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February 2014

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❑ Dioxins/Furans (17 types of 2,3,7,8-congeners)

○ Analytical method (Korean Official Analytical Standards for Persistent Organic Pollutants (ES 10368.1))

Sample preparation
- Sample 10 L
- Surrogate STD (^{13}C-labeled 15 standards) 1 ng (^{13}C-OCDD 2 ng)

Extraction (separatory funnel)
- DCM 100 mL (X3)
- anhydrous sodium sulfate 50 g
- concentration (1 mL, rotary evaporator)
- concentration (100 μL, N_2)
- n-Hexane 2 mL

Multilayered Silicagel column (15mm I.D. x 30cm glass column)
- from top 6g Na_2SO_4, 3g 10%-$AgNO_3$ Impregnated silicagel, 0.9g Silicagel, 6g 22%-H_2SO_4 Impregnated silicagel, 4.5g 44%-H_2SO_4 Impregnated silicagel, 0.9g Silicagel, 3g 2%-KOH Impregnated silicagel, 0.9g Silicagel
- n-Hexane 150 mL
- concentration (5 mL, rotary evaporator)
- concentration (1 mL, N_2)

Alumina column (15mm I.D. x 30cm glass column)
- from top anhydrous sodium sulfate 2g, activated alumina 6g
- 2% dichloromethane in hexane 100 mL
- 50% dichloromethane in hexane 150 mL
- concentration (1 mL, rotary evaporator)
- concentration (100 μL, N_2)
- solvent transfer(toluene)
- Internal STD (^{13}C-1,2,3,4-TCDD, 1,2,3,7,8,9-HxDD) 1 ng
- final volumn 10~50 μL

HRGC/HRMS

○ GC/MS condition

HRGC	Instrument	HP 6890
	Injection mode	Splitless, 1㎕, 260℃ (purge time 6min)
	Separation column	SP2331 (60m×0.32mm×250㎛ film thickness)
	Oven temperature	120℃ (3min)→20℃/min→220℃ (5min)→3℃/min →260℃ (27min)
	Carrier gas flow	Helium (99.9999%), 1.0㎖/min
HRMS	Instrument	Autospec Ultima Premier
	Ion mode	SIM (M/M+2, M+2/M+4)
	Resolution	above 10,000 (10% Valley)
	Ionization mode	Electron Ionization Positive Mode (EI^+)
	Ionization energy	36 eV
	Ion source temp.	260℃

4501

○ Calibrations

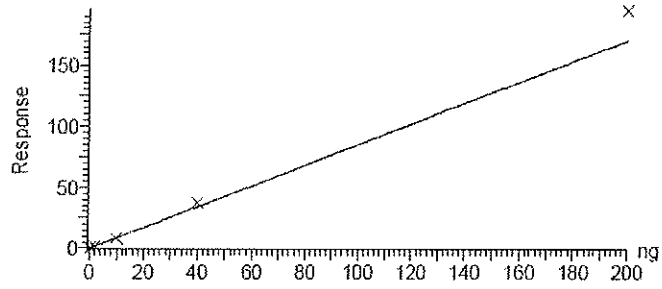
Calibration Standards (Unit : pg/μL)						Recovery
PCDDs/PCDFs	CS1	CS2	CS3	CS4	CS5	(%)
2,3,7,8-TeCDD	0.5	2.0	10	40	200	
2,3,7,8,-TeCDF	0.5	2.0	10	40	200	
1,2,3,7,8-PeCDD	2.5	10	50	200	1000	
1,2,3,7,8-PeCDF	2.5	10	50	200	1000	
2,3,4,7,8-PeCDF	2.5	10	50	200	1000	
1,2,3,4,7,8-HxCDD	2.5	10	50	200	1000	
1,2,3,6,7,8-HxCDD	2.5	10	50	200	1000	
1,2,3,7,8,9-HxCDD	2.5	10	50	200	1000	
1,2,3,4,7,8-HxCDF	2.5	10	50	200	1000	
1,2,3,6,7,8-HxCDF	2.5	10	50	200	1000	
1,2,3,7,8,9-HxCDF	2.5	10	50	200	1000	
2,3,4,6,7,8-HxCDF	2.5	10	50	200	1000	
1,2,3,4,6,7,8-HpCDD	2.5	10	50	200	1000	
1,2,3,4,6,7,8-HpCDF	2.5	10	50	200	1000	
1,2,3,4,7,8,9-HpCDF	2.5	10	50	200	1000	
1,2,3,4,6,7,8,9-OCDD	5.0	20	100	400	2000	
1,2,3,4,6,7,8,9-OCDF	5.0	20	100	400	2000	
$^{13}C_{12}$-1,2,3,4-TeCDD	100	100	100	100	100	-
$^{13}C_{12}$-2,3,7,8-TeCDD	100	100	100	100	100	74.7~99.0
^{37}Cl-2,3,7,8-TeCDD	0.5	2.0	10	40	200	-
$^{13}C_{12}$-2,3,7,8,-TeCDF	100	100	100	100	100	79.9~113.8
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100	100	100	100	100	97.0~116.8
$^{13}C_{12}$-1,2,3,7,8-PeCD	100	100	100	100	100	
$^{13}C_{12}$-2,3,4,7,8-PeCDF	100	100	100	100	100	84.5~106.6
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	100	100	100	100	100	80.4~100.3
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100	100	100	100	100	69.7~92.5
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100	100	100	100	100	-
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	100	100	100	100	100	71.0~95.8
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100	100	100	100	100	70.3~101.7
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	100	100	100	100	100	62.2~102.2
$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	100	100	100	100	100	63.3~106.0
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100	100	100	100	100	79.4~104.2
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100	100	100	100	100	67.7~93.0
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	100	100	100	100	100	56.4~80.1
$^{13}C_{12}$-1,2,3,4,6,7,8,9-OCDD	200	200	200	200	200	66.2~109.7

TeCDD = TetrachloroDibenzo-p-dioxin / TeCDF = Tetrachlorodibenzofuran
PeCDD = PentachloroDibenzo-p-dioxin / PeCDF = Pentachlorodibenzofuran
HxCDD = HexachloroDibenzo-p-dioxin / HxCDF = Hexachlorodibenzofuran
HpCDD = HeptachloroDibenzo-p-dioxin / HpCDF = Heptachlorodibenzofuran
OCDD = OctachloroDibenzo-p-dioxin / OCDF = Octachlorodibenzofuran

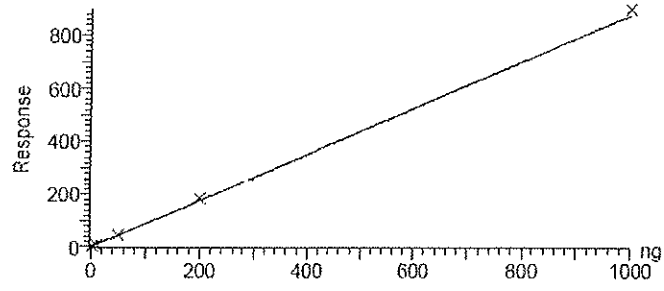
4502

○ Calibration curves

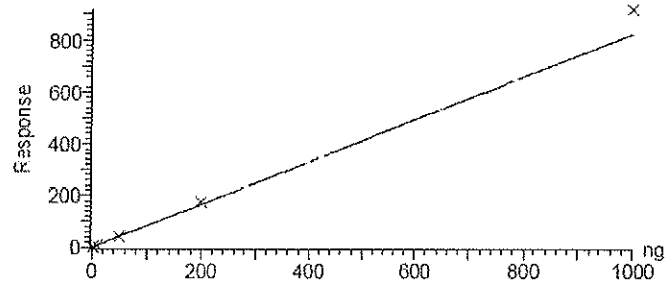
Compound name: 2378-TCDF
Response Factor: 0.850392
RRF SD: 0.106181, % Relative SD: 12.4861
Response type: Internal Std (Ref 18), Area * (IS Conc. / IS Area)
Curve type: RF



Compound name: 12378-PeCDF
Response Factor: 0.877089
RRF SD: 0.0510214, % Relative SD: 5.81713
Response type: Internal Std (Ref 19), Area * (IS Conc. / IS Area)
Curve type: RF

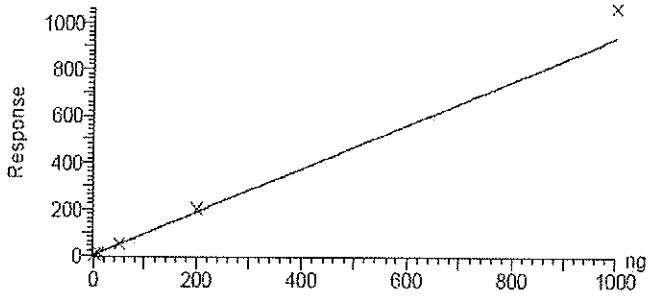


Compound name: 23478-PeCDF
Response Factor: 0.825018
RRF SD: 0.0886775, % Relative SD: 10.7485
Response type: Internal Std (Ref 20), Area * (IS Conc. / IS Area)
Curve type: RF

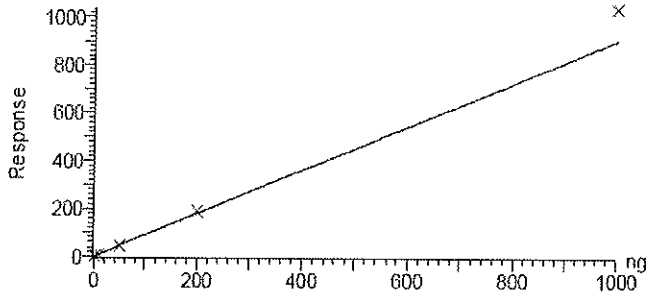


4503

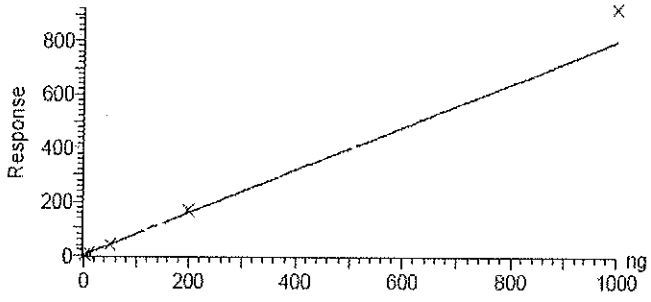
Compound name: 123478-HxCDF
Response Factor: 0.934887
RRF SD: 0.10656, % Relative SD: 11.3982
Response type: Internal Std (Ref 21), Area * (IS Conc. / IS Area)
Curve type: RF



Compound name: 123678-HxCDF
Response Factor: 0.904464
RRF SD: 0.0979612, % Relative SD: 10.8308
Response type: Internal Std (Ref 22), Area * (IS Conc. / IS Area)
Curve type: RF

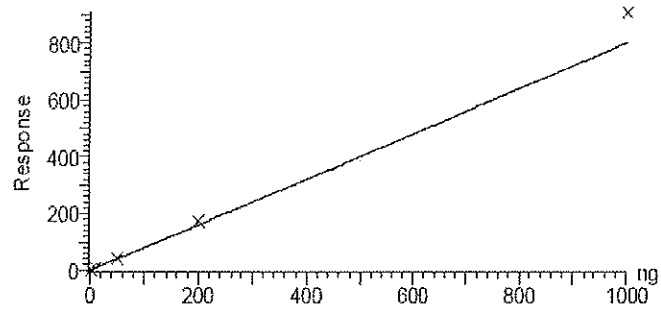


Compound name: 123789-HxCDF
Response Factor: 0.798906
RRF SD: 0.0930294, % Relative SD: 11.6446
Response type: Internal Std (Ref 23), Area * (IS Conc. / IS Area)
Curve type: RF

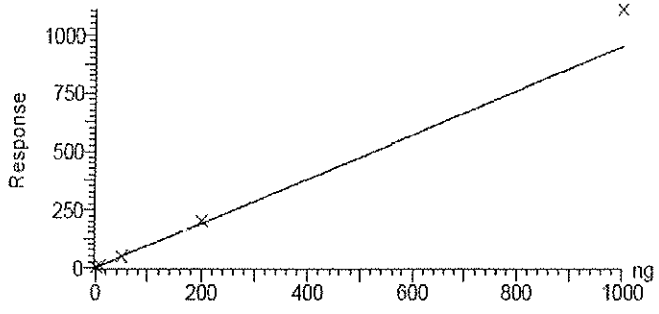


4504

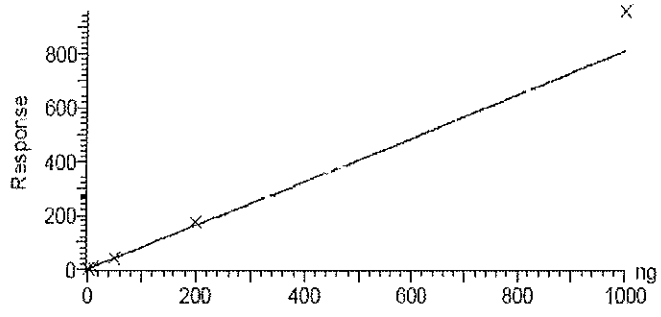
Compound name: 234678-HxCDF
Response Factor: 0.802589
RRF SD: 0.0935845, % Relative SD: 11.6603
Response type: Internal Std (Ref 24), Area * (IS Conc. / IS Area)
Curve type: RF



