)

The hunter scenario is based on the length of the Iowa deer hunting season (shotgun; 5 days). An extended season (9 days) also exists (Peterson's Hunting, September 1989 issue); however, it is assumed that the hunter would be on-site for a total of 5 days, 8 hours per day. This scenario is designed to overestimate the duration of exposure since few hunters would stay at an unproductive site more than 1-2 days before moving to a different location. In addition, most deer hunting is performed from tree stands, which would further limit the potential for direct soil contact by restricting movement.

In assessing the hunter's exposure to soil, the assumption was made that the rate of incidental ingestion of soil was 10 mg/day on-site. This is the level of exposure that might be expected to result from an individual removing articles of clothing and equipment (e.g. boots and gloves) that may have soil adhering to them. Given that deer season occurs in October, this ingestion rate is considered to overestimate exposure because the hands would likely be covered by gloves. Dermal exposure has also been estimated for hands only because of the type of clothing worn by a hunter in October. The surface area available for exposure to contaminants is 8.4×10^2 cm^2 which is the area of skin on the hands (Exposure Factors Handbook; USEPA, 1989).

3.3.2 HUNTER (JUVENILE)

The juvenile hunter scenario is based on an individual who hunts on-site with an estimated frequency of 5 days per week for a period of 12 weeks. The duration of each period of time on-site is assumed to be 2 hours. The frequency is based on a scenario whereby an adolescent would hunt frequently throughout the Iowa rabbit hunting season (Peterson's Hunting. September 1989) and considerably overestimates the potential exposure for the following reasons:

- Rabbit hunting is a mobile activity. It would take less than one hour to completely walk over the site and move on to a new hunting area; and
- Continuous hunting of a site for more than a few days would cause game depletion, which would force the hunter to temporarily abandon the site for hunting activities.

Several of the exposure parameters given for the adult hunter have been used in estimating exposure for the juvenile hunter. These include the soil ingestion rate and the surface area of skin available for exposure.

3.3.3 FARMER

This scenario is based on a farmer who is assumed to enter the site 1 day per week, four weeks per month for the 9 warmest months of the year. The duration of each visit to the site is assumed to be 2 hours.

The surface area of skin available for exposure estimated for the farmer is the same as for the adult hunter. The rate of soil ingestion is higher for the farmer and is essentially the rate given by Hawley (1985) for adults. The higher rate of soil ingestion for the farmer reflects the fact that this individual might be on-site in warmer weather more conducive to exposure. Also, the farmer may engage in activities that would increase the likelihood of contact with soil (e.g. cutting back brush, cutting back dead trees, etc.).

3.3.4 HIKER GATHERING EDIBLES

The hiker gathering edibles scenario assumes that hikers would be on-site for 8-hour lengths of time, 8 weekends per year. The frequency is based on the fact that mushroom picking would occur only in the spring and only on warm and dry weekends. The total window of time for these activities is assumed to be 2 months.

The soil ingestion rate for this group of hikers is given as 60 mg/day on-site (Hawley, 1985) to account for the fact that the activities of these receptors necessarily facilitates contact with soil. The estimated surface area of skin available for exposure is 8.4×10^2 cm^2 (hands only).

3.3.5 HIKER (CHILD)

Since this scenario assumes a child accompanying an adult hiker, the frequency and duration of visits to the site by the child are similar to those of the adult except that the exposure period is assumed to be 12 years.

The parameters for estimating exposure to contaminants in soil are essentially the same as the adult. A distinction is made on the soil ingestion rate, however, and a higher rate (100 mg/day on-site) has been estimated for the child hiker. This value is conservative (i.e., will overestimate exposure) compared with that given in the SEAM (1988) for children 5 to 18 years of age. This soil ingestion rate is intended to reflect the fact that children exhibit increased hand-to-mouth activity, increased contact with soil, and to account for any food brought on-site.

3.3.6 HIKER (YEAR-ROUND)

Hikers in this scenario are assumed to be on-site once per week during the 9 warmest months of the year (36 days total). The duration of each visit is assumed to be 2 hours.

All exposure parameters relating to potential exposure to contaminants in soil (i.e., dermal contact and soil ingestion) are the same as those estimated for the adult hunter.

3.4 ESTIMATION OF EXPOSURE POINT CONCENTRATIONS

Exposure point concentrations are the contaminant concentrations to which a receptor is exposed when contact is made with a specific environmental medium. The contaminant concentrations presented in Table 2-1 have been used as exposure point concentrations in this RA. The use of these concentrations is conservative and will overestimate exposures for the following reasons:

- The concentrations are expressed as arithmetic means which are inherently skewed by higher contaminant concentrations;
- Contaminant concentrations in only surficial soils have been used as exposure point concentrations; and
- The exposure point concentrations are assumed to remain constant for the duration of the estimated exposure periods (i.e., 12, 30 or 70 years).

Exposure point concentrations have been calculated for soil only since both of the complete exposure pathways at the sites involve that medium (i.e., soil ingestion and dermal contact with soil).

3.5 CALCULATION OF DAILY CONTAMINANT INTAKES (CDIs)

Daily contaminant intakes (CDIs) represent the daily amount of a contaminant taken in by a receptor per kilogram body weight. The CDIs are used to estimate hazard quotients and potential cancer risks for each contaminant. A CDI for a contaminant is calculated as follows:

Intake Factor x Exp. Point Conc. = CDI

It is noted that different CDIs are used in calculating respective hazard quotients and potential cancer risks for a contaminant. A CDI used for calculating a hazard quotient makes use of intake factors developed for exposure periods less than lifetime, whereas the CDI used to calculate potential cancer risks uses an intake factor based on lifetime exposures.

The respective intake factors are presented in Attachment I (following Section 8.0) and exposure point concentrations are presented in Section 2.0 of this RA. The CDIs calculated for each contaminant for the various exposure scenarios are presented in Section 5.0 of this RA.

3.6 UNCERTAINTIES

Evaluation of potential exposures involves uncertainties that may cause the estimated exposures to be less than or greater than actual exposures at the sites. These uncertainties are discussed qualitatively and quantitatively in Section 6.0 of this RA.

TABLE 3-1
SUMMARY OF EXPOSURE SCENARIOS

Receptor Population	Potential Exposure Pathways[1]
Hunter (Adult)	Incidental Ingestion; Dermal Contact
Hunter (Juvenile)	Incidental Ingestion; Dermal Contact
Farmer	Incidental Ingestion; Dermal Contact
Hiker Gathering Edibles	Incidental Ingestion; Dermal Contact
Hiker (Child)	Incidental Ingestion; Dermal Contact
Hiker (Adult)	Incidental Ingestion; Dermal Contact

Note:

[1] All scenarios are based on exposure to soil only. Exposure pathways involving surface water, ground water, and air do not appear to be complete at the sites.

4.0 TOXICITY ASSESSMENT

A toxicity assessment is performed as part of the RA to provide a summary of the potential biological effects of the contaminants found at the sites. The purpose of this section is to summarize concisely and present the potential toxic effects of the compounds of concern as a group. The potential toxicities of each contaminant, including acute and chronic effects, teratogenic/reproductive effects, mutagenicity and carcinogenicity are thoroughly discussed in Attachment II of this RA. In addition, epidemiological studies pertaining to each contaminant have also been discussed in order to provide information on possible health effects of contaminants in human populations.

In general, metals represent a relatively well-characterized class of contaminants. As described in Attachment II, each of the metals appears to affect a unique physiological system (i.e., target organ) at the appropriate doses. This is significant in that the potential effects due to exposures to several metals may not be additive. Thus, the assumption used in this RA that the critical effects of metals are additive greatly overestimates the potential health hazards associated with exposure to contaminants at the sites.

In addition, it is noted that several of the metals found at the site antagonize (i.e., counter-act) the toxicities of other metals. For example, selenium and arsenic antagonize the actions of each other and selenium has been used as an antidote for arsenic poisoning. Moreover, the fact that the contaminant metals were used as paint pigments is noteworthy. Paint pigments tend to be highly insoluble compounds; and, therefore, are characterized by low bioavailability (i.e., low potential for absorption) if ingested by a receptor. The fact that the RA does not consider these characteristics when estimating health hazards and cancer risks again indicates that the potential health risks for the sites will be overestimated.

In conclusion, the specific metals found on the sites are well characterized with respect to their toxicities in animals and, to some extent, man. However, the physicochemical and biological properties of the metals indicate that any potential effects resulting from exposure would be mitigated.

5.0 CHARACTERIZATION OF POTENTIAL CARCINOGENIC RISKS AND NON-CARCINOGENIC HEALTH HAZARDS

5.1 PROCEDURES FOR CALCULATION OF POTENTIAL CARCINOGENIC RISK AND NON-CARCINOGENIC HEALTH HAZARDS

In order to estimate the health risks associated with the Fort Madison disposal sites, the estimated daily contaminant intakes (CDIs) for all chemicals of concern were initially calculated. These values were calculated for each exposure scenario as part of the exposure assessment (Section 3.0). Two CDIs were calculated for each contaminant using the respective arithmetic mean (i.e., representative level of exposure) and a concentration based on the upper 95 percent confidence limit of the arithmetic mean (e.g. the reasonable maximum exposure [RME]). The reasonable maximum exposure is a worst-case scenario defined by USEPA as the highest possible level of exposure that may occur on-site (RAG; USEPA, 1989). However, in many cases, the RME values are greater than the maximum concentrations measured on-site and, therefore, may not be consistent with actual site contamination. The use of the RME is considered highly conservative and in some cases, unreasonable.

The CDIs are summarized in Table 5-1. It should be noted that the CDI values for the Baier site are based on data obtained from sampling performed as part of the Removal Action Work Plan (RAW; Woodward-Clyde Consultants, 1989). Soil sampling for the RAW was not conducted randomly, but rather, was performed only in regions of obvious contamination. This contributes to overestimation of the mean (representative) and RME concentrations for the site. Thus, the CDI values for the Baier site greatly overestimate the degree of contaminant intake. In conjunction with the CDIs, the slope factor (SF) and reference doses (RfDs) are used to estimate the respective carcinogenic and non-carcinogenic health risks. These values are obtained from USEPA sources and are presented in Table 5-2. It should be noted that arsenic is the only chemical of concern with a listed oral SF. All other chemicals of concern are strictly non-carcinogenic via oral uptake, with the possible exception of lead, which will be addressed separately. It should also be noted that dermal RfDs are defined as the product of the oral RfDs and the percent gastrointestinal (GI) absorption (RAG, Appendix A). The GI absorption values, as reported in Friberg et al (1979, 1986), are presented in Table 5-2.

The potential cancer risk of a compound is calculated as the arithmetic product of its CDI and SF. The overall cancer risk for each exposure route is calculated as the sum of risks for all contaminants within the exposure route. An overall cancer risk estimate is calculated for each exposure scenario by summing the risks for each exposure route within the scenario. The basis for this approach is the assumption that cancer risks are additive. In the case where only one compound is being assessed (i.e., arsenic), this approach is probably valid.

The non-carcinogenic health hazard differs from the carcinogenic health hazard in several ways. A non-carcinogenic health hazard is assumed to exist only when exposure exceeds a threshold concentration (e.g. the reference dose) associated with the lowest observed adverse effect level for a compound. The ratio of the CDI over the RfD is termed the Hazard Quotient (HQ). The summation of the HQs for all compounds is the Hazard Index (HI). An HI greater than 1 indicates that the threshold has been exceeded and a potential health hazard exists, while a value less than 1 indicates the absence a health hazard. The HI is designed to show only the potential for a health hazard and is not probabilistic. Thus, the magnitude of the HI is unimportant in that an HI of 10 denotes no greater potential for a health hazard than an HI of 100.

The assumption of additivity of sub-threshold HQ values in calculating an HI is valid only when all compounds affect the same primary target organs, and when there are no antagonistic or synergistic effects between compounds. Neither of these requirements are met by the contaminants of concern found at the Fort Madison sites due to the following:

- The various metals affect different target organs; and
- Selenium, for example, antagonizes the effects of several other metals and decreases their toxicity.

Both of these factors indicate that the HIs calculated by summation of HGS are extremely conservative and overestimate the potential for a health hazard. The use of an HI based on the summed HQs for heavy metal especially concentrations may not be valid due to the varied biological effects of these compounds.

5.2 SUMMARY OF POTENTIAL CANCER RISKS

The purpose of the risk characterization is to evaluate the potential health risks associated with exposure to contaminants on-site. Potential cancer risks for arsenic have been calculated for ingestion and dermal contact with soils on for the Baier and McCarl sites. These estimates are presented in Table 5-3. None of the other contaminants of concern are classified as oral carcinogens, with the exception of lead which is treated separately later in this report. In addition, this risk characterization presents potential risks associated with both the mean exposure (i.e., exposure based on arithmetic mean of soil contaminant concentrations) and the RME (i.e., exposure based on the upper 95 percent confidence interval of the arithmetic mean).

As presented in Table 5-3, potential cancer risks were within the 10^{-9} to 10^{-6} range for both dermal and ingestion routes in all scenarios. The highest potential risks were calculated using RMEs. The receptor group with the greatest potential risks is the farmer scenario at the Baier site, with a risk of 1.2×10^{-6} (based on ingestion). Risks associated with other receptors/exposure routes, based on the RME data, ranged from 2.4×10^{-9} to 7.6×10^{-7}. Potential cancer risks were even lower when calculated for more likely exposure concentrations, based on the mean contaminant concentration, with values ranging from 1.2×10^{-9} to 4.0×10^{-7}. Because of the relatively poor dermal absorption of arsenic, the greatest potential risks were always associated with the ingestion route of exposure.

It is noteworthy that the mean concentrations of arsenic, the only compound for which cancer risks were calculated, were almost identical for the McCarl and Baier sites, and were near or at background levels. Thus, the potential cancer risks developed in this document, based on the mean contaminant concentrations, reflect background cancer risks rather than risks associated with paint waste disposal.

5.3 SUMMARY OF POTENTIAL NON-CARCINOGENIC HEALTH HAZARDS

Non-carcinogenic health hazards were evaluated for all exposure scenarios for both Fort Madison sites. The HQ and HI values are presented in Table 5-4. The HQ values represent the hazards associated with the individual contaminants, while the HI values represent the total non-carcinogenic hazard for a particular pathway. As was done when calculating potential cancer risks, health hazards were calculating using CDI values for both RME and mean contaminant concentrations. In no case did an HI value approach the threshold value of 1.0. The largest HI (8.21×10^{-2}) was calculated for the juvenile hunter at the Baier site, assuming dermal contact based on RME contaminant concentrations. Other HI values based on RME data ranged from 9.05×10^{-4} to 6.58×10^{-2}. Hazard indices based on mean contaminant concentrations are lower than HI values based on RME data and range from 2.83×10^{-4} to 2.68×10^{-2}. The highest HI value was estimated for juvenile hunter at the Baier site.

The HI values calculated in this RA are substantially less than the threshold risk value of 1.0, suggesting the absence of potential non-carcinogenic health hazards for the proposed scenarios at either site. It is noted that the RfD values used to calculate the HQs are health protective in that they were developed based on the toxicity of the most toxic or bioavailable forms of these metals. However, the contaminants of concern at the Fort Madison sites are highly stable and insoluble compounds with limited bioavailability. Thus, the RfDs contribute to an overestimation of the health hazards. Other factors which may lead to an overestimation of health hazards by overestimating the CDI are discussed in the analysis of uncertainties (Section 6.0).

5.4 POTENTIAL HEALTH EFFECTS OF LEAD

There is currently no USEPA-approved reference dose for lead. The reason for this is that the USEPA is re-evaluating its policy towards lead based on current scientific evidence that suggests that the neurobehavioral effects of lead (e.g. learning deficit, hyperkinesis, diminished cognitive behavior, etc.) do not exhibit a threshold. This finding is not consistent with current concepts regarding non-carcinogenic (i.e., toxic) effects and appears unique for lead. The concept of a reference dose is based on the observation that even the most sensitive toxic effect produced by a chemical requires a minimum dose for expression (i.e., a threshold). The interim policy states that since certain non-carcinogenic effects of lead may not exhibit a threshold, a reference dose type of approach cannot be used to characterize the health risks associated with exposures to lead.

An alternate approach for assessing the potential non-carcinogenic effects of lead is to estimate the blood lead levels that may result from exposures and comparing the resulting blood concentrations to an advisory range of concentrations. The latter refers to a range of blood lead concentrations in which the potential for harmful effects may exist. Blood lead levels greater than the advisory range may indicate the potential for harmful effects of clinical concern.

Although there are several models that may be used to predict blood lead levels from soil lead concentrations, the Integrated Uptake/Biokinetic (IUBK) model has been selected for current usage (USEPA, 1989). This model has a fundamental advantage in that it can be used to calculate blood lead levels as a function of absorbed lead as opposed to lead intake. This is important because one of the key factors governing the sensitivity of an organism to lead is the extent of absorption from the gastrointestinal tract. Basically, the model is based on the following equation:

$$\textbf{(Eq. 5.1)} \quad Pb_{blood} = Pb_{soil} + Pb_{background}$$

The $Pb_{background}$ term refers to the contribution to blood lead levels from sources other than soil (e.g. air water, food, etc.). The background blood lead value suggested by USEPA is 5 ug/dL although the background concentration may be quite variable. Equation 5.1 may be expanded to yield the following:

(Eq. 5.2) $$Pb_{blood} = (C_{soil})(SI)(AF)(BKSF) + (Pb_{background})$$

where:

C_{soil} = soil lead concentration
SI = soil ingestion rate
AF = gastrointestinal absorption factor
BKSF = biokinetic slope factor
$Pb_{background}$ = background blood lead level in ug/dL

The values of the variables given in Equation 5.2 are age-dependent. Children (i.e., 2 years of age) are generally regarded as among the most sensitive populations to lead exposure. (See Attachment II.) However, for purposes of this RA, a 6-year-old child will be assumed to be the most likely receptor since younger children would not easily be able to enter the sites. Based on this assumption, the values assigned to the variables are as follows:

- SI = 0.010 g/day (Exposure Factors Handbook; USEPA, 1989);
- AF = 0.20 (see Attachment II);
- BKSF = 0.4045 ug/dL per ug/day (Harley and Kneip, 1985); and
- $Pb_{background}$ = 5 ug/dL.

Using Equation 5.2 and the soil lead data for the two sites, blood lead levels have been calculated for the 6-year-old child and are presented below:

	Soil Concentration[1]	Blood Lead Level[2]
McCarl Site		
Representative	1,314	6.1
RME	3,192	7.6
Baier Site		
Representative	14,026	16.3
RME	42,397	39.3

Notes: [1] Soil concentrations have units of ug/g.
[2] Blood lead levels have units of ug/dL.

These results are compared to the advisory range established by USEPA to be indicative of potential health concerns (Federal Register 53:31416, August 18, 1988). Compared to this range (10 to 15 ug/dL) the blood lead levels estimated for the McCarl site do not appear to warrant concern. However, the blood lead levels estimated for the Baier site exceed the advisory range. In fact, the blood concentrations estimated for the RME exceed 30 ug/dL which is the concentration at which the IUBK model becomes non-linear (USEPA, 1989). Under this circumstance, the model may underestimate the blood concentrations associated with exposure to lead in soil. Moreover, blood lead levels greater than 40 ug/dL may be associated with peripheral neuropathy.

However, an important distinction must be noted with regard to the soil concentrations at the McCarl and Baier sites. Soil samples at the Baier site were taken exclusively from areas where overt evidence of surface wastes was apparent and thus are not representative of the entire site. Therefore, the blood lead levels are greatly overestimated unless exposures occur exclusively in contaminated portions of the site exceeding the site-specific, health-based cleanup goal. The sampling at the McCarl site, on the other hand, was over the entire site and may be regarded as more representative.

Other uncertainties are associated with the estimated blood lead levels in addition to the sampling patterns at the two sites. Key uncertainties relate to the exposure assumptions (i.e., soil ingestion rate and gastrointestinal absorption factor) as well as the fundamental assumption that a young child could enter the sites.

In addition, it is noted that the IUBK model itself represents a source of uncertainty. Specifically, the slope value used to equate soil lead concentrations with blood lead concentrations was developed based on human exposures at the Bunker Hill lead site. Human exposure levels are regarded as high for that site due to the extent of lead contamination and the potential for multi-media exposures (i.e., air, soil, water, etc.). The magnitude of the slope in the IUBK equation reflects the high potential for exposure to lead at that site, and may overestimate exposures at sites where lead is less pervasive (e.g. Baier and McCarl sites). Moreover, the advisory range of blood lead concentrations is intended to be protective of sensitive populations (e.g. children and pregnant women) that are not likely to be on site. Indeed, the receptor populations likely to be on-site (i.e., adult hunters and farmers) are expected to be more tolerant to exposures to lead.

5.5 POTENTIAL HEALTH RISKS ASSOCIATED WITH GROUND WATER

A future use scenario was developed to evaluate potential health risks for ground water ingestion. Potential health risks associated with ground water ingestion were calculated from mean values (total metals) based on near-site wells for both the Baier and McCarl sites. The monitoring wells used to evaluate potential health risks for ground water use near the Baier site include a, b, dl, and 11. Two monitoring wells (1 and 4a) and two residential wells (Glasgow and King) were used to develop hypothetical exposure point concentrations for ground water near the McCarl site. The likelihood of a receptor using water similar to that obtained from the majority of the monitoring wells is questionable because of the very poor water quality. The ground water considered in this exercise contains an appreciable sediment load. Exposure parameters used in this exercise include the following:

- 50-year exposure period;
- 351-days/year exposure frequency;
- 70-kg body weight;
- 75-year life expectancy; and
- 1.6-liter/day water ingestion (based on the mean uptake in Iowa, Exposure Factors Handbook; USEPA, 1989).

Potential non-carcinogenic health hazards were not indicated for either site (i.e., the HI values were less than the threshold value of 1.0). The HI calculated for the McCarl site was 0.2 and the HI for the Baier site ranged from 0.6 (assuming trivalent chromium) to 0.8 (assuming hexavalent chromium). Since the metals associated with the paint wastes are generally insoluble and adhere to clay particles, the estimated HI values probably represent sediment ingestion rather than ingestion of metals dissolved in ground water.

The estimated cancer risks associated with the sites ranged from 1.3×10^{-5} (McCarl) to 8.2×10^{-5} (Baier). It should be noted that the cancer risks were based on arsenic only. The arsenic present in the Baier wells was at or near background levels. Indeed, no arsenic was detected in any of the wells adjacent to the McCarl site. However, using half the detection limit as the arsenic concentration for the McCarl wells, and based on the conservative intake factors (e.g. exposure period, exposure frequency, ingestion volume), a relatively large cancer risk was calculated (10^{-5}). Since cancer risks from ground water ingestion at both sites are based on naturally occurring arsenic levels, and would be the same for contaminated or non-contaminated wells, on- or off-site, these relatively high estimated cancer risks cannot be considered a result of paint waste disposal activities.

5.6 SUMMARY OF POTENTIAL HEALTH RISKS

Cumulative potential cancer risks and non-carcinogenic hazard indices for each exposure scenario are given in Table 5-5. The potential cancer risk for the farmer at the Baier site, based on the RME data, is 1.2×10^{-6}, which is at the lower end of the advisory range (i.e., 1×10^{-6} to 1×10^{-4}). Using a more realistic exposure based on mean contaminant concentrations, the farmers' risk is 4.0×10^{-7}. Potential cancer risks for all other exposure scenarios are low, ranging from 1.0×10^{-8} to 7.8×10^{-7} (considering both mean and RME levels of exposure).

In general, the potential cancer risks are low at both sites, and are below the 10^{-6} to 10^{-4} advisory range. Thus, under the conditions described in this RA, the sites appear to pose little potential cancer risk. This conclusion is based on the following:

- Exposure estimates used to calculate potential health risks were based on conservative criteria and have been overestimated.

- Health risks based on a RME scenario do not reflect realistic exposures to contaminants.

- Cancer risks were developed based on arsenic exposure only. However, it appears that the arsenic on-site is at or near background levels; therefore, associated cancer risks should be considered as background cancer risks.

Potential non-carcinogenic health hazards were not indicated for any of the exposure scenarios developed in this EA, with the possible exception of the effects of lead on young children.

The potential health risks presented in this RA have been estimated for receptor groups that could reasonably come into contact with contaminants at the Fort Madison paint waste disposal sites. However, the exposure scenarios evaluated in this RA are comprehensive in relation to the range of actual exposures that may occur at the sites.

TABLE 5-1

ESTIMATED DAILY INTAKES (CDIs) RME
USED FOR ESTIMATION OF HAZARD INDICES
(mg/kg/day)

Contaminant	Hiker (Child)	Juvenile Hunter	Hiker (Edibles)	Hiker (Year Round)	Hunter	Farmer
McCarl - Oral						
Arsenic	6.52×10^{-7}	3.49×10^{-7}	2.39×10^{-7}	1.79×10^{-7}	2.50×10^{-8}	1.08×10^{-6}
Barium	3.31×10^{-4}	1.77×10^{-4}	1.22×10^{-4}	9.10×10^{-5}	1.27×10^{-5}	5.47×10^{-4}
Cadmium	1.05×10^{-5}	5.62×10^{-6}	3.85×10^{-6}	2.88×10^{-6}	4.02×10^{-7}	1.73×10^{-5}
Chromium	1.43×10^{-5}	7.64×10^{-6}	5.24×10^{-6}	3.92×10^{-6}	5.46×10^{-7}	2.36×10^{-5}
Copper	3.37×10^{-5}	1.81×10^{-5}	1.24×10^{-5}	9.27×10^{-6}	1.29×10^{-6}	5.57×10^{-5}
Lead	6.96×10^{-3}	8.71×10^{-5}	5.97×10^{-5}	4.47×10^{-5}	6.22×10^{-6}	2.69×10^{-4}
Manganese	1.12×10^{-4}	6.03×10^{-5}	4.13×10^{-5}	3.09×10^{-5}	4.31×10^{-6}	1.86×10^{-4}
Selenium	3.87×10^{-6}	2.08×10^{-6}	1.42×10^{-6}	1.07×120^{-6}	1.48×10^{-7}	6.41×10^{-6}
Zinc	2.28×10^{-4}	1.22×10^{-4}	8.37×10^{-5}	6.26×10^{-5}	8.72×10^{-6}	3.77×10^{-4}
McCarl - Dermal						
Arsenic	7.94×10^{-9}	4.25×10^{-8}	4.86×10^{-9}	2.19×10^{-8}	3.03×10^{-9}	2.19×10^{-8}
Barium	4.03×10^{-6}	2.16×10^{-5}	2.47×10^{-6}	1.11×10^{-5}	1.54×10^{-6}	1.11×10^{-5}
Cadmium	1.28×10^{-7}	6.84×10^{-7}	7.83×10^{-8}	3.52×10^{-7}	4.88×10^{-8}	3.52×10^{-7}
Chromium	1.74×10^{-7}	9.30×10^{-7}	1.06×10^{-7}	4.79×10^{-7}	6.64×10^{-8}	4.79×10^{-6}
Copper	4.10×10^{-7}	2.20×10^{-6}	2.52×10^{-7}	1.13×10^{-6}	1.57×10^{-7}	1.13×10^{-6}
Lead	2.83×10^{-6}	1.06×10^{-5}	1.21×10^{-6}	5.46×10^{-6}	7.57×10^{-7}	5.46×10^{-6}
Manganese	1.37×10^{-6}	7.33×10^{-6}	8.39×12^{-7}	3.78×10^{-6}	5.24×10^{-7}	3.78×10^{-6}
Selenium	4.72×10^{-8}	2.53×10^{-7}	2.89×10^{-8}	1.30×10^{-7}	1.80×10^{-8}	1.30×10^{-7}
Zinc	2.77×10^{-6}	1.49×10^{-5}	1.70×10^{-6}	7.65×10^{-6}	1.06×10^{-6}	7.65×10^{-6}

TABLE 5-1
(Continued)
ESTIMATED DAILY INTAKES (CDIs) - REPRESENTATIVE USED FOR ESTIMATION OF HAZARD INDICES
(mg/kg/day)

Contaminant	Hiker (Child)	Juvenile Hunter	Hiker (Edibles)	Hiker (Year Round)	Hunter	Farmer
McCarl - Oral						
Arsenic	3.41×10^{-7}	1.83×10^{-7}	1.25×10^{-7}	9.38×10^{-8}	1.31×10^{-8}	5.64×10^{-7}
Barium	1.34×10^{-4}	7.34×10^{-5}	5.03×10^{-5}	3.76×10^{-5}	5.24×10^{-6}	2.26×10^{-4}
Cadmium	2.20×10^{-6}	1.18×10^{-6}	8.08×10^{-7}	6.05×10^{-7}	8.42×10^{-8}	3.64×10^{-6}
Chromium	5.38×10^{-6}	2.88×10^{-6}	1.97×10^{-6}	1.48×10^{-6}	2.06×10^{-7}	8.89×10^{-6}
Copper	6.87×10^{-6}	3.69×0^{-6}	2.52×10^{-6}	1.89×10^{-6}	2.63×10^{-7}	1.14×10^{-5}
Lead	2.86×10^{-3}	3.59×10^{-5}	2.46×10^{-5}	1.84×10^{-5}	2.56×10^{-6}	1.11×10^{-4}
Manganese	6.68×10^{-5}	3.61×10^{-5}	2.47×10^{-5}	1.85×10^{-5}	2.58×10^{-6}	1.11×10^{-4}
Selenium	5.80×10^{-7}	3.11×10^{-7}	2.13×10^{-7}	1.60×10^{-7}	2.22×10^{-8}	9.60×10^{-7}
Zinc	9.93×10^{-5}	5.32×10^{-5}	3.65×10^{-5}	2.73×10^{-5}	3.80×10^{-6}	1.64×10^{-4}
McCarl - Dermal						
Arsenic	4.15×10^{-9}	2.22×10^{-8}	2.55×10^{-9}	1.15×10^{-8}	1.59×10^{-9}	1.15×10^{-8}
Barium	1.67×10^{-6}	8.93×10^{-6}	1.02×10^{-6}	4.60×10^{-6}	6.37×10^{-6}	4.60×10^{-6}
Cadmium	2.68×10^{-8}	1.43×10^{-7}	1.64×10^{-8}	7.39×10^{-8}	1.02×10^{-8}	7.39×10^{-8}
Chromium	6.55×10^{-8}	3.51×10^{-7}	4.01×10^{-8}	1.81×10^{-7}	2.50×10^{-8}	1.81×10^{-7}
Copper	8.37×10^{-8}	4.48×10^{-7}	5.13×10^{-8}	2.31×10^{-7}	3.20×10^{-8}	2.31×10^{-7}
Lead	1.16×10^{-6}	4.36×10^{-6}	4.99×10^{-7}	2.25×10^{-6}	3.11×10^{-7}	2.26×10^{-6}
Manganese	8.13×10^{-7}	4.39×10^{-6}	5.02×10^{-7}	2.26×10^{-6}	3.13×10^{-7}	2.25×10^{-6}
Selenium	7.07×10^{-9}	3.78×10^{-8}	4.33×10^{-9}	1.95×10^{-8}	2.70×10^{-9}	1.95×10^{-8}
Zinc	1.21×10^{-6}	6.47×10^{-6}	7.41×10^{-7}	3.33×10^{-6}	4.62×10^{-7}	3.33×10^{-6}