Compound name: 1234678-HpCDF
Response Factor: 0.949917
RRF SD: 0.1169, % Relative SD: 12.3063
Response type: Internal Std (Ref 25), Area * (IS Conc. / IS Area)
Curve type: RF

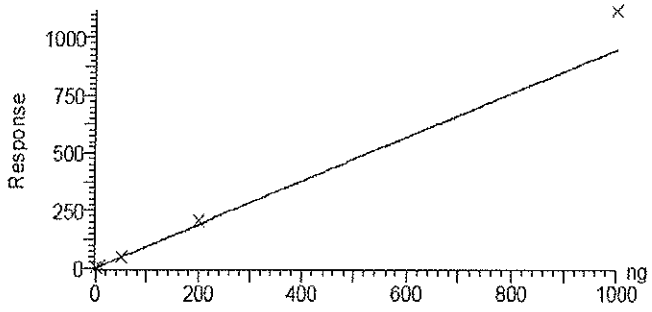


Compound name: 1234789-HpCDF
Response Factor: 0.809045
RRF SD: 0.112372, % Relative SD: 13.8894
Response type: Internal Std (Ref 26), Area * (IS Conc. / IS Area)
Curve type: RF

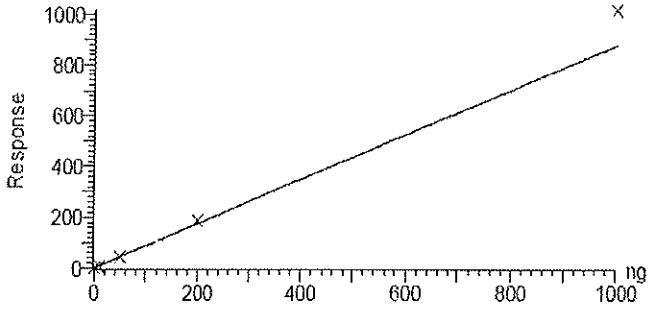


4505

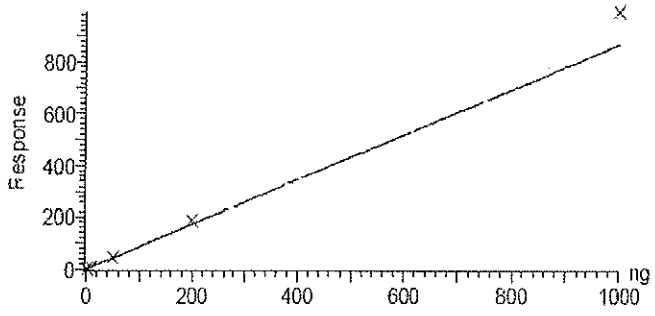
Compound name: 123478-HxCDD
Response Factor: 0.949809
RRF SD: 0.130455, % Relative SD: 13.7349
Response type: Internal Std (Ref 29), Area * (IS Conc. / IS Area)
Curve type: RF



Compound name: 123678-HxCDD
Response Factor: 0.878481
RRF SD: 0.110277, % Relative SD: 12.5531
Response type: Internal Std (Ref 30), Area * (IS Conc. / IS Area)
Curve type: RF

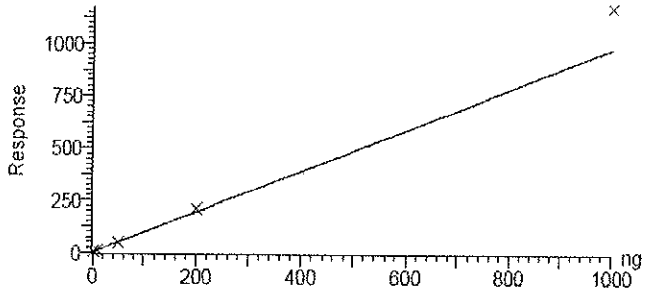


Compound name: 123789-HxCDD
Response Factor: 0.865829
RRF SD: 0.120217, % Relative SD: 13.8846
Response type: Internal Std (Ref 30), Area * (IS Conc. / IS Area)
Curve type: RF

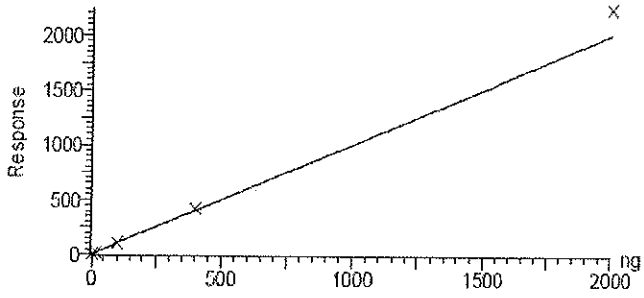


4506

Compound name: 1234678-HpCDD
Response Factor: 0.978146
RRF SD: 0.141371, % Relative SD: 14.4529
Response type: Internal Std (Ref 31), Area * (IS Conc. / IS Area)
Curve type: RF



Compound name: OCDD
Response Factor: 1.0059
RRF SD: 0.0872685, % Relative SD: 8.67569
Response type: Internal Std (Ref 32), Area * (IS Conc. / IS Area)
Curve type: RF



4507

○ Chromatogram

- 2,3,7,8-TCDD standard (CS1)

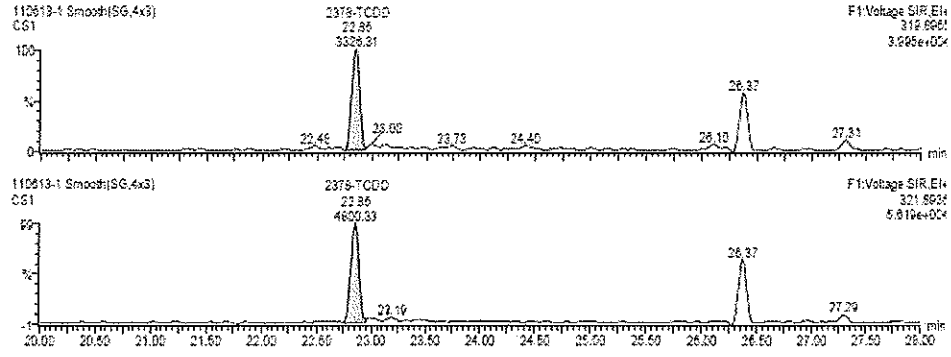
Quantify Sample Report **MassLynx 4.1**

Dataset: C:\MassLynx\DIOXIN11.PRO\Result\STD\110613_1-5.qld

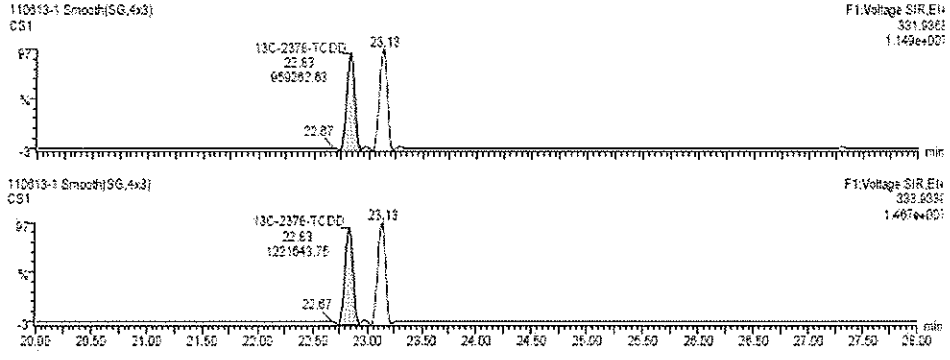
Last Altered: Monday, June 13, 2011 15:39:58 Korea Standard Time
Printed: Thursday, July 07, 2011 16:39:13 Korea Standard Time

Name: 110613-1, Date: 13-Jun-2011, Time: 09:45:52, ID: , Description: CS1

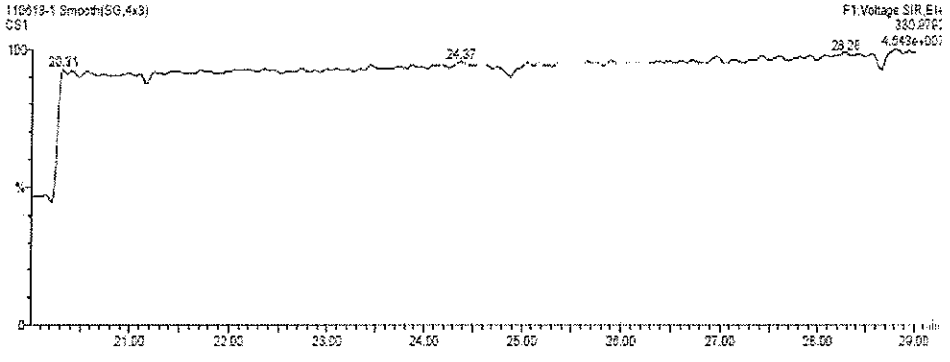
2378-TCDD



13C-2378-TCDD



LOCK MASS1



4508

- OCDD standard (CS1)

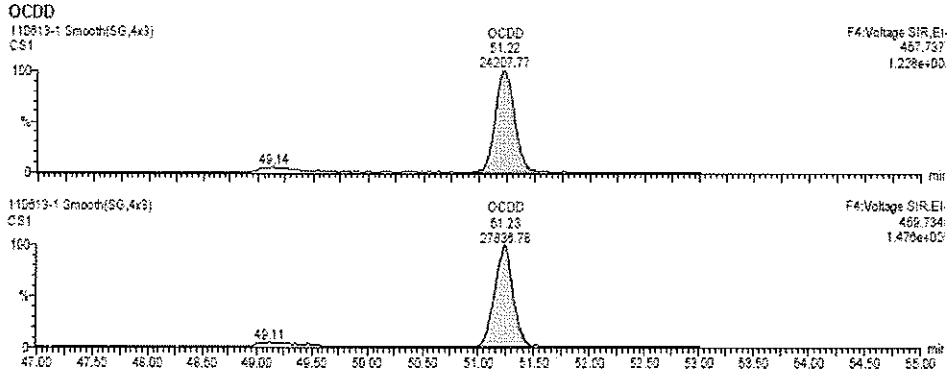
Quantify Sample Report **MassLynx 4.1**

Dataset: C:\MassLynx\DIOXIN11.PRO\Result\STD\110613_1-5.qld

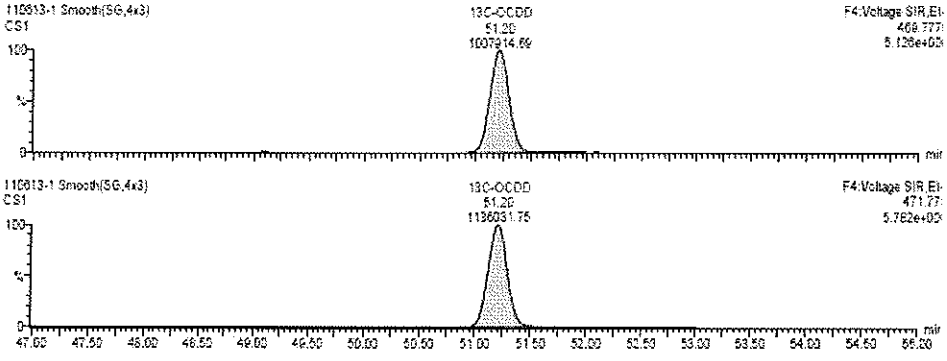
Last Altered: Monday, June 13, 2011 15:39:58 Korea Standard Time
Printed: Thursday, July 07, 2011 16:39:13 Korea Standard Time