TABLE 5-1
(Continued)
ESTIMATED DAILY INTAKES (CDIs) - RME
USED FOR ESTIMATION OF HAZARD INDICES
(mg/kg/day)

Contaminant	Hiker (Child)	Juvenile Hunter	Hiker (Edibles)	Hiker (Year Round)	Hunter	Farmer
Baier - Oral						
Arsenic	1.02×10^{-6}	5.49×10^{-7}	3.76×10^{-7}	2.81×10^{-7}	3.92×10^{-8}	1.69×10^{-6}
Cadmium	1.90×10^{-5}	1.02×10^{-5}	6.98×10^{-6}	5.22×10^{-6}	7.27×10^{-7}	3.14×10^{-5}
Chromium	9.40×10^{-5}	5.04×10^{-5}	3.45×10^{-5}	2.59×10^{-5}	3.60×10^{-6}	1.56×10^{-4}
Lead	9.24×10^{-2}	1.16×10^{-3}	7.93×10^{-4}	5.94×10^{-4}	8.27×10^{-5}	3.57×10^{-3}
Selenium	9.98×10^{-6}	1.60×10^{-6}	1.10×10^{-6}	8.20×10^{-7}	1.14×10^{-7}	4.93×10^{-6}
Baier - Dermal						
Arsenic	1.25×10^{-8}	6.67×10^{-8}	7.64×10^{-9}	3.44×10^{-8}	4.76×10^{-9}	3.44×10^{-8}
Cadmium	2.31×10^{-7}	1.24×10^{-6}	1.42×10^{-7}	6.38×10^{-7}	8.84×10^{-8}	6.38×10^{-7}
Chromium	1.15×10^{-6}	6.13×10^{-6}	7.02×10^{-7}	3.16×10^{-6}	4.38×10^{-7}	3.16×10^{-6}
Lead	3.76×10^{-5}	1.41×10^{-4}	1.61×10^{-5}	7.25×10^{-5}	1.00×10^{-5}	7.25×10^{-5}
Selenium	3.63×10^{-8}	1.95×10^{-7}	2.23×10^{-8}	1.00×10^{-7}	1.39×10^{-8}	1.00×10^{-7}

TABLE 5-1
(Continued)
ESTIMATED DAILY INTAKES (CDIs) REPRESENTATIVE USED FOR ESTIMATION OF HAZARD INDICES
(mg/kg/day)

Contaminant	Hiker (Child)	Juvenile Hunter	Hiker (Edibles)	Hiker (Year Round)	Hunter	Farmer
Baier - Oral						
Arsenic	3.36×10^{-7}	1.80×10^{-7}	1.23×10^{-7}	9.24×10^{-8}	1.29×10^{-8}	5.56×10^{-7}
Cadmium	5.96×10^{-6}	3.19×10^{-6}	2.19×10^{-6}	1.64×10^{-6}	2.28×10^{-7}	9.84×10^{-6}
Chromium	3.11×10^{-5}	1.67×10^{-5}	1.14×10^{-5}	8.57×10^{-6}	1.19×10^{-6}	5.15×10^{-5}
Lead	3.06×10^{-2}	3.83×10^{-4}	2.62×10^{-4}	1.96×10^{-4}	2.74×10^{-5}	1.18×10^{-3}
Selenium	9.37×10^{-7}	5.02×10^{-7}	3.44×10^{-7}	2.58×10^{-7}	3.59×10^{-7}	1.55×10^{-6}
Baier - Dermal						
Arsenic	4.09×10^{-9}	2.19×10^{-8}	2.51×10^{-9}	1.13×10^{-8}	1.56×10^{-9}	1.13×10^{-8}
Cadmium	7.25×10^{-8}	3.88×10^{-7}	4.44×10^{-8}	2.00×10^{-7}	2.77×10^{-8}	2.00×10^{-7}
Chromium	3.79×10^{-7}	2.03×10^{-6}	2.33×10^{-7}	1.05×10^{-6}	1.45×10^{-7}	1.05×10^{-6}
Lead	1.24×10^{-5}	4.66×10^{-5}	5.33×10^{-6}	2.40×10^{-5}	3.32×10^{-5}	2.40×10^{-5}
Selenium	1.14×10^{-8}	6.11×10^{-8}	6.99×10^{-9}	3.15×10^{-8}	4.36×10^{-8}	3.15×10^{-8}

TABLE 5-1
(Continued)
ESTIMATED DAILY INTAKES (CDIs) USED FOR ESTIMATION OF CANCER RISKS ARSENIC ONLY
(mg/kg/day)

Contaminant	Hiker (Child)	Juvenile Hunter	Hiker (Edibles)	Hiker (Year Round)	Hunter	Farmer
McCarl - RME						
Oral	1.04×10^{-7}	1.40×10^{-7}	9.57×10^{-8}	7.18×10^{-8}	9.97×10^{-9}	4.31×10^{-7}
Dermal	1.26×10^{-9}	1.70×10^{-8}	1.95×10^{-9}	8.74×10^{-9}	1.21×10^{-9}	8.74×10^{-9}
McCarl - Representative						
Oral	5.44×10^{-8}	7.30×10^{-8}	5.01×10^{-8}	3.76×10^{-8}	5.22×10^{-9}	2.26×10^{-7}
Dermal	6.61×10^{-10}	8.91×10^{-9}	1.02×10^{-9}	4.58×10^{-9}	6.35×10^{-10}	4.58×10^{-9}
Baier - RME						
Oral	1.63×10^{-7}	2.19×10^{-7}	1.50 x 10-7	1.13×10^{-7}	1.57×10^{-8}	6.77×10^{-7}
Dermal	1.99×10^{-9}	2.67×10^{-8}	3.06×10^{-9}	1.37×10^{-8}	1.91×10^{-9}	1.37×10^{-8}
Baier - Representative						
Oral	5.36×10^{-8}	7.19×10^{-8}	4.94×10^{-8}	3.70×10^{-8}	5.14×10^{-9}	2.22×10^{-7}
Dermal	6.53×10^{-10}	8.78×10^{-9}	1.00×10^{-9}	4.51×10^{-9}	6.26×10^{-10}	4.51×10^{-9}

TABLE 5-2

CRITICAL TOXICITY VALUES
SLOPE FACTORS (SFs) AND REFERENCE DOSES (RfDs)

Contaminant	Percent GI Absorption	Slope Factor		Reference Dose (RFD)	
		Oral	Dermal[2]	Oral	Dermal[3]
Arsenic[4]	90	1.75	1.94	1×10^{-3}	9.0×10^{-4}
Barium[5]	0	NC[5]	NC	5×10^{-2}	ND[6]
Cadmium[7]	6	NA[8]	NA	1×10^{-3}	6.0×10^{-5}
Chromium	2	NA	NA	5×10^{-3}	1.0×10^{-4}
Copper	50	NC	NC	1.3	6.5×10^{-1}
Lead	2-60[9]	NE[10]	NE	NE	NE
Manganese	3	NC	NC	2×10^{-1}	6.0×10^{-3}
Selenium	80	NC	NC	3×10^{-3}	2.4×10^{-3}
Zinc	58	NC	NC	2×10^{-1}	1.2×10^{-1}

Notes:

[1] Critical toxicity values obtained from Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Tables (HEAST) (USEPA, 1st and 2nd quarters, Fiscal Year 1990).

[2] Dermal carcinogen potency factor = SF_{oral}/Percent GI absorption

[3] Dermal reference dose = RFD_{oral} x Percent GI absorption

[4] Arsenic is only metal classified as carcinogenic.

[5] NC - Compound is not a known or suspected carcinogen.

[6] ND - Barium is not absorbed dermally and thus has no RFD_{dermal}.

[7] Two RfD_{oral} values are assigned to cadmium, 1 x 10-3 for food, and 5×10^{-4} for water.

[8] NA - Compound is carcinogenic via inhalation route, but not via oral route.

[9] Percent absorption decreases with age.

[10] None established. Lead is a known toxicant and probable human carcinogen, but CTVs are unavailable at the current time.

TABLE 5-3

POTENTIAL CANCER RISKS ASSOCIATED WITH INGESTION AND DERMAL CONTACT WITH CONTAMINATED SOIL ARSENIC ONLY

	Exposure Scenario					
	Hiker (Child)	Juvenile Hunter	Hiker (Edibles)	Hiker (Year Round)	Hunter	Farmer
Ingestion - RME						
Baier	2.9×10^{-7}	3.8×10^{-7}	2.6×10^{-7}	2.0×10^{-7}	2.7×10^{-8}	1.2×10^{-6}
McCarl	1.8×10^{-7}	2.4×10^{-7}	1.7×10^{-7}	1.3×10^{-7}	1.7×10^{-8}	7.6×10^{-7}
Dermal - RME						
Baier	3.9×10^{-9}	5.2×10^{-8}	5.9×10^{-9}	2.7×10^{-8}	3.7×10^{-9}	2.7×10^{-8}
McCarl	2.5×10^{-9}	3.3×10^{-8}	3.8×10^{-9}	1.7×10^{-8}	2.4×10^{-9}	1.7×10^{-8}
Ingestion - Representative						
Baier	9.4×10^{-8}	1.3×10^{-7}	8.6×10^{-8}	6.5×10^{-8}	9.0×10^{-9}	3.9×10^{-7}
McCarl	9.5×10^{-8}	1.3×10^{-7}	8.8×10^{-8}	6.6×10^{-8}	9.1×10^{-9}	4.0×10^{-7}
Dermal - Representative						
Baier	1.3×10^{-9}	1.7×10^{-8}	2.0×10^{-9}	8.8×10^{-9}	1.2×10^{-9}	8.8×10^{-9}
McCarl	1.3×10^{-9}	1.7×10^{-8}	2.0×10^{-9}	8.9×10^{-9}	1.2×10^{-9}	8.9×10^{-9}

TABLE 5-4
NON-CARCINOGENIC HAZARD QUOTIENTS ASSOCIATED WITH INGESTION OF CONTAMINATED SOIL BASED ON REASONABLE MAXIMUM EXPOSURE (RME)

	Exposure Scenario					
	Hiker (Child)	Juvenile Hunter	Hiker (Edibles)	Hiker (Year Round)	Hunter	Farmer
McCarl						
Arsenic	6.49×10^{-4}	3.49×10^{-4}	2.39×10^{-4}	1.79×10^{-4}	2.50×10^{-5}	1.08×10^{-3}
Barium	6.59×10^{-3}	3.55×10^{-3}	2.43×10^{-3}	1.82×10^{-3}	2.54×10^{-4}	1.09×10^{-2}
Cadmium	1.04×10^{-2}	5.62×10^{-3}	3.85×10^{-3}	2.88×10^{-3}	4.02×10^{-4}	1.73×10^{-2}
Chromium	2.84×10^{-3}	1.53×10^{-3}	1.05×10^{-3}	7.84×10^{-4}	1.09×10^{-4}	4.72×10^{-3}
Copper	2.58×10^{-5}	1.39×10^{-5}	9.52×10^{-6}	7.13×10^{-6}	9.93×10^{-7}	4.29×10^{-5}
Manganese	5.60×10^{-4}	3.02×10^{-4}	2.07×10^{-4}	1.55×10^{-4}	2.15×10^{-5}	9.30×10^{-4}
Selenium	1.29×10^{-3}	6.93×10^{-4}	4.74×10^{-4}	3.55×10^{-4}	4.95×10^{-5}	2.14×10^{-3}
Zinc	1.13×10^{-3}	6.11×10^{-4}	4.18×10^{-4}	3.13×12^{-4}	4.36×10^{-5}	1.88×10^{-3}
$\sum$[1]	2.35×10^{-2}	1.27×10^{-2}	8.68×10^{-3}	6.50×10^{-3}	9.05×10^{-4}	3.91×10^{-2}
Baier						
Arsenic	1.02×10^{-3}	5.49×10^{-4}	3.76×10^{-4}	2.81×10^{-4}	3.92×10^{-5}	1.69×10^{-3}
Cadmium	1.89×10^{-2}	1.02×10^{2}	6.98×10^{-3}	5.22×10^{-3}	7.27×10^{-4}	3.14×10^{-2}
Chromium	1.87×10^{-2}	1.01×10^{-2}	6.91×10^{-3}	5.17×10^{-3}	7.20×10^{-4}	3.11×10^{-2}
Selenium	9.90×10^{4}	5.33×10^{-4}	3.65×10^{-4}	2.73×10^{-4}	3.81×10^{-5}	1.64×10^{-3}
$\sum$[1]	3.96×10^{-2}	2.13×10^{-2}	1.46×10^{-2}	1.09×10^{-2}	1.52×10^{-3}	6.58×10^{-2}

Notes: [1] The summation of the hazard quotients is the hazard index.

TABLE 5-4
(Continued)
NON-CARCINOGENIC HAZARD QUOTIENTS ASSOCIATED WITH INGESTION OF CONTAMINATED SOIL BASED ON REPRESENTATIVE SOIL CONCENTRATIONS

	Exposure Scenario					
	Hiker (Child)	Juvenile Hunter	Hiker (Edibles)	Hiker (Year Round)	Hunter	Farmer
McCarl						
Arsenic	3.40×10^{-4}	1.83×10^{-4}	1.25×10^{-4}	9.38×10^{-5}	1.31×10^{-5}	5.64×10^{-4}
Barium	2.73×10^{-3}	1.47×10^{-3}	1.01×10^{-3}	7.53×10^{-4}	1.05×10^{-4}	4.53×10^{-3}
Cadmium	2.19×10^{-3}	1.18×10^{-3}	8.08×10^{-4}	6.05×10^{-4}	8.42×10^{-5}	3.64×10^{-3}
Chromium	1.07×10^{-3}	5.77×10^{-4}	3.95×10^{-4}	2.96×10^{-4}	4.12×10^{-5}	1.78×10^{-3}
Copper	5.27×10^{-6}	2.84×10^{-6}	1.94×10^{-6}	1.45×10^{-6}	2.03×10^{-7}	8.74×10^{-6}
Manganese	3.35×10^{-4}	1.80×10^{-4}	1.24×10^{-4}	9.25×10^{-5}	1.29×10^{-5}	5.56×10^{-4}
Selenium	1.93×10^{-4}	1.04×10^{-4}	7.11×10^{-5}	5.32×10^{-5}	7.41×10^{-6}	3.20×10^{-4}
Zinc	4.94×10^{-4}	2.66×10^{-4}	1.82×10^{-4}	1.37×12^{-4}	1.90×10^{-5}	8.21×10^{-4}
$\sum$[1]	7.35×10^{-3}	3.96×10^{-3}	2.71×10^{-3}	2.03×10^{-3}	2.83×10^{-4}	1.22×10^{-2}
Baier						
Arsenic	3.35×10^{-4}	1.80×10^{-4}	1.23×10^{-4}	9.24×10^{-5}	1.29×10^{-5}	5.56×10^{-4}
Cadmium	5.93×10^{-3}	3.19×10^{-3}	2.19×10^{-3}	1.64×10^{-3}	2.28×10^{-4}	9.84×10^{-3}
Chromium	6.21×10^{-3}	3.34×10^{-3}	2.29×10^{-3}	1.71×10^{-3}	2.39×10^{-4}	1.03×10^{-2}
Selenium	3.11×10^{-4}	1.67×10^{-4}	1.15×10^{-4}	8.59×10^{-5}	1.20×10^{-5}	5.16×10^{-4}
$\sum$[1]	1.28×10^{-2}	6.88×10^{-3}	4.71×10^{-3}	3.53×10^{-3}	4.91×10^{-4}	2.12×10^{-2}

Notes: [1] The summation of the hazard quotients is the hazard index.

TABLE 5 4
NON-CARCINOGENIC HAZARD QUOTIENTS ASSOCIATED WITH DERMAL CONTACT WITH CONTAMINATED SOIL BASED ON REASONABLE MAXIMUM EXPOSURE (RME)

	Exposure Scenario					
	Hiker (Child)	Juvenile Hunter	Hiker (Edibles)	Hiker (Year Round)	Hunter	Farmer
McCarl						
Arsenic	1.26×10^{-5}	4.72×10^{-5}	5.40×10^{-6}	2.43×10^{-5}	3.37×10^{-6}	2.43×10^{-5}
Barium	...	...	...	...	...	...
Cadmium	3.04×10^{-3}	1.14×10^{-2}	1.30×10^{-3}	5.87×10^{-3}	8.14×10^{-4}	5.87×10^{-3}
Chromium	2.48×10^{-3}	9.30×10^{-3}	1.06×10^{-3}	4.79×10^{-3}	6.64×10^{-4}	4.79×10^{-3}
Copper	9.02×10^{-7}	3.38×10^{-6}	3.87×10^{-7}	1.74×10^{-6}	2.41×10^{-7}	1.74×10^{-6}
Manganese	3.26×10^{-4}	1.22×10^{-3}	1.40×10^{-4}	6.30×10^{-4}	8.73×10^{-5}	6.30×10^{-4}
Selenium	2.81×10^{-5}	1.05×10^{-4}	1.20×10^{-5}	5.42×10^{-5}	7.51×10^{-6}	5.42×10^{-5}
Zinc	3.42×10^{-5}	1.28×10^{-4}	1.47×10^{-5}	6.60×12^{-5}	9.14×10^{-6}	6.60×10^{-5}
$\sum^{1}$	5.92×10^{-3}	2.22×10^{-2}	2.54×10^{-3}	1.14×10^{-2}	1.58×10^{-3}	1.14×10^{-2}
Baier						
Arsenic	1.98×10^{5}	7.41×10^{-5}	8.49×10^{-6}	3.82×10^{-5}	5.29×10^{-6}	3.82×10^{-5}
Cadmium	5.51×10^{-3}	2.06×10^{-2}	2.36×10^{-3}	1.06×10^{-2}	1.47×10^{-3}	1.06×10^{-2}
Chromium	1.64×10^{-2}	6.13×10^{-2}	7.02×10^{-3}	3.16×10^{-2}	4.38×10^{-3}	3.16×10^{-2}
Selenium	2.16×10^{-5}	8.11×10^{-5}	9.28×10^{-6}	4.18×10^{-5}	5.79×10^{-6}	4.18×10^{-5}
$\sum^{1}$	2.19×10^{-2}	8.21×10^{-2}	9.40×10^{-3}	4.23×10^{-2}	5.86×10^{-3}	4.23×10^{-2}

Notes:
[1] The summation of the hazard quotients is the hazard index.
[2] Barium is not absorbed dermally.

TABLE 5-4
NON-CARCINOGENIC HAZARD QUOTIENTS ASSOCIATED WITH DERMAL CONTACT WITH CONTAMINATED SOIL BASED ON REPRESENTATIVE SOIL CONCENTRATIONS

	Exposure Scenario					
	Hiker (Child)	Juvenile Hunter	Hiker (Edibles)	Hiker (Year Round)	Hunter	Farmer
McCarl						
Arsenic	6.60×10^{-6}	2.47×10^{-5}	2.83×10^{-6}	1.27×10^{-5}	1.76×10^{-6}	1.27×10^{-5}
Barium	...	...	...	...	...	...
Cadmium	6.38×10^{-4}	2.39×10^{-3}	2.74×10^{-4}	1.23×10^{-3}	1.71×10^{-4}	1.23×10^{-3}
Chromium	9.36×10^{-4}	3.51×10^{-3}	4.01×10^{-4}	1.81×10^{-3}	2.50×10^{-4}	1.81×10^{-3}
Copper	1.84×10^{-7}	6.90×10^{-7}	7.89×10^{-8}	3.55×10^{-7}	4.92×10^{-8}	3.55×10^{-7}
Manganese	1.95×10^{-4}	7.31×10^{-4}	8.37×10^{-5}	3.76×10^{-4}	5.22×10^{-5}	3.76×10^{-4}
Selenium	4.21×10^{-6}	1.58×10^{-5}	1.81×10^{-6}	8.12×10^{-6}	1.13×10^{-6}	8.12×10^{-6}
Zinc	1.49×10^{-5}	5.58×10^{-5}	6.39×10^{-6}	2.87×10^{-5}	3.98×10^{-6}	2.87×10^{-5}
$\sum$[1]	1.79×10^{-3}	6.72×10^{-3}	7.70×10^{-4}	3.46×10^{-3}	4.80×10^{-4}	3.46×10^{-3}
Baier						
Arsenic	6.50×10^{-6}	2.43×10^{-5}	2.79×10^{-6}	1.25×10^{-5}	1.74×10^{-6}	1.25×10^{-5}
Cadmium	1.73×10^{-3}	6.47×10^{-3}	7.40×10^{-4}	3.33×10^{-3}	4.62×10^{-4}	3.33×10^{-3}
Chromium	5.42×10^{-3}	2.03×10^{-2}	2.33×10^{-3}	1.05×10^{-2}	1.45×10^{-3}	1.05×10^{-2}
Selenium	6.79×10^{-6}	2.55×10^{-5}	2.91×10^{-6}	1.31×10^{-5}	1.82×10^{-6}	1.31×10^{-5}
$\sum$[1]	7.16×10^{-3}	2.68×10^{-2}	3.07×10^{-3}	1.38×10^{-2}	1.92×10^{-3}	1.38×10^{-2}

Notes:

[1] The summation of the hazard quotients is the hazard index.

[2] Barium is not absorbed dermally.

TABLE 5-5
SUMMARY OF CUMULATIVE POTENTIAL CANCER RISKS AND NON-CARCINOGENIC HAZARDS INDICES

Exposure Scenario	Reasonable Maximum Exposure (RME)		Representative Exposure	
	Potential Cancer Risk	Non-Carcinogenic Hazard Index	Potential Cancer Risk	Non-Carcinogenic Hazard Index
Baier				
Hiker (Child)	2.9×10^{-7}	0.062	9.5×10^{-8}	0.020
Juvenile Hunter	4.3×10^{-7}	0.10	1.5×10^{-7}	0.034
Hiker (Edibles)	2.7×10^{-7}	0.016	8.8×10^{-8}	0.0078
Hiker (Year Round)	2.3×10^{-7}	0.053	7.4×10^{-8}	0.017
Hunter	3.1×10^{-8}	0.0074	1.0×10^{-8}	0.0024
Farmer	1.2×10^{-6}	0.11	4.0×10^{-7}	0.035
McCarl				
Hiker (Child)	1.8×10^{-7}	0.029	9.6×10^{-8}	0.0092
Juvenile Hunter	2.7×10^{-7}	0.035	1.5×10^{-7}	0.011
Hiker (Edibles)	1.7×10^{-7}	0.011	8.8×10^{-8}	0.0035
Hiker (Year Round)	1.5×10^{-7}	0.018	7.5×10^{-8}	0.0055
Hunter	1.9×10^{-8}	0.0025	1.0×10^{-8}	0.00076
Farmer	7.8×10^{-7}	0.051	4.1×10^{-7}	0.016

6.0 ANALYSIS OF UNCERTAINTIES

The estimation of the potential health risks associated with a site is based on the best available data regarding chemical exposures and contaminant toxicities. Because of the uncertainties inherent in this information, the actual risks associated with the site are unknown. The major sources of uncertainty include the exposure assumptions, estimated exposure point concentrations, and the use of toxicity data based on animal studies. The uncertainty associated with animal data refers specifically to the extrapolation of high-dose animal studies to low-dose human exposure.

Uncertainty can lead to an under- or overestimation of potential risk. Table 6-1 presents a qualitative assessment of factors which may contribute to uncertainty in the estimation of potential risks.

A quantitative sensitivity analysis was also performed on a number of exposure parameters to determine their effect on risk. The parameters analyzed include the following:

- Dermal surface area;
- Frequency of exposure;
- Duration of exposure;
- Body weight; and
- Soil ingestion rate.

Two scenarios were investigated, the juvenile hunter (hazard index) and the farmer (cancer risk), both from the Baier site. These scenarios were chosen for analysis because they were associated with the highest respective risk estimates in the risk characterization. Sensitivity of risk estimates to changes in the various parameters were examined using both the RME and representative (i.e., mean) exposure point concentrations. The results are presented in Figures 6-1 through 6-10. The exposure values originally presented in the exposure assessment are listed on the x-axis as the 100 percent values. The sensitivity of the HI and cancer risk (CR) values to variations in the exposure parameters was evaluated by varying the exposure values from 10 percent to 1,000 percent of the original value. In some cases, the values became impossibly high (e.g. the frequency of exposure cannot exceed 365 days per year, nor could an individual live on-site for 300 years).

In the case of the farmer scenario, a cancer risk greater than of 1×10^{-5} was obtained only using the RME. To obtain a CR in excess of 1×10^{-5}, a ten-fold increase in exposure duration (not possible), frequency of exposure or soil ingestion rate, or ten-fold decrease in body weight (not possible) would be required. It is noted that increasing the surface area of exposed skin does not affect the overall (cumulative) cancer risk estimate for the farmer.

Sensitivity analysis of the juvenile hunter demonstrated that a ten-fold increase in dermal surface area, exposure duration or exposure frequency, or a ten-fold decrease in body weight was required to obtain HI values near 1.0. Even using these unrealistic values (e.g. impossible), HI values near 1.0 could only be obtained only using the RME. It should be noted that for non-carcinogenic health hazards, dermal contact was a more pathway than soil ingestion. A ten-fold increase in the ingestion rate produced an increase in the HI value which was still less than 1.0.

TABLE 6-1

SUMMARY OF UNCERTAINTIES ASSOCIATED WITH RISK ASSESSMENT FOR FORT MADISON PAINT WASTE DISPOSAL SITES

Assumption	Estimated[1] Magnitude of Effect on Risk	Direction of Effect on Risk Estimate
Environmental Sampling and Analysis		
Errors in chemical analysis.	Low	May over-or underestimate risk.
Soil samples from the Baier site were collected from regions of obvious contamination only.	Moderate - High	May overestimate risk.
Fate and Transport Modeling		
Chemical concentrations reported as "below method detection limit" are used at one-half detection limit when calculating mean chemical concentrations.	Low	May over- or underestimate risk.
Toxicological Data		
Reference Doses (RfDs) are based on the most bioavailable forms of these compounds, while paint pigments tend to be highly stable, with low bioavailability.	Low - Moderate	May overestimate risk.
The model used to determine the toxic effects of lead assumes daily lead exposure, and makes no allowance for infrequent or periodic exposure.	Low - Moderate	May overestimate risk.
Hazard indices for the Baier site were calculated for only those chemicals of concern identified in the Removal Action Work Plan (RAW). Hazard indices for the McCarl site included the chemicals used for the Baier site plus barium, copper, manganese, and zinc.	Low	May underestimate risk at Baier site.

TABLE 6-1
(Continued)
SUMMARY OF UNCERTAINTIES ASSOCIATED WITH RISK ASSESSMENT FOR FORT MADISON PAINT WASTE DISPOSAL SITES

Assumption	Estimated[1] Magnitude of Effect on Risk	Direction of Effect on Risk Estimate
Exposure Parameters		
Conservative values were used for exposure duration, frequency, ingestion rate, and dermal surface area.	Low - Moderate	May overestimate risk.
Dermal absorption was assumed to be the same for all contaminants.	Low	May over- or underestimate risk.
Estimation of soil adherence factor.	Low	May over- or underestimate risk.

Note: The effect of altering a variable on estimated risk is defined as low if it is less than one order of magnitude; moderate if it is between one and two orders of magnitude; and great if it is greater than two orders of magnitude.