Name: 110613-1, Date: 13-Jun-2011, Time: 09:45:52, ID: , Description: CS1

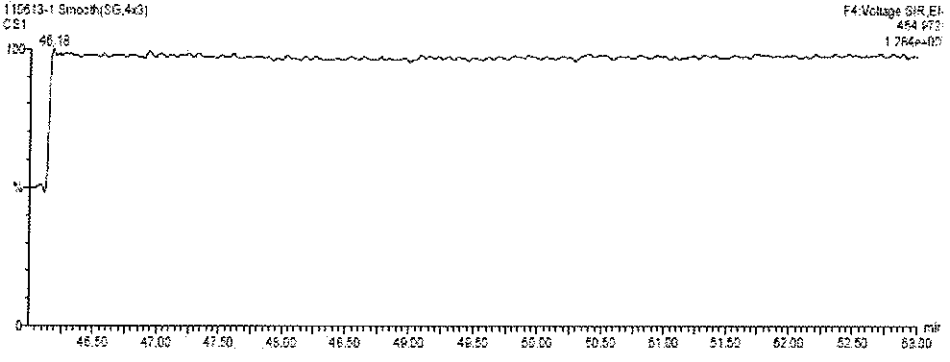
OCDD



13C-OCDD

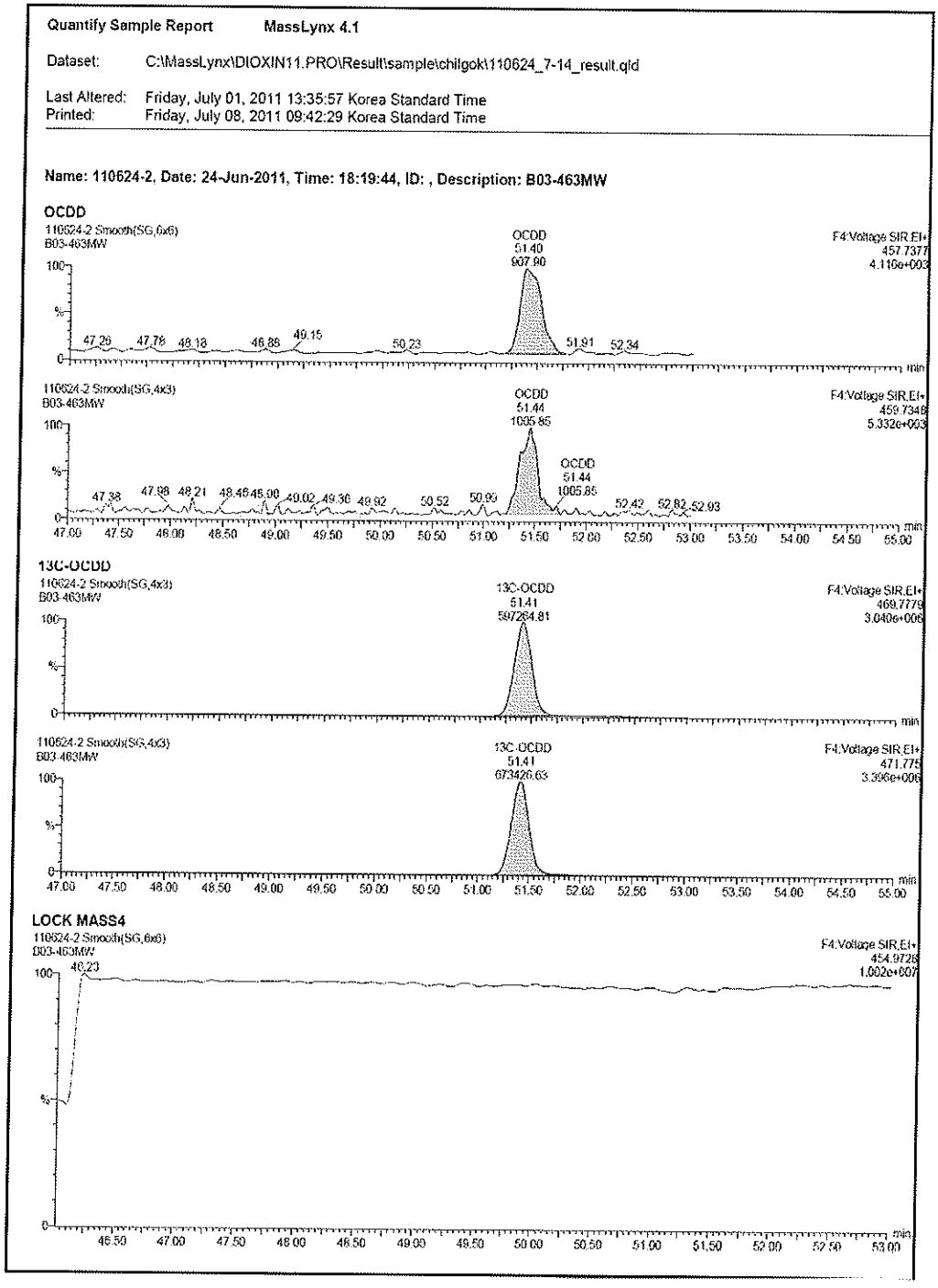


LOCK MASS4



4509

- Sample chromatogam of OCDD (B03-463MW)



4510

- Sample chromatogam of OCDD (B07-178MW)

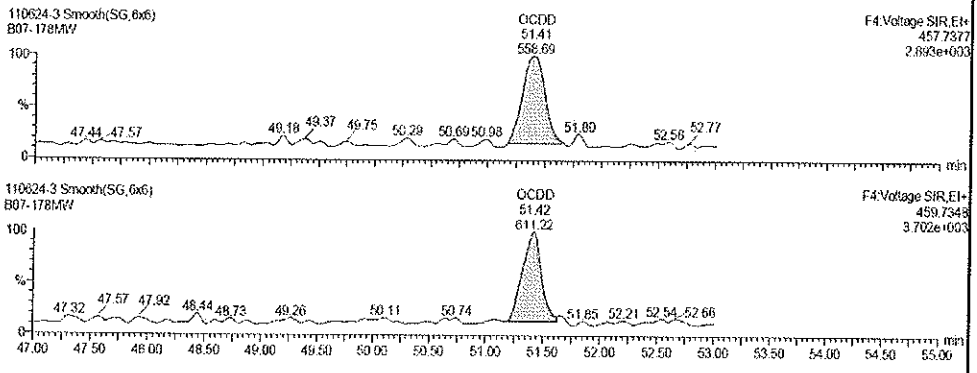
Quantify Sample Report MassLynx 4.1

Dataset: C:\MassLynx\DIOXIN11.PRO\Result\sample\chilgok\110624_7-14_result.qld

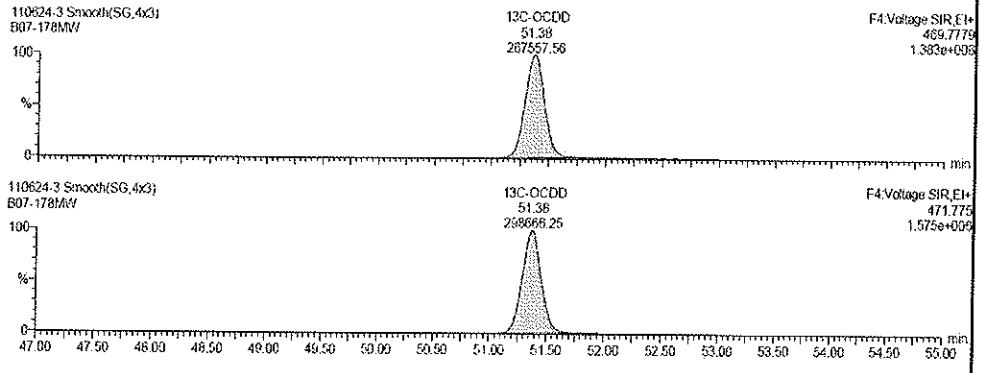
Last Altered: Friday, July 01, 2011 13:35:57 Korea Standard Time
Printed: Friday, July 08, 2011 09:46:16 Korea Standard Time

Name: 110624-3, Date: 24-Jun-2011, Time: 19:17:31, ID: , Description: B07-178MW

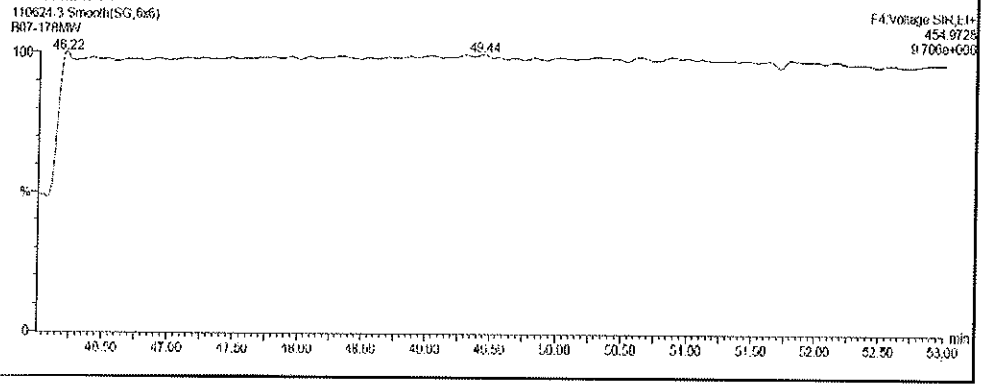
OCDD



13C-OCDD



LOCK MASS4



4511

- Sample chromatogam of OCDD (B07-220MW)

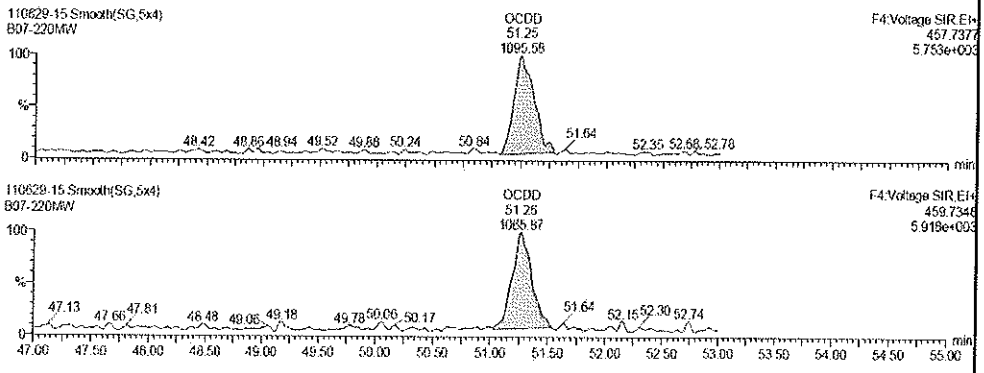
Quantify Sample Report MassLynx 4.1

Dataset: C:\MassLynx\DIOXIN11.PRO\Result\sample\chilgok\110629_9-18_result.qld

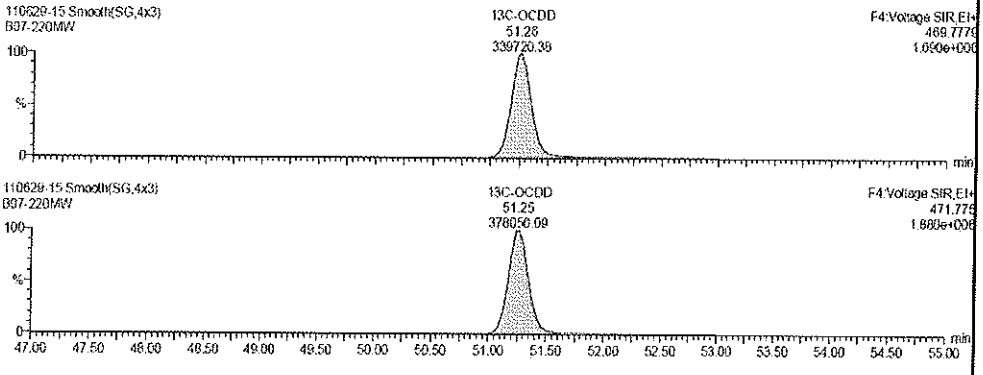
Last Altered: Friday, July 08, 2011 10:02:41 Korea Standard Time
Printed: Friday, July 08, 2011 10:03:28 Korea Standard Time

Name: 110629-15, Date: 30-Jun-2011, Time: 16:39:18, ID: , Description: B07-220MW

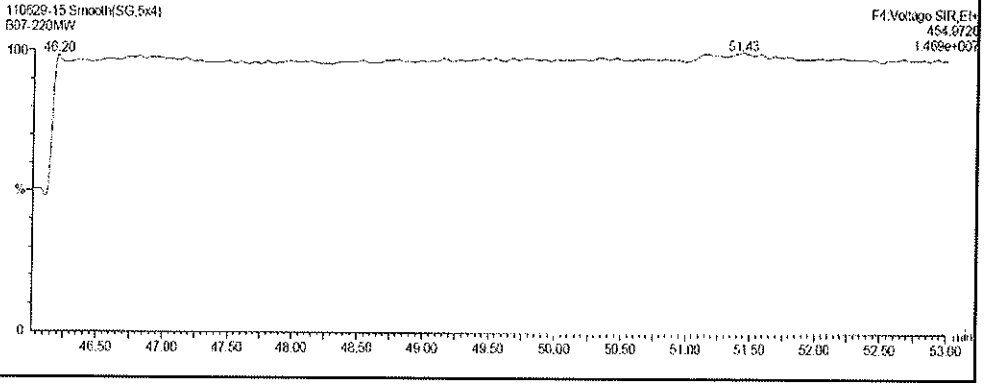
OCDD



13C-OCDD



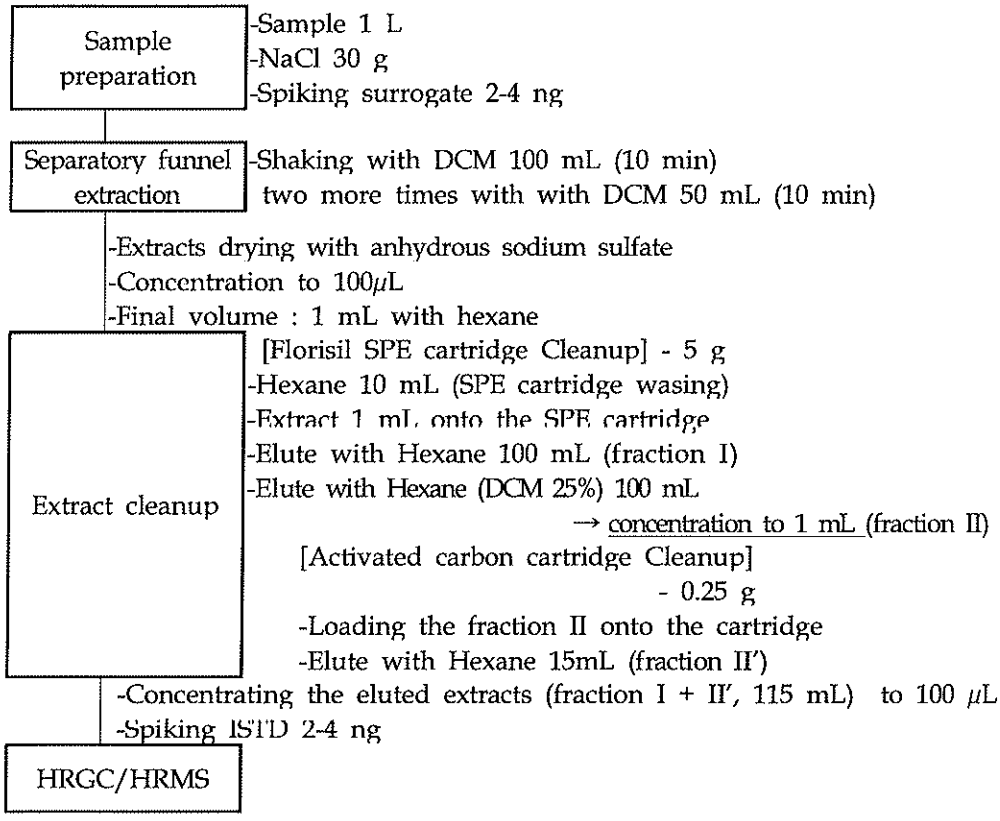
LOCK MASS4



4512

❑ OCPs

○ Analytical method (Korean Official Testing Method for Persistent Organic Pollutants Official Test Method (ES 10903.1a))