FIGURE 6-1

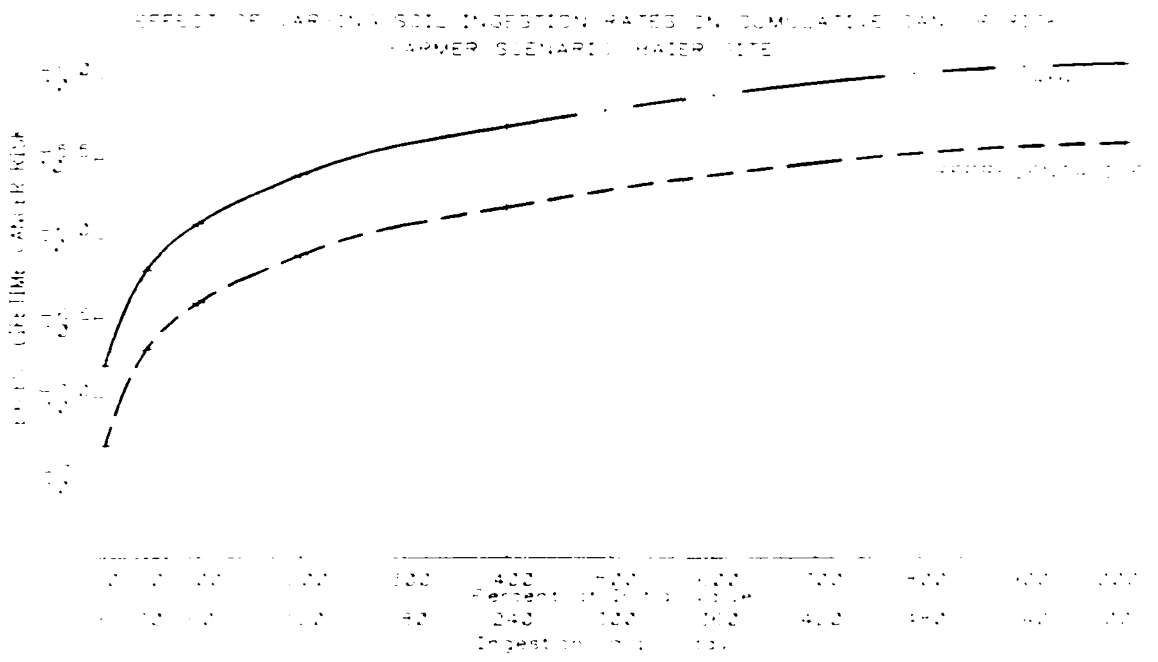


FIGURE 6-2

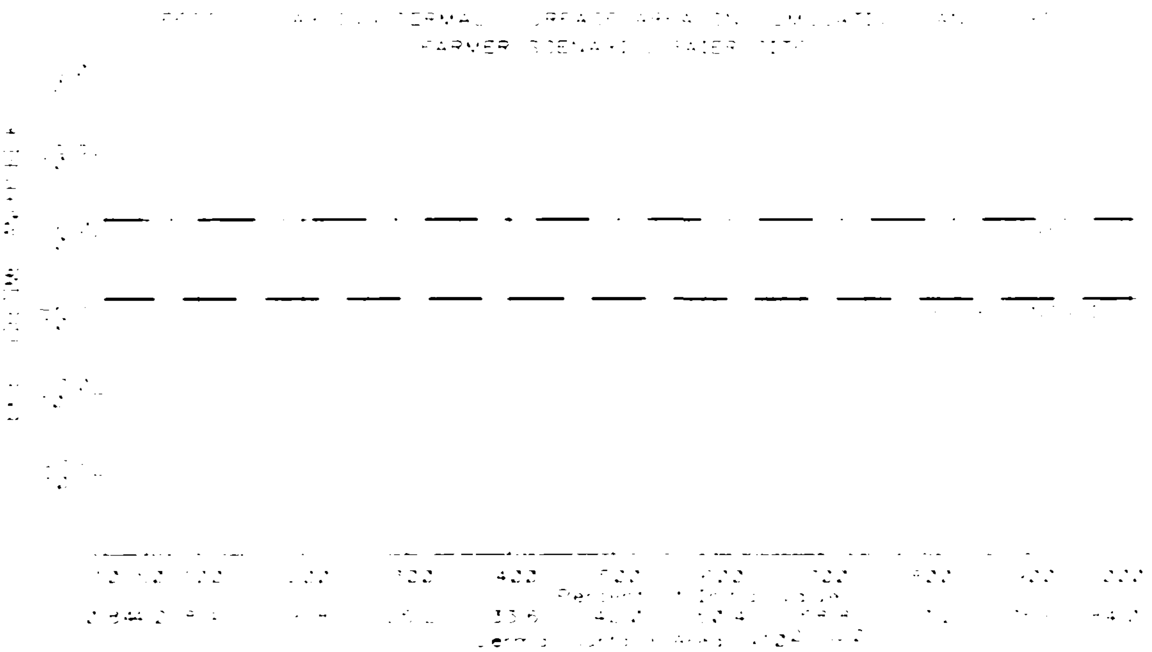


FIGURE 6-3

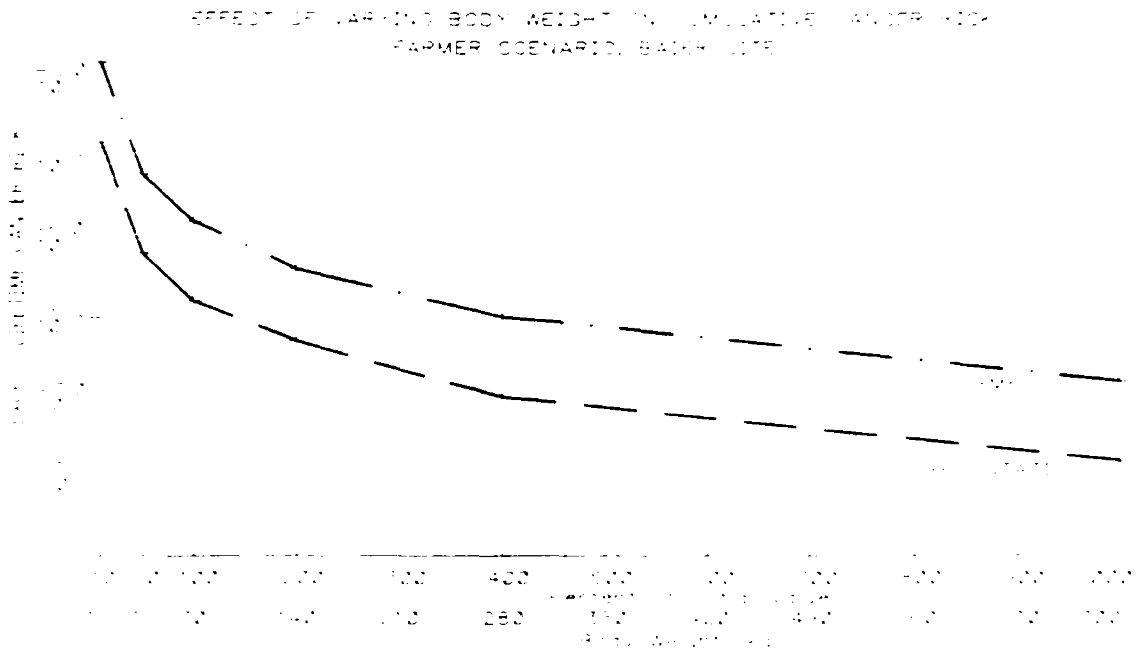


FIGURE 6-4

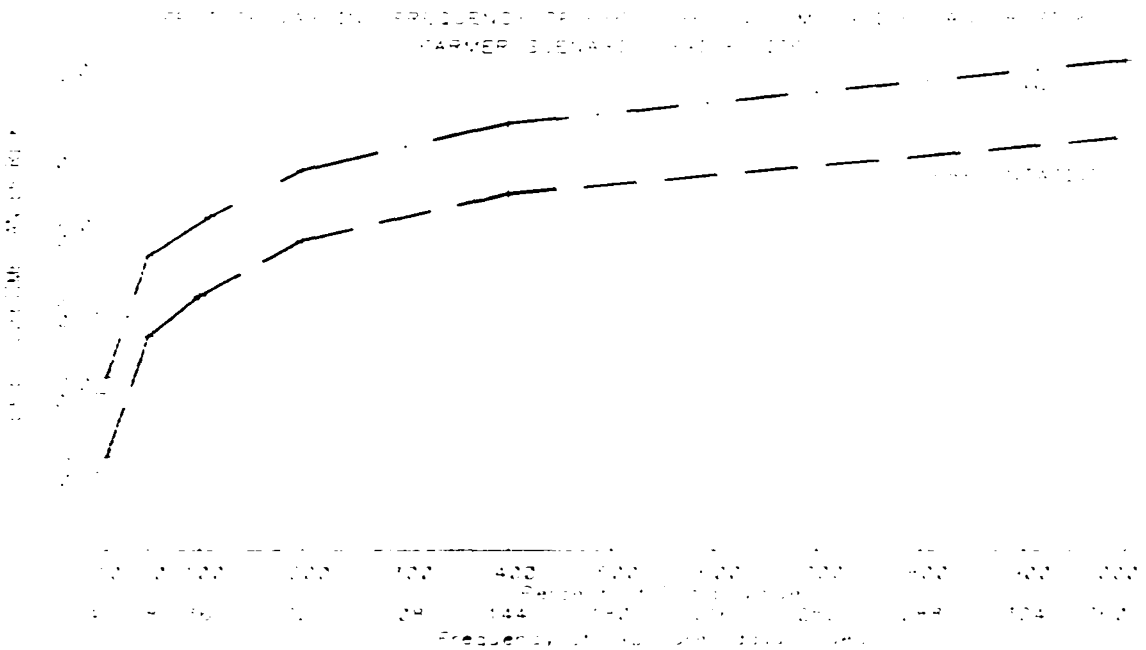


FIGURE 6-5

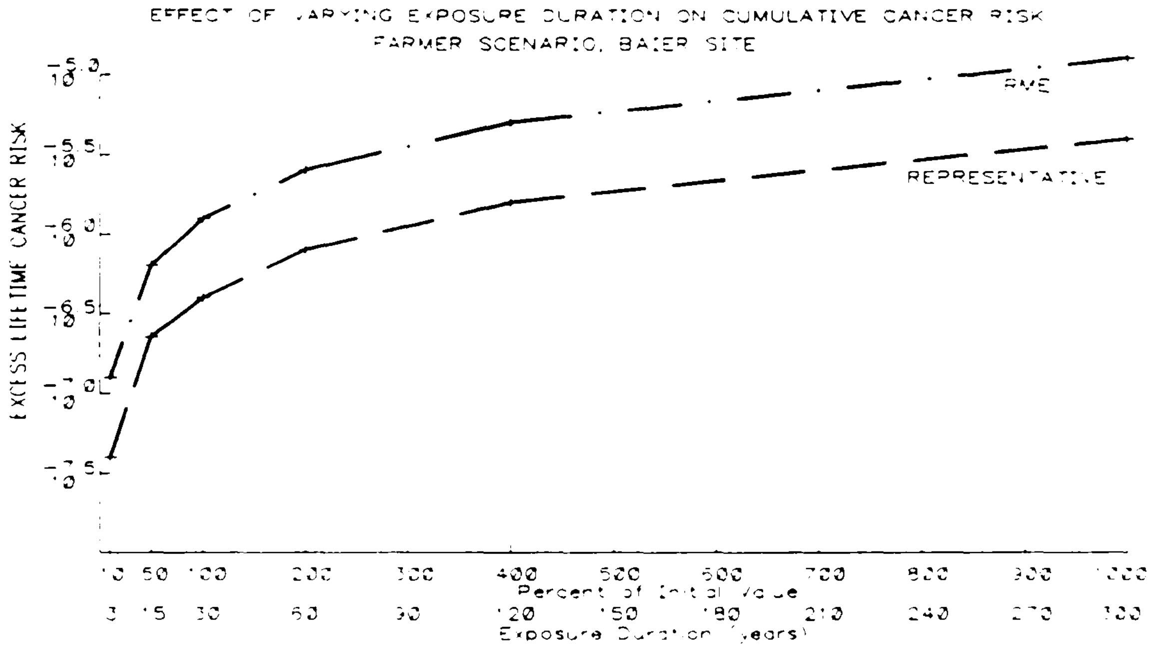


FIGURE 6-6

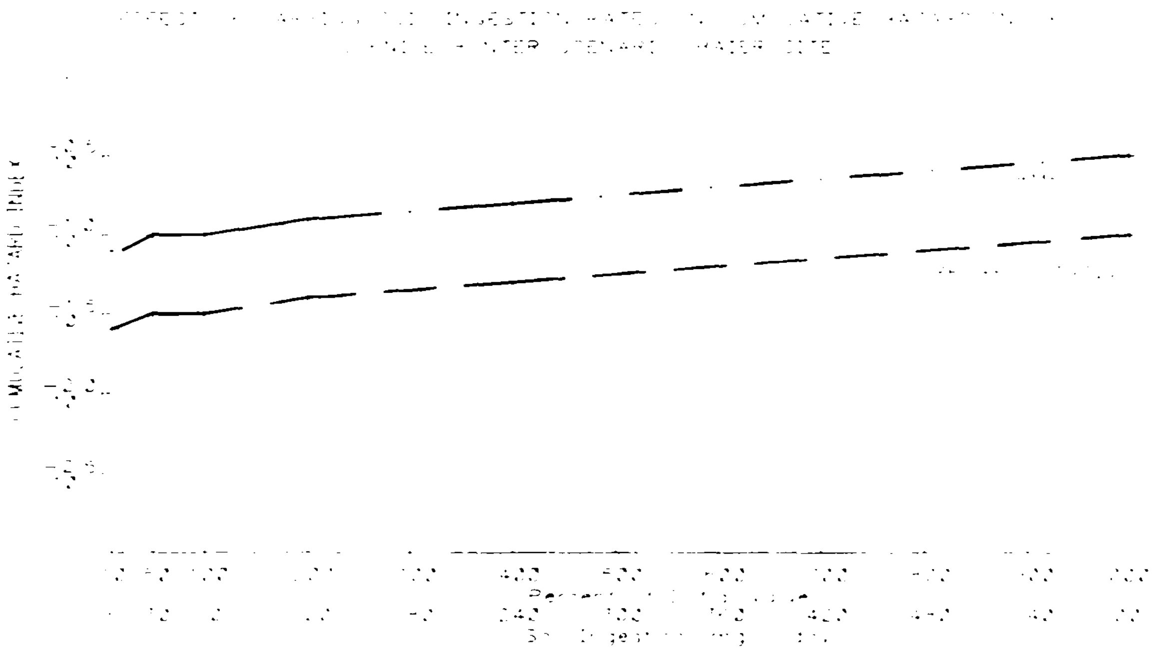


FIGURE 6-7

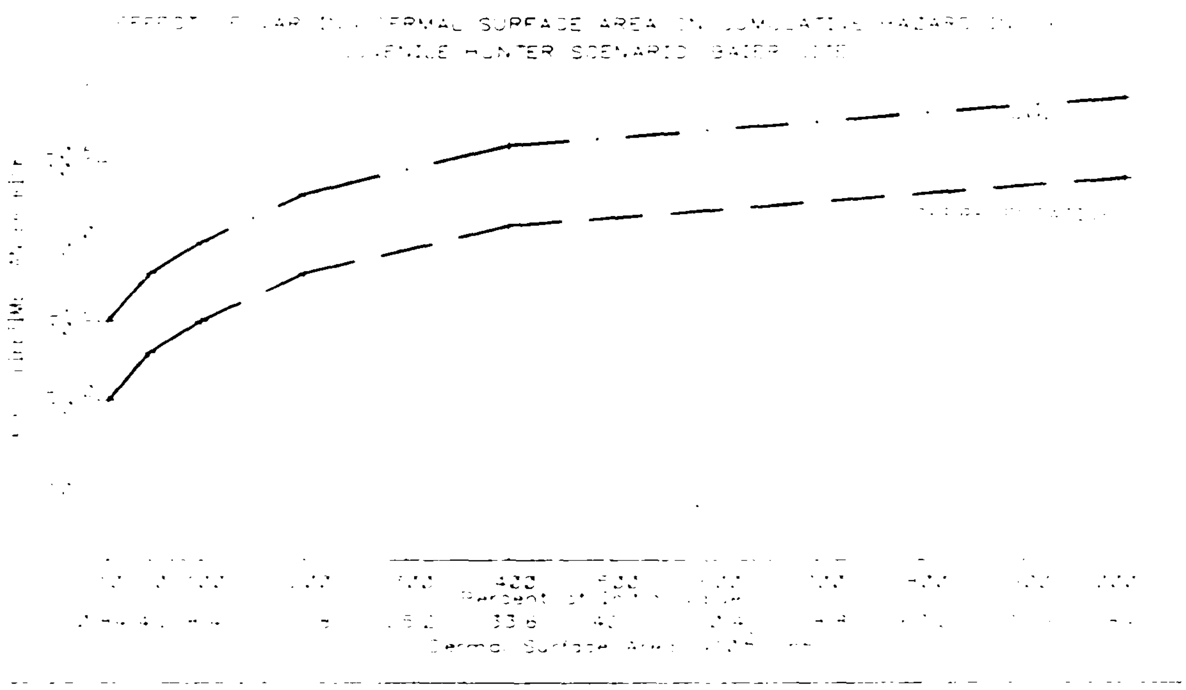


FIGURE 6-8

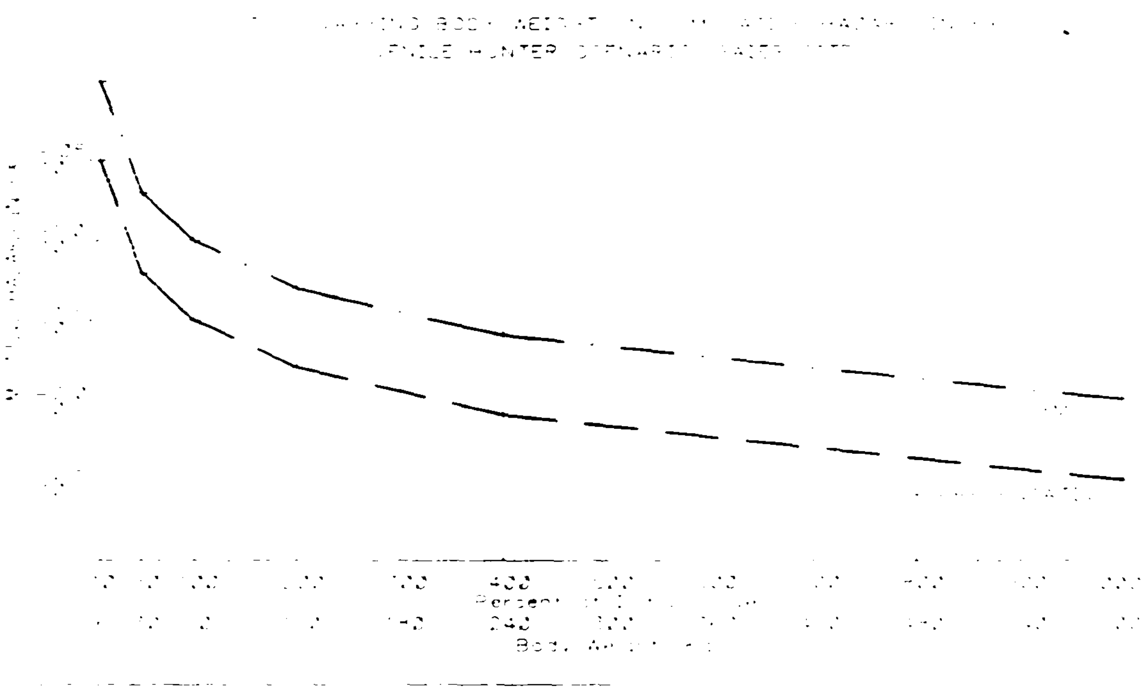


FIGURE 6-9

EFFECT OF VARYING FREQUENCY OF EXPOSURE ON CUMULATIVE HAZARD INDEX
JUVENILE HUNTER SCENARIO, BAIER SITE

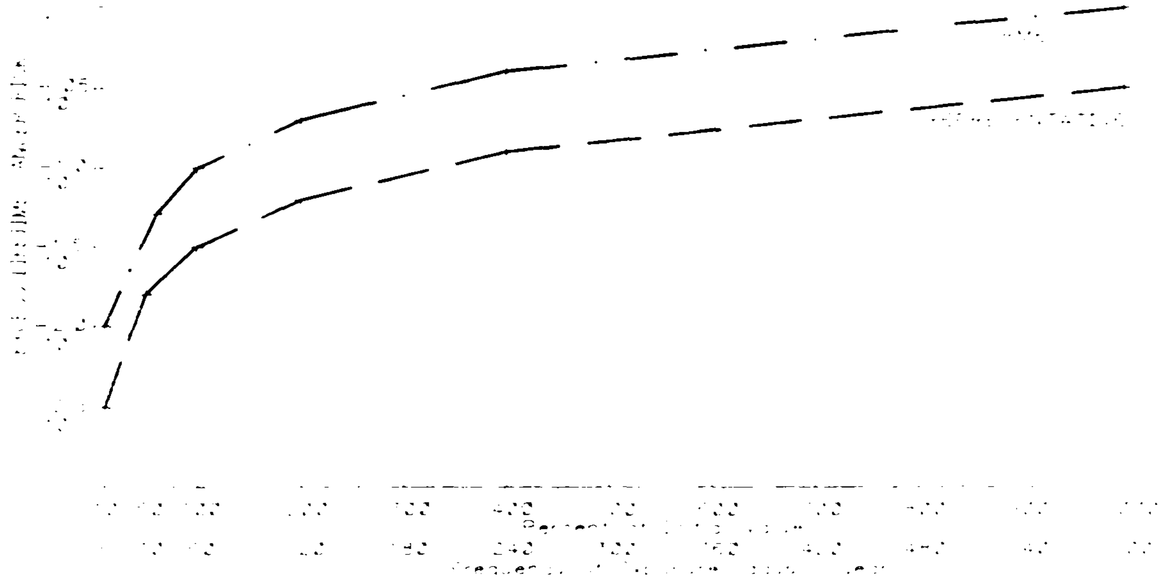
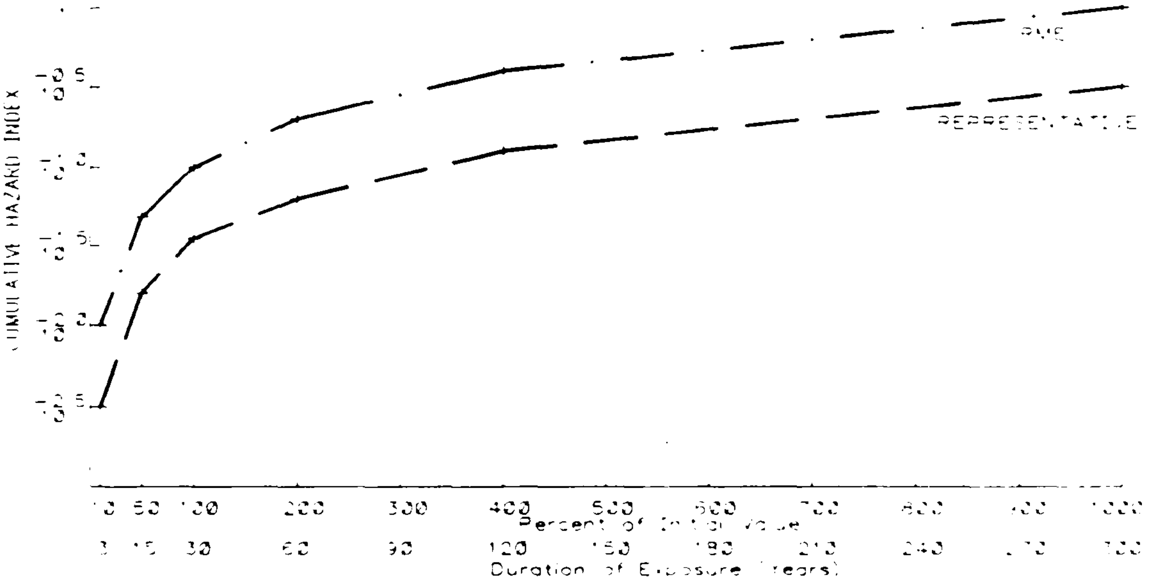


FIGURE 6-10

EFFECT OF VARYING DURATION OF EXPOSURE ON CUMULATIVE HAZARD INDEX
JUVENILE HUNTER SCENARIO, BAIER SITE



7.0 SUMMARY AND CONCLUSIONS

This RA has evaluated potential health hazards (i.e., non-carcinogenic effects) and cancer risks that may result from exposure to contaminant metals found on the Baier and McCarl sites. An evaluation of potential health risks has been performed for a group of exposure scenarios believed to represent the most likely forms of human activities occurring on the sites. Potential health risks were evaluated for two pathways, soil ingestion and soil dermal contact, and assumed either a representative level of exposure or a reasonable maximum exposure.

The results of the risk characterization indicate that potential cancer risks estimated for the sites range from 10^{-9} to 10^{-6} at reasonable maximum levels of exposure. The range of potential cancer risks estimated for representative levels of exposure was even lower (10^{-9} to 10^{-7}). These levels of potential risks do not appear excessive for these sites for the following reasons:

- The sites are remote;
- Human activity (if any) is infrequent on the sites; and
- The estimated risks are at the low end, or below, the advisory range of 10^{-6} to 10^{-4} established by USEPA.

A non-carcinogenic health hazard does not exist for any of the exposure scenarios evaluated in this RA. However, exposure to lead in portions of the Baier site may result in unacceptable blood lead levels (i.e., greater than 15 ug/dL). It is noted that blood lead levels are currently used to assess the potential for health hazards posed by this contaminant and that increases in blood lead levels are generally of greatest concern in children. However, the blood lead levels estimated in this RA are believed to be conservative (i.e., overestimated) based on the following:

- Estimates of blood lead levels are based on the assumption that exposures occur exclusively in the areas of former waste disposal (i.e., exposures are localized); and

- Increases in blood lead levels are most significant for very young children (newborns to 6 years of age) and it is unlikely that this group of receptors would enter the site.

Hypothetical ground water ingestion was considered as a potential future use of the Baier and McCarl sites. Potential cancer risks estimated for arsenic in an ingestion scenario were on the order of 10^{-5} which corresponds to risks associated with background levels of arsenic in ground water.

In conclusion, based on the evaluation presented in this RA, it appears that neither site poses significant health risks to persons on or near the respective sites. The exception may be exposure to lead which could pose a health hazard to younger children. However, the likelihood of children entering either site appears remote. Based on the results of this RA, several recommendations can be made that would further reduce the potential for exposures at the sites including:

- Install sufficient fencing around the site perimeters to prevent access by children;
- Obtain deed restrictions for both sites to prevent any future residential use; and
- Cap or remove any areas containing high levels of lead wastes (waste disposal site, burn areas, etc.) to reduce potential for exposure to lead on the Baier site.

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ATTACHMENT I

ALGORITHMS FOR ESTIMATION OF DAILY CHEMICAL INTAKES AND TABLES OF EXPOSURE PARAMETERS, INTAKE FACTORS

1.0 INGESTION OF SOIL

$$OEX = \frac{IR \times C(x) \times F}{BW \times AP}$$

where:

OEX = Estimated oral exposure (mg/kg/day)

IR = Soil ingestion rate (mg/day)

C(x) = Exposure point concentration in soil (as mass fraction; unitless)

F = Frequency of exposure (number/average period)

BW = Body weight (kg)

AP = Averaging period (days); 1.10×10^4 days (chronic exposures), 4.38×10^3 days (chronic exposures for child), 2.74×10^4 days (lifetime exposure)

2.0 DERMAL EXPOSURE TO SOIL

$$DEX = \frac{AV \times C(x) \times F \times AD \times AF}{BW \times AP}$$

where:

DEX = Estimated dermal exposure (mg/kg/day)

AV = Available skin surface (cm^2)

C(x) = Exposure point concentration in soil (as mass fraction, unitless)

F = Frequency of exposure (number/averaging period)

AD = Adherence factor (mg/cm^2)

BW = Body weight (kg)

AP = Averaging period (days); 1.10×10^4 (chronic exposures), 4.38×10^3 days (chronic exposures for child), 2.74×10^4 days (lifetime exposure)

AF = Absorption factor; absorption through skin is assumed to be 0.1 percent of the applied dose

TABLE I-1

EXPOSURE PARAMETERS FOR ESTIMATION OF CONTAMINANT INTAKE BY INGESTION OF SOIL

Parameter	Exposure Scenarios		
	Hunter	Hunter (Juvenile)	Farmer
Ingestion Rate (IR)	10 mg/event	10 mg/event	60 mg/event
Frequency/Year (F)	5 days	60 days	36 days
Body Weight (BW)	70 kg	60 kg	70 kg
Days/Lifetime	2.74×10^{4}	2.74×10^{4}	2.74×10^{4}
Days/Exposure Period	1.10×10^{4}	1.10×10^{4}	1.10×10^{4}
Intake Factor (Exposure Period)[1]	**1.95×10^{-9}**	**2.73×10^{-8}**	**8.42×10^{-8}**
Intake Factor (Lifetime)[1]	**7.79×10^{-10}**	**1.09×10^{-8}**	**3.37×10^{-8}**

Notes: [1] Intake factors have units of kg/kg/day.

TABLE I-1
(Continued)
EXPOSURE PARAMETERS FOR ESTIMATION OF CONTAMINANT INTAKE BY INGESTION OF SOIL

Parameter	Exposure Scenarios		
	Hiker (Adult)	Hiker (Child)	Hiker (Year-Round)
Ingestion Rate (IR)	60 mg/event	100 mg/event	10 mg/event
Frequency/Year (F)	8 days	8 days	36 days
Body Weight (BW)	70 kg	43 kg	70 kg
Days/Lifetime	2.74×10^4	2.74×10^4	2.74×10^4
Days/Exposure Period	1.10×10^4	1.10×10^4	1.10×10^4
Intake Factor (Exposure Period)	1.87×10^{-8}	5.07×10^{-8}	1.40×10^{-8}
Intake Factor (Lifetime)	7.48×10^{-9}	8.12×10^{-9}	5.61×10^{-9}

TABLE I-2

EXPOSURE PARAMETERS FOR ESTIMATION OF CONTAMINANT INTAKE BY DERMAL CONTACT WITH SOIL

Parameter	Exposure Scenarios		
	Hunter	Hunter (Juvenile)	Farmer
Available Surface	$8.4 \times 10^2 cm^2$	$8.4 \times 10^2 cm^2$	$8.4 \times 10^2 cm^2$
Frequency/Year (F)	5 days	60 days	36 days
Adherence Factor (AD)	$1.45\ mg/cm^2$	$1.45\ mg/cm^2$	$1.45\ mg/cm^2$
Body Weight (BW)	70 kg	60 kg	70 kg
Days/Lifetime	2.74×10^4	2.74×10^4	2.74×10^4
Days/Exposure Period	1.10×10^4	1.10×10^4	1.10×10^4
Intake Factor (Exposure Period)[1]	**2.37×10^{-10}**	**3.32×10^{-9}**	**1.71×10^{-9}**
Intake Factor (Lifetime)[1]	**9.48×10^{-11}**	**1.33×10^{-9}**	**6.83×10^{-10}**

Notes: [1] Intake factors have units of kg/kg/day.

TABLE I-2
(Continued)
EXPOSURE PARAMETERS FOR ESTIMATION OF CONTAMINANT INTAKE BY DERMAL CONTACT WITH SOIL

Parameter	Exposure Scenarios		
	Hiker (Adult)	Hiker (Child)	Hiker (Year-Round)
Available Surface	$8.4 \times 10^2 cm^2$	$8.4 \times 10^2 cm^2$	$8.4 \times 10^2 cm^2$
Frequency/Year (F)	8 days	8 days	36 days
Adherence Factor (AD)	$1.45\ mg/cm^2$	$1.45\ mg/cm^2$	$1.45\ mg/cm^2$
Body Weight (BW)	70 kg	43 kg	70 kg
Days/Lifetime	2.74×10^4	2.74×10^4	2.74×10^4
Days/Exposure Period	1.10×10^4	1.10×10^4	1.10×10^4
Intake Factor (Exposure Period)[1]	3.80×10^{-10}	6.21×10^{-10}	1.71×10^{-9}
Intake Factor (Lifetime)[1]	1.52×10^{-10}	9.92×10^{-11}	6.83×10^{-10}

ATTACHMENT II

TOXICITY PROFILES FOR METALS OF CONCERN AT THE BAIER AND MC CARL SITES

FORT MADISON, IOWA

ARSENIC

Arsenic is a ubiquitous metal found throughout the environment. There are a number of medicinal, agricultural, and industrial uses for arsenic compounds. However, arsenic is neither a product nor a by-product of paint formulation, and thus would not be expected in high concentrations in association with any paint sludge materials.