○ GC/MS condition

HRGC	Instrument	HP 6890N
	Injection mode	Splitless, 1㎕, 200℃ (purge time 6min)
	Separation column	ZB-Multiresidue-2 (30m×0.25mm×0.20㎛ film thickness)
	Oven temperature	100℃ (5min)→5℃/min→200℃ (5min)→2℃/min→220℃ (20min)→50℃/min→300℃
	Carrier gas flow	Helium (99.9999%), 1.0㎖/min
HRMS	Instrument	Micromass Autospec Ultima NT
	Ion mode Resolution	SIM (M/M+2, M+2/M+4) above 10,000 (10% Valley)
	Ionization mode	Electron Ionization Positive Mode (EI^+)
	Ionization energy	36 eV
	Ion source temp.	260℃

4/5/13

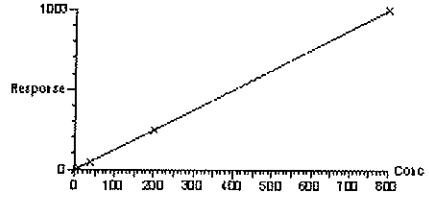
❍ **Calibrations** : 2, 10, 40, 200, 800 ng/mL

(Surrogates and Internal Standards : 20 ng/mL)

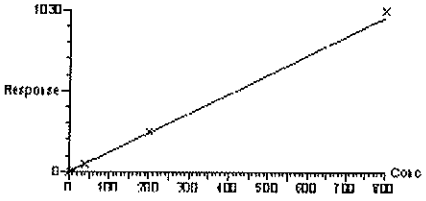
Compound	Response Factor	% RSD
α-HCH	1.249	3.389
β-HCH	1.149	3.008
γ-HCH(Lindane)	1.236	4.428
δ-HCH	1.242	3.841
HCB	0.998	1.404
Heptachlor	1.102	7.398
c-Heptachlor Epoxide	0.920	9.496
t-Heptachlor Epoxide	0.208	5.619
Aldrin	1.001	5.483
Dieldrin	0.898	2.008
Endrin	0.950	4.307
Oxychlordane	0.964	9.193
t-Chlordane	0.955	10.561
c-Chlordane	0.989	7.301
t-Nonachlor	0.793	4.395
c-Nonachlor	0.973	4.294
2,4-DDE	1.022	2.664
4,4-DDE	1.038	1.279
2,4-DDD	0.947	4.174
4,4-DDD	1.037	3.747
2,4-DDT	1.011	4.559
4,4-DDT	1.064	3.251
Mirex	1.001	3.408
Pentachlorobenzene	0.998	1.425

○ Calibration curves

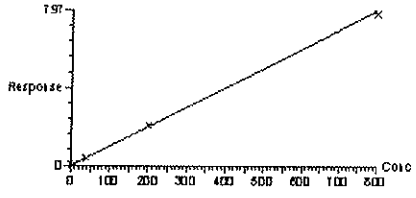
Compound name: alph-HCH
Response Factor: 1.24932
RRF SD: 0.0423409, % Relative SD: 3.38912
Response type: Internal Std (Ref 46), Area * (IS Conc. / IS Area)
Curve type: RF



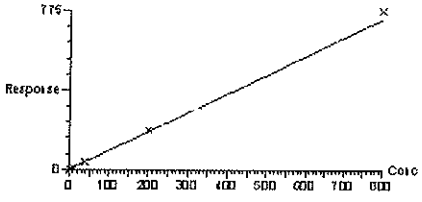
Compound name: gamma-HCH
Response Factor: 1.23623
RRF SD: 0.0547425, % Relative SD: 4.42819
Response type: Internal Std (Ref 46), Area * (IS Conc. / IS Area)
Curve type: RF



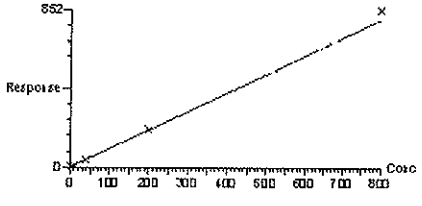
Compound name: HCB
Response Factor: 0.99756
RRF SD: 0.0140076, % Relative SD: 1.40419
Response type: Internal Std (Ref 27), Area * (IS Conc. / IS Area)
Curve type: RF



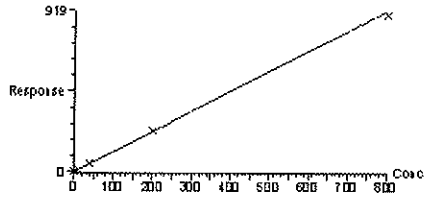
Compound name: cis-Haptachlor epoxide
Response Factor: 0.919989
RRF SD: 0.0873577, % Relative SD: 9.49551
Response type: Internal Std (Ref 43), Area * (IS Conc. / IS Area)
Curve type: RF



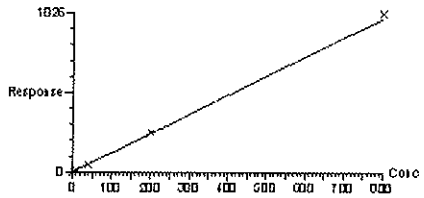
Compound name: Aldrin
Response Factor: 1.00102
RRF SD: 0.0548626, % Relative SD: 5.48269
Response type: Internal Std (Ref 29), Area * (IS Conc. / IS Area)
Curve type: RF



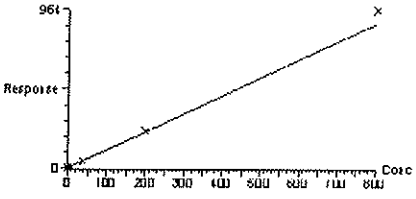
Compound name: beta-HCH
Response Factor: 1.14928
RRF SD: 0.0345727, % Relative SD: 3.00819
Response type: Internal Std (Ref 47), Area * (IS Conc. / IS Area)
Curve type: RF



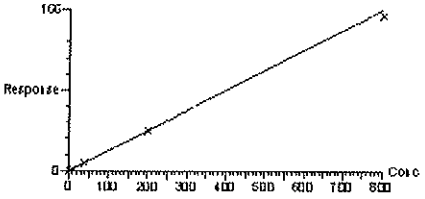
Compound name: delta-HCH
Response Factor: 1.24187
RRF SD: 0.0476998, % Relative SD: 3.84097
Response type: Internal Std (Ref 48), Area * (IS Conc. / IS Area)
Curve type: RF



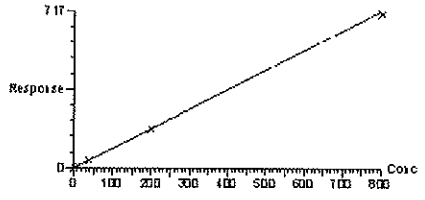
Compound name: Haptachlor
Response Factor: 1.1017
RRF SD: 0.0815082, % Relative SD: 7.39843
Response type: Internal Std (Ref 42), Area * (IS Conc. / IS Area)
Curve type: RF



Compound name: t-Haptachlor epoxide
Response Factor: 0.207911
RRF SD: 0.0116827, % Relative SD: 5.61909
Response type: Internal Std (Ref 43), Area * (IS Conc. / IS Area)
Curve type: RF



Compound name: Dieldrin
Response Factor: 0.897561
RRF SD: 0.0180256, % Relative SD: 2.00829
Response type: Internal Std (Ref 30), Area * (IS Conc. / IS Area)
Curve type: RF



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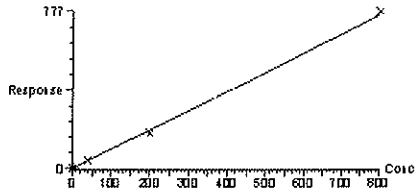
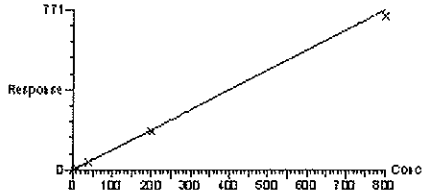
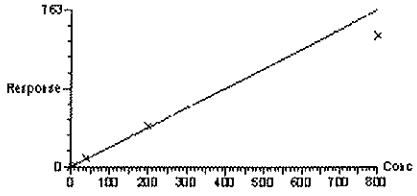
Compound name: Endrin
Response Factor: 0.950102
RRF SD: 0.0409211, % Relative SD: 4.30702
Response type: Internal Std (Ref 31), Area * (IS Conc. / IS Area)
Curve type: RF



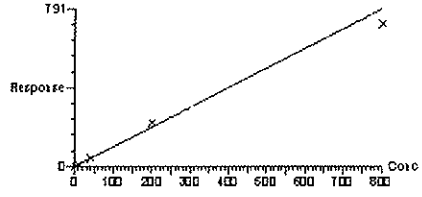
Compound name: Oxychlordane
Response Factor: 0.964496
RRF SD: 0.0886652, % Relative SD: 9.19291
Response type: Internal Std (Ref 41), Area * (IS Conc. / IS Area)
Curve type: RF



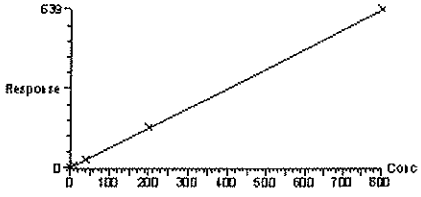
Compound name: trans- Chlordane
Response Factor: 0.955043
RRF SD: 0.100863, % Relative SD: 10.5611
Response type: Internal Std (Ref 38), Area * (IS Conc. / IS Area)
Curve type: RF



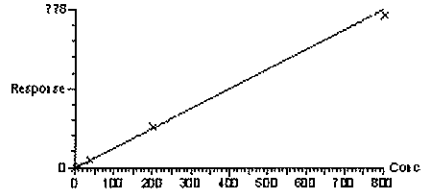
Compound name: cis-Chlordane
Response Factor: 0.989336
RRF SD: 0.0722347, % Relative SD: 7.30134
Response type: Internal Std (Ref 38), Area * (IS Conc. / IS Area)
Curve type: RF



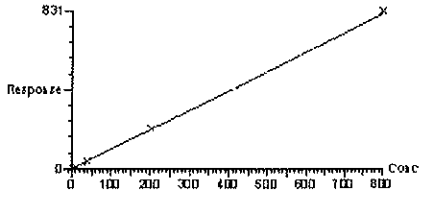
Compound name: t- nonachlor
Response Factor: 0.783355
RRF SD: 0.034865, % Relative SD: 4.39452
Response type: Internal Std (Ref 39), Area * (IS Conc. / IS Area)
Curve type: RF



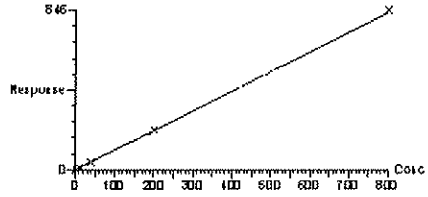
Compound name: cis-nonachlor
Response Factor: 0.97287
RRF SD: 0.0417784, % Relative SD: 4.29435
Response type: Internal Std (Ref 40), Area * (IS Conc. / IS Area)
Curve type: RF



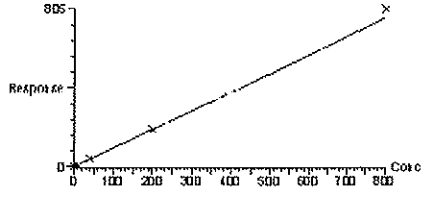
Compound name: 2,4-DDE
Response Factor: 1.02189
RRF SD: 0.027226, % Relative SD: 2.66419
Response type: Internal Std (Ref 36), Area * (IS Conc. / IS Area)
Curve type: RF



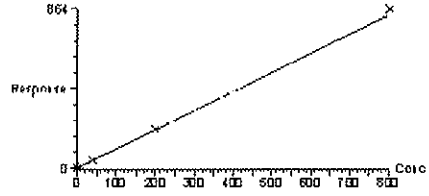
Compound name: 4,4-DDE
Response Factor: 1.03776
RRF SD: 0.0132753, % Relative SD: 1.27923
Response type: Internal Std (Ref 33), Area * (IS Conc. / IS Area)
Curve type: RF



Compound name: 2,4-DDD
Response Factor: 0.84736
RRF SD: 0.0395392, % Relative SD: 4.17362
Response type: Internal Std (Ref 37), Area * (IS Conc. / IS Area)
Curve type: RF



Compound name: 4,4-DDD
Response Factor: 1.03749
RRF SD: 0.038871, % Relative SD: 3.74664
Response type: Internal Std (Ref 34), Area * (IS Conc. / IS Area)
Curve type: RF



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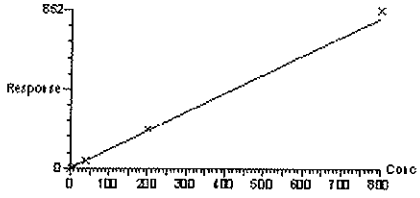
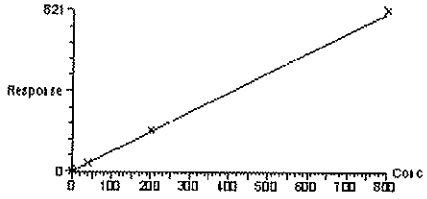
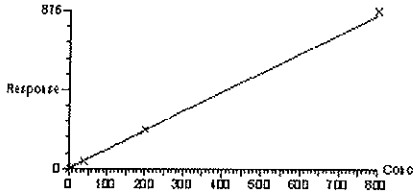
Compound name: 2,4-DDT
Response Factor: 1.01111
RRF SD: 0.0460947, % Relative SD: 4.56883
Response type: Internal Std (Ref 35), Area * (IS Conc. / IS Area)
Curve type: RF



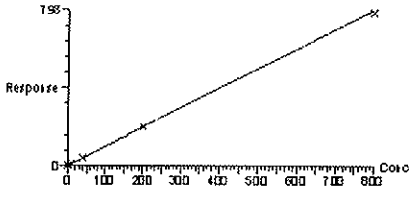
Compound name: Mirex
Response Factor: 1.00126
RRF SD: 0.0341203, % Relative SD: 3.40775
Response type: Internal Std (Ref 44), Area * (IS Conc. / IS Area)
Curve type: RF



Compound name: 4,4-DDT
Response Factor: 1.06391
RRF SD: 0.0345843, % Relative SD: 3.25073
Response type: Internal Std (Ref 32), Area * (IS Conc. / IS Area)
Curve type: RF



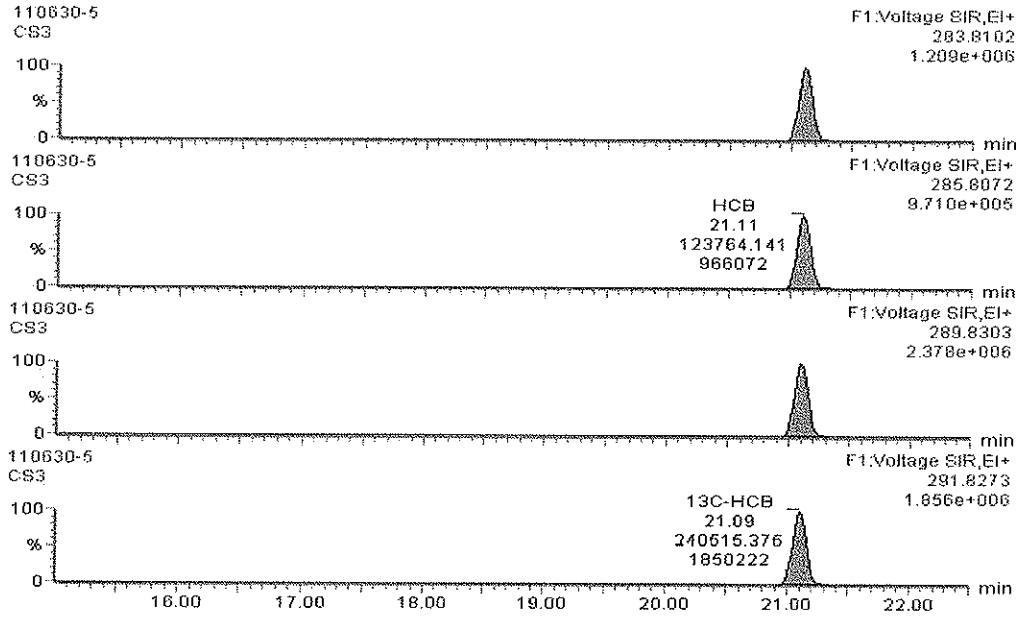
Compound name: PCBz
Response Factor: 0.986144
RRF SD: 0.0142202, % Relative SD: 1.42466
Response type: Internal Std (Ref 28), Area * (IS Conc. / IS Area)
Curve type: RF



4512

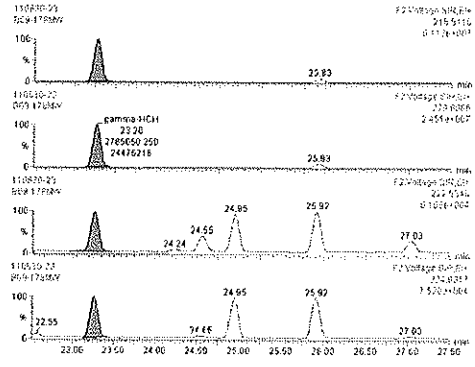
○ Chromatogram

- HCB standard

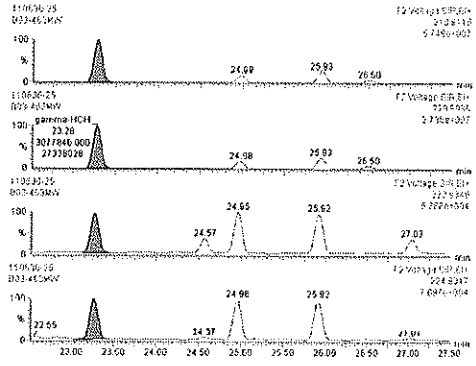


- Samples

(B09-178MW)

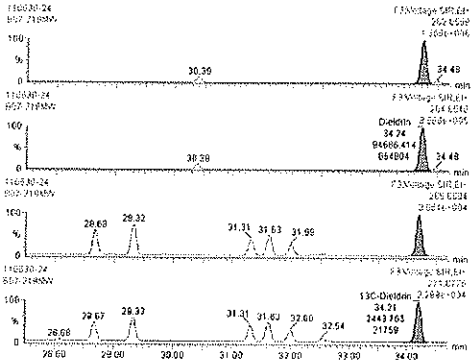


(B03-463MW)

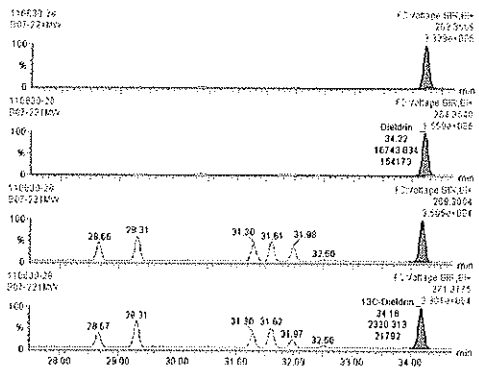


4518

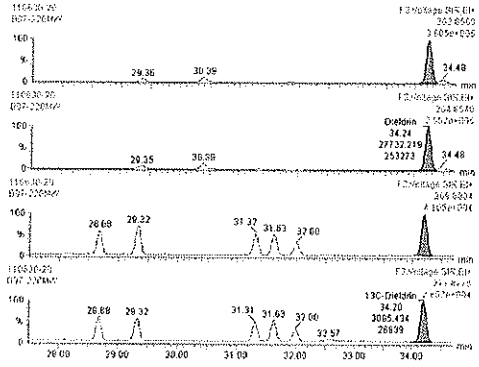
(B07-219MW)



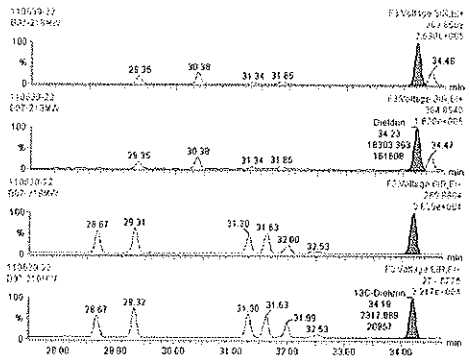
(B07-221MW)



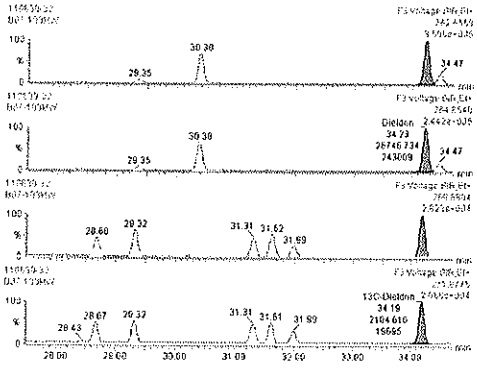
(B07-220MW)



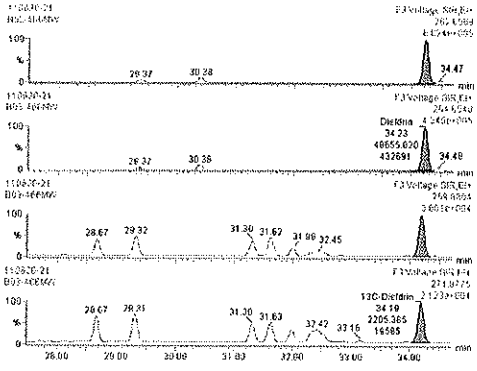
(B07-218MW)



(B09-193MW)



(B03-466MW)



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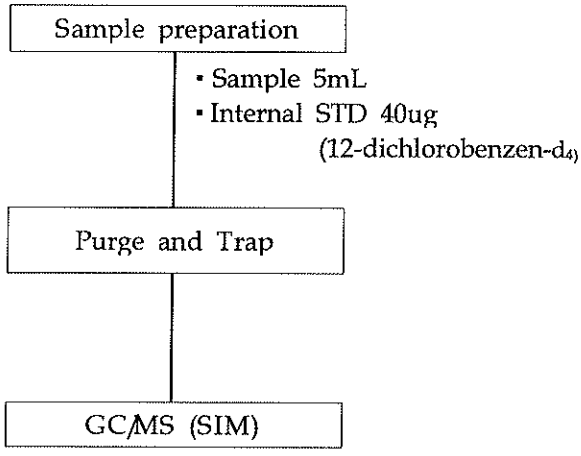
❑ VOCs

○ Analytical method (Korean Official Testing Method for Drinking Water (ES 056011Aa))



○ GC/MS condition

GC	Instrument	Agilent Technologies 6890N
	Injection mode	Split, 10 : 1, (purge time 11min)
	Separation column	DB-5MS (30m×0.32mm×250㎛ film thickness)
	Oven temperature	30℃ (7min)→3℃/min→60℃ (3min)→15℃/min →80℃ (0min)→10℃/min→100℃ (0min) →20℃/min→200℃ (0min)
	Carrier gas flow	Helium (99.999%), 1.5 ㎖/min
MS	Instrument	Agilent Technologies 5975B
	Ion mode Resolution	SIM (M/M+2, M+2/M+4) above 10,000 (10% Valley)
	Ionization mode	Electron Ionization
	Ionization energy	70 eV
	Ion source temp.	230℃

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❍ **Calibrations** : 0.5, 1, 2, 5, 15, 20, 25 μg/L

Compound	Calibration Curve	Response Factor	% RSD	Recovery
1,1-Dichloroethylene	y=0.259x+0.0119	0.998	5.83	97.08%
trans-1,2-Dichloroethylene	y=0.603x+0.00598	0.999	10.61	95.85%
cis-1,2-Dichloroethylene	y=0.607x+0.0121	0.999	4.70	102.50%
Dichloromethane	y=0.400x+0.0341	0.987	3.59	102.85%
Chloroform	y=1.34x+0.0107	1.000	6.22	93.83%
1,1,1-Trichloroethane	y=1.13x+0.0289	1.000	2.25	114.43%
Benzene	y=2.75x+0.0913	0.999	1.45	105.23%
Tetrachlorocarbon	y=0.978x-0.0114	0.998	3.25	109.95%
Trichloroethylene	y=0.840x+0.0265	0.999	5.33	97.03%
Bromodichloromethane	y=1.28x+0.0282	0.999	3.44	100.05%
Toluene	y=3.10x+0.122	0.999	2.33	92.15%
Dibromochloromethane	y=1.80x+0.0139	0.999	2.27	99.28%
Tetrachloroethylene	y=1.10x+0.00733	0.999	3.51	96.48%
Ethylbenzene	y=3.81x-0.362	0.995	18.52	79.85%
p-Xylene	y=3.10x-0.549	0.991	0.37	81.78%
m-Xylene	y=3.35x-0.527	0.994	0.45	80.28%
o-Xylene	y=1.73x-0.297	0.992	0.57	84.43%
Bromoform	y=0.938x-0.0652	0.999	1.96	92.35%