Acute effects of arsenic exposure have been reported for both oral and respiratory routes of exposure. Irritant and vesicant arsenicals such as arsenic trioxide and arsenic trichloride can cause severe damage to the respiratory system, as well as cough, dyspnea, and chest pains (Ishinishi et al., 1986). Numerous acute incidences of poisoning (accidental and suicidal) via arsenic ingestion have been reported. One very large incident involved 12,131 Japanese infants who were exposed to infant formula tainted with pentavalent inorganic arsenic (1.3 to 3.6 mg/day). Among the exposed population, 130 infants (approximately 1 percent) died of acute poisoning, and the majority of the survivors exhibited one or more symptoms, including fever, insomnia, anorexia, liver swelling, melanosis and disturbed heart function (World Health Organization, 1981). Accidental ingestion has also been reported in adults exposed for 2 to 3 weeks to tainted soy sauce. Symptoms included facial edema, anorexia, skin lesions, and liver swelling (Mizuta et al., 1956).

Individuals recovering from poisoning with inorganic arsenic exhibit disturbances of the peripheral nervous system with some wallerian degeneration of the axons (World Health Organization, 1981). The toxicity of arsenic compounds is generally related to solubility. The relatively soluble arsenic trioxide has a reported fatal dose of 70 to 180 mg (Vallee et al., 1960). Arsine gas (hydrogen arsenide) is a powerful hemolytic poison, and its toxic effects are quite different than other arsenicals. Arsine poisoning is characterized by nausea, abdominal colic, vomiting, backache, and shortness of breath, followed by dark blood urine and jaundice (Kipling and Fothergill, 1964). Arsine fatalities are usually due to renal failure cause by hemoglobin casts in the renal tubules (Fowler and

Weissberg, 1974). The lethal dose for arsine is reported to be 250 mg/m^3 over several hours (Henderson and Haggard, 1943).

Chronic exposure to arsenic has been reported in a number of epidemiological studies based on inhalation (i.e., industrial) exposure and ground water ingestion. Kurtasone (1972) reported that populations neighboring on an arsenic trioxide refinery exhibited skin lesions and peripheral neuropathy, with some increases in chronic respiratory disease, although a causal relationship with arsenic was never established. Several studies have described the effects of ingesting water from regions with high naturally occurring (background) levels of arsenic. Hyperkeratotic skin lesions were seen in populations in Chile (Borgano et al., 1977) and Taiwan (Tseng, 1977). In addition, a condition known as blackfoot disease, characterized by gangrene of the lower extremities, has been reported in the Taiwanese population. Skin lesions, which occur primarily on the palm of the hand and the sole of the foot, have been reported to occur from occupational exposure (Hamada and Horiguchi, 1976) and from therapeutic administration of Fowler's solution (Fierz, 1965), as well as from drinking water. Other chronic effects include melanosis on the eyelids, around the temples, nipples, and folds of the axillae and the formulation of Mee's Lines (white striae of the fingernails). Arsenic tends to accumulate in the skin, probably because of high concentrations of proteins containing sulfhydryl groups to which arsenic binds. Arsenic dust has been reported to cause perforation of the nasal septum (e.g. the cartilaginous portion) (Ishinishi et al., 1986), and an association of aplastic anemia has been reported among users of arsenical drugs (Westhoff et al., 1975).

The USEPA has classified arsenic as a Class A potential carcinogen, based on human studies. Skin cancer, in the form of epithelioma, has been seen at the sites of arsenic-induced keratoses (Borgone et al., 1977; Tseng et al., 1977). An increased incidence of lung cancer has been reported among shelter workers (Ishinishi et al., 1986), although it should be noted that these workers were also exposed to sulfur dioxide and other metals. No relationship of arsenic exposure to any other form of cancer has been established (IARC, 1980). Chromosomal abnormalities have been observed among lymphocytes of workers and patients exposed to arsenic (Beckman et al., 1977; Petres et al., 1977). In vitro studies have shown that trivalent arsenic compounds can induce sister chromatic exchanges (SCEs), but pentavalent forms do not. The relevance of SCE studies is questionable, since lymphocytes from chronically exposed individuals suffering from blackfoot disease showed no differences in SCE patterns from control populations (Wen et al., 1981). Mutagenicity tests for both trivalent and pentavalent arsenic compounds were negative in Salmonella, E. Col: and Chinese hamster V9 assays, but positive in Bacillus subtiles (Ishinishi et al., 1986).

Arsenic-induced terata have been produced in hamsters exposed to high doses of sodium arsenate (6 to 10 mg/kg) on day 8 of pregnancy. Defects included anencephaly, renal agenesis and rib malformations. An increase in fetal resorption was also noted (Ferm, 1977). An epidemiological study among female workers at a copper smelter showed a birth defect rate 5 times that of the control population, but no conclusion about the role of arsenic could be drawn because of the simultaneous exposure be other metals and sulfur dioxide (Nordstrom et al., 1979). It should be noted that co-administration of sodium selenite has been reported to prevent arsenic-induced teratogenesis in animals (Holmberg and Ferm, 1969).

Arsenic has been used extensively in medicine (Fowler's Solution) for the treatment of leukemia, psoriasis, asthma, and as a tonic, and has also been used in the formulation of anti-parasitic drugs. Medicinal dosages were frequently as high as 3 mg/day. In recent years, with the development of less toxic drugs, the medicinal use of arsenic has declined (Ishinishi et al., 1986).

BARIUM

Barium is a relatively non-toxic metal with numerous industrial agricultural, and medicinal uses. Barium sulfate, when combined with zinc sulfidel, is frequently used as a paint pigment known as lithophone. Barium sulfate is a chemically stable, highly insoluble compound with little potential for migration. It is likely that any barium sulfate present in paint sludge materials will remain in this chemical form. It should be noted that barium sulfate is also used medicinally as an x-ray contrast material in the lower gastrointestinal tract.

Barium toxicity is related to its solubility. Soluble barium salts such as barium chloride can be absorbed in the gut and are toxicants, while the more common insoluble forms such as barium sulfate are very poorly absorbed and are essentially non-toxic. Cuddihy and Ozog (1973) have reported that 11 to 32 percent of the highly soluble barium chloride is absorbed in the GI tract of hamsters. Absorption in the GI tract can be minimized by the prompt administration of soluble sulfate (e.g. Glauber's salt), which causes precipitation of barium sulfate. Absorbed barium partitions to the bone surface, pigmented parts of the eye, and the submaxillary gland. Accumulation usually occurs in proportion to the calcium content of the tissue. The majority of absorbed barium (75 percent) is excreted within 3 days (Reeves, 1986).

Most reported cases of acute barium toxicity have involved suicide attempts or accidental poisonings with medicinals containing barium. one epidemiological study was performed in Szechuan, China where a condition resembling familiar periodic paralysis was thought to be due to food poisoning caused by high barium content in the slat from the region (Allen, 1943). Poisonings in occupational settings are essentially unknown, despite the widespread use of barium compounds. Acute toxicity is related to the action of barium as a muscle poison, causing muscle stimulation followed by paralysis. Symptoms of poisoning include gastroenteritis, decreased pulse rate, ventricular fibrillation, extra systoles, salivation, and diarrhea. Lethal doses are also associated with the loss of tendon reflexes, heart fibrillation, and general and respiratory muscle paralysis leading to death (Reeves, 1986). Animal studies have demonstrated highly variable LD_{50} values for different species, ranging from 7 to 29 mg/kg in mice to 800 to 1,200 mg/kg in horses. It is believed that these variations may be related to differences in the degree of sulfate precipitation in the gut between different species. The threshold dose for toxicity in humans is 0.2 to 0.5 grams (absorbed dose) and the lethal dose is 3 to 4 grams. It is believed that barium toxicity is due to a potassium deficiency. Nielsen (1981) reports that barium acts by blocking the potassium channel of the sodium-potassium pump in cells. Potassium infusion relieves the symptoms of poisoning.

Few cases of chronic barium intoxication have been reported. Chronic inhalation of insoluble forms (barium sulfate and barium carbonate) may induce a benign pneumoconiosis (baritosis). This ailment is not incapacitating and is usually reversible on termination of exposure (Klaassen et al., 1986). Studies on chronic inhalation of barium sulfate in rats indicates that baritosis is not associated with fibrosis, and appears to be due to the accumulation of alveolar macrophages and reversible hyperplasia of the bronchial epithelium (Holusa et al., 1973).

Barium has not been linked to carcinogenesis, mutagenesis, teratogenesis, or any reproductive effects. Medicinally, barium sulfate is commonly used as an x-ray contrast material in the low GI tract because of its very low toxicity (Reeves, 1986).

CADMIUM

Cadmium is a metal commonly used in the production of yellow, orange, and red paint pigments. Representative pigments include cadmium selenite, cadmiumsulfoselenide, and cadmium sulfide. As is the case with other paint pigments, these are highly stable, insoluble compounds with limited bioavailability. Soil samples from the Baier and McCarl sites demonstrate that cadmium and selenium are co-distributed, suggesting that much of the pigment is in its original form.

Cadmium is a relatively toxic metal. Acute inhalation of cadmium fumes (e.g. welding) causes a chemical pneumonitis with occasional associated pulmonary edema. Symptoms may require 24 hours to appear. Inhalation of concentrations of 5 mg/m^3 for over 8 hours has been reported to be fatal, and sensitive individuals may show some symptoms at concentrations of

1 mg/m^3 for 8 hours. Symptoms include shortness of breath, general weakness, fever, and in severe cases respiratory insufficiency followed by shock and death (Elinder, 1985). Ingestion of toxic amounts of cadmium can produce nausea, vomiting, abdominal cramps, and headache, with diarrhea and shock in severe cases. Onset of symptoms usually occur within minutes of ingestion. Concentrations as low as 15 mg/l are sufficient to induce vomiting, while higher concentrations are required in protein-containing foods to produce the same symptoms (Friberg et al., 1986). Injection of soluble cadmium salts (1 to 3 mg/kg) in animals demonstrates that cadmium can cause testicular damage (Barlow and Sullivan, 1982). However, testicular damage is not seen in human populations, probably because of the protective effects of metallothionein (Nordberg, 1972).

Toxicity related to chronic ingestion of cadmium is very rare. Ingestion of food and water from cadmium-contaminated regions of Japan has been shown to produce a disease known as itai-itai. This disease is characterized by severe renal tubular damage, osteomalacia and osteoporosis, and leg and back pain (Kjellstrom, 1981). It appears that deficiencies in calcium and vitamin D in the diet of affected populations contributes to the disease (Friberg et al., 1986).

Most cases of chronic exposure to cadmium occur among industrial workers exposed via inhalation. Concentrations of cadmium in the workplace can be as high as 4 to 5 mg/m^3, although typically less than 2 mg/m^3. Respiratory absorption of cadmium is approximately 15 to 30 percent (Klaassen et al., 1986). Chronic inhalation produces a number of effects. The kidney is probably the primary target organ in man. Kidney damage is characterized by renal tubule damage and associated tubular proteinuria (e.g. excretion of low molecular weight proteins). In cases of severe exposure, glomerular damage may occur. Physiological disturbance in the handling of calcium and phosphorus may cause mineral resorption from the bone, leading to osteomalacia and kidney stone formation. Tubular damage persists and may even increase after exposure had stopped, and is probably related to cadmium bound to metallothionein in the tubular cells (Elinder, 1985). Chronic cadmium exposure may also produce lung damage that leads to emphysema. Reversible anemia has also been reported, and is probably due to hemolysis (Bernard et al., 1979). Animal studies have indicated that hypertension may occur in some species, although epidemiology studies suggest that this effect does not occur in humans (Elinder, 1985). Liver is the major cadmium storage organ, and some animal studies have shown liver damage. Only slight changes in liver function have been reported in man, however (Friberg, 1986). Chronic inhalation exposure has also been shown to cause increases in excretion of calcium and phosphorus in animals which may lead to bone effects similar to itai-itai. Although epidemiological studies indicate that osteomalacia may occur among workers (Nicaud et al., 1942), in general bone effects are usually not seen among workers with high occupational exposure (Friberg, 1986).

Epidemiological studies by Elinder (1985) suggest a possible link of cadmium to prostate and lung cancer. Studies by Takenaka et al., (1983) have demonstrated increased lung cancer in rats exposed for 18 months to cadmium chloride aerosols (12.5 to 50 mg/m^3). Cadmium has been classified by the USEPA as a class B2 potential human carcinogen, based on animal studies.

Teratogenesis has been induced in rats and hamsters injected with high doses of cadmium (3 mg/kg or more). Defects included cleft lips, palates, and limb defects (Friberg et al., 1975). Ferm and Hanlon (1983) demonstrated that maternal pretreatment with cadmium minimized the incidence of terata. Epidemiological studies among industrially exposed women do not show increases in terata (Cvetkova, 1970). It should be noted that the enzyme metallothionein offers a protective effect against cadmium toxicity in most organs (with the exception of the kidney) by binding free cadmium. Pretreatment with cadmium, zinc, or mercury induces metallothionein synthesis, which in turn can bind greater concentrations of cadmium. It has been suggested that cadmium toxicity in the kidney may be related to cadmium saturation of metallothionein (Friberg et al., 1986). There is also some information that co-administration of selenium with cadmium minimizes toxicity. This is particularly relevant, given that cadmium and selenium are co-contaminants at the Fort Madison sites.

CHROMIUM

Chromium is a relatively common metal, and exists in a number of oxidation states ranging from Cr^{2+} to Cr^{6+}, although only the trivalent and hexavalent forms have any biological relevance. A number of chromium compounds are commonly used as paint pigments, including lead chromate, zinc chromates, and chrome oxides. The primary chromium paint pigment disposed at the Fort Madison sites was lead chromate. As with other paint pigments, this is a highly stable, insoluble compound with little potential for migration or absorption.

Hexavalent chromium is the most toxic form of chromium and is absorbed more readily than the trivalent form. Absorption can occur through the lungs or the gastrointestinal tract. Ingestion studies suggest that 3 to 6 percent of chromates are absorbed through the GI tract of rats (Mertz et al., 1965). Upon absorption, hexavalent chromium is rapidly converted to the trivalent form which binds to intracellular macromolecules. Many of the toxic effects of chromium have been related to these macromolecular complexes. Animal studies show the chromium is retained in the lung, hair, reticuloendothelial system, liver, spleen, and bone marrow (Wisek et al., 1953) as well as the testis and epididymis (Hopkins, 1965). Tossavainen (1980) estimated that the elimination half-live for chromium in welders ranged from 15 to 41 hours. Excretion is primarily through the urine.

Acute effects of chromium exposure have been noted for dermal, respiratory, and oral routes of exposure. Direct contact of broken skin with hexavalent chromium compounds may cause deep ulcerations of the skin which are slow to heal. Ingestion may produce local ulceration of the stomach and intestinal mucosa, and ingestion of very high doses (5 gm) has been reported to cause GI bleeding, fluid loss, and death via cardiovascular shock (Langard and Norseth, 1986). Intravascular injection of sodium chromate (0.5 to 30 mg/kg) has been shown to cause proximal tubule kidney damage in rats (Tandon, 1982). Similar damage is seen in kidneys of humans ingesting toxic levels (1 to 5 gm) of chromate (Langard and Norseth, 1986), along with some hepatic necrosis. Acute inhalation of chromate dust for 4 to 8 hours has been reported to induce bronchial asthma (Langard, 1980).

Chronic ingestion of hexavalent chromium (potassium dichromate, 1.3 mg/kg per day for 6 weeks) has been shown to produce hepato toxicity in rabbits, characterized by thickening of the liver capsule, congestion of the control vein and parenchymal necrosis (Tandon et al., 1978).

Two types of dermatitis may occur in response to Cr (VI) exposure. Acute irritative dermatitis is characterized as a contact irritation which becomes less severe with repeated contact. Allergic eczematous dermatitis is an unrelated condition which becomes more severe with repeated contact due to skin sensitization (Langard and Norseth, 1986).

Chronic inhalation primarily affects the nasal mucosa and the lungs. Atmospheric concentrations of 100 mg/m^3 or greater may cause ulceration and perforation of the nasal septum due to cartilage necrosis (Bloomfield and Blum, 1928). Some studies suggest that chronic chromate inhalation may cause a form of pneumoconiosis, although this is not usually seen (Langard, 1980).

The USEPA classifies chromium as a Class A potential human carcinogen, based on human studies. Numerous epidemiological studies of chromate-exposed workers have shown correlations between chromium exposure and respiratory cancers, although no direct cause and effect has been established (Langard, 1983). Because of the co-occurrence of Cr (III) and CRr (VI), as well as other contaminants, it is unknown which form of chromium (if either) is responsible for the observed cancers. Animal studies have proven inconclusive for supporting the role of chromium as a carcinogen. Only one study in mice (Nettesheim et al., 1971) has demonstrated cancer via inhalation of chromate (13 mg/m^3). In vitro mutagenicity studies have shown that chromium can cause DNA damage, sister chromatic exchange, and can induce DNA repair. Chromosomal aberrations have been noted in the lymphocytes of chronically exposed workers (Bigaliev et al., 1979).

There is some evidence that maternal chromium can be transported across the placenta. Chromate injection (8 mg/kg) during the period of organogenesis has produced cleft palate in hamsters (Gale and Bunch, 1983). Increased incidences of normally occurring terata have also been seen in chicks exposed to chromate (0.002 to 0.05 mg/egg). These effects include reduced body weight, microphthalmia, short and twisted limbs, ectopic heart and everted viscera (Gilani and Marano, 1979).

Chromium is a cofactor for insulin action. facilitating the attachment of insulin to insulin receptors. It is necessary for glucose tolerance, and thus has been classified as an essential element. The quantities required for purposes of human health are quite low, and no dietary requirements have been established. Evidence for chromium deficiency in man is sparse (Langard and Norseth, 1986).

COPPER

Copper is an essential metal with a wide variety of industrial uses, including paint pigments. Cuprous oxide is the most frequently used copper pigment. The primary use of cuprous oxide is as a toxic paint pigment on the bottom of ships to prevent growth of algae. As with other pigments, cuprous oxide is highly insoluble and unlikely to migrate from a disposal site.

Acute effects of ingestion of copper are well described, and consist of vomiting, epigastric burns and diarrhea. Doses as low as 10 to 15 mg of copper sulfate may cause gastrointestinal problems among sensitive individuals, although typical medicinal doses (as an emetic) range from 25 to 75 mg. The acute toxicity of copper is generally limited by its prompt emetic effect, although ingestion of very high doses during suicide attempts has caused kidney damage, with associated hematuria, proteinuria, oliguria and uremia, as well as liver damage (Wahal et al., 1978). Contact dermatitis has been rarely reported, although it is not generally seen in high exposure industrial settings (NAS, 1977). Some allergic responses have also been associated with dermal contact or with the use of copper intrauterine devices (Barkoff, 1976). Acute inhalation of copper dust or fumes is associated with upper respiratory irritation and metal fume fever. This ailment can be induced by copper dust concentrations as low as 0.1 mg/m^3, and is similar to influenza in its symptoms, disappearing after 24 hours (Gleason, 1968).

Chronic inhalation in mice exposed to copper sulfate (5 percent aqueous solution, not adjusted for pH) for 4 months has been reported to produce some changes in the lung, primarily the influx of macrophages into the alveoli (Eckert and Jerochin, 1982). Some evidence for respiratory effects to copper sulfate has also been seen in vineyard workers exposed to fungicide known as Bordeaux mixture. The histology of the lung injury is similar to that seen in silicosis. The role of copper in the etiology of this injury is unclear because of the other components (particularly calcium) in the fungicide (Villar, 1974). Epidemiological studies of workers chronically exposed to copper dust in industrial settings show no signs of respiratory damage. Chronic ingestion has been reported for pigs accidentally exposed to approximately 700 mg/kg of copper in their feed for a period of several months. The animals were reported to develop an iron-deficiency type of anemia, gastric ulcers, hepatic centrilobular necrosis, and increased copper content in the liver (100 to 170 mg/kg wet weight) (Hatch et al., 1979).

Copper exposure has not been positively correlated to increased incidence of cancer. In vitro studies have shown that copper may cause an increase in the number of non-complementary nucleotides incorporated into the DNA (Sirover and Loeb, 1976), although the significance of this finding is unclear. An epidemiological study by Kurtasune et al., (1974) demonstrated incidence of lung cancer among copper-refinery workers, but the effect could have been attributed to arsenic present in the fumes.

There is little evidence to indicate copper is either a teratogen or a reproductive toxicant. O'Shea and Kaufman (1979) have reported that intramuscular injection of 4 mg/kg in early pregnancy may affect the fetal central nervous system. Batterby et al., (1982) have reported that incubation of sperm in the presence of metallic copper causes reduced sperm mobility.

As mentioned earlier, copper is an essential metal. It is required as a cofactor by a number of enzymes, including ferroxidases, cytochrome oxidase, superoxide dismutase and amine oxidases. Copper is essential for the biological utilization of iron, and may also be an anti-carcinogen because of its role in superoxide dismutase. Daily copper requirements have been recommended at 30 mg/kg in adults and 80 mg/kg in infants (Klevay, 1982). Medicinally, copper has been used as an emetic for intoxication in children.

LEAD

Lead is a metal with numerous industrial applications. Use of lead in paint pigments was widespread in the past, but has been curtailed in recent years. Typical lead-based paint pigments include lead chromate, dibasic lead phosphite, and various lead oxides. The lead pigments reported to be in use during the period of paint sludge disposal at the Fort Madison sites include lead chromate and lead oxides. As is the case with most paint pigments, these are highly stable, insoluble compounds with little potential for migration. It is probable that most of the lead on-site as a result of paint waste disposal has remained in its original pigment form.

Lead toxicity is related to absorption, which is age-dependent. Gastrointestinal absorption has been reported to be 5 to 15 percent in adults, with less than 5 percent being retained, and approximately 42 percent in children, with approximately 32 percent being retained. Respiratory absorption is even greater, with approximately 90 percent of respirable particles (0.5 um or smaller) being absorbed. Lead is not an essential element, and the primary target organ system in lead exposure is the nervous system. Absorbed lead tends to distribute in two pools in the body, the skeleton and soft tissue. Lead in the skeleton is released very slowly, with a biologic half-life of approximately five years. Lead in the soft tissue has a much shorter half-life, approximately 3 to 4 weeks.

(Schulz et al., 1981). The extent of lead absorption in the GI tract has been linked to a number of dietary factors. Absorption is enhanced by milk products, low calcium and vitamin D levels, fasting, or iron deficiencies. Generally, 90 percent of ingested lead is excreted in the feces, while most of the absorbed lead is excreted in the urine (Tsuchiya, 1986). The major targets for lead toxicity are the central nervous system, hematopoietic system, GI tract, and renal system.

Gastrointestinal colic is the most common effect of acute lead ingestion. The initial stages of lead intoxication include anorexia, dyspepsia, and constipation, followed by colic characterized by a diffuse paroxysmal abdominal pain. The skin is pale and blood pressure may increase, reflecting sporadic contraction of the smooth muscle.

Lead encephalopathy has also been reported. Although it is rare in adults, numerous cases have been reported in children exhibiting pica. The encephalopathy may be characterized by a sudden onset with seizures and delirium, with commonly associated papilledema. In severe cases, coma and cardiorespiratory arrest may occur. In some cases, the encephalopathy syndrome in children is characterized by vomiting, apathy, drowsiness, stupor, ataxia, hyperactivity, and other neurological symptoms. Blood lead levels typically associated with lead encephalopathy range from 80 to 300 ug/100 ml (Tsuchiya, 1986). Most studies report lead intoxication as a function of blood lead levels rather than lead intake.

Anemia is a common symptom among workers chronically exposed to lead. The anemia is probably due to both an inhibition of hemoglobin synthesis and a shortened lifespan of the erythrocytes. The decreased hemoglobin synthesis is apparently due to inhibition of several key enzymes (Wada et al., 1972). Chronic exposure also affects the central and peripheral nervous systems, particularly in children. Effects include mental deterioration, hyperkinetic or aggressive behavior, sleeping difficulties, and vomiting. Subclinical effects have also been noted in children with moderately elevated blood lead levels (40 to 80 ug/100 ml). Recent work by Bellinger et al., (1987) suggests that fetal blood levels as low as 10 ug/100 ml (compared to background levels of 6 to 7 ug/100 ml) may cause significant deficiencies in learning ability during the first two years of life. Neural effects have also been reported in chronically exposed workers, and include impairment of memory, attention, concentration, and psychrometer performance (Arnvig et al., 1980). Peripheral neuropathy is characterized clinically by wrist and foot drop, and subclinically by reduced peripheral nerve conduction. Chronic GI effects may include loss of appetite, upset stomach, diarrhea, or constipation. Degenerative changes have been noted in the proximal tubular lining cells of the kidney, and are associated with swelling of the mitochondria. Long-term exposure produces a characteristic type of nuclear inclusion body in the tubular cells of the kidney. These bodies are composed of a lead-protein complex, and apparently function as a protective mechanism for other organelles. Long-term exposure is also associated with intense, interstitial fibrosis, tubular atrophy and dilation. There is glomerular involvement at the late stages of chronic exposure (Emmerson, 1968). There is little evidence for either hepatic or cardiovascular effects of chronic lead exposure.

The U.S. Environmental Protection Agency (USEPA) classifies lead as a B2 potential human carcinogen based on animal studies. Lead has been shown to induce cancer in the kidneys of rodents under conditions of high exposure (Moore and Meredith, 1979). There is no evidence of renal carcinogenicity in man, nor does lead appear to produce chromosomal anomalies in humans.

Animal studies suggest that lead may be a teratogen. Ferm and Carpenter (1967) showed that lead salts can cause skeletal anomalies in hamsters, and may also influence litter size, weight, survival rate, and behavior. Lead and cadmium produce a synergistic teratogenic effect (Ferm, 1969), while zinc is an antagonist to lead (Willoughby et al., 1972).

MANGANESE

Manganese is an essential element, and is present as a co-factor in a number of enzymes. It is widely distributed in the environment and is found in all living organisms. Commercially, manganese has numerous industrial applications, although it is not used in any major paint pigments. There is no reported use of manganese in paint formulation during the period of paint sludge disposal at the Fort Madison sites.

Daily intake of manganese ranged from 2 to 9 mg, with less than 5 percent absorbed in the GI tract. The biological half-life in man is approximately 37 days, although it varies with different parts of the body. The primary rule of excretion of manganese is in the feces. manganese tends to concentrate in the mitochondria, and this is found in higher concentrations in organs with high mitochondrial content (e.g. pancreas, liver, kidney, intestine) (Klaassen et al., 1986).

Manganese is a relatively non-toxic metal. Sigan and Vitvickaja (1971 report that the oral LD^{50} values for soluble manganese compounds in rodents (guinea pigs, mice and rates) ranged from 400 to 830 mg/kg. Acute manganese poisoning in man is very rare, with most cases occurring after prolonged inhalation of large amounts of manganese oxides. the primary acute effects of manganese inhalation are restricted to the lungs. Lloyd Davies and Harding (1949) showed that intratracheal injection of 10 mg of manganese dioxide in rates produced rapid epithelia changes, followed by a granulomatous reaction after 14 days. Zaidi et al., (1973) reported that a single instillation of 50 mg of manganese dioxide in guinea pigs caused an increase in alveolar macrophages after 7 days, leading to fibrosis after 180 days of exposure. There is some evidence that inhalation of manganese may temporarily increase susceptibility to bacterial respiratory infections due to immunosuppressive activity (Adkins et al., 1980; Lawrence, 1981).

Chronic exposure to manganese has been reported for both the oral and respiratory exposure routes. One case of chronic oral exposure to manganese was reported in Japan, where well water was contaminated by manganese from batteries (Kawamura, 1941). Exposure was thought to be 20 to 30 mg/liter, and the clinical manifestations in affected individuals included lethargy, increased muscle tonus and tremor. Some mental disturbances were also noted. Laboratory studies have demonstrated that dietary levels of 200 to 20,000 ppm can cause decreased weight gain in rats, and 200,000 ppm causes weight loss (Exon and Koller, 1975). Concentrations of 20,000 ppm in water was not shown to have any effect on brain enzyme activity in rates (Lai et al., 1981). Increased morbidity and mortality from pneumonia has been reported for workers exposed to manganese dust. Fibrosis was not seen in individuals after recovery (Saric, 1986). Most studies investigating chronic exposure to manganese dust have not estimated exposure concentrations. Rodier (1955) reported that concentrations in mines can be very high (800 mg/m^3), while Saric et al., (1974) have shown increases in the incidence of pneumonia and bronchitis among workers exposed to 0.39 to 16.35 mg/m^3. Chronic manganese exposure is also reported to influence the central nervous system. Depletion of dopamine from the basal ganglia has been reported, and is thought to be related to changes in the activity of the enzyme tyrosine hydroxylase (Chandra and Shukla, 1981). Chronic human exposure has also been linked to manganism, which is clinically similar to Parkinson's disease. The clinical manifestations of the disease are related to the extrapyramidal system, and are characterized by an initial asthenia and apathy, followed by a staggering gait, incoherent and slow speech, and aggressiveness. After continued exposure, muteness, clumsiness, difficulty in walking, muscular hypertonia, and tremor occur. This type of chronic poisoning is thought to be irreversible (Saric, 1986).

At the present time there is no evidence to suggest that manganese is either a carcinogen or a mutagen. One study by Watanabe et al., (1981) showed a cluster of prostate cancers in a region of manganese mining activities, but no cause and effect relationship was established.

Manganese is not a known teratogen, although manganese deficiencies may cause skeletal abnormalities (Underwood, 1977). Manganese is an essential element, being a co-factor in a number of enzymes, including glycosyltransferase. The skeletal defects seen as a result of manganese deficiency are thought to be due to deficiencies in glycosyl transferase and its role in glycosaminoglycan metabolism (Leach and Lilburn, 1978).

Manganese is also a cofactor in enzymes related to phosphorylation, cholesterol, and fatty acid synthesis.

SELENIUM

Selenium is an essential element which may be toxic at relatively high doses, dependent on the chemical form. There are a number of industrial applications for selenium, and it is also used in medicine and topically as an ingredient in shampoo. Because it is an essential element, selenium is occasionally added to the food chain in some countries, and it is frequently administered to cattle to help mediate stress related to transportation. Cadmium selenide and cadmium sulfoselenide are two compounds that are frequently used as paint pigments. As is the case for most paint pigments, these are highly stable, insoluble compounds with little potential for migration. It is likely that the majority of the selenium originally associated with paint wastes at the Fort Madison sites will remain in their original form.