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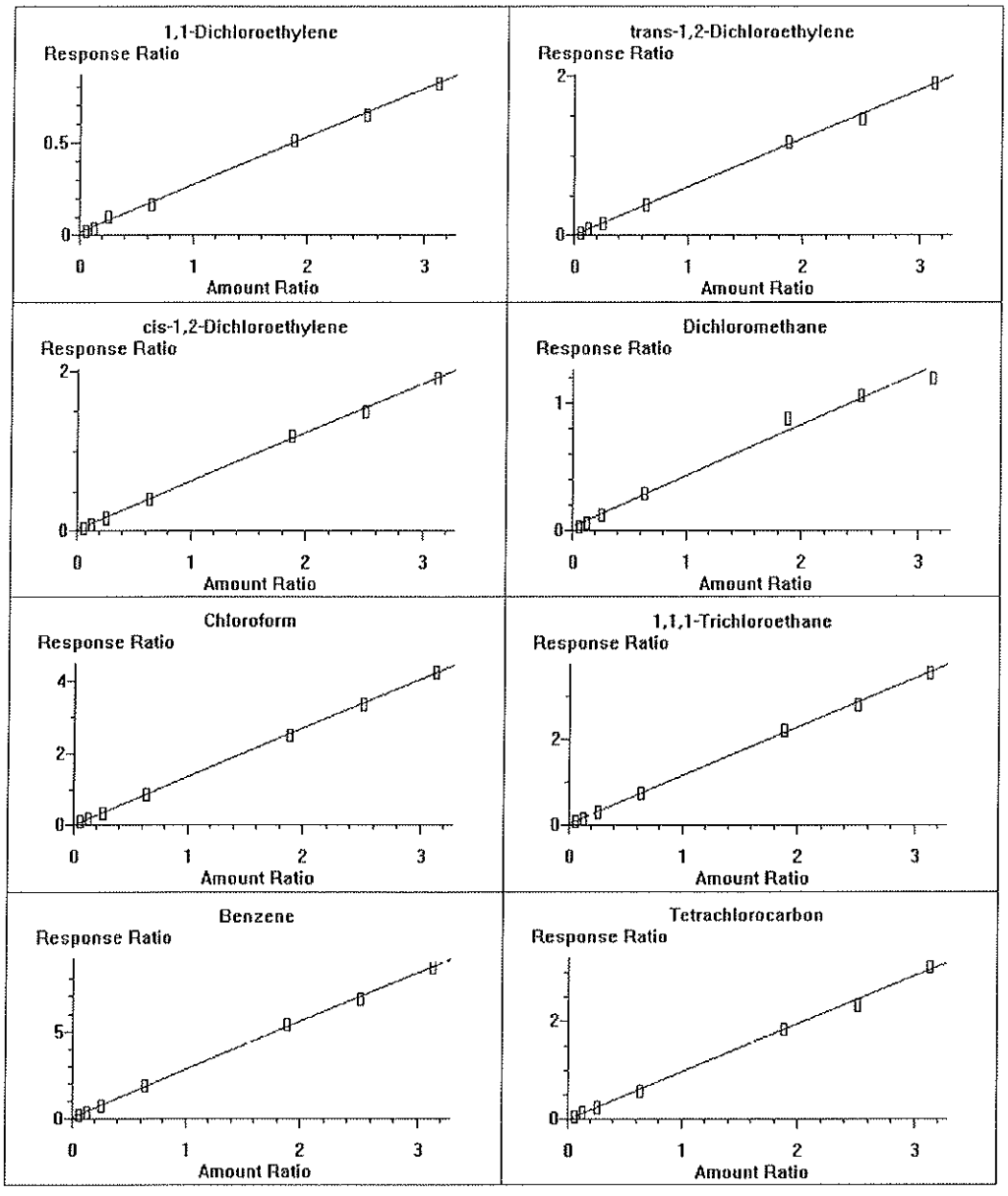
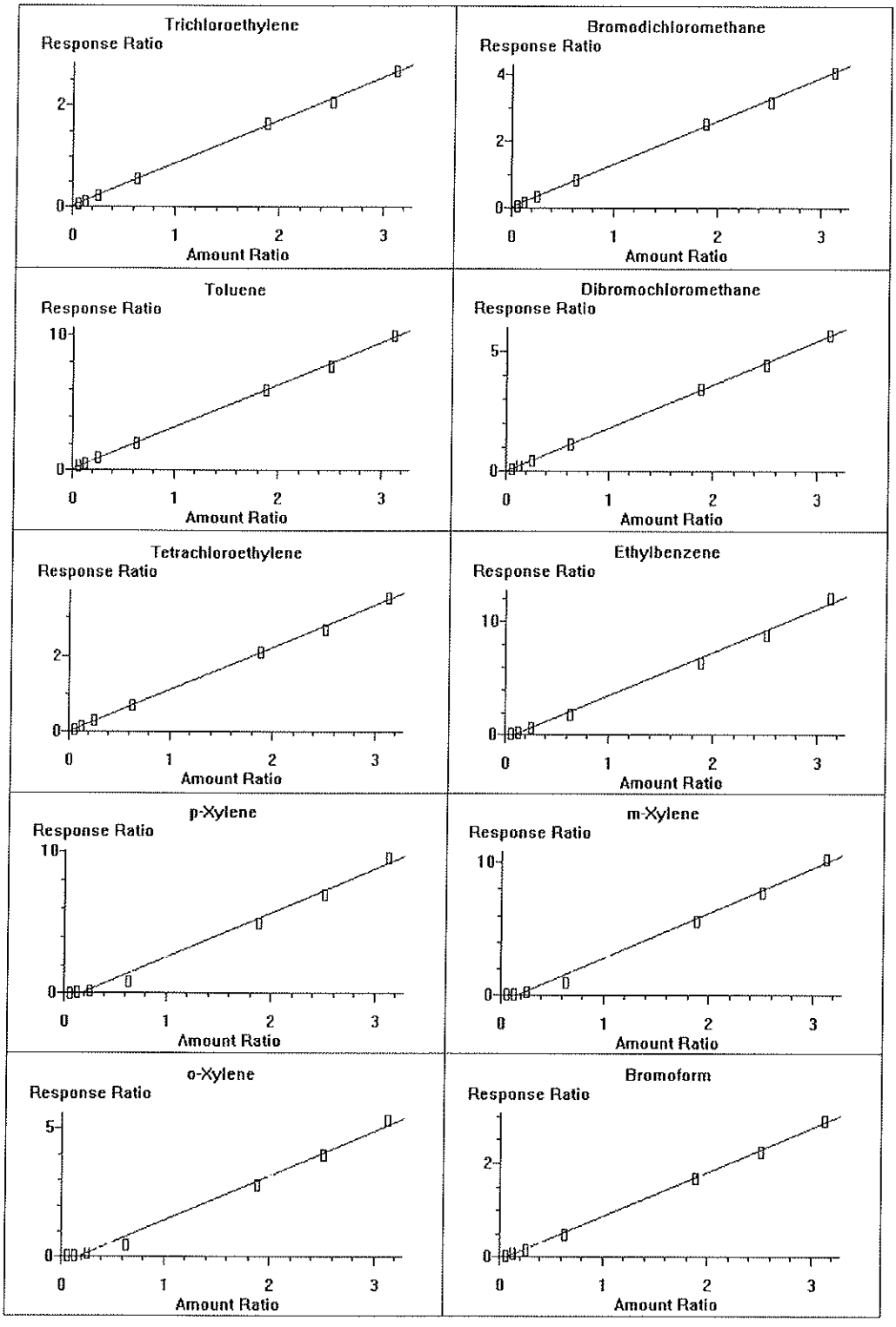
○ Calibration curves



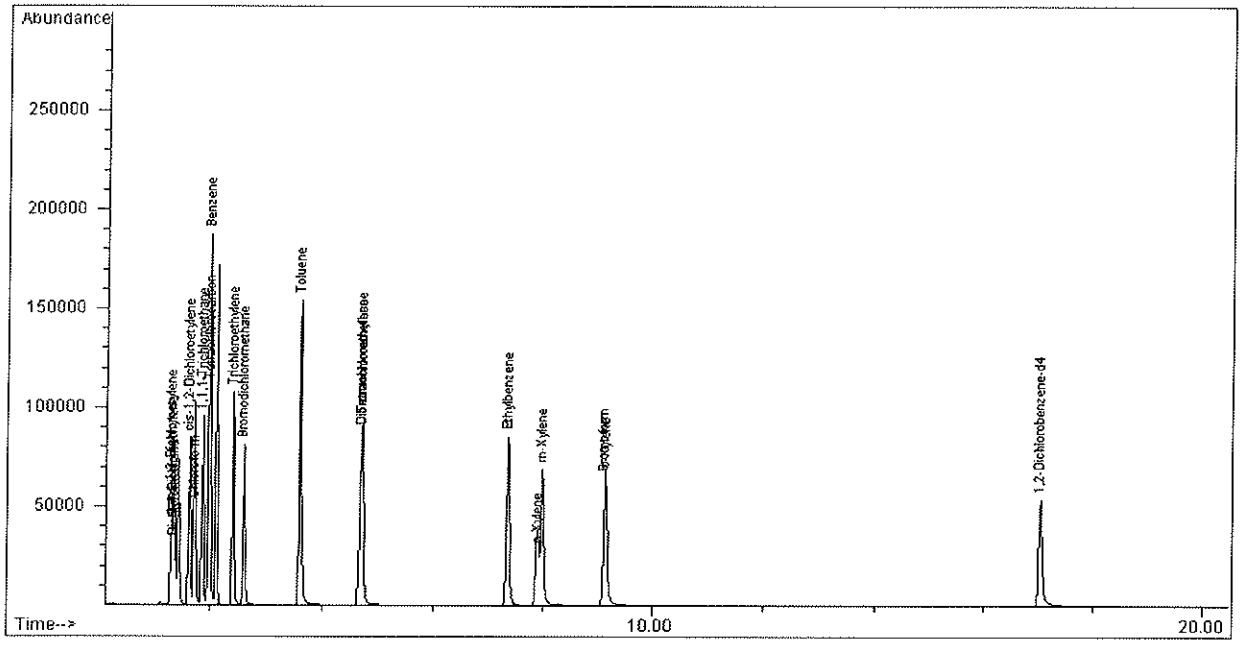
4522


Trichloroethylene
Response Ratio
2
0
0
1
2
3
Amount Ratio
Bromodichloromethane
Response Ratio
4
2
0
0
1
2
3
Amount Ratio
Toluene
Response Ratio
10
0
0
1
2
3
Amount Ratio
Dibromochloromethane
Response Ratio
5
0
0
1
2
3
Amount Ratio
Tetrachloroethylene
Response Ratio
2
0
0
1
2
3
Amount Ratio
Ethylbenzene
Response Ratio
10
0
0
1
2
3
Amount Ratio
p-Xylene
Response Ratio
10
0
0
1
2
3
Amount Ratio
m-Xylene
Response Ratio
10
0
0
1
2
3
Amount Ratio
o-Xylene
Response Ratio
5
0
0
1
2
3
Amount Ratio
Bromoform
Response Ratio
2
0
0
1
2
3
Amount Ratio

4523

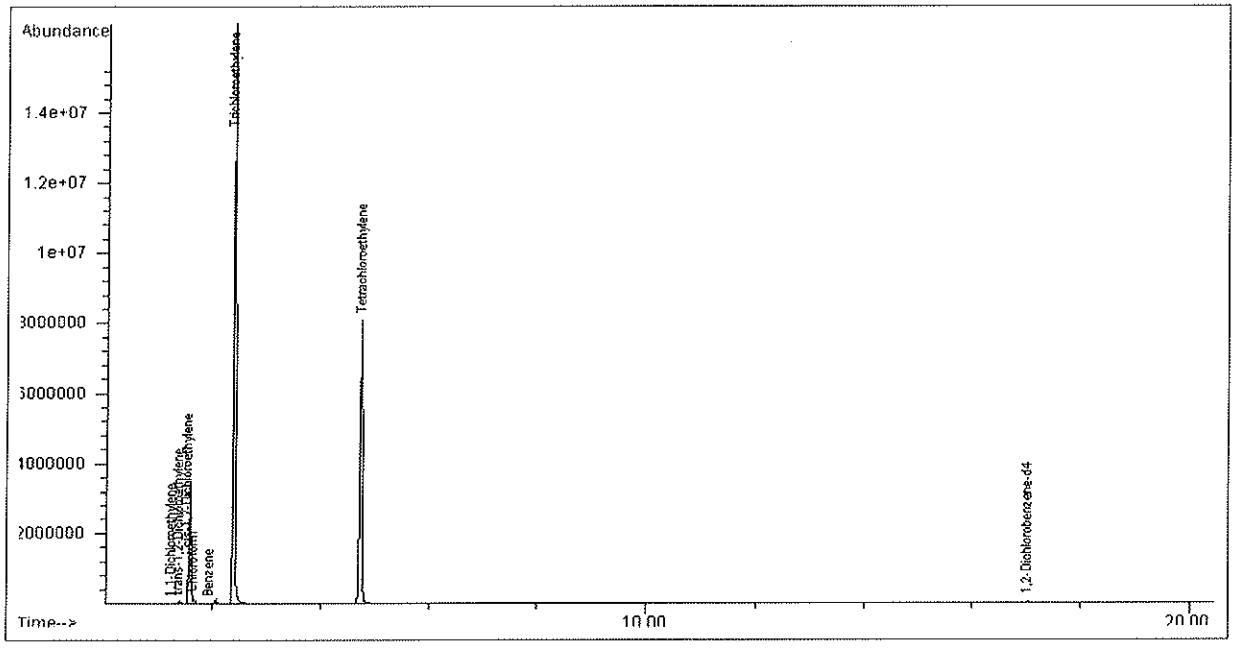
○ Chromatogram

- Standard 5 μg/L



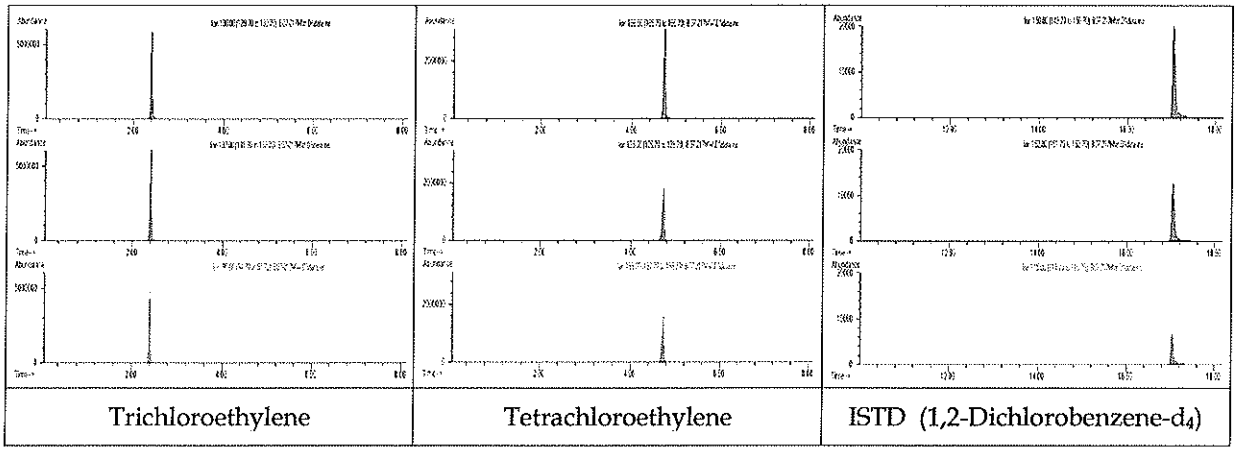
4524

▪ B07-217MW (TIC)



4535

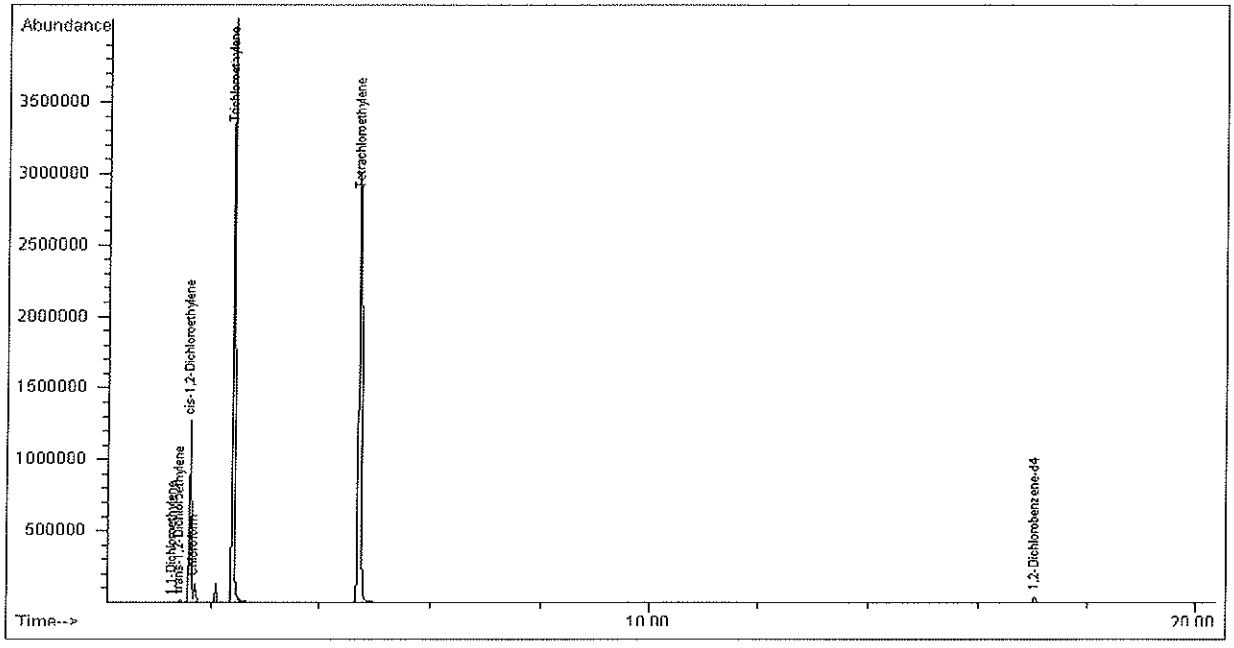
- B07-217MW (Quantitation Ions)



Trichloroethylene	Tetrachloroethylene	ISTD (1,2-Dichlorobenzene-d_4)

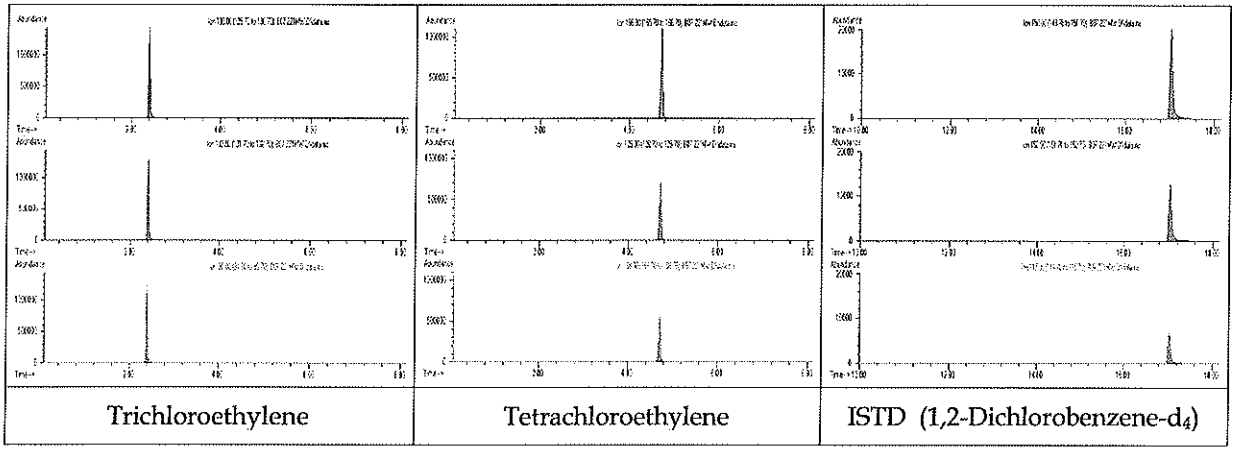
4506

- B07-221MW (TIC)



4/527

- B07-221MW (Quantitation Ions)

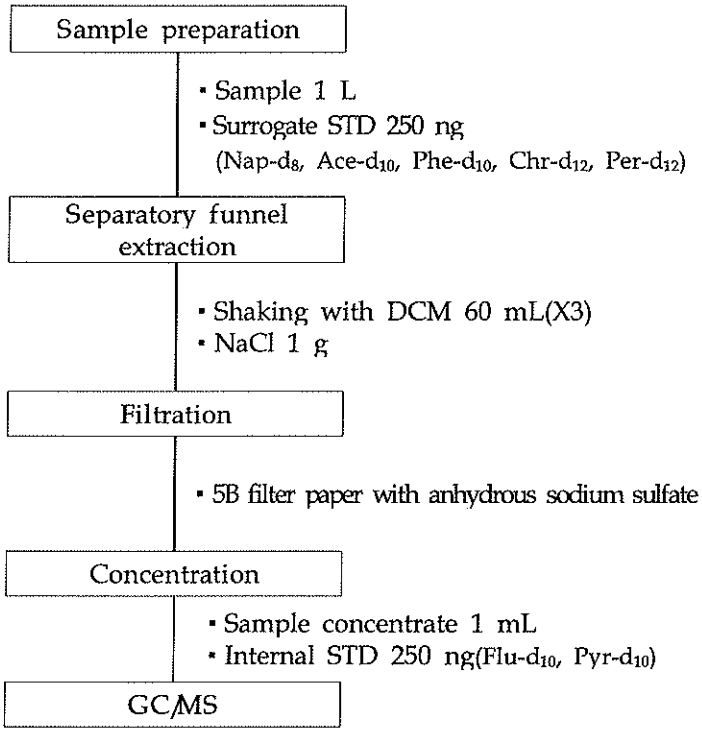


Trichloroethylene	Tetrachloroethylene	ISTD (1,2-Dichlorobenzene-d_4)

4528

❑ PAHs

❍ Analytical method (EPA method 3510C and EPA method 8270D)



❍ GC/MS condition

Instrument	(GC) Agilent 6890N (MS) Agilent 5975B inert XL MSD
Separation column	HP5-MS 5% Phenyl methyl siloxane (30m×250um×0.25um)
Oven temperature	70℃ (4min)→10℃/min→300℃ (15min)
Injection temperature	250℃
Detector temperature	280℃
Splitless injection	1 uL
Carrier gas flow	1.2 mL/min (He)
Ionization	EI (70 eV)
Data Aquisition	SIM mode

4529

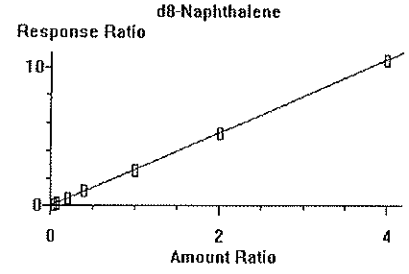
○ **Calibrations** : 10, 20, 50, 100, 250, 500, 1000 pg

Compound		Calibration Curve	Response Factor	Recovery (%)
d8-Naphthalene (S1)		y=2.62x+0.0158	1.000	50.5~74.2
d10-Acenaphthene (S2)		y=0.836x+0.0124	1.000	52.0~82.8
d10-Phenanthrene (S3)		y=1.33x-0.000862	1.000	56.1~117.2
d12-Chrysene (S4)		y=0.962x+0.0137	1.000	55.2~93.1
d12-Perylene (S5)		y=0.876x+0.00613	1.000	52.4~88.6
S1	Acenaphthylene	y=1.45x+0.0151	1.000	-
S2	Acenaphthene	y=0.894x+0.000747	1.000	-
	Fluorene	y=1.06x-0.00577	1.000	-
S3	Phenanthrene	y=1.44x-0.00836	1.000	-
	Anthracene	y=1.18x-0.0145	0.999	-
	Fluoranthene	y=1.24x+0.0092	0.999	-
	Pyrene	y=1.23x+0.00637	0.999	-
	Benzo(a)anthrathene	y=0.846x+0.0194	1.000	-
S4	Chrysene	y=0.879x+0.00668	1.000	-
	Benzo(b)fluoranthene	y=0.86x-0.00558	1.000	-
	Benzo(k)fluoranthene	y=0.812x+0.00479	0.999	-
	Benzo(a)pyrene	y=0.66x+0.00978	0.999	-
S5	Indeno(1,2,3-c,d)pyrene	y=0.651x-0.00633	0.999	-
	Dibenz(a,h)anthracene	y=0.683x+0.0135	0.999	-
	Benzo(g,h,i)perylene	y=0.728x+0.00784	0.999	-