Several studies have reported on acute selenium toxicity in man, but fatalities are rare. Animal studies suggest that some forms of selenium may be highly toxic. Injection of selenite has been reported to kill 75 percent of treated rats at doses of 3.25 to 3.5 mg/kg. Selenate produced a similar results at 5.5 to 5.75 mg/kg, and selenocysteine at 4 mg/kg (Wilber, 1980). It is noted that injection studies may not reflect oral or respiratory toxicity. Ingestion studies have demonstrated LD_{50} values for selenium sulfide at 138 mg/kg, elemental selenium at 6700 mg/kg (Cummins and Kimura, 1971), and dimethyl selenide at 1600 mg/kg (Wilber, 1980). Animals administered lethal doses of selenium are reported to have "garlic breath" and exhibit central nervous system effects. Central nervous system (CNS) effects include nervousness and fear, respiratory impairment, and death usually results after tetanic (and ultimately clonic) seizures (Moxon and Rhain, 1943). Inhalation of selenium dust (30 mg/m^3) has been reported to cause interstitial pneumonia, with a 10 percent mortality in rats (Hall et al., 1951). Acute selenium toxicity in humans has been reported in cases of accidental ingestion. Typical symptoms include nausea, vomiting, diarrhea, abdominal pain, chills, and tremor. Individuals generally recover within several days (Sioris et al., 1989; Hogberg and Alexander, 1986). One incident has been reported in which a child died after ingesting an unknown quantity of selenous acid. Acute inhalation exposure has been reported to cause intense irritation of the eyes, nose, and throat, as well as headache (Clinton, 1947). An incident where 37 individuals were exposed to selenium oxide during a fire produced bronchial spasm, chills, nausea and vomiting, headache, fever, bronchitis, and in several cases, chemical pneumonia (Wilson, 1962).

Chronic exposure to selenium has been reported to affect the CNS, liver, spleen, pancreas, and blood. Chronic exposure in man is rare, except in highly seleniferous regions where individuals eat large quantities of locally produced foods. Doses of dietary selenite ranging from 5 to 8 mg/kg have been reported to cause anemia, splenomegaly, pancreatic enlargement, and chronic hepatitis in rats (Halverson et al., 1966; Harr et al., 1967). A condition known as "blind staggers" occurs in animals ingesting selenium in accumulator plants in regions with high soil selenium content. The disease is characterized by impaired vision, decreased appetite, and a tendency to walk around in circles. Paralysis and respiratory failure may occur, leading to death. Blind staggers may be considered an acute effect that develops 3 to 4 weeks after exposure. "Alkali disease" is a more chronic condition in livestock, and is associated with ingestion of feed containing 5 to 25 mg/kg selenium. The condition is characterized by a lack of vitality, loss of appetite, emaciation, deformation and shedding of hooves, hair loss and joint erosion, with a potential for liver cirrhosis as well (Moxon and Rhain, 1943). Epidemiologic studies have attempted to determine the effect of chronic selenium ingestion on human health. Studies in regions of high background selenium in the United States demonstrate increased incidence in GI disturbances, skin discoloration and tooth decay (Smith and Westfall, 1937). A study of endemic selenium intoxication in China showed that affected individuals had loss of hair and nails, skin irritation and mottled teeth. Central nervous system disorders were seen in one heavily affected village, where individuals suffered from numbness, convulsions, paralysis and motor disturbances, leading to death in one individual. Daily intake was estimated at 5 mg (Yang et al., 1983). Chronic occupational exposure to airborne selenium has been associated with conjunctivitis and allergic reactions in the eyes. Dermal exposure to selenium dioxide may produce burns, dermatitis, or urticaria (Glover, 1967, 1970).

Selenium has not been shown to be carcinogenic in numerous animal studies (Hogberg and Alexander, 1986). Epidemiological studies among workers chronically exposed to selenium showed an increased incidence of cancer (Glover, 1970). It should be noted that selenium is a co-factor in a number of enzymes, including glutathione peroxidase. This enzyme is important in protecting membrane lipids, proteins and nucleic acids from oxidant damage, and may, thus, act as an anti-carcinogen by preventing potential DNA damage (Sunde and Hoekstra, 1980).

Moxon and Rhain (1943) demonstrated an increased incidence of terata among embryos from chickens fed 3.4 ppm selenium. Terata have also been induced in embryos from mice, rats, pigs, and sheep (Hogberg and Alexander, 1986). No conclusive evidence has been shown for a role selenium as a human teratogen.

Selenium plays several roles as an essential element. It is a co-factor in glutathione peroxidase, which protects cells from oxidative damage. It may also be important for synthesis of cytechrom P-450, and has some role in heme metabolism. Recommended daily intake is 50 to 70 mg, a level which is readily supplied in a normal diet (Hogberg and Alexander, 1986). It is interesting to note that selenium is an antidote to poisoning by other metals, including arsenic, cadmium, mercury, copper, and thallium. To some extent, these other metals also tend to antagonize the toxicity of selenium (Klaassen et al., 1986; Hogberg and Alexander, 1986).

ZINC

Zinc is a relatively non-toxic metal that is ubiquitous in the environment. Zinc oxide and zinc sulfate are two forms which are commonly used as pigments in the formulation of paints. The predominant form of zinc used by DuPont during the period of paint sludge disposal was zinc oxide. This is a highly stable compound with low solubility, a characteristic which makes it an effective paint pigment and also limits its potential for migration. Zinc oxide is frequently used in ointments to prevent sunburn and to treat rashes. Because of the stability of the compound in the environment, it is likely that any zinc originally associated with paint sludge disposal will remain as zinc oxide.

Acute toxicity to high levels of zinc is very unusual. Very few cases of toxicity due to zinc ingestion have been reported. One study on the accidental ingestion of 12 grams of elemental zinc by a child reported lethargy, headache, and a transient elevation of serum amylase, but no effects on hematologic, hepatic, or renal function (Murphy, 1970). Ingestion of 1 to 2 grams of zinc sulfate has been shown to cause nausea, vomiting, and diarrhea, but no permanent effects (Brown et al., 1964). Animal studies indicate that uptake of zinc from the GI tract is highly variable, ranging from less than 10 percent to more than 90 percent. One human study demonstrated absorption ranging from 58 percent to 77 percent for ingestion of low levels of zinc chloride (Lombeck et al., 1975). The amount of uptake is probably regulated at the intestine via a homeostatic mechanism related to the total body burden of zinc (Evans et al., 1979).

Chronic ingestion of zinc causes effects in humans and animals that are thought to be due to secondary copper deficiency. This deficiency is probably related to competition between copper and zinc for absorption sites in the gut (Lantzsch and Schenkel, 1978). Anemia has been reported in humans exposed for up to half a year to medicinal doses (135 mg/day) of zinc sulfate (Prasad et al., 1978). Animal feeding studies have demonstrated poor growth, arthritis, lameness, and GI inflammation in pigs

(Brink et al., 1959) and poor growth and anemia in sheep (Ott et al., 1966) when the animals were fed very high levels of zinc oxide (1000 mg/kg/day).

Most cases of zinc toxicity have been reported through inhalation. One incident was reported in which 70 workers were acutely exposed to an unknown quantity of zinc chloride fumes. Ten individuals died within a few hours, and 25 survivors displayed signs of severe respiratory inflammation. Autopsy demonstrated edematous bronchi, and it is believed that the toxic response was due to the formation of hydrochloric acid in vivo rather than zinc toxicity (Hunter, 1969). Acute exposure to zinc oxide fumes (greater than 15 mg/m^3) has been reported to cause metal fume fever, although other metal co-contaminants in the fumes may be responsible for the illness. The symptoms resemble influenza, and are characterized by headache, fever, hyperpnea, leukocytosis, sweating, and leg and chest pain. The illness is never fatal, and complete recovery occurs within 2 days (Jaremin, 1973). Chronic inhalation of zinc oxide dust does not appear to produce significant toxicity. Studies with rats exposed to 15 mg/m^3 for 8 hours/day for up to 84 days produced only minor microscopic changes with some signs of chronic inflammation (Pistorius, 1976). Occupational studies on 234 Finnish workers chronically exposed to zinc oxide dust (2.5 to 4.5 mg/m^3) have not demonstrated respiratory effects (Roto 1980).

No human data exists linking zinc exposure to cancer. An epidemiological study by Logue et al., (1982) found no increases in cancer among zinc-refinery workers. Some chromosomal abnormalities have been demonstrated in workers exposed to zinc in a rolling mill (DeKnudt and Leonard, 1975), but these workers were also exposed to cadmium and lead. The only animal studies which show a potential link to cancer involved testicular sarcomas in chickens and rats which had received repeated intratesticular injections of zinc chloride. The relevance of this type of exposure is highly questionable. No other routes of administration were found to produce cancer (Sunderman, 1977; Pories et al., 1978).

Zinc is an essential element, and is required as a cofactor in over 20 metalloenzymes, including alcohol dehydrogenase, alkaline phosphatase, carbonic anhydrase, and leucine aminopeptidase. It is also a component of DNA polymerase and thus is required for cell division (NRC, 1979). Zinc deficiencies occur when dietary levels fall below 1 mg/kg in food, and may occur at levels as high as 12 mg/kg (Williams and Mills, 1970) Recommended daily zinc requirements are 15 mg for adults and 25 mg for nursing mothers (Food and Nutrition Board, 1974).

It is noted that terata can be produced by zinc deficiencies (NRC, 1979). Zinc-induced teratogenesis has not been reported, although Kumar (1976) reported that dietary levels of 150 mg/kg interfered with implantation in the rat.

ECOLOGICAL ASSESSMENT

FOR THE

BAIER SITE AND MCCARL SITE
LEE COUNTY, IOWA

JANUARY 16, 1991

PREPARED FOR:

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WCC PROJECT 89C7583-1

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0.0 EXECUTIVE SUMMARY

The objective of the ecological assessment for the Du Pont Baier and McCarl sites was to evaluate qualitatively the potential impacts that paint sludge and associated wastes may have on wildlife and vegetation at the sites. The approach used in this ecological assessment is that recommended by the guidance provided by the U.S. Environmental Protection Agency (USEPA, 1989).

Many of the initial steps used to evaluate the human risks were applicable to the ecological assessment. For example: identifying contaminants of concern and evaluating the release, migration, and fate of chemicals in the environment. After these initial steps have taken place, the next steps in an ecological assessment are to identify wildlife populations and habitats that may be potentially impacted, evaluate the chemical concentrations at these locations and characterize the potential for adverse impacts. Both flora and fauna are considered as potential receptors.

The selection of chemicals of concern is the first step in an ecological assessment. The objective of selecting compounds of concern is to identify a subset of chemicals that represent those chemicals that are the most toxic, environmentally mobile and/or environmentally persistent and that would potentially occur in concentrations sufficient to be threatening.

The twelve chemicals selected for this ecological assessment are:

- three volatile organic compounds (VOCs) (ethylbenzene, toluene, and total xylenes);
- two semi-volatile compounds (naphthalene and 2-methylnaphthalene); and
- seven metals (arsenic, cadmium, chromium, iron, lead, selenium, and zinc).

The contaminants of concern were selected based on the following criteria:

- The chemicals are considered at least moderately toxic; and

- The persistence of the chemical in the environment may pose a potential hazard to biota.

The evaluation of the ecological exposure is the second step in an ecological assessment. There are four basic elements in evaluating ecological exposure: identifying the environmental transport pathway, identifying exposure points, evaluating the chemical concentrations at the exposure point and evaluating the route or exposure pathway of chemical intake for the wildlife species. These distinct elements which are all necessary in order for wildlife species to be exposed to the chemicals of concern are discussed below:

- An exposure or environmental transport pathway is the mechanism by which chemicals are transported from a source or sources to a wildlife receptor. In this ecological assessment the sources were on-site soils and sediments contaminated by paint wastes.
- The exposure locations or areas of concern in this ecological assessment were the points where wildlife receptors can potentially contact the medium (soil, sediments, or vegetation) on which the chemical of concern are deposited.
- For a chemical to pose an ecological risk to wildlife, the chemical must travel through environmental media to the exposure point and reach receptors in biologically significant concentrations. The exposure pathway must be complete or there is no hazard. The exposure pathway in this ecological assessment was the release of the chemicals of concern to the soils and sediments, environmental transport of the chemicals to the exposure point and uptake of the contaminated media by a receptor.
- Media uptake routes are the final connection between chemical release and the exposed wildlife. The potential routes included dermal exposure to contaminated soils and sediments and ingestion of contaminated soils, sediments, and vegetation. Ingestion was considered the most important route in this ecological assessment.

There were three terrestrial pathways of concern at the Baier site, soil, sediment and soil/vegetation, and two terrestrial pathways of concern at the McCarl site, soil and soil/vegetation. Within these terrestrial pathways six scenarios were identified at the Baier site involving; earthworms, worm-eating warblers, voles, barn owls, the eastern cotton tail, the eastern squirrel, and the white-tailed deer and three scenarios were identified at the McCarl site involving; earthworms, worm-eating warblers, mice, barn owls, and raccoons.

None of the wildlife species identified above and incorporated into the scenarios at the Baier and McCarl sites should be adversely affected by the metals of concern. The concentrations of the metals of concern were within or below those concentrations in the literature that have been documented as having no adverse affects on these species.

Therefore, the evaluation of the potential effects of the chemicals of concern (for which literature was available) on the wildlife and ecology of the Baier and McCarl sites was these chemicals do not appear to pose a threat to the ecology of these sites.

1.0 INTRODUCTION AND OBJECTIVE

This ecological assessment is complimentary to the human risk assessment because many of the initial steps used to evaluate the human risks are applicable to this ecological assessment (WCC, 1990). For example: identifying contaminants of concern and evaluating the release, migration, and fate of chemicals in the environment are common elements of both the Human Health Risk Assessment and the Ecological Assessment. After these initial steps have taken place, the next steps in an ecological assessment are to identify wildlife populations and habitats that may be potentially impacted, evaluate the chemical concentrations at these locations and characterize the potential for adverse impacts. Both flora and fauna are considered as potential receptors.

The Baier and McCarl sites were combined by USEPA for Hazard Ranking System (HRS) purposes. However, the sites are separated by approximately two miles of woodlands; and, therefore, the surface water drainage pathways are different. Also, the amount of wastes disposed at each site were different. These differences are definitive and affect the parameters evaluated to perform an ecological assessment; therefore, an ecological assessment is performed for each site individually. These individual assessments relied on the existing scientific literature and utilized the known toxicity of the chemicals of concern at the Baier and McCarl sites on closely related species, because there is little toxicological data available for the specific biota that inhabit the Baier and McCarl sites that may be impacted by the identified chemicals of concern.

The intent of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and its amendment is "to protect human health and the environment". Therefore, the objective of this ecological assessment is to evaluate qualitatively the potential impacts that paint sludge and associated wastes may have on wildlife and vegetation at the Baier and McCarl Sites. The approach used in this ecological assessment is that recommended by the U.S. Environmental Protection Agency (USEPA, 1989).

2.0 SCOPE OF EVALUATION BAIER SITE

2.1 DESCRIPTION OF THE BAIER SITE

The following description of the area is from site visits and from summarizing existing DuPont reports including: the Removal Action Workplan for the Baier Site (WCC, 1989); the Draft Workplan for the Focused Ground Water Investigation (WCC, 1989); the Site Histories/Chronology of the Baier and McCarl sites (WCC, 1989); the Draft Statement of Work for Engineering Evaluation/Cost Analysis of the Baier site (WCC, 1989); and the sampling data collected by USEPA for the James Baier site (USEPA, 1986). Review of these documents leads to the conclusion that the Baier site is isolated from major water bodies and accessible only through two locked gates. Access is restricted to a single lane gravel road behind a locked gate and another locked gate at the site boundary.

2.1.1 PHYSICAL ENVIRONMENT

The Baier site is located in Lee County, Iowa approximately 3.5 miles south of West Point, Iowa and approximately 5 miles west-northwest of Fort Madison, Iowa. The Baier site (approximately 3 acres) is comprised of a small open area ringed by woods. A fallow pasture lies immediately south of the site. The average elevation across the Baier site is 670 feet above mean sea level with an elevation range from 700 feet above mean sea level along the eastern ridge to 640 feet above mean sea level along the western drainage ditches. Surface water flows within several drainage pathways into either Sugar Creek or Devils Creek.

2.1.1.1 Climate

The climate of the region is temperate with cold winters (mean average temperature from 1981 to 1988 was 35.71 degrees Fahrenheit) and hot summers (mean average temperature from 1981 to 1988 was 66.30 degrees Fahrenheit). The mean average temperature from 1981 to 1988 was 51.74 degrees Fahrenheit. The average annual rainfall is 34.6 inches, although the precipitation from October 1, 1988 through September 30, 1989 was 29.98 inches. About 75 percent of the annual precipitation occurs during the warm season from April through September.

2.1.1.2 Geology and Soils

The surficial geologic units at the Baier site consist primarily of unconsolidated loess or glacial till. The loess thickness ranges from 0.5 to 9.0 feet in areas with relatively flat slopes, and the average loess thickness is 5.4 feet. In general, the thickness of loess decreases with increasing slope at the site and is not present in the drainages due to erosion. The underlying geologic units are weathered glacial till with a lower contact of a thin sand deposit, underlain by an unweathered till. The thickness of the weathered glacial till ranges across the site from 25 to 54 feet. The unweathered glacial till is approximately 170 feet thick as determined from a soil boring to bedrock.

Soils at the Baier site include brown, silty clay typical of the loess deposits and reddish brown, silty clay typical of the weathered glacial till. The surface soil exhibits low permeability except for desiccation fracture zones which may increase the permeability. The surface soil also has a high available water capacity.

2.1.1.3 Surface Water Hydrology

The Baier site is characterized by an open area ringed by wooded areas. A fallow pasture lies immediately south of the site. The open area bisects the site and essentially acts as a natural divide for surface water drainage. The surface runoff flows either towards the west - northwest or towards the southeast through the wooded areas down the steep slopes into various drainage pathways. These drainages intersect and eventually lead to intermittent tributaries of Sugar Creek.

2.1.2 ECOLOGY OF THE BAIER SITE

The Baier Site contains a variety of terrestrial and aquatic habitats. The center area of the site is open. This area has disturbed (i.e. perturbation occurred more than 100 years ago) vegetation types interspersed with tall grass prairie vegetation and remnant pasture grasses. The perimeter of the site is characterized by deciduous woodlands and ravines. The deciduous woodlands habitat is a second or possibly third growth stands of oak, hickory and black walnut interspersed with dogwood and cottonwood and brushy areas characterized by red sumac. A fallow pasture lies immediately south of the site. Artificial property boundaries do not restrict the utilization of habitat on-site by the local fauna, because animals can not distinguish between habitat that is located on-site and habitat that is located immediately adjacent to a site.

2.1.2.1 Aquatic Ecology

The aquatic habitats on the Baier site are restricted to the ephemeral drainage pathways leading off-site to the intermittent streams that flow into Sugar Creek. This type of drainage path contains water only a very short time period over an annual rainfall season.

Standing water was observed on-site in shallow depressions created by tire ruts. Tadpoles have been observed in these ephemeral pools (i.e., pools of water which are of short duration) on previous site visits. However no permanent standing water bodies, such as ponds or lakes, are present on the site.

2.1.2.2 Terrestrial Ecology

FLORA

The Baier site is an area of low rolling terrain characterized by grasslands, sumac shrublands, stands of white oak, hickory, and black walnut with dogwoods, cottonwoods, redbuds and maples comprising the understory. The woodland habitat at the Baier site is divided by an open grassy area. The fallow pasture immediately south of the site is dominated by mid-grass species and tall-grass species which are typically found in mesic areas or those areas which support vegetation types that require a fair amount of moisture to survive. White oak, hickory, black walnut and black locust are the dominant tree species in the deciduous woodlands. The dominant shrub species on the Baier site includes red sumac. Sedges, mosses and plant species tolerant of mesic conditions are found within the woodlands along the drainage pathways.

FAUNA

The most conspicuous mammals on the Baier site are the eastern cottontail (Sylvilagus floridanus), raccoon (Procyon lotor) and white-tailed deer (Odocoileus virginianus). A beaver (Castor canadensis) was identified near a tributary of Sugar Creek approximately 1 mile from the Baier site. An ecological literature review pertaining to areas that have similar habitats as the Baier site provided the following list of common rodents which because of habitat similarity may inhabit the Baier site:

- o the Franklin ground squirrel (Citellus franklini) in tall-grasses, borders of fields and open woods;
- o woodchuck (Marmota monax) found in brushy and rocky ravines and open woods;
- o eastern chipmunk (Tamias striatus) found in deciduous forests and brushy areas;
- o eastern gray squirrel (Sciurus carolinensis) inhabits hardwood forests with nut trees;
- o eastern fox squirrel (Sciurus niger) inhabits open hardwood lots with interspersed clearings;
- o southern flying squirrel (Glaucomys volans) inhabits woodlots and forests of deciduous trees;
- o plains pocket gopher (Geomys bursarius) inhabits grassland and pastures;
- o western harvest mouse (Reithrodontomys megalotis) in grassland with dense vegetation near water;

- white-footed mouse (Peromyscus leucopus) prefers woody or brushy areas;
- deer mouse (Peromyscus maniculatus) inhabits a mixture of forests and grasslands;
- meadow vole (Microtus pennsylvanicus) prefers high grasslands with rank growths of vegetation, occasionally in forests with little ground cover;
- prairie vole (Microtus ochrogaster) prefers open prairie;
- pine vole (Pitymys pinetorum) inhabits forest floors thick with deciduous matter;
- meadow jumping mouse (Zapus hudsonius) found in low meadows;
- norway rat (Rattus norvegicus) found along building foundations or beneath rubbish piles; and
- house mouse (Mus musculus) usually found in buildings.

Other mammals possibly inhabiting the Baier site include:

- opossum (Didelphis marsupialis) prefers woodlands along streams;
- least shrew (Cryptotis parva) inhabits open grass-covered areas with scattered brush;
- shorttail shrew (Blarina brevicauda) inhabits forests, grasslands and brushy areas;
- eastern mole (Scalopus aquaticus) prefers moist sandy loam, fields and meadows;
- keen myotis (Myotis keeni) prefers buildings, hollow trees, forested areas;
- little brown myotis (Myotis lucifugus) found in hollow trees or buildings;
- Indiana myotis (Myotis sodalis) found in hollow trees;
- small-footed myotis (Myotis subulatus) found in crevices in rocks, buildings or near forested areas;
- silver-haired bat (Lasionycteris noctivagans) typically inhabits forested areas;
- eastern pipistrel (Pipistrellus subflavus) found in caves, crevices in rocks and wooded areas;

- red bat (Lasiurus borealis) prefers wooded areas and normally roosts in trees;
- big brown bat (Eptesicus fuscus) inhabits caves, crevices, hollow trees and wooded areas;
- hoary bat (Lasiurus cinereus) inhabits wooded areas;
- evening bat (Nycticeius humeralis) is found in buildings and hollow trees;
- least weasel (Mustela rixosa) inhabits meadows, fields, brushy areas and open woods;
- longtail weasel (Mustela frenata) is not restricted and is found in all land habitats near water;
- badger (Taxidea taxus) is found in open grasslands;
- spotted skunk (Spilogale putorius) prefers sparsely wooded areas, brushy areas and prairies;
- striped skunk (Mephitis) inhabits mixed woods, brushland and semi-open country;
- coyotes (Canis latrans) inhabit prairies, open woodlands, brushy areas;
- red fox (Vulpes fulva) prefers a mixture of forest and open country; and
- bobcat (Lynx rufus) typically found in forests.

Although it is theoretically possible for the mammals listed above to inhabit the Baier site, it is not ecologically expected to find all of these mammals utilizing the site. The Baier site lacks the diversity to support all representatives of the mammals species listed; for example, the potential exists for one or two species of bats to inhabit the site but it is not possible from an ecological standpoint for all 10 bat species listed to inhabit the site. The diversity of species and numbers of species that inhabit a site are directly correlated to the availability of diverse habitat. The competitive exclusion principle (also known as the Gausian Model states that two closely related species can not coexist when the habitat is limited) limits the numbers of species that may coexist within a specific habitat.

Several different species of birds are attracted to the diverse habitats at the Baier site. Different species are found according to their preferred habitat for nesting and feeding. These habitats include the open grassland, shrub habitats and the deciduous woodlands. Species identified during site visits include; indigo bunting (Passerina cyanea), red-winged blackbird (Agelaius phoeniceus), blue jay (Cyanocitta cristata), brown thrasher (Toxostoma rufum) and killdeer (Charadrius vociferous).

Upland game birds visible on site visits include bobwhite (Colinus virginianus), turkey (Meleagris gallopava) and ring-necked pheasant (Phasianus colchicus). The turkey vulture (Cathartes aura), a scavenger along roadsides and in fields has been identified during site visits also.

Turtles, toads and lizards are probably found on the Baier site. Northern cricket (Acris crepitans) and tree frogs (Hyla species), a bullsnake (Pituophis melanoleucus sayi) and red milksnake (Lampropeltis triangulum syspila) have been identified during site visits.

2.1.3 THREATENED AND ENDANGERED SPECIES

According to the Bureau of Preserves and Ecological Services within the Iowa Department of Natural Resources (IDNR) there is one species listed on the state of Iowa threatened species list in Sections 28 and 22 of Township 68 North, Range 5 West. This threatened species is the orange-throated darter (Etheostoma spectabile) which was collected in Pitman Creek in 1971. Pitman Creek is located approximately one and one-half miles north of the Baier site. Surface water drainage from the site is towards the west-northwest or the southeast. Surface water draining from the site ultimately flows into Devils Creek or Sugar Creek. Pitman Creek flows into Sugar Creek in the southwest corner of Section 20. Therefore, it is impossible for the surface water drainage from the Baier site to impact Pitman Creek and consequently the orange-throated darter.

The Indiana bat (Myotis sodalis) is an endangered species listed on both the state of Iowa and the Federal endangered species lists. According to the IDNR the Indiana bat may be expected in the area based on habitat. The Indiana bat is found in areas where there are large trees with shaggy bark. The worm-eating warbler (Helmitheros verivorus) and hooded warbler (Wilsonia citrina) are considered rare, but have no special legal status and also may be expected in the area due to available habitat. The warblers are typical of mature woodland with large trees.

2.2 CONTAMINANTS OF CONCERN

2.2.1 CHEMICALS OF CONCERN: SELECTION PROCESS

The selection of chemicals of concern is the first step in an ecological assessment. The objective of selecting compounds of concern is to identify a subset of chemicals that represent those chemicals that are the most toxic, environmentally mobile and/or environmentally persistent and that would potentially occur in concentrations sufficient to be threatening. The chemicals of concern for this analysis may be included in the chemicals selected in the human risk assessment.

2.2.1.1 Chemicals Selected from the Human Risk Assessment

The chemicals that were selected as chemicals of concern in the human health risk assessment (arsenic, cadmium, chromium, lead and selenium) were considered for inclusion in the ecological assessment. Chemicals that were eliminated in the human health risk assessment because of a low indicator score were reconsidered as part of this ecological assessment. Volatile organic compounds (VOCs) identified during the May 1989 sampling of discrete waste piles were not considered as chemicals of concern. The VOCs found in these waste piles were identified at depths of 6-36 inches and would not affect surface dwelling species. It is reasonable to assume that semi-fossorial and fossorial species would avoid these waste piles due to the odiferous nature of the waste especially since animals have evolved avoidance mechanisms (Joosse and Buker, 1979). Moreover, "Organisms have developed or used a number of mechanisms to overcome the adverse influence of otherwise toxic concentrations of compounds. These mechanisms may be arranged and treated as avoidance, exclusion, immobilization, excretion and mechanisms involving enzymatic change." (page 204 in Tyler et al., 1989). Moreover, studies have shown animals have a capacity to discriminate between contaminated and uncontaminated food (Joosse et al., 1981; Joosse and Verhoef, 1983; Tranvik and Eijsackers, 1989) and organisms may develop tolerance to compounds (Tyler et al., 1989). "The concept of tolerance comprises both the mechanisms by which an organism or population may develop resistance to chemical exposure and the degree of the actual resistance." "Tolerance may be both phenotypically and genotypically acquired. Individuals of any species amy be 'trained' to endure elevated exposure provided the exposure increase is not too great or too sudden." "Tolerance may also be due to changes in the genetic properties of a population, mainly a result of induced selection." (page 203 in Tyler et al., 1989).

2.2.1.2 Chemicals of Concern for the Ecological Assessment

The twelve chemicals selected for this ecological assessment are listed in Table 1. Three volatile organic compounds (VOCs) (ethylbenzene, toluene and total xylenes), two semi-volatile compounds (naphthalene and 2-methylnaphthalene) and seven metals (arsenic, cadmium, chromium, iron, lead, selenium and zinc) were selected. The contaminants of concern were selected based on the following criteria:

- The chemicals are considered at least moderately toxic; and
- The persistence of the chemical in the environment may pose a potential hazard to biota.

Literature reviewed concerned the fate, uptake and transport of arsenic, cadmium, chromium, lead, selenium and zinc on flora and fauna. Literature concerning the fate, uptake and transport of ethylbenzene, toluene, total xylenes, naphthalene, 2-methylnaphthalene and iron on flora and fauna was not readily available.

2.2.1.2.1 Arsenic

Arsenic exists in four oxidation states in either inorganic or organic forms. Its bioavailability and toxic properties are significantly modified by numerous biological and abiotic factors that include the physical and chemical forms of arsenic, the route of administration, the dose and the species of animal. Generally, inorganic arsenic compounds are more toxic than organic compounds and trivalent species are more toxic than pentavalent species (Eisler, 1988).

This chemical is a common element and is present in air, water, soil, plants and in all living tissues (Woolson, 1975; NAS, 1977; NRCC, 1978; Pershagen and Vahter, 1979; USEPA 1980, 1985; Hood, 1985, Andreae, 1986). Arsenic occurs naturally as sulfides and as complex sulfides of iron, nickel and cobalt (Woolson, 1975) and is present in rocks, soils, water and living organisms in one form or another (NAS, 1977). Soil arsenic levels are normally elevated near mineralized zones rich in sulfides of lead and zinc (Dudas, 1984).

Arsenic is ubiquitous in living tissue and is constantly being oxidized, reduced or metabolized (Eisler, 1988). Insoluble or slightly soluble arsenic compounds in soils are constantly being resolubilized and the arsenic is available for plant uptake or reduction by organisms and chemical processes.

Exposure of wildlife to arsenic may occur through air (e.g., emissions from smelters, coal-fired power plants) and water (e.g., smelter wastes, natural mineralization). Arsenic may be taken up by ingestion, inhalation or absorption through the skin or mucous membranes (Eisler, 1988).

2.2.1.2.2 Cadmium

Cadmium is a naturally occurring element and has been detected in more than 1,000 species of aquatic and terrestrial flora and fauna (Eisler, 1985).

Older organisms generally contain greater concentrations of cadmium than younger organisms (Eisler, 1984). Point source discharges of cadmium containing wastes generally increase the cadmium concentrations within a species of animals (Eisler, 1985).

2.2.1.2.3 Chromium

Chromium can be affected by various physical and chemical parameters which alter the elemental concentration (e.g., trivalent chromium vs. hexavalent chromium) thereby influencing the mobility and reactivity of the chemical resulting in different environmental effects (Steven et al., 1976). Soil pH and organic complexing substances in the soil affect the solubility and therefore the potential bioavailability of chromium in the soils (James and Bartlett, 1983).

Although soil pH can affect oxidation rates of hexavalent chromium to trivalent chromium, organic complexes appear to play a more significant role. Organically complexed trivalent chromium added to soils may remain soluble for at least a year, whereas the free trivalent chromium metal ion in the absence of soluble complexing ligands quickly becomes adsorbed or hydrolyzed and precipitated (Eisler, 1986).

Acute and chronic adverse effects of chromium to warm-blooded organisms are caused mainly by hexavalent chromium (Eisler, 1986). In general, hexavalent chromium compounds are hazardous to animals, trivalent chromium is essentially nontoxic (Gale, 1978). Chromium in biological materials is in the majority of circumstances in the trivalent state. No organic trivalent chromium complexes of toxicological importance have been described (Eisler, 1986). Little is known about the relation between concentrations of total chromium in a given environment and biological effects on the organisms living there.

2.2.1.2.4 Lead

Lead is a ubiquitous trace constituent in rocks, soils, water, plants, animals and air (Eisler, 1988). Absorption and retention of lead from the gastrointestinal tract (the major intake pathway) varies widely as a function of age, sex and diet of the organism. The lack of particular chemicals in the diet often affects the toxicity and storage of lead in tissue greater than the effect of doubling the dose of lead in the diet (Levander, 1979).

2.2.1.2.5 Selenium

Selenium occurs in nature in four oxidation states of biological significance; selenide, elemental selenium, selenite and selenate. Hydrogen selenide is a highly toxic and reactive gas that quickly decomposes in the presence of oxygen to elemental selenium and water. Elemental selenium is insoluble and not subject to rapid oxidation or reduction in nature. This form is apparently not toxic (Ohlendorf, 1989). Selenate is the predominant mobile inorganic form of selenium in alkaline soils of semiarid areas whereas selenite predominates in soils of humid regions.

Selenium concentrations in animal tissues reflect dietary levels, particularly when selenium occurs in natural dietary ingredients as compared to inorganic selenite or selenate (Sharma and Singh, 1983). Animals readily absorb inorganic and some organic selenium compounds through the small intestine (Rosenfield and Beath, 1964; Allaway et al., 1967; Olson, 1967; Fishbein, 1977) but selenides and elemental selenium are poorly absorbed (Ohlendorf, 1989). Most of the selenium (between 70 to 80 percent) is quickly excreted in urine, breath, perspiration and bile. The remaining selenium becomes bound to tissue proteins or blood and is only slowly eliminated (Ohlendorf, 1989).

2.3 ECOLOGICAL EXPOSURE

There are four basic elements in evaluating ecological exposure: identifying the environmental transport pathway, identifying exposure points, evaluating the chemical concentrations at the exposure point and evaluating the route or exposure pathway of chemical intake for the wildlife species. These distinct elements which are all necessary in order for wildlife species to be exposed to the chemicals of concern are discussed in the following sections.

2.3.1 ENVIRONMENTAL TRANSPORT PATHWAYS

An exposure or environmental transport pathway is the mechanism by which chemicals are transported from a source or sources to a wildlife receptor. In this ecological assessment the sources are on-site soils and sediments contaminated by paint wastes.

The volatile organic compounds (VOCs) and metals of concern on-site were transported through the soils and sediments and are found at depths as great as 25 feet (Table 2). The Remedial Investigation/Feasibility Study (RI/FS) contains more detailed information pertaining to the chemicals of concern. Surface water run-off and percolation are the mechanisms responsible for the transport of these chemicals of concern. The surface transport pathway is responsible for the contamination of the sediments in the drainage pathways. The chemicals of concern were transported via surface water run-off into these drainage pathways.

2.3.2 EXPOSURE POINT IDENTIFICATION

The exposure locations or areas of concern in this ecological assessment are the points where wildlife receptors can potentially contact the medium (soil, sediments or vegetation) on which the chemicals of concern are deposited. Sediment is defined as the medium in the drainage pathways that usually has a high moisture content and does not support vegetation. Soil is the defined as the medium on the slopes which supports the growth of vegetation which in turn may take up contaminants via the root system. Wildlife that may contact the air or surface water media are not considered at risk in this ecological assessment and these media are not evaluated as exposure media. There is little, if any, fugitive dust from the site; therefore, the air is not considered as an exposure medium. There are no standing water bodies on-site, therefore the surface water is not considered as an exposure medium.

2.3.2.1 Soils

Soils are an important exposure medium in this ecological assessment. The selection of exposure points for soils was based on those locations which are most ecologically significant in terms of important wildlife species, such as the worm-eating warbler and their food webs. Worms contact the soil medium directly through ingestion and indirectly through burrowing. Worms are a prey item of not only the worm-eating warbler but also shrews, skunks and opossums. Thus, soils also may serve as a direct contact and incidental ingestion route.

Additionally, soils are an important exposure medium, indirectly through burrowing and directly through accidental ingestion while cleaning for semi-fossorial mammals such as voles and for fossorial mammals such as moles. Voles are a prey item of predaceous animals such as owls, hawks and snakes.

2.3.2.2 Sediments

Sediment is defined as the medium in the drainage pathways that usually has a high moisture content but does not support vegetation. Sediments are ecologically important when the contaminants are hydrophobic substances that become absorbed by organic matter or clay particles in the sediment. Worms contact the sediment medium in areas where detrital matter has collected directly through ingestion and indirectly through burrowing. Other species (e.g., frogs, toads, lizards, snakes, raccoons and opossums) may potentially come into contact with the sediment medium transiently.

2.3.2.3 Vegetation

Vegetation also was considered as an exposure medium in this ecological assessment. The exposure areas selected for consideration were those vegetation communities that were judged to have the highest potential to impact wildlife. The following scenarios are examples of the importance of vegetation in food webs:

- Voles ingest the stems of grasses and sedges and the eastern cottontail grazes on grasses; therefore, these vegetation types are considered important exposure media for the scenarios presented in this ecological assessment.
- Squirrels ingest nuts such as acorns and hickory nuts. These food sources may fall to the ground and pick up soil particles associated with paint wastes; therefore, the oak and hickory trees are considered as exposure media for the scenarios presented in this ecological assessment.
- White-tailed deer are browsers and ingest leaves and stems of shrubs and trees, if the chemicals of concern have been taken up by the shrubs and trees within the deciduous woodlands then they are considered important exposure media for the scenarios presented in this ecological assessment.

2.3.3 CHEMICAL FATE AND TRANSPORT

For a chemical to pose an ecological risk to wildlife, the chemical must travel through environmental media to the exposure point and reach receptors in biologically significant concentrations. The exposure pathway must be complete or there is no hazard. The exposure pathway in this ecological assessment is the release of the chemicals of concern to the soils and sediments, environmental transport of the chemicals to the exposure point and uptake of the contaminated media by a receptor. The term "transport" refers to the possible physical mechanisms that serve to move a chemical through the environment. "Fate" refers to the chemical and physical processes which limit (or enhance) the ability of a chemical to migrate in the environment to its ultimate destination. The term "environmental fate" is broadly defined in the literature as the collective chemical phenomena which tend to attenuate a chemical and its concentration. Some of the phenomena included in the term environmental fate are adsorption to mineral and organic particles in soil, volatilization, dispersion and dilution in ground water or surface water, chemical degradation, biological degradation and chemical speciation transformations.

2.3.3.1 Soil Concentrations

It was assumed for this ecological assessment that the chemicals of concern were deposited onto the soil and that soil was subsequently ingested (either directly or indirectly, via inhalation of particles or by dermal contact and subsequent cleaning of the exposed area) by the exposed wildlife.

Geometric means of the data collected in 1989 and 1990 were calculated. This approach differs from the human health risk assessment where arithmetic means were calculated as results of statistical analyses of data. This ecological assessment required that geometric means be calculated from the data for the following reasons:

- The data were collected as samples from areas of greatest suspected contamination in order to characterize the site for the human health risk assessment.
- The ecological assessment requires the entire extent of the site (including but not limited to localized areas) be evaluated. Moreover, plants found in the vicinity of the high contamination area gradually increased in density away from the high contamination area.
- In order to use these data to evaluate the areal extent of the site it was necessary to calculate geometric means.
- Geometric means are typically calculated when data collected in a nonrandom manner is used in a representative manner to evaluate a site.

Vegetation and animal samples from the site were not collected. Therefore, the soil and sediment samples collected from the site were used in conjunction with a thorough literature review to evaluate the potential effects of the chemicals of concern on the wildlife. Statistical tests were not performed due to the paucity of soil and sediment samples collected at repetitive sampling locations.

The 1989 soils data are presented in Table 2. The range of geometric means of the volatile organic compounds (VOCs) detected in soils collected at various depths are; ethylbenzene (0.006 milligrams per kilogram [mg/kg] to 21.16 mg/kg), toluene (0.006 mg/kg to 2.91 mg/kg), total xylenes (0.006 mg/kg to 92.47 mg/kg), methylene chloride (0.006 mg/kg to 0.08 mg/kg), acetone (0.012 mg/kg to 0.15 mg/kg) and 2-butanone (1.11 mg/kg to 10.0 mg/kg). Methylene chloride, acetone and 2-butanone are common laboratory contaminants and were seen at very low concentrations. Five of the seven metals of concern (arsenic, cadmium, chromium, lead and selenium) were detected on-site in 1989. The range of geometric means of the 1989 metals data indicate arsenic (4.10 mg/kg to 8.15 mg/kg), cadmium (0.96 mg/kg to 3.92 mg/kg), chromium (10.5 mg/kg to 39.38 mg/kg) and lead (6.91 mg/kg to 104.45 mg/kg) were detected from a depth of 0.5 feet to a depth of 25 feet (Table 2). The geometric means of the selenium concentrations (0.32 mg/kg to 1.55 mg/kg) represent the detection limits for these samples. The geometric means of the toluene concentrations (0.006 mg/kg to 4.80 mg/kg) are estimated values. Estimated values pertain to those concentrations that are less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL) and therefore are designated estimates by the analytical laboratory.

The 1990 volatile organics compounds (VOCs), semi-volatile compounds data and soils data are presented in Tables 3 & 4. The geometric means of the 1990 volatile organic compounds data (Table 3) indicate that toluene (0.66 mg/kg), ethylbenzene (1.76 mg/kg), total xylenes (6.81 mg/kg), methylene chloride (0.24 mg/kg), acetone (0.62 mg/kg) and 2-butanone (0.40 mg/kg) were detected in the soils collected on-site. The geometric means of the concentrations of arsenic (5.84 mg/kg), cadmium (27.50 mg/kg), chromium (173.73 mg/kg), iron (36,124.95 mg/kg), lead (1,176.48 mg/kg), selenium (7.32 mg/kg) and zinc (2,080.57 mg/kg) are presented in Table 4. The sediment collected from a depth of 0 to 1 foot had levels of cadmium (1.80 mg/kg), chromium (20.78 mg/kg), iron (16,759. 98 mg/kg), lead

(58.25 mg/kg), selenium (0.93 mg/kg) and zinc (145.24 mg/kg) which were less than the concentrations of these metals found in the soils. The concentration of arsenic in sediment (5.99 mg/kg) was greater than the concentration of arsenic in the soils (5.84 mg/kg) (Table 4).

Six semi-volatile compounds were detected at the Baier site (Table 3). Of these compounds the origin of naphthalene and 2-methylnaphthalene on-site is not known. The other four compounds (benzoic acid, di-n-butylphthalate, bis(2-ethylhexyl) phthalate and di-n-octylphthalate) are ubiquitous in the environment. The concentrations of naphthalene (4.87 mg/kg) and 2-methylnaphthalene (19.98 mg/kg) are presented in Table 3. The available literature concerning potentially hazardous semi-volatile compounds in the environment and their ecological effects on the environment is sparse; therefore, it is difficult to interpret these data as having a potential adverse impact on the environment.

Two soil exposure points were selected. The worm that ingests soil was considered an important soil exposure point because the worm-eating warbler, a species considered rare by the state of Iowa but with no legal status, (and numerous other worm-eating bird species) ingest worms. The second important soil exposure point selected in this ecological assessment involves the vole which indirectly ingests soil through dermal contact (and subsequent cleaning) and inhalation of soil particles and was considered an important component of this soil exposure point because of the occurrence of predatory birds in the area. Predators of the vole (a semi-fossorial mammal) include owls, hawks, other predatory birds and snakes.

Although the depth of chemicals has been documented as deep as 25 feet the ingestion of soil by worms or voles is limited to one foot because the soil exposure point is limited in depth.

2.3.3.2 Sediment Concentrations

For the purposes of this ecological assessment the chemicals of concern are thought to be transported through the soil and into the drainage pathways via surface water run-off. Those potentially contaminated sediments can then be subsequently ingested by the exposed wildlife.

One sediment exposure point was selected. The worm that ingests sediments was considered an important exposure point because the worm-eating warbler, a species considered rare by the state of Iowa but with no legal status, (and numerous other worm-eating bird species) ingest worms.

Although the depth of chemicals has been documented as deep as 25 feet the ingestion of sediment by worms or voles is limited to one foot because the sediment exposure point is limited in depth.

2.3.3.3 Vegetation Concentrations

For the purposes of this ecological assessment the chemicals of concern are assumed to be transported through the soil and were incorporated into edible portions via root uptake of various components from the soil. In addition, it was assumed that those potentially contaminated plants were subsequently ingested by the exposed wildlife. However, data are not available for estimating the contaminant uptake of the vegetation on-site.

Four vegetation exposure points were selected. The vole that ingested contaminated vegetation and was subsequently ingested by a barn owl was considered an important exposure point because predatory birds such as the barn owl may occur in this area. The eastern cottontail and the white-tailed deer ingesting vegetation that was exposed to the chemicals of concern was considered an important exposure pathway because of human hunters. The eastern squirrel ingesting white oak acorns or hickory nuts that were exposed to the chemicals of concern was considered an important exposure pathway because of human hunters also.

Although the depth of chemicals has been documented as deep as 25 feet the ingestion of vegetation by voles, eastern cottontail and white-tailed deer is limited to one foot because the vegetation exposure points are limited in depth. We are assuming the depth of concern with regard to the ingestion of acorns or nuts by the eastern squirrel is six feet because the trees that produce nuts generally have root zones extending as deep as six feet.

2.3.4 EXPOSURE POINT CONCENTRATIONS

This ecological assessment is qualitative in nature because of unknowns such as plant uptake of contaminants, the amount of contaminants consumed, et cetera, and as a result calculation of specific concentrations for individual chemicals at the exposure points is not feasible.

2.3.5 CHEMICAL OR MEDIA UPTAKE ROUTES

Media uptake routes are the final connection between chemical release and the exposed wildlife. The potential routes include dermal exposure to contaminated soils and sediments and ingestion of contaminated soils, sediments and vegetation. Ingestion was considered the most important route in this ecological assessment, because bioaccumulation in terrestrial environments most frequently involves the food chain because general exposure and uptake of the chemicals of concern from air is considerably less than the general exposure and uptake from prey.

2.3.5.1 Ingestion Pathway

Uptake of the chemicals of concern may occur from ingestion of soil, sediments or vegetation. Bioaccumulation (i.e., concentration of the chemicals from diet alone) of the chemicals of concern (arsenic, cadmium, chromium, iron, lead, selenium and zinc) will have the greatest potential to impact the wildlife at the Baier site because these metals have not been demonstrated to biomagnify (i.e., concentration of the chemicals increase as they move through the trophic structure of the community). Food chain biomagnification is uncommon for terrestrial communities (Eisler, 1988).

The site-specific terrestrial (soil-biota, sediment-biota and soil-vegetation-biota) food web or ingestion pathways were used to evaluate the ecological exposures at the Baier site. The pathways approach involves a multiple food chain pathway analysis to address the potential for adverse effects at various trophic levels and the potential for contaminants to bioaccumulate within food webs. The pathway approach incorporates exposure estimates by various organisms to contaminants present in the environment. This approach takes into consideration the potential for the following key factors:

- bioconcentration (concentration from direct exposure to water in an aquatic medium);
- bioaccumulation (concentration from water and/or from diet); and
- biomagnification (systematic increase in concentration as contaminants move through food chains to higher trophic levels).

The worm-eating warbler and barn owl are predators at the top of a food chain and are susceptible to the effects of contaminant bioaccumulation. The worm-eating warbler (or similar species of songbird) derives a major portion of its food supply from worms. The barn owl (or a similar predatory bird) derives a major portion of its food supply from voles, mice and snakes. The vole is susceptible to incidental ingestion of the chemicals of concern because it is a semi-fossorial (or semi-burrowing) mammal. The eastern squirrel, eastern cottontail, and white-tailed deer are of special interest with regard to bioaccumulation as they are common targets of human hunters.

Therefore these animals were incorporated into scenarios to evaluate the potential effects of the chemicals of concern on the food chain. Six separate scenarios (worm-eating warbler, vole, barn owl, eastern squirrel, eastern cottontail and white-tailed deer) were developed for the exposure pathway analysis to evaluate qualitatively the effects of the chemicals of concern on these animals. While these scenarios aid in understanding what ecological effects these compounds of concern may cause, it is important to note that other variables such as predation, parasitism, niche competition and unfavorable microclimate may affect all the hypothetical pathways considerably more than the chemicals under consideration. Moreover, this site is an extremely small area when considering the entire ecological system within Lee County.

Internal biochemical processes may influence the ultimate fate of the chemicals of concern by negating any potential harmful effects of the chemicals. One method employed by animals to avoid detrimental effects of metals once ingested is to store them in one or more organs in a form which will not distribute throughout the body and interfere with essential biochemical processes in other tissues (Hopkin and Martin, 1984). Additionally, the animals can use efficient removal mechanisms such as excretion via molting and defecation (Joosse and Buker, 1979; van Straalen et al., 1985).

2.3.5.2 The Terrestrial Pathway

The terrestrial pathway is evaluated by comparing the geometric means of the chemical concentrations in the soil, sediment or vegetation to an estimate of the uptake of these chemicals in the animals diet and the ultimate fate of these chemicals in the animals bodies.

There are three subpathways within the terrestrial pathway. These are the soil pathway, the sediment pathway and the soil/vegetation pathway. The six scenarios previously discussed are presented below within their respective terrestrial pathway.

2.3.5.2.1 Soil Pathway

The principal terrestrial pathway for the worm-eating warbler at the Baier site is:

soil --- worm --- worm-eating warbler.

A review of the literature concerning the effects of arsenic, cadmium, chromium, lead, selenium and zinc on this scenario was conducted.

It is important to note that body concentrations of metals in invertebrates differ between taxonomic groups, species and individuals within one species (Hunter et al., 1987). However, for this ecological assessment the decision was made to lump the available data from the literature and present a broad, generalized scenario of the effects of the metals of concern on earthworms because no earthworms were collected and analyzed from the site. Unfortunately, this extrapolation of the potential effects of the metals of concern on earthworms is not truly representative. Critical concentrations of metals in soils are more difficult to establish for soil invertebrates (such as earthworms) when using the concentration of the metals in soil as a reference. This is due to the varying degree of immobility versus availability of metals in soils. A more representative alternative in evaluating the potential effects of the metals of concern on earthworms would be to measure the actual levels in the body tissues as a reference.

It should be noted that for this ecological assessment the comparison is directly between concentrations of the metals of concern in the soils and their effects on earthworms without accounting for the potential affects of the soil chemical parameters on the metals of concern. Studies have emphasized the importance of relating the soil pH, organic matter and soil moisture content to the metal concentrations in the soil and earthworms (Ma, 1982; Morgan, 1985; Ma et al., 1983; Morris and Morgan, 1986).

The effects of environmental pollution on earthworms have been researched for the last 20 years and earthworms have been sampled in various habitats such as roadside soils (Williamson and Evans, 1972; Gish and Christensen, 1973; Ash and Lee, 1980), mines and industrial areas (Ireland, 1975, 1979; Ireland and Richards, 1977; Wright and Stringer, 1980; Bengtsson et al., 1983) and analyzed for metal concentrations. The results of these (and other) studies indicate that earthworms have been documented in soils with concentrations of metals that exceed those concentrations present on the Baier site and these concentrations of metals on the Baier site are within levels detected in whole body earthworm samples.

The concentrations of the metals of concern on the Baier site should not adversely impact the earthworms or consequently the worm-eating warbler. The concentrations of these metals of concern at a depth of 0 to 1 foot are arsenic (4.10 mg/kg to 7.75 mg/kg), cadmium (1.08 mg/kg to 1.07 mg/kg), chromium (10.5 mg/kg to 19.5 mg/kg), lead (16.75 mg/kg to 58.11 mg/kg), selenium (0.39 mg/kg to 0.32 mg/kg) (Table 2) and zinc at a depth of 0 to 6 feet (2,080.57 mg/kg) (Table 4). These concentrations are within or below documented levels of these metals in soils inhabited by earthworms or within actual earthworm whole body samples.

Documentation detailing the metals of concern found in soils and in earthworms includes the following information:

- Concentrations of arsenic in soils have been documented in the USA at 7.4 mg/kg, and worldwide at 7.2 mg/kg, and arsenic concentrations in living organisms (such as; terrestrial flora, fauna and birds) are usually <1.0 mg/kg (fresh weight) (Dudas, 1984). Arsenic concentrations at the Baier site at the 0 to 1 foot level range from 4.10 to 7.75 mg/kg. These concentrations are within the concentration typically found in the USA; therefore, the earthworms on-site should have similar levels of arsenic.

- The levels of some metals in the bodies of earthworms parallels the concentrations found in the soils these earthworms inhabit. This has been documented for lead (Ma, 1982; Morgan, 1985). Therefore, it is reasonable to assume that the same is true for the other metals of concern.

- Concentrations of cadmium have been documented in earthworms from 3.0 mg/kg (dry weight) in control areas to 12.6 mg/kg when earthworms were collected 3.0 meters from a highway (Gish and Christensen, 1973). Cadmium concentrations at the Baier site at the 0 to 1 foot level range from 1.08 to 1.07 mg/kg. Making a gross assumption that earthworms will have a body concentration of cadmium equal to the concentration of cadmium in the soils they inhabit, the earthworms on-site would have concentrations of 1.08 to 1.07 mg/kg cadmium. The earthworms on-site should not be adversely affected by these concentrations of cadmium (based on the above assumption) because these concentrations are less than typical background or control concentrations.

- Concentrations of chromium were documented in earthworms from 0.8 mg/kg (dry weight) when earthworms were fed grain to 13.0 mg/kg when earthworms resided 28 days in sewage sludge containing 299 to 650 ppm chromium (Hartenstein et al., 1980; Jenkins, 1980). Chromium concentrations at the Baier site at the 0 to 1 foot level ranged from 10.5 to 19.5 mg/kg. These concentrations of chromium are below the concentrations in the sewage sludge in the above example and should impact the earthworms to a lesser degree than the sewage sludge.

- Concentrations of lead have been documented in earthworms from 12 mg/kg (dry weight) when the earthworms were collected 18 miles from a low traffic density area (1,100 vehicles per day) to 2,100 mg/kg when the earthworms were collected from non-specified uncontaminated areas (Goldsmith and Scanlon, 1977; Beyer and Moore, 1980; Jenkins, 1980; Beyer and Cromartie, 1987). Lead concentrations at the Baier site at the 0 to 1 foot level ranged from 16.75 to 58.11 mg/kg. Making a gross assumption that earthworms will have a body concentration of lead equal to the concentration of lead in the soils they inhabit, the earthworms on-site would have whole body concentrations of 16.75 to 58.11 mg/kg lead. The earthworms on-site should not be adversely affected by these concentrations of lead (based on the above assumption) because these concentrations are less than the concentrations in earthworms collected from uncontaminated areas.

- Earthworms exhibiting no ill effects have been found in soils with concentrations of lead (3,564 mg/kg), arsenic (163 mg/kg), cadmium (26 mg/kg) and copper (333 mg/kg) (Bengtsson and Tranvik, 1989). The concentrations of lead, arsenic and cadmium at the Baier site at the 0 to 1 foot level are less than these concentrations; therefore, the earthworms on-site should not be adversely affected by these metals.

- Earthworms were collected from soil which was not selenite-enriched and from selenite-enriched soil. These earthworms exhibited no ill effects and had concentrations of selenium ranging from 2.2 mg/kg (fresh weight) to 7.5 mg/kg, respectively (Gissel-Nielsen and Gissel-Nielsen, 1973). Selenium concentrations at the Baier site at the 0 to 1 foot level ranged from 0.32 to 0.39 mg/kg. Making a gross assumption that earthworms will have a body concentration of selenium equal to the concentration of selenium in the soils they inhabit, the earthworms on-site would have whole body concentrations of 0.32 to 0.39 mg/kg selenium. The earthworms on-site should not be adversely affected by these concentrations of selenium (based on the above assumption) because these concentrations are less than the concentrations in earthworms collected from selenite-enriched and non selenite-enriched soils.

- The lethal concentration of zinc with additive effects of copper, in soil, to all species of earthworms has been documented at 35,000 mg/kg (Bengtsson and Tranvik, 1989). The concentration of zinc at the Baier site at the 0 to 6 feet level was 2,080.57 mg/kg, well below 35,000 mg/kg; therefore, the earthworms on-site should not be adversely affected by this metal.

- The age of the earthworm as well as the length of exposure to the metal can determine the accumulation rate by the earthworms of the metals encountered in the soils. This has been documented for lead (Honda et al., 1984). Therefore, it is reasonable to assume that the same is true for the other metals of concern.

- Earthworms may however concentrate some of the metals of concern. Although earthworms have been documented as having the capability of concentrating selenium up to 100 times the concentration present in their environment, they were not adversely affected (Nielsen and Gissel-Nielsen, 1975; Beyer and Cromartie, 1987).

- Synergistic, antagonistic and additive effects of metals acting in concert with each other may affect the potential impact of the metals of concern on earthworms and consequently their predators. The uptake of lead in earthworms is affected by its interaction with calcium. Calcium found simultaneously with lead in soil tends to suppress lead bioaccumulation (Anderson, 1979; Ireland, 1979; Anderson and Laursen, 1982). The concentration of zinc in earthworms tends to decrease with increasing soil metal concentration (Ma, 1982; Morgan, 1985).

Based on the above documentation, it appears that the concentrations of the metals of concern in soils on the Baier site should not present an acute or chronic threat to earthworms and should not adversely affect them or their predators. The worm-eating warbler and other worm-eating animals have the capacity to produce metallothioneins. Birds are protected from deleterious effects of high metal body burdens by metallothioneins.

Metallothioneins (metal binding proteins) are induced by metal pollution (Cooke et al., 1979; Suzuki et al., 1980; Morgan and Morris, 1982; Hopkin and Martin, 1984; van Capelleveen and Faber, 1987) and are thought to be related to stress proteins which are synthesized to a variety of environmental stresses (Marx, 1983). The amounts of these metal-binding proteinaceous metallothioneins and heavy metal loading appear to depend on the degree of pollution, the species of animal and the position in the food web (Eisler, 1985). Metallothioneins are responsible for the physiological mechanism in a variety of animals for metal tolerance.

Although metallothioneins have been documented extensively in mammals, metallothioneins also occur in several phyla (Hamer, 1986). "Metallothionein (MT) is a low-molecular-weight, heavy metal-binding protein which is rich in cysteine but lacks aromatic amino acids and histidine. MT has been found in many vertebrates and MT or MT-like proteins occur in several phyla." (page 56 in Hogstrand and Haux, 1990).

Metallothioneins have been documented in various human and animal tissues (Kagi and Vallee, 1960, 1961; Kagi and Nordberg, 1979; Nordberg et al., 1972). The occurrence of this protein in mammalian tissues modifies the toxicity of several elements (Nordberg et al., 1986). There has been documented evidence of the detoxication of heavy metals by metallothioneins (Bremner, 1987; Webb, 1987).

Another terrestrial pathway for the Baier site encompasses voles incidental ingestion of soil:

soil --- vole.

A review of the literature concerning the effects of arsenic, cadmium, chromium, lead, selenium and zinc on this scenario was conducted.

The concentrations of the metals of concern on the Baier site should not adversely impact voles or other semi-fossorial or fossorial mammals that incidentally ingest these metals. The concentrations of these metals of concern at a depth of 0 to 1 foot are arsenic (4.10 mg/kg to 7.75 mg/kg), cadmium (1.08 mg/kg to 1.07 mg/kg), chromium (10.5 mg/kg to 19.5 mg/kg), lead (16.75 mg/kg to 58.11 mg/kg), selenium (0.39 mg/kg to 0.32 mg/kg) (Table 2) and zinc at a depth of 0 to 6 feet (2,080.57 mg/kg) (Table 4).

Literature detailing the effects of the indirect ingestion of chromium, lead, and selenium on semi-fossorial mammals was available. This documentation includes the following information:

- Cotton rats trapped in a fescue field adjacent to the source of chromium contamination (cooling towers) contained up to 10 times more chromium in hair, pelt and bone than control animals; but accumulations in viscera and other internal organs were negligible. Licking of the fur by the cotton rats appeared to be the principal route of uptake (Langard and Nordhagen, 1980). Cotton rats were fed radiochromium-51 which demonstrated low assimilation (0.8 percent) and rapid initial loss of hexavalent chromium (99 percent in one day) which suggests that chromium is neither essential to cotton rats nor accumulated to any great extent through ingestion of drift contaminated vegetation or inhalation of drift contaminated air (Taylor, 1980).
- Lead is typically indirectly ingested through the consumption of an food item which contains lead shot or pellets (Stendell, 1980; Pattee, 1984).
- Selenium concentrations in the livers of small mammals usually are less than 2 mg/kg (Nielsen and Gissel-Nielsen, 1975; Fleming et al., 1979; Wren, 1984; Clark, 1979).