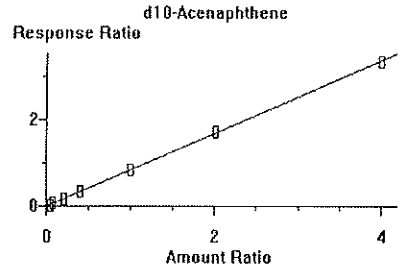
4/530

○ Calibration curves

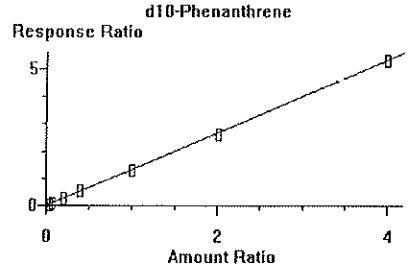
d8-Naphthalene



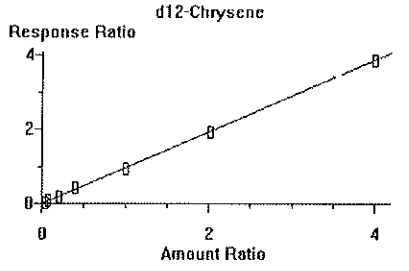
d10-Acenaphthene



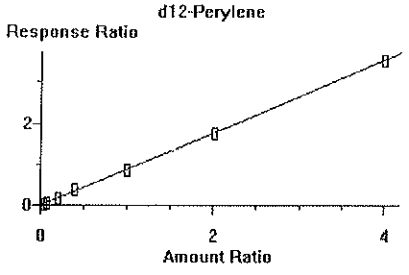
d10-Phenanthrene



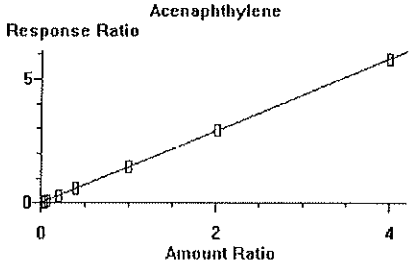
d12-Chrysene



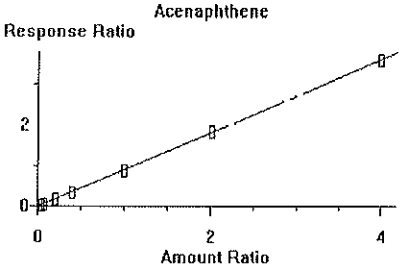
d12-Perylene



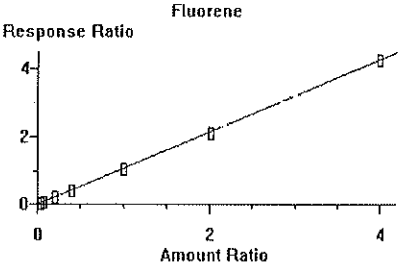
Acenaphthylene



Acenaphthene



Fluorene



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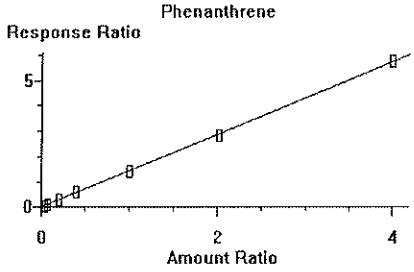
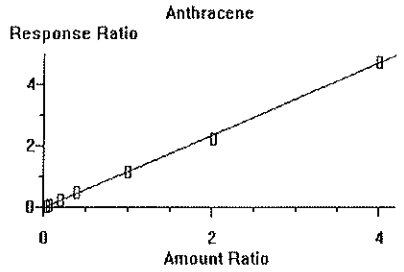
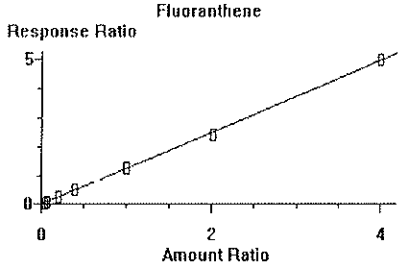
Phenanthrene



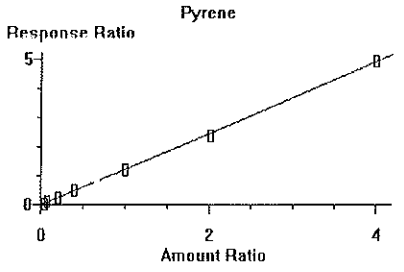
Anthracene



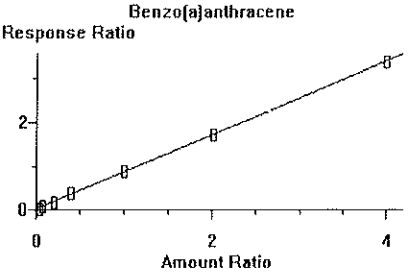
Fluoranthene



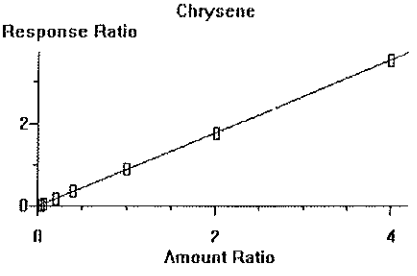
Pyrene



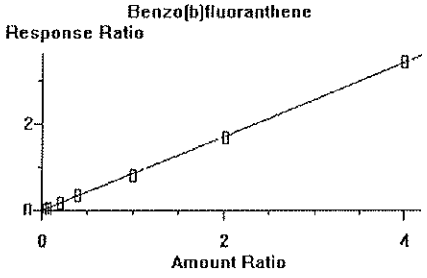
Benzo(a)anthrathene



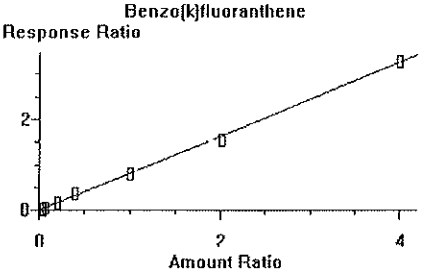
Chrysene



Benzo(b)fluoranthene

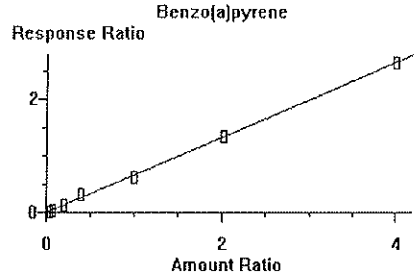


Benzo(k)fluoranthene

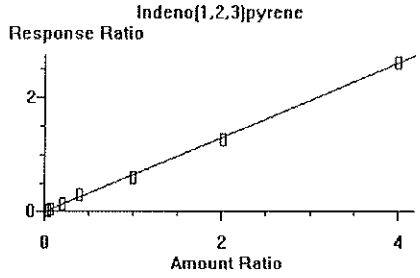


4532

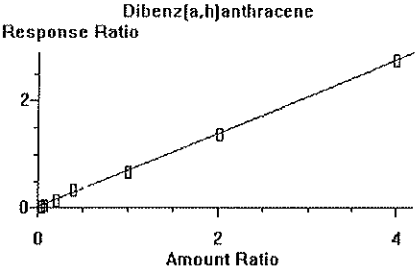
Benzo(a)pyrene



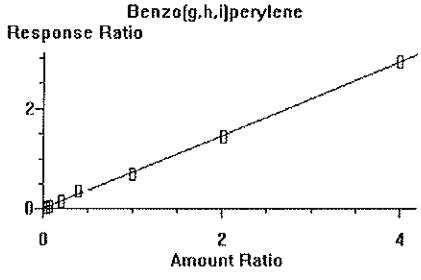
Indeno(1,2,3-c,d)pyrene



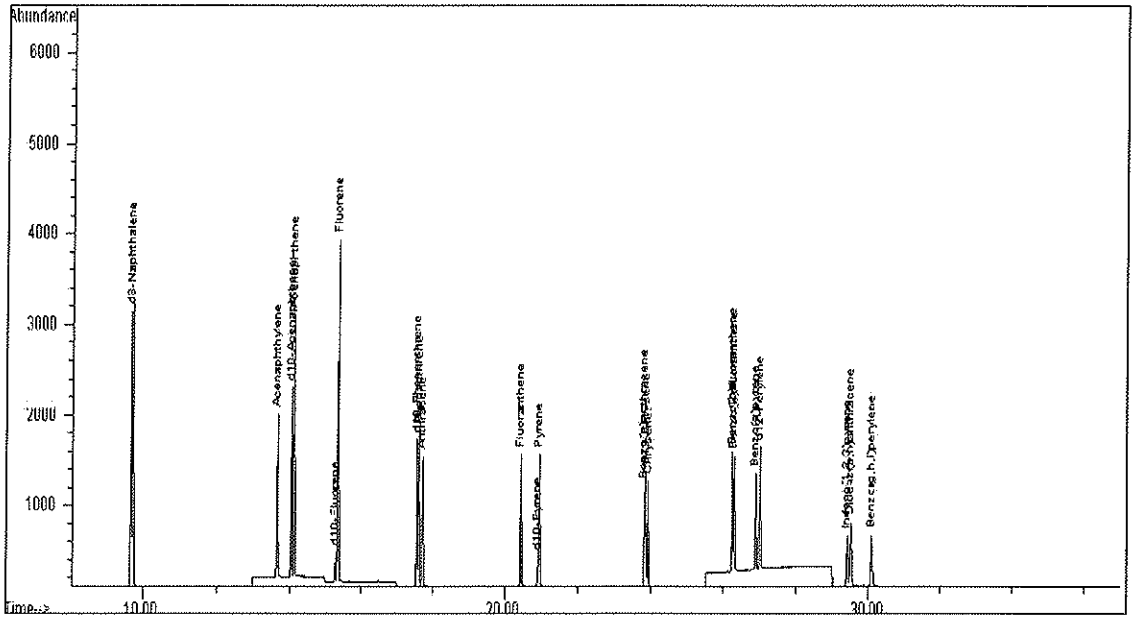
Dibenz(a,h)anthracene



Benzo(g,h,i)perylene



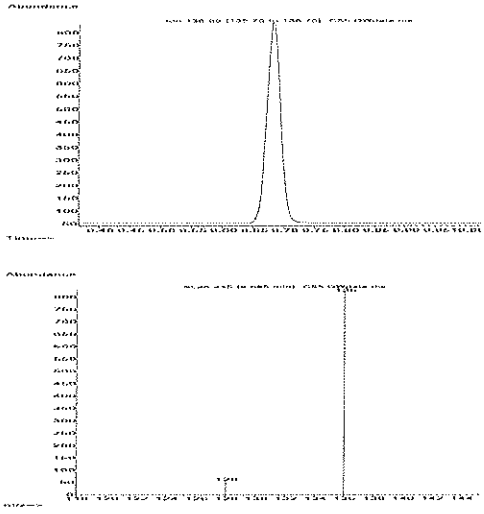
○ Chromatogram



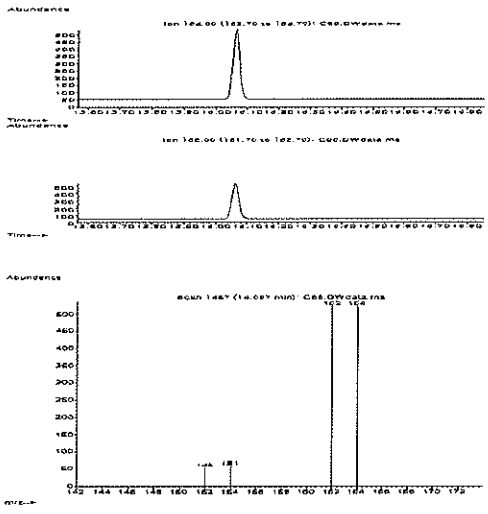
4533

- Surrogate Standard

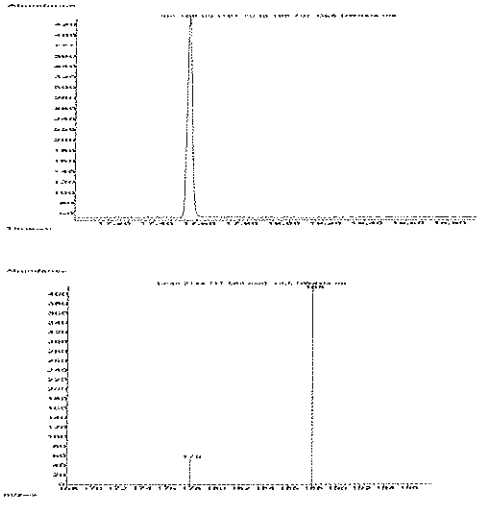
<d8-Naphthalene>



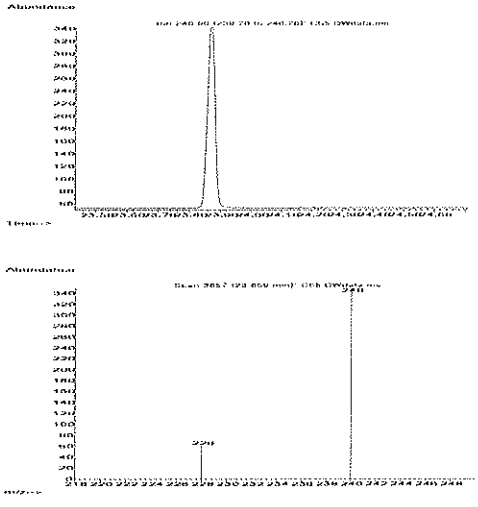
<d10-Acenaphthene>



<d10-Phenanthrene>



<d12-Chrysene>



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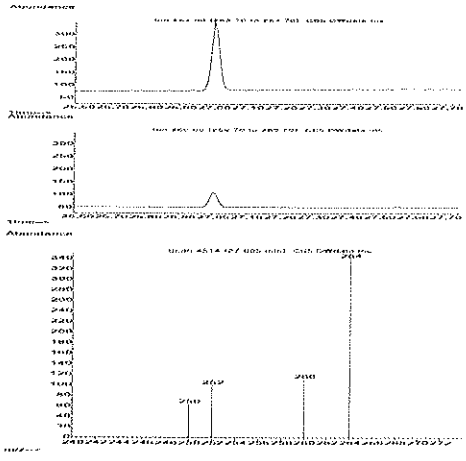