Although incidental ingestion of heavy metals by cleaning (licking fur) appears to be a common route of indirect ingestion, the levels of metals in the surface soils on-site that semi-fossorial or fossorial mammals are exposed to are relatively low when compared to levels found in the literature. These metals appear to either accumulate in the viscera or skeletal mass or fur, parts of small mammals not typically eaten by predators. The effects of the metals of concern on this pathway and on the food web associated with this scenario are therefore, minimal.

2.3.5.2.2 Sediment Pathway

The principal terrestrial pathway for the worm-eating warbler at the Baier site is:

sediment --- worm --- worm-eating warbler.

The interaction between the chemicals of concern and sediments closely parallels the interactions between the chemicals of concern and soils. Therefore the effects of the chemicals of concern (arsenic, cadmium, chromium, lead, selenium and zinc) in this scenario through sediments are likely to be the same as the scenario through soils. The geometric mean concentrations of the metals of concern in sediments are; arsenic (5.99 mg/kg), cadmium (1.80 mg/kg), chromium (20.78 mg/kg), lead (58.25 mg/kg), selenium (0.93 mg/kg) and zinc (145.24 mg/kg) (Table 4). All of these metals (with the exception of arsenic) were detected at greater concentrations in the soils than the sediments on-site.

2.3.5.2.3 Soil/Vegetation Pathway

The principal terrestrial pathway for the barn owl at the Baier site is:

soil --- vegetation --- vole --- barn owl.

A review of the literature concerning the effects of arsenic, cadmium, chromium, lead, selenium and zinc on this scenario was conducted.

It is important to note for this scenario the role the vegetation on-site assumes. Attempting to characterize the uptake of heavy metals by the plants on the Baier site is difficult, because vegetation samples were not collected for metals analysis. Information obtained from the available literature was extrapolated and interpreted for the potential effects of heavy metals on the plant species occurring on-site.

Although several plant species, including grasses, herbs and trees, are able to evolve tolerance to heavy metals; however, sensitive species or genotypes (i.e., type species) are supposedly affected by heavy metals at relatively low concentrations. Generally, zinc is the least toxic of the heavy metals (Pahlsson, 1989) and several grasses, herbs and tree species are capable of evolving tolerance to zinc. There are also lead resistant and lead sensitive plant species including some genetically fixed resistant species that can grow in soils containing lead up to 10,000 mg/kg (Holl and Hampp, 1975).

The degree of toxicity of the metals of concern to plants is influenced by time of exposure, biological availability of the metals and interactions with other metals in the soils, nutritional status, age and mycorrhizal infection of the plant. For example, adjusting the soil pH affects the plant uptake of cadmium, lead and zinc (Massey, 1972; Cavallaro and McBride, 1978; Kuo and Baker, 1980; Soon, 1981) and reduces plant uptake of these metals (Honma and Shirata, 1977; Street et al., 1978; Kuo et al., 1985). Bioavailability of lead in soils for plant uptake is limited but may be enhanced by reducing soil pH, organic matter content, organic colloids, iron oxide and phosphorus content and increasing the overall concentration of lead in soils (NRCC, 1973; Boggess, 1977).

The bioavailability of the metals of concern in soils for plant uptake is influenced by several parameters (NRCC, 1973; Boggess, 1977) and the ingestion of food containing biologically incorporated heavy metals is usually unlikely to lead to poisoning in herbivorous or predaceous animals (Custer et al., 1984; Franson et al., 1983).

The concentrations of the metals of concern on the Baier site should not adversely affect the vegetation or consequently the voles (herbivores) nor the barn owl (predator of herbivores). The concentrations of these metals of concern at a depth of 0 to 1 foot are; arsenic (4.10 mg/kg to

7.75 mg/kg), cadmium (1.08 mg/kg to 1.07 mg/kg), chromium (10.5 mg/kg to 19.5 mg/kg), lead (16.75 mg/kg to 58.11 mg/kg), selenium (0.39 mg/kg to 0.32 mg/kg) (Table 2) and zinc at a depth of 0 to 6 feet (2,080.57 mg/kg) (Table 4). These concentrations are within or below documented levels of these metals in soils, vegetation, herbivores (such as voles) or predators (e.g., barn owls).

Documentation detailing the metals of concern found in soils, vegetation, voles (herbivores) and the barn owl (predators) includes the following information:

- Cadmium is not known to have any useful function in plants (Pahlsson, 1989). Chemically cadmium is similar to zinc and available cadmium is easily taken up by plants. A limited transport of cadmium to the shoots of plants and binding to the cell walls occurs in the roots. Background levels of cadmium in plants are usually less than 1.0 mg/kg (Eisler, 1985). When ingested by mammals, cadmium tends to concentrate in the viscera of vertebrates, particularly the liver and kidneys.

- Recorded concentrations of cadmium in the liver and kidneys of the meadow vole (Microtus pennsylvanicus) collected from fields that received sewage sludge for four years at a yearly rate of 8,960 kg sludge/ha (hectare) were compared and contrasted with concentrations of cadmium in the liver and kidneys of meadow voles collected from control fields (Maly and Barrett, 1984). The concentration of cadmium in the livers and kidneys of the voles appeared to be dependent on the age (reproductive capacity) and sex of the vole. The general trend was a greater concentration of cadmium in the kidneys and livers of those voles collected from the fields which received the sewage sludge. These voles exhibited no obvious ill effects.

- Accumulations of chromium in organisms depends on the chemical form, route of entry and amount of chromium ingested (Yamaguchi et al., 1983). Tissue residues in mice fed 0.1 ppm hexavalent chromium in food and water during a lifetime of exposure ranged from 0.1 mg/kg (fresh weight) of chromium in the liver to 0.7 mg/kg in the heart; mice administered 5.1 ppm hexavalent chromium in a similar experiment contained 0.5 to 1.8 mg/kg (fresh weight) in tissues, primarily the heart and spleen (Schroeder et al., 1964).

- Effects of chromium on biological systems have been investigated in Kentucky and Tennessee (Taylor and Parr, 1978; Taylor, 1980; Taylor et al.,. 1975, 1979, 1983). No adverse biological effects were observed in native vegetation bearing high chromium residues. Chromium residues in the soils on-site at the Baier site are below those concentrations typically considered "high".

- Diet provides the major pathway for lead exposure and amounts of lead in bone are indicative of estimated lead exposure and metabolism (Chmiel and Harrison, 1981). Amounts of whole body lead and feeding habits of roadside rodents were correlated; body burdens were highest in insectivores such as shrews, intermediate in herbivores and lowest in granivores (Boggess, 1977; Getz et al., 1977, Clark, 1979).

- Birds of prey may ingest lead in the form of shot from dead or crippled game animals or as biologically incorporated lead from lead poisoned waterfowl, small roadside mammals and invertebrates (Stendell, 1980; Pattee, 1984). Lead poisoning in carnivorous birds has been reported in various species of eagles, condors, vultures and falcons but most if not all cases seem to be the result of the ingestion of lead shot found in food items (Custer et al., 1984). Ingestion of food containing biologically incorporated lead, although contributing to the lead burden of carnivorous birds, is unlikely to cause clinical lead poisoning (Custer et al., 1984; Franson et al., 1983). The form of lead that is ingested is crucial in evaluating the effects of lead ingestion on birds.

- Accumulation of selenium by plants depends on the species of plant, environmental conditions, age and rate of plant growth, and the nature of the selenium compounds (Rosenfeld and Beath, 1964; Johnson et al., 1967; Girling, 1984).

- The leaves, roots, stems and seeds often contain very different concentrations of selenium (Beath et al., 1937; NAS-NRC, 1976). Because selenium is associated with protein in the plant, leaves usually contain higher selenium levels than seeds (Ohlendorf, 1989). The metabolic pathways for selenium are poorly known in plants (NAS-NRC, 1983). Although selenium is essential in animal nutrition, it appears to be nonessential for plant growth. Moreover, selenium is not considered toxic to plants in natural conditions (Ohlendorf, 1989). Rosenfeld and Beath (1964) reported that crop plants are not injured by selenium until they accumulate more than 300 mg/kg, a concentration not yet found, even in naturally occurring highly seleniferous areas of the USA (NAS-NRC, 1983).

- Selenium concentrations in plant tissues usually decline with maturity, so the highest levels generally occur in the spring (Rosenfeld and Beath, 1964; Girling, 1984). Total selenium concentrations in soil do not necessarily reflect whether plants growing there will produce toxicity or nutritional deficiency in animals (Lakin, 1972). Grains and grasses normally do not accumulate selenium in excess of 50 mg/kg when grown on seleniferous soils (soils containing between 50 to 100 mg/kg selenium) (Rosenfeld and Beath, 1964). Selenium enters the food chain almost entirely via plants (NAS-NRC, 1976). Dietary plant selenium is readily absorbed by animals, up to 100 percent absorption can occur depending on the chemical form of selenium ingested and the animal species consuming the food (Glover et al., 1979).

- The biological availability of selenium is higher in plant foods than in foods of animal origin (Lo and Sandi, 1980). The net effect of soil, plant and animal metabolism is to convert selenium to inert and insoluble forms such as elemental selenium, metallic selenides and complexes of selenite with ferric oxides. Therefore bioaccumulation of selenium within a food chain is not likely.

- Few reports of selenium concentrations in tissues of several species of wild mammals from freshwater and terrestrial ecosystems exist. Selenium concentrations in livers of herbivorous wild mammals usually average less than 2 mg/kg (dry weight) (Nielsen and Gissel-Nielsen, 1975; Fleming et al., 1979; Wren, 1984; Clark, 1987). Concentrations in raccoons (Procyon lotor; 2.8 mg/kg wet weight) and moles (Talpa europaea; 2.6 mg/kg dry weight) were higher. Livers of ornate shrews (Sorex ornatus) (92.7 mg/kg) averaged six times more selenium than western harvest mice (Reithrodontomys megalotis) (15.5 mg/kg) and 22 times more than voles (4.29 mg/kg) from the same habitat at Kesterson Reservoir (part of the Kesterson National Wildlife Refuge in Merced County, California). These differences among species illustrate species to species differences and how concentrations of selenium differ with regard to carnivory (ornate shrew) and herbivory (voles) (Ohlendorf, 1989). The concentrations of selenium within wild animals is directly related to the animals diet. Herbivores (such as voles) should have the lowest concentrations of selenium in their body as compared to granivores (harvest mice) and carnivores (shrews). Omnivores (such as raccoons and moles) have fairly typical concentrations of selenium in their bodies, around 2.0 mg/kg.

It appears that the concentrations of the metals of concern in soils on the Baier site are not lethal to the vegetation and should not adversely affect either voles (herbivores) that ingest this vegetation, or barn owls (predator of these herbivores).

Most herbivores do not ingest roots of plants, therefore cadmium should not adversely affect most herbivores because cadmium binds to the cell walls of roots when taken up by plants. Vegetation is not adversely affected by high levels of chromium residues, and the accumulation of chromium in mammals through incidental ingestion of chromium was negligible. Lead accumulation is not great in herbivores and most predators are exposed to lead through ingesting prey. Selenium enters the food chain almost entirely via plants and herbivorous mammals typically have concentrations of selenium within their bodies of (approximately) 2.0 mg/kg, a low level. Therefore; it appears that a vole should not bioaccumulate these metals of concern to an extent that a predator (such as a barn owl), upon ingestion of the vole, is exposed to deleterious concentrations of heavy metals.

The principal terrestrial pathway for the eastern squirrel at the Baier site is:

> soil --- white oak or hickory trees --- acorns or nuts --- eastern squirrel.

A review of the literature specific to effects of heavy metals on eastern squirrels was conducted. This review included information pertaining to concentrations of heavy metals in nuts, and viscera of squirrels. The uptake and fate of the metals of concern in soils and plants were discussed in the previous scenario.

The concentrations of the metals of concern on the Baier site should not adversely affect oak or hickory trees, acorns or nuts, nor consequently the eastern squirrel. The concentrations of these metals of concern at a depth of 0 to 6 feet are; arsenic (4.10 mg/kg to 6.62 mg/kg in 1989 and 5.84 mg/kg in 1990), cadmium (1.08 mg/kg to 1.20 mg/kg in 1989 and 27.50 mg/kg in 1990), chromium (10.5 mg/kg to 18.66 mg/kg in 1989 and 173.73 mg/kg in 1990), lead (16.75 mg/kg to 20.98 mg/kg in 1989 and 1,176.48 mg/kg in 1990), selenium (0.39 mg/kg to 0.55 mg/kg in 1989 and 7.32 mg/kg in 1990) and zinc (2,080.57 mg/kg in 1990) (Tables 2 & 4).

Available documentation detailing the metals of concern found in acorns, nuts and squirrels includes the following information:

- Accumulated arsenic is usually distributed throughout plant bodies in nontoxic amounts (NAS, 1977).
- Cadmium residues (dry weight) detected in acorns and berries collected approximately 2.1 km downgradient of two zinc smelters were 1.2 mg/kg and 0.6 mg/kg when the acorns were collected approximately 9.7 upgradient from the zinc smelters (Beyer et al., 1985).
- The levels of cadmium in the soils on the Baier site were less than the mean concentration of cadmium in soil litter (710 ppm), where berries (1.2 ppm) were grown (Beyer et al., 1985).

- Cadmium tends to concentrate in the viscera of vertebrates, particularly the liver and kidneys. Cadmium concentrations (fresh weight) in the kidneys of two year old gray squirrels (Sciurus carolinensis) have been documented at 15.9 mg/kg in urban areas and 2.0 to 4.6 mg/kg in rural areas (Jenkins, 1980). Cadmium concentrations (fresh weight) in the kidney of red squirrels (Sciurus hudsonicus) were documented at 7.8 to 17.4 mg/kg and in the liver at 0.7 to 2.0 mg/kg (Jenkins, 1980).

- Rock squirrels (Spermophilus variegatus) with high levels of selenium concentrated in their kidneys were found at sites with high selenium concentrations (mean selenium concentration 53 mg/kg) (Sharma and Shupe, 1977).

- The major selenium compounds in seeds and forage plants appear to be selenocystine, selenocysteine, selenomethionine and selenium-methylselenomethionine (Ohlendorf, 1989). Selenomethionine is the predominant form of selenium ingested by animals; however, it is not readily absorbed by animals (Smith et al., 1938).

- Minimum toxicity has been documented at 250 ug/g in Quercus species (oak trees) (Jordan, 1975; Burton et al., 1983). Symptoms of zinc toxicity in plants are decreased leaf chlorophyll content and rate of photosynthesis (Van Assche et al., 1979; Porter and Sheridan, 1981).

Although ingestion of heavy metals by eating acorns or nuts that have accumulated these metals through plant uptake and/or have contaminated soil particles adhering to them appears to be a common route of ingestion, the levels of metals in the soils on-site that these trees are exposed to (5.84 mg/kg of arsenic, 27.50 mg/kg of cadmium, 173.73 mg/kg of chromium, 1,176.48 mg/kg of lead, 7.32 mg/kg of selenium and 2,080.57 mg/kg of zinc) are relatively low when compared to levels found in the literature (7.4 mg/kg of arsenic in soils within the USA, 710 mg/kg of cadmium in soil litter, 3,564 mg/kg lead in soils, and 35,000 mg/kg of zinc in soils. The concentrations of these metals should not be toxic to the oak or hickory trees, nor consequently the eastern squirrel. These metals appear to accumulate in the viscera of eastern squirrels. The ultimate endpoint of this particular scenario is the human hunter, who does not ingest the viscera of game animals; therefore, it is unlikely that humans would be adversely affected by ingesting eastern squirrels from this site.

The principal terrestrial pathway for the eastern cottontail at the Baier site is:

soil --- vegetation --- eastern cottontail.

A review of the literature specific to effects of heavy metals on eastern cottontails was conducted. Information concerning the effects of arsenic and cadmium on this scenario were available. The uptake and fate of this metal and the other metals of concern in soils and vegetation were discussed in previous scenarios.

Documentation detailing arsenic and cadmium concentrations found in eastern cottontails includes the following information:

- Arsenic concentrations in grasses from areas not treated with arsenical pesticides are usually between 0.1 to 0.9 mg/kg (dry weight). Arsenic concentrations in grasses which have been treated with arsenical pesticides are typically between 0.5 to 60,000 mg/kg (dry weight) (Eisler, 1988).
- The mean concentration of cadmium in soil litter was 710 ppm and the mean concentration of cadmium in leaves collected from this area was 8.1 ppm cadmium (Beyer et al., 1985).
- Cadmium concentrations (fresh weight) have been documented in the liver of eastern cottontails (<u>Sylvilagus</u> <u>floridanus</u>) up to 21 mg/kg in the kidneys up to 13.5 mg/kg and in the muscle up to 0.5 mg/kg (Jenkins, 1980).

Most herbivores do not ingest roots of plants, therefore cadmium should not adversely affect most herbivores as cadmium binds to the cell walls of roots when taken up by plants. Vegetation is not adversely affected by high levels of chromium residues, and the accumulation of chromium in mammals through incidental ingestion of chromium was negligible. Lead accumulation is not great in herbivores and most predators are exposed to lead through ingesting prey. Selenium enters the food chain almost entirely via plants and herbivorous mammals bioaccumulate selenium at low levels. Therefore; it appears that an eastern cottontail will not bioaccumulate these metals of concern to an extent that a predator upon ingestion of the eastern cottontail, is exposed to deleterious concentrations of heavy metals.

Although ingestion of heavy metals by consuming vegetation which has taken up these metals appears to be a route of incidental ingestion of heavy metals, the levels of metals in the soils on-site that the vegetation is exposed to are relatively low when compared to levels found in the literature. The concentrations of these metals should not be toxic to the vegetation, and consequently the eastern cottontail. These metals appear to accumulate in the viscera of vertebrates, and presumably eastern cottontails. The ultimate endpoint of this particular scenario is the human hunter. Humans do not ingest the viscera of game animals; therefore it is unlikely that humans would be adversely affected by ingesting eastern cottontails from this site.

The principal terrestrial pathway for the white-tailed deer at the Baier site is:

soil --- shrubs and trees --- white-tailed deer.

A review of the literature specific to effects of heavy metals on white-tailed deer was conducted. Information concerning the effects of arsenic, cadmium, lead and selenium on this scenario was available. The uptake and fate of these metals in soils and plants were discussed in previous scenarios.

Available documentation detailing the metals of concern found in white-tailed deer includes the following information:

o Lethal doses of arsenic for white-tailed deer have been documented at between 923 mg/kg to 2,770 mg/kg (Eisler, 1988). Arsenic concentrations at the Baier site at the 0 to 1 foot level range from 4.10 to 7.75 mg/kg in the soils. It is unlikely that these low concentrations of arsenic in the soil on-site will impact the vegetation to the extent that the arsenic concentrations in the vegetation will approach the above lethal values.

- Cadmium concentrations (fresh weight) have been documented in the white-tailed deer (Odocoileus virginianus) kidney from 0.7 to 11.7 mg/kg, in the muscle at 0.0 to 0.3 mg/kg and in the liver at 0.0 to 0.7 mg/kg (Jenkins, 1980). Cadmium concentrations at the Baier site at the 0 to 1 foot level range from 1.07 to 1.08 mg/kg in the soils. It is highly unlikely that these low concentrations will impact the vegetation on-site to the extent that cadmium concentrations in the vegetation will approach the above lethal concentrations.

- Lead concentrations in white-tailed deer both near a zinc smelter and 100 km from a zinc smelter were documented in Sileo and Beyers (1985) study. The mean lead concentration (dry weight) in the:

  - feces was 16 mg/kg (range 6 to 37 mg/kg);
  - bone was 9 mg/kg (range 4 to 17 mg/kg);
  - teeth was 6 mg/kg (range 3 to 11 mg/kg);
  - kidney was 2 mg/kg (range 1 to 3 mg/kg); and
  - liver was less than 2 mg/kg in white-tailed deer near the zinc smelter.

  The mean lead concentration (dry weight) in the:

  - feces was 8 mg/kg (range 4 to 16 mg/kg);
  - bone was 6 mg/kg (range 3 to 11 mg/kg);
  - teeth was 2 mg/kg (range 1 to 4 mg/kg);
  - kidney was 0.8 mg/kg (range 0.5 to 1 mg/kg); and
  - liver was less than 0.4 mg/kg in white-tailed deer 100 km away from the smelter.

  Tissue samples collected from the white-tailed deer near the smelter during this study did not contain elevated levels of lead (Sileo and Beyer, 1985). The soil litter at this location (near the zinc smelters) contained 2,700 ppm lead. The concentration of zinc at the Baier site at the 0 to 6 feet level was 2,080.57, which is below the level near the zinc smelter in the above example.

- Muscle samples from white-tailed deer from Michigan averaged 0.16 mg/kg selenium concentrations (Ullrey et al., 1981). Selenium concentrations at the baier site at the 0 to 1 foot level ranged from 0.39 to 0.32 mg/kg. It is highly unlikely that these low concentrations will impact the vegetation on-site to the extent that selenium concentrations in the vegetation will approach the high concentrations necessary for the above selenium concentrations present in muscle tissue of the white-tailed deer.

Usually white-tailed deer do not ingest plant roots, therefore cadmium should not adversely affect white-tailed deer as cadmium binds to the cell walls of roots when taken up by plants. Vegetation is not adversely affected by high levels of chromium residues, and the accumulation of chromium in mammals through incidental ingestion of chromium was negligible. Lead accumulation is not great in herbivores and most predators are exposed to lead through ingesting prey. Selenium enters the food chain almost entirely via plants and herbivorous mammals bioaccumulate selenium at low levels. Therefore, it appears that white-tailed deer will not bioaccumulate these metals of concern to an extent that it is exposed to deleterious concentrations of heavy metals.

Although ingestion of heavy metals by consuming vegetation which has taken up these metals appears to be a common route of indirectly ingesting metals, the levels of metals in the soils on-site that the vegetation is exposed to are relatively low when compared to levels found in the literature. The concentrations of these metals should not be lethal to the vegetation, nor consequently the white-tailed deer. These metals appear to accumulate in the viscera of vertebrates, and presumably white-tailed deer.

The ultimate endpoint of this particular scenario is the human hunter. Humans do not ingest the viscera of game animals; therefore it is unlikely that humans would be adversely affected by ingesting white-tailed deer from this site.

3.0 SCOPE OF EVALUATION MCCARL SITE

3.1 DESCRIPTION OF THE MCCARL SITE

The following description of the area is from site visits and from summarizing existing DuPont reports including: the Draft Workplan for the Focused Ground Water Investigation (WCC, 1989); and the Site Histories/Chronology of the Baier and McCarl sites (WCC, 1989).

3.1.1 PHYSICAL ENVIRONMENT

The McCarl site is located in Lee County, Iowa approximately 1.5 miles northeast of the Baier site. The McCarl site is located on Chalkridge Road which is accessed by County Road X-23. The McCarl site (approximately 0.5 acres) is comprised of a highly disturbed area parallel to Chalkridge Road and a drainage pathway to the north. The average elevation across the McCarl site is 667 feet above mean sea level with an elevation range from 700 feet above mean sea level along the northeastern ridge to 650 feet above mean sea level along the northern drainage ditches. Surface water flows within several drainage pathways into Devils Creek. Access to the site is controlled by a locked gate.

3.1.1.1 Climate

The climate of the region is the same as the description provided for the Baier site (section 2.1.1.1).

3.1.1.2 Geology and Soils

The geology and soils at the McCarl site are similar to the geology and soils discussed in the Baier site (section 2.1.1.2).

3.1.1.3 Surface Water Hydrology

The McCarl site is characterized by an open highly disturbed area parallel to Chalkridge Road. Immediately north of this disturbed, graded area is a drainage pathway. Deciduous wooded areas are to the east and north of the disturbed, graded area. A house is immediately west of the site. The surface run-off flows either towards the northeast or towards the east through the wooded areas down the steep slopes into various drainage pathways. These drainages intersect and eventually lead to intermittent tributaries of Devils Creek.

3.1.2 ECOLOGY OF THE MCCARL SITE

The McCarl Site contains few terrestrial and aquatic habitats. Most of the site has been disturbed and the habitat is conducive to invasive flora. This area has invasive species such as crabgrass, bermuda grass, queen annes lace, and wild daisies. The perimeter of the site is characterized by deciduous woodlands and a ravine. The deciduous woodlands habitat has stands of oak, hickory and black locust interspersed with cedar and cottonwood and brushy areas characterized by stands of red sumac. Artificial property boundaries do not restrict the utilization of habitat on-site by the local fauna, because animals can not distinguish between habitat that is located on-site and habitat that is located immediately adjacent to a site.

3.1.2.1 Aquatic Ecology

The aquatic habitats on the McCarl site are restricted to the ephemeral drainage pathways leading off-site to the intermittent streams that flow into Devils Creek. This type of drainage path contains water only a very short time period over an annual rainfall season.

The aquatic habitats on the McCarl site are restricted to the ephemeral (drainages that lasted a very short time) drainage pathways leading off-site to the intermittent streams that flow into Devils Creek. However no standing water bodies, such as ponds or lakes, are present on the site.

3.1.2.2 Terrestrial Ecology

FLORA

The McCarl site is a disturbed, graded area with a drainage pathway to the north. This site is characterized by invasive flora, notably crabgrass, bermuda grass, queen annes lace and wild daisies. The deciduous wooded area is comprised of sumac and cedar shrubs, stands of white oak, pin oak, and hickory with cottonwoods, ash and maples comprising the understory. The woodland habitat at the McCarl site surrounds the disturbed, graded area to the east, west and north. The wooded habitat surrounding the disturbed, graded area consists primarily of red sumac shrubs interspersed with red cedars. White oak, pin oak, hickory and black locust are the dominant tree species in the deciduous woodlands; the dominant shrub species on the McCarl site includes red sumac; sedges, cockleburs, ferns, saw grass, grape vines and plant species tolerant of mesic conditions (those areas which support vegetation types that require a fair amount of moisture to survive) are found within the woodlands along the drainage pathways.

FAUNA

The most conspicuous mammals on the McCarl site are the raccoon (Procyon lotor) and white-tailed deer (Odocoileus virginianus). Common rodents possibly inhabiting the McCarl site include:

- o eastern chipmunk (Tamias striatus) found in deciduous forests and brushy areas;
- o eastern gray squirrel (Sciurus carolinensis) inhabits hardwood forests with nut trees;
- o white-footed mouse (Peromyscus leucopus) prefers woody or brushy areas;

- o pine vole (Pitymys pinetorum) inhabits forest floors thick with deciduous matter;
- o norway rat (Rattus norvegicus) found along building foundations or beneath rubbish piles; and
- o house mouse (Mus musculus) usually found in buildings.

Other mammals possibly inhabiting the McCarl site include:

- o opossum (Didelphis marsupials) prefers woodlands along streams;
- o shorttail shrew (Blarina brevicauda) inhabits forests, grasslands and brushy areas;
- o little brown myotis (Myotis lucifigus) found in hollow trees or buildings;
- o Indiana myotis (Myotis sodalis) found in hollow trees;
- o red bat (Lasiurus borealis) prefers wooded areas and normally roosts in trees;
- o big brown bat (Eptesicus fuscus) inhabits caves, crevices, hollow trees and wooded areas;
- o hoary bat (Lasiurus cinereus) inhabits wooded areas;
- o evening bat (Nycticeius humeralis) is found in buildings and hollow trees;
- o longtail weasel (Mustela frenata) is not restricted and is found in all land habitats near water; and
- o striped skunk (Mephitis) inhabits mixed woods, brushland and semi-open country.

Although it is theoretically possible for the mammals listed above to inhabit the McCarl site, it is not ecologically expected to find all of these mammals utilizing the site. The McCarl site lacks the diversity to support all mammals species listed; for example, the potential exists for one or two species of bats to inhabit the deciduous woodlands on-site but it is not possible from an ecological standpoint for all six bat species listed to inhabit the site. The diversity of species and numbers of species that inhabit a site are directly correlated to the availability of diverse habitat. The competitive exclusion principle (also known as the

Gausian Model states that two closely related species can not coexist when the habitat is limited) limits the numbers of species that may coexist within a specific habitat.

Bird species are present whenever their preferred habitat for nesting and/or feeding is available. The available habitats on-site include the disturbed, graded area, shrubs and the deciduous woodlands. Species identified during site visits include; blue jays (Cyanocitta cristata), starlings (Sturnus vulgaris) and an assortment of sparrows.

Turtles, toads and lizards are probably found in the deciduous woodlands on the McCarl site.

3.1.3 THREATENED AND ENDANGERED SPECIES

The threatened and endangered species for the region which includes the McCarl and Baier sites are described in section 2.1.3.

3.2 CONTAMINANTS OF CONCERN

3.2.1 CHEMICALS OF CONCERN: SELECTION PROCESS

The selection of chemicals of concern for the McCarl site is the same process for the Baier site as outlined in section 2.2.1.

3.2.1.1 Chemicals Selected from the Human Risk Assessment

The chemicals that were selected as chemicals of concern in the human health risk assessment (arsenic, barium, cadmium, chromium, copper, magnesium, lead, selenium and zinc) were considered for inclusion in the ecological assessment. Inclusion of chemicals of concern for this ecological assessment was unfortunately restricted to those compounds which have been broadly reviewed in the ecological literature.

3.2.1.2 Chemicals of Concern for the Ecological Assessment

The twelve chemicals selected for this ecological assessment are listed in Table 5. Three volatile organic compounds (VOCs) (toluene, total xylenes and ethylbenzene), two semi-volatiles (naphthalene and 2-methylnaphthalene) and seven metals (arsenic, cadmium, chromium, iron, lead, selenium and zinc) were selected. The contaminants of concern were selected based on the same criteria as presented in section 2.2.1.2 for the Baier site.

3.3 ECOLOGICAL EXPOSURE

There are four basic elements in evaluating ecological exposure and they are presented in section 2.3.

3.3.1 ENVIRONMENTAL TRANSPORT PATHWAYS

An exposure or environmental transport pathway is the mechanism by which chemicals are transported from a source or sources to a wildlife receptor. In this ecological assessment the sources are the on-site soils contaminated by paint wastes.

The volatile organic compounds (VOCs) and metals of concern on-site were transported through the soils and are found at depths of six feet (Tables 6 & 7). Surface water run-off and percolation are the mechanisms responsible for the transport of these chemicals of concern. The Remedial Investigation/Feasibility Study (RI/FS) contains more detailed information pertaining to the chemicals of concern.

3.3.2 EXPOSURE POINT IDENTIFICATION

The exposure locations or areas of concern in this ecological assessment are the points where wildlife receptors can potentially contact the medium (soil or vegetation) on which the chemicals of concern are deposited. Soil is the defined as the medium on the slopes which supports the growth of vegetation. Wildlife that may contact the air or surface water media are not considered at risk in this ecological assessment and these media are not evaluated as exposure media. There is no fugitive dust from the site, therefore the air is not considered as an exposure medium. There are no standing water bodies on-site, therefore the surface water is not considered as an exposure medium.

3.3.2.1 Soils

Soils are an important exposure medium in this ecological assessment. The selection of exposure points for soils was based on those locations which are most ecologically significant in terms of important wildlife species, such as the worm-eating warbler and their food webs. Worms contact the soil medium directly through ingestion and indirectly through burrowing. Worms are a prey item of not only the worm-eating warbler but also shrews, skunks and opossums.

3.3.2.2 Vegetation

Vegetation was considered as an exposure medium in this ecological assessment. The exposure areas selected for consideration were those vegetation communities that were judged to have the highest potential to impact wildlife. The following scenarios are examples of the importance of vegetation in food webs:

- Mice ingest a variety of items including the stems and seeds of grasses, if the chemicals of concern have been taken up by these forms of vegetation than they are considered an integral part of the exposure media for the scenarios presented in this ecological assessment.
- Raccoons are ubiquitous and omnivorous potentially ingesting nuts and berries which may have fallen to the ground and been exposed to soil particles associated with paint wastes; therefore, trees and bushes are considered as exposure media for the scenarios presented in this ecological assessment.

3.3.3 CHEMICAL FATE AND TRANSPORT

The chemical fate and transport for the McCarl site are the same as the Baier site (section 2.3.3).

3.3.3.1 Soil Concentrations

It was assumed for this ecological assessment that the chemicals of concern were deposited onto the soil and that soil was subsequently ingested (either directly or indirectly, via inhalation of particles or by dermal contact and subsequent cleaning of the exposed area) by the exposed wildlife.

The 1990 soils data from the McCarl site are presented in Table 6. The geometric means of the 1990 volatile organic compounds data and semi-volatiles data are presented in Table 7. The range of geometric mean concentrations of the VOCs detected on-site include; toluene (0.006 mg/kg to 4.06 mg/kg), total xylene (0.005 mg/kg to 20.00 mg/kg), ethylbenzene (0.006 mg/kg to 4.06 mg/kg) and acetone (0.073 mg/kg to 4.05 mg/kg) (Table 7). Acetone is a common laboratory contaminant. The mean concentrations of toluene, total xylenes and ethylbenzene were calculated incorporating the detection limits at some depths because of the paucity of the data.

Four semi-volatile compounds were detected in the soils at the McCarl site (Table 7). Of these compounds the origin of naphthalene and 2-methylnaphthalene on-site is not known. The other two compounds (benzoic acid and bis(2-ethylhexyl) phthalate) are ubiquitous in the environment. The range of geometric mean concentrations of the semi-volatile compounds detected on-site are; benzoic acid (0.36 mg/kg to 0.56 mg/kg), naphthalene (0.24 mg/kg to 43.87 mg/kg), bis(2-ethylhexyl)phthalate (0.15 mg/kg to 2.70 mg/kg) and 2-methylnaphthalene (0.63 mg/kg to 27.39 mg/kg).

The available literature concerning potentially hazardous semi-volatile compounds in the environment and their ecological effects on the environment is sparse; therefore, it is difficult to interpret this data as having a potential adverse impact on the environment.

The 1990 metals data are presented in Table 6. The range of geometric mean concentrations of the metals of concern detected at the McCarl site include; arsenic (4.15 mg/kg to 6.18 mg/kg), cadmium (0.92 mg/kg to 20.48 mg/kg), chromium (17.57 mg/kg to 85.58 mg/kg), iron (19,810.17 mg/kg), lead (28.58 mg/kg to 1,026.17 mg/kg), selenium (0.39 mg/kg to 3.53 mg/kg) and zinc (85.57 mg/kg to 1,561.48 mg/kg) (Table 6). The concentrations of these metals decreased with depth.

One soil exposure point was selected. The worm that ingests soil was considered an important exposure point because the worm-eating warbler, a species considered rare by the state of Iowa but with no legal status, (and numerous other worm-eating bird species) ingest worms.

Although the depth of chemicals has been documented at a depth of six feet because the ingestion of soil by worms is limited to one foot the soil exposure point is limited in depth.

3.3.3.2 Vegetation Concentrations

For the purposes of this ecological assessment the chemicals of concern are assumed to be transported through the soil and incorporated into the edible portions of vegetation via root uptake of various components from the soil. In addition, it was assumed that those potentially contaminated plants were subsequently ingested by the exposed wildlife. However, data are not available for estimating the contaminant uptake of the vegetation on-site.

Two vegetation exposure points were selected. The barn owl ingesting a mouse that ingested vegetation was considered an important exposure point because predatory birds such as the barn owl may occur in this area. The raccoon ingesting nuts and berries that may have been exposed to the chemicals of concern was considered an important exposure pathway because raccoons are omnivorous and appear to be ubiquitous in this area.

Although the depth of chemicals has been documented to a depth of six feet the ingestion of vegetation by mice is limited to one foot because the vegetation exposure point is limited in depth. We are assuming the depth of concern with regard to the ingestion of nuts and berries by the raccoon is six feet because the trees that produce nuts generally have root zones extending as deep as six feet.

3.3.4 EXPOSURE POINT CONCENTRATIONS

The data for this ecological assessment is qualitative in nature, because of unknowns such as plant uptake of contaminants, the amount of contaminants consumed, et cetera, and as a result calculation of specific concentrations for individual chemicals at the exposure points is not feasible.

3.3.5 CHEMICAL OR MEDIA UPTAKE ROUTES

Media uptake routes are the final connection between chemical release and the exposed wildlife. The potential routes include dermal exposure to contaminated soils and ingestion of contaminated soils and vegetation. Ingestion was considered the most important route in this ecological assessment, because bioaccumulation in terrestrial environments most frequently involves the food chain because general exposure and uptake of the chemicals of concern from air is considerably less than the general exposure and uptake from prey.

3.3.5.1 Ingestion Pathway

This pathway is the same for the McCarl site as described for the Baier site (section 2.3.5.1).

The worm-eating warbler and barn owl are predators at the top of a food chain and are susceptible to the effects of contaminant bioaccumulation. The worm-eating warbler (or similar species of songbird) derives a major portion of its food supply from worms. The barn owl (or a similar predatory bird) derives a major portion of its food supply from mice, voles and snakes. The raccoon is of special interest with regard to bioaccumulation because it is omnivorous.

Therefore these animals were incorporated into scenarios to evaluate the potential effects of the chemicals of concern on the food chain. Three separate scenarios (worm-eating warbler, barn owl and raccoon) were developed for the exposure pathway analysis to evaluate qualitatively the effects of the chemicals of concern on these animals. While these scenarios aid in understanding what ecological effects these compounds of concern may cause, it is important to note that other variables such as predation, parasitism, niche competition and unfavorable microclimate may affect all the hypothetical pathways considerably more than the chemicals under consideration. Moreover, this site is an extremely small area when considering the entire ecological system within Lee County.

3.3.5.2 The Terrestrial Pathway

The terrestrial pathway for the McCarl site is the same as described for the Baier site (section 2.3.5.2).

There are three subpathways within the terrestrial pathway. These are the soil pathway, the sediment pathway and the soil/vegetation pathway. The six scenarios previously discussed are presented below within their respective terrestrial pathway.

3.3.5.2.1 Soil Pathway

The principal terrestrial pathway for the worm-eating warbler at the McCarl site is:

soil --- worm --- worm-eating warbler.

A review of the literature concerning the effects of arsenic, cadmium, chromium, lead, selenium and zinc on this terrestrial pathway was conducted. The documentation detailing the metals of concern found in soils and in earthworms is presented in section 2.3.5.2.1, the soil pathway of the Baier site and is the same for the McCarl site.

The geometric mean concentrations of the metals of concern in soils on-site the McCarl site at a depth of 0 to 1 foot are; arsenic (6.18 mg/kg), cadmium (20.48 mg/kg), chromium (76.38 mg/kg), lead (1,005.30 mg/kg), selenium (3.53 mg/kg) and zinc (1,561.48 mg/kg) (Table 6). Most of these metals (with the exceptions of arsenic and zinc) were detected at greater concentrations in the soils at the McCarl site than at the Baier site. However, the concentrations are still within or below documented levels of metals in soils inhabited by earthworms or within earthworm whole body samples.

Based on the documentation in section 2.3.5.2.1, it appears that the concentrations of the metals of concern in soils on the McCarl site are not lethal to earthworms and should not adversely affect them or their predators. The worm-eating warbler and other worm-eating animals have the capacity to produce metallothioneins. Birds are protected from deleterious effects of high metal body burdens by metallothioneins.

Metallothioneins (metal binding proteins) are induced by metal pollution (Cooke et al., 1979; Suzuki et al., 1980; Morgan and Morris, 1982; Hopkin and Martin, 1984; van Capelleveen and Faber, 1987) and are thought to be related to stress proteins which are synthesized to a variety of environmental stresses (Marx, 1983). The amounts of these metal-binding proteinaceous metallothioneins and heavy metal loading appear to depend on the degree of pollution, the species of animal and the position in the food web (Eisler, 1985). Metallothioneins are responsible for the physiological mechanism in a variety of animals for metal tolerance.

3.3.5.2.2 Soil/Vegetation Pathway

The principal terrestrial pathway for the barn owl at the McCarl site is:

soil --- vegetation --- mouse --- barn owl.

A review of the literature concerning the effects of arsenic, cadmium, chromium, lead, selenium and zinc on this terrestrial pathway was conducted. The documentation detailing the metals of concern in soils, vegetation, mice and barn owls is presented in section 2.3.5.2.3, the soil/vegetation pathway of the Baier site and is the same for the McCarl site.

The interaction between the chemicals of concern and soils at the McCarl site closely parallels the interactions between the chemicals of concern and soils at the Baier site (section 2.3.5.2.1). Therefore the effects of the chemicals of concern (arsenic, cadmium, chromium, lead, selenium and zinc) in this scenario at the McCarl site are assumed to be the same as the scenario at the Baier site.

It is important to note for this scenario the role the vegetation on-site assumes. Attempting to characterize the uptake of heavy metals by the plants on the McCarl site is difficult, because vegetation samples were not collected for metals analysis. Information obtained from the available literature was extrapolated and interpreted for the potential effects of heavy metals on the plant species occurring on-site.

The concentrations of the metals of concern on the McCarl site should not adversely affect the vegetation or consequently the mice (granivores) nor the barn owl (predator of granivores). The concentrations of these metals of concern at a depth of 0 to 1 foot are; arsenic (6.18 mg/kg), cadmium (20.48 mg/kg), chromium (76.38 mg/kg), lead (1,005.30 mg/kg), selenium (3.53 mg/kg) and zinc (1,561.48 mg/kg) (Table 6). These concentrations are within or below documented levels of these metals in soils, vegetation, granivores (such as mice) or predators (e.g., barn owls).

It appears that the concentrations of the metals of concern in soils on the McCarl site are not lethal to the vegetation and should not adversely affect either mice (granivores) that ingest this vegetation, or barn owls (predator of these granivores).

Most granivores do not ingest roots of plants, therefore cadmium should not adversely affect most granivores because cadmium binds to the cell walls of roots when taken up by plants. Vegetation is not adversely affected by high levels of chromium residues, and the accumulation of chromium in mammals through incidental ingestion of chromium was negligible. Lead accumulation is very low in granivores and most predators are exposed to lead through ingesting prey. Selenium enters the food chain almost entirely via plants and granivorous mammals bioaccumulate selenium at low levels. Therefore; it appears that a mouse should not bioaccumulate these metals of concern to an extent that a predator (such as a barn owl), upon ingestion of the mouse, is exposed to deleterious concentrations of heavy metals.

The principal terrestrial pathway for the raccoon at the McCarl site is:

soil --->hickory trees or berry bushes--- nuts or berries --- raccoon.

A review of the literature specific to effects of heavy metals on raccoons was conducted. This review included information pertaining to concentrations of heavy metals in nuts, berries and viscera of raccoons. The uptake and fate of the metals of concern in soils and plants were discussed in the previous scenarios. The documentation detailing the metals of concern found in soils, hickory trees or berry bushes and nuts or berries is presented in section 2.3.5.2.3, the soil/vegetation pathway of the Baier site and is the same for the McCarl site.

The interaction between the chemicals of concern and soils at the McCarl site closely parallels the interactions between the chemicals of concern and soils at the Baier site (section 2.3.5.2.1). Therefore the effects of the chemicals of concern (arsenic, cadmium, chromium, lead, selenium and zinc) in this scenario at the McCarl site are assumed to be the same as the scenario at the Baier site.

The concentrations of the metals of concern in the soils at the McCarl site should not adversely affect hickory trees or berry bushes, nuts or berries, nor consequently raccoons. The concentrations of the metals of concern at a depth of 0 to 6 feet are; arsenic (6.18 mg/kg to 4.13 mg/kg), cadmium (20.48 mg/kg to 0.92 mg/kg), chromium (76.38 mg/kg to 17.57 mg/kg), lead (1,005.30 mg/kg to 28.58 mg/kg), selenium (3.53 mg/kg to 0.39 mg/kg) and zinc (1,561.48 mg/kg to 85.57 mg/kg) (Table 6).

The additional documentation not presented in section 2.3.5.2.3 detailing the metals of concern found in raccoons includes the following information:

- Few reports of selenium concentrations in tissues of several species of wild mammals from freshwater and terrestrial ecosystems exist. Selenium concentrations in livers of herbivorous wild mammals usually average less than 2 mg/kg (dry weight) (Nielsen and Gissel-Nielsen, 1975; Fleming et al., 1979; Wren, 1984; Clark, 1987). Concentrations in raccoons (Procyon lotor; 2.8 mg/kg wet weight) and moles (Talpa europaea; 2.6 mg/kg dry weight) were higher.

Although ingestion of heavy metals by eating acorns or nuts that have accumulated these metals through plant uptake and/or have contaminated soil particles adhering to them appears to be a common route of ingestion, the levels of metals in the soils on-site that these trees are exposed to (6.18 to 4.13 mg/kg of arsenic, 20.48 to 0.92 mg/kg of cadmium, 76.38 to 17.57 mg/kg of chromium, 1,005.30 to 28.58 mg/kg of lead, 3.53 to 0.39 mg/kg of selenium and 1,561.48 to 85.57 mg/kg of zinc) are relatively low when compared to levels found in the literature (7.4 mg/kg of arsenic in soils within the USA, 710 mg/kg of cadmium in soil litter, 3,564 mg/kg lead in soils, and 35,000 mg/kg of zinc in soils. The concentrations of these metals should not be toxic to the oak or hickory trees or the berry bushes, nor consequently raccoons. These metals appear to accumulate in the viscera of raccoons.

4.0 ASSUMPTIONS AND UNCERTAINTIES

It is necessary to make assumptions for any ecological assessment. Identification of assumptions and subsequent uncertainties and their impact on estimated exposures places the exposure estimates in perspective. High uncertainty (low degree of confidence in the completeness of the data and available literature or little available literature) indicates that an estimated exposure is less accurate and may change with additional information. Low uncertainty (high degree of confidence in the completeness of the data and available literature) is an indication that an exposure estimate is more accurate and probably will not change as more data are available. Realistic assumptions are those which are substantiated with a quantity of literature and information or which have a low level of uncertainty.

In the absence of adequate information the approach taken in this ecological assessment was to make conservative assumptions to ensure that exposure estimates were not underestimated. Assumptions were made in the initial selection of chemicals of concern and the exposure assessment. When many conservative assumptions are used to develop an overall assessment the sum of the effect typically results in an overly conservative assessment. The major assumptions made in this ecological assessment are presented below with some discussion of their uncertainty or conservativeness.

4.1 FACTORS WHICH MAY OVERSTATE THE EXPOSURE ESTIMATE

The assumptions made for the selection of chemicals of concern may overstate the exposure estimate by including chemicals that do not pose an ecological threat to the environment. The selection of the chemicals of concern for the ecological assessment were based on the following criteria:

- The chemicals are considered at least moderately toxic; and
- The persistence of the chemical in the environment may pose a potential hazard to biota.

Assumptions were made for evaluating the ecological exposure of the Baier and McCarl sites. The ecological exposure was evaluated by identifying four elements: the environmental transport pathway, identification of the exposure points, evaluation of the chemical concentrations at the exposure points and evaluation of the route or exposure pathway of chemical intake for the wildlife species.

The transport mechanism for the chemicals of concern was assumed to be percolation and surface water run-off. The exposure locations or areas of concern are the points where wildlife receptors can potentially contact the media.

The assumptions made for the fate and transport of the chemicals of concern may overstate the exposure estimate, these assumptions include:

- soil concentrations - the chemicals of concern were deposited on the soil and the soil was subsequently ingested by exposed wildlife;
- sediment concentrations - the chemicals of concern were transported through the soil and into the drainage pathways via surface water run-off; and
- vegetation concentrations - the chemicals of concern were transported through the soils and incorporated into the vegetation via root uptake of nutrients through the soil and were assimilated into the edible portions of the plant.

Several assumptions were made regarding the terrestrial pathways approach. The pathways approach (soil pathway, sediment pathway and vegetation pathway for the Baier site and soil pathway and vegetation pathway for the McCarl site) is theoretical and involves many parameters which are imprecisely known. Actual percent uptake of the contaminants by vegetation, earthworms, voles, mice, the worm-eating warbler, barn owl, eastern cottontail, eastern squirrel, white-tailed deer and raccoon are not known for these sites. Therefore, in order to evaluate the effects of the chemicals of concern on the various scenarios incorporated into the pathways approach, data obtained from an extensive literature review was extrapolated and used in an effort to examine the potential ecological

Beyer et al. (1985) demonstrated that only a small portion of all metals measured in the soil become incorporated into plant foliage and suggested that most of the metal contamination detected in biota was from aerial deposition. Because aerial deposition is not of concern at the Baier or McCarl sites it therefore appears unlikely that the concentrations of metals in the soils on-site will adversely affect the flora and/or fauna.

This ecological assessment is qualitative because data are not available for the flora and fauna on-site. As a qualitative assessment it is important to understand that the concentrations of metals in animals can not be accurately predicted from the concentrations in soil or forest litter, and the concentration of metals in one species can not be used to predict the concentration in another without proper knowledge about differences in diet, digestive system and storage/excretion mechanisms.

The Baier and McCarl sites and areas immediately adjacent to these sites are not pristine ecological habitats. The land surrounding the Baier site is fallow pasture and the habitat defined as the Baier site has progressed through various stages of succession. The McCarl site is highly disturbed and characterized by invasive species of flora. The habitat defined as the McCarl site includes the remnants of an open refuse dump.

Based on the extrapolation of the information concerning the chemicals of concern obtained from the extensive literature review, and on the concentrations of the chemicals of concern in the soils on-site; the evaluation of the potential effects of the chemicals of concern (for which literature was available) on the wildlife and ecology of the Baier and McCarl sites is these chemicals do not appear to pose a threat to the ecology of these sites.

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TABLE 1
BAIER SITE
CONTAMINANTS OF CONCERN
ECOLOGICAL ASSESSMENT

Chemical	Media	Depth of Contamination (ft.)
Ethylbenzene	Soils	0.5-25
Toluene	Soils	0.5-25
Total Xylenes	Soils	0.5-25
Naphthalene	Soils	0-6
2-Methylnaphthalene	Soils	0-6
Arsenic	Soils Sediments	0.5-25 0-1
Cadmium	Soils Sediments	0.5-25 0-1
Chromium	Soils Sediments	0.5-25 0-1
Iron	Soils Sediments	0.5-25 0-1
Lead	Soils Sediments	0.5-25 0-1
Selenium	Soils Sediments	0.5-25 0-1
Zinc	Soils Sediments	0.5-25 0-1

TABLE 2
BAIER SITE
MAY & JULY 1989 SOILS DATA
GEOMETRIC MEANS FOR
VOLATILE ORGANIC COMPOUNDS (VOCs) AND METALS

	VOCs (mg/kg)						Metals (mg/kg)				
Depth (ft.)	Toluene	Ethylbenzene	Total Xylenes	Methylene Chloride	Acetone	2-Butanone	Arsenic	Cadmium	Chromium	Lead	Selenium
0-0.5[1,5]	0.006	0.006	0.006	0.006	0.012	NA	4.10	1.08	10.5	16.75	0.39
1-2[5]	0.08[2]	0.14[2]	0.25[2]	0.08[2]	0.15[2]	NA	7.75[3]	1.07[3]	19.5[3]	58.11[3]	0.32[3]
3-4[6]	4.8[1]	21.16[1]	92.47[1]	NA	NA	10[1]	7.67[2]	3.92[2]	34.04[2]	65.12[2]	1.55[2]
4-5[2,6]	1.52	6.03	28.81	NA	NA	3.16[1]	8.15	0.98	33.59	38.46	0.73
5-6[2,6]	1.65	13.38	50.83	NA	NA	10[1]	6.62	1.20	18.66	20.98	0.55
6-7[3,6]	1.58	4.85	27.94	NA	NA	1.11[2]	5.19	2.23	22.67	37.09	0.61
7-10[6]	2.91[4]	9.36[4]	38.44[4]	NA	NA	6.43[4]	7.56[3]	2.22[3]	39.38[3]	104.45[3]	0.64[3]
14-25[2,6]	1.44	6.65	25.91	NA	NA	7.49	5.60	0.96	14.24	6.91	0.48

Notes:

[1] Geometric mean was calculated from two data points.
[2] Geometric mean was calculated from three data points.
[3] Geometric mean was calculated from four data points.
[4] Geometric mean was calculated from five data points.
[5] May 1989 data
[6] July 1989 data
NA - Data not available for this compound.
Data incorporates the detection limit for some samples that were not detectable, particularly the VOCs.

TABLE 3
BAIER SITE
1990 SOILS DATA
GEOMETRIC MEANS FOR VOLATILE ORGANIC COMPOUNDS (VOCs) AND SEMI-VOLATILE COMPOUNDS

Depth (feet)	VOCs (mg/kg)					
	Toluene	Ethylbenzene	Total Xylenes	Methylene Chloride	Acetone	2-Butanone
0-6	0.66[3]	1.76[3]	6.81[3]	0.24[1]	0.62[2]	0.40[1]

Depth (feet)	Semi-Volatile Compounds (mg/kg)					
	Benzoic Acid	Naphthalene	Di-n-Butyl-phthalate	bis(2-Ethylhexyl) Phthalate	Di-n-Octyl Phthalate	2-Methyl naphthalene
0-6	0.92[4]	4.87[3]	0.15[2]	0.39[2]	0.45[1]	19.98[2]

Notes:

[1] Geometric mean was calculated from three data points.
[2] Geometric mean was calculated from six data points.
[3] Geometric mean was calculated from nine data points.
[4] Geometric mean was calculated from ten data points.
Data incorporates the detection limit for some samples that were not detectable, particularly the VOCs.

TABLE 4
BAIER SITE
MAY 1990 DATA
GEOMETRIC MEANS FOR METALS IN SEDIMENT AND DEEP SOILS

Soil Type & Depth (ft.)	Aluminum	Arsenic	Cadmium	Chromium	Iron	Lead	Mercury	Selenium	Zinc
Soils Composite 0-2', 2-4', & 4-6'	7624.80	5.84	27.50	173.73	36,124.96	1176.48	0.13	7.32	2080.57
Sediments 0-1	9522.08	5.99	1.80	20.78	16,759.98	58.25	0.10	0.93	145.24

Notes: The geometric means were calculated from six data points.
Data incorporates the detection limits for some samples that were not detectable, particularly cadmium, mercury, and selenium.
Concentrations of metals are milligrams per kilogram (mg/kg).

TABLE 5
MCCARL SITE
CONTAMINANTS OF CONCERN
ECOLOGICAL ASSESSMENT

Chemical	Media	Depth of Contamination (ft.)
Toluene	Soils	3.5-6
Total Xylenes	Soils	3.5-6
Ethylbenzene	Soils	3.5-6
Naphthalene	Soils	0-6
2-Methylnaphthalene	Soils	0-6
Arsenic	Soils	0-1
Cadmium	Soils	0-4
Chromium	Soils	0-4
Iron	Soils	0-4
Lead	Soils	0-6
Selenium	Soils	0-4
Zinc	Soils	0-6

TABLE 6
MCCARL SITE
1990 DATA
GEOMETRIC MEANS FOR METALS IN SOILS

Depth (ft.)	Aluminum	Arsenic	Cadmium	Chromium	Iron	Lead	Mercury	Selenium	Zinc
0-1[1]	8,653.48	6.18	20.48	76.38	19,810.17	1,005.30	0.11	3.53	1,561.48
0-2[2]	NA	4.64	15.66	85.58	NA	1,026.17	NA	1.83	1,485.58
2-4[2]	NA	4.15	2.50	24.93	NA	90.88	NA	1.15	186.17
4-6[2]	NA	4.31	0.92	17.57	NA	28.58	NA	0.39	85.57

Notes:

[1] Geometric means were calculated from twenty-seven data points.
[2] Geometric means were calculated from six data points.
NA = Sample was not analyzed for analyte.
The locations of where data were collected were combined.
Data incorporates the detection limits for some samples that were not detectable, particularly cadmium, mercury and selenium.
Concentrations of metals are milligrams per kilogram (mg/kg).

TABLE 7
MCCARL SITE
MAY 1990 DATA
GEOMETRIC MEANS FOR VOLATILE ORGANIC COMPOUNDS (VOCs) AND SEMI-VOLATILE COMPOUNDS IN SOILS

	VOCS (mg/kg)			
Depth (feet)	Toluene[1]	Total Xylene[2]	Ethylbenzene[2]	Acetone[2]
1.5-2.0	0.006	0.005	0.006	0.073
3.5-4.0	0.59	15.12	1.13	2.28
5.5-6.0	4.06	20.00	4.06	4.05

	Semi-Volatile Compounds (mg/kg)			
Depth (feet)	Benzoic Acid[3]	Naphthalene[1]	bis(2-Ethylhexyl) Phthalate[4]	2-Methylnaphthalene[1]
0-2	0.56	43.87	2.70	27.39
2-4	0.46	0.24	0.15	0.63
4-6	0.36	2.69	0.86	1.42

Notes:

[1] Geometric means were calculated from two data points.
[2] Geometric means were calculated from three data points.
[3] Geometric mean was calculated from four data points.
[4] Geometric mean was calculated from five data points.
The locations of where data were collected were combined.
Data incorporates the detection limits for some samples that were not detectable.

APPENDIX J

NORMALIZED XRF DATA CALCULATION FILE (APPROACH)

METHODOLOGY
USED TO CALCULATE
MODIFIED XRF VALUES
FROM LAB ANALYSIS RESULTS

INTRODUCTION

The purpose of this discussion is to summarize the methodology used to modify the McCarl site and Baier site XRF screening results to better match the laboratory verification results. A comparison of the raw XRF data with the laboratory results from verification samples and risk assessment samples revealed a consistent trend by the XRF method to overestimate the lead content in the soil. While precautions were taken during calibration of the XRF instrument in the field, such as using spiked soil samples for calibration standards, other factors may have been introduced that resulted in overestimation of the actual lead concentration of the soil. One such factor may be additional fluorescence by zinc, which overlaps with the lead spectrum.

In order to utilize the many lead XRF results that were collected as part of the field activities for volume estimation purposes, it was desirable to correct the XRF results to better reflect the true value of lead in the soil as determined by laboratory analysis. The correction was accomplished by using linear regression to modify the raw XRF data. The following sections discuss the method used to modify the data and present the results of the linear regression analysis.

LINEAR REGRESSION

Linear regression is a statistical method that computes the "best fit" line through a group of data. The best fit line is a line that minimizes the errors of deviation from the computed value to the actual value. In practice the squares of the error values are used so that positive and negative errors won't cancel. Because of this the method is also called least squares. The method computes coefficients to the equation:

modified XRF = 0.899 (raw XRF) - 164.57
number of data points = 27

Once these formulae have been developed, all XRF data were modified by the appropriate equation to obtain a set of data which more accurately reflects, within the statistical constraints of the linear regression method, the true lead concentrations in the soil.

REFERENCES

Miller, Irwin and John E. Freund, 1977. Probability and Statistics for Engineers. Second Edition. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

SUMMARY
OF
XRF SCREENING AND LABORATORY ANALYSIS

Site	XRF Results (ppm)	Lab Results (ppm)
McCarl	147.4	43
McCarl	156.5	69
McCarl	200.2	113
McCarl	208.6	35
McCarl	209.9	38
McCarl	225.1	49
McCarl	262.7	161
McCarl	87.19	63
McCarl	251	26
McCarl	190.8	24
McCarl	216.7	41
McCarl	195.7	47
McCarl	155.3	42
McCarl	139.7	27
McCarl	67.74	28
McCarl	165.3	20
McCarl	178	29
McCarl	202.7	117
McCarl	212.4	21
McCarl	106.8	20
McCarl	231.7	101
McCarl	435.8	267
McCarl	204.4	0
McCarl	69.14	0

Site	XRF Results (ppm)	Lab Results (ppm)
Baier	264.2	34
Baier	206.1	20
Baier	191	24
Baier	171.6	28
Baier	199	26
Baier	212.1	32
Baier	208.9	32
Baier	206.3	0
Baier	212.4	27
Baier	153.5	21
Baier	197.2	66
Baier	174.4	32
Baier	209.3	32
Baier	180.3	106
Baier	231	59
Baier	291.6	341
Baier	247.4	21
Baier	10000	16700
M-risk	1130	959
M-risk	2354	1720
M-risk	5855	3560
M-risk	7999	3060
M-risk	674	1370
M-risk	5745	2510
M-risk	7170	3180
M-risk	1561	861
M-risk	559.9	297
M-risk	2678	1550
M-risk	489	281
M-risk	537.4	1310
M-risk	922.3	471
M-risk	696	456
M-risk	669.4	474
M-risk	2263	1590
M-risk	632.4	2800
M-risk	633.7	566
M-risk	644.9	517
M-risk	545.4	708
M-risk	1959	1280
M-risk	810.2	715
M-risk	532	581
M-risk	601.9	542
M-risk	2098	1350
M-risk	2586	2290
M-risk	798	481

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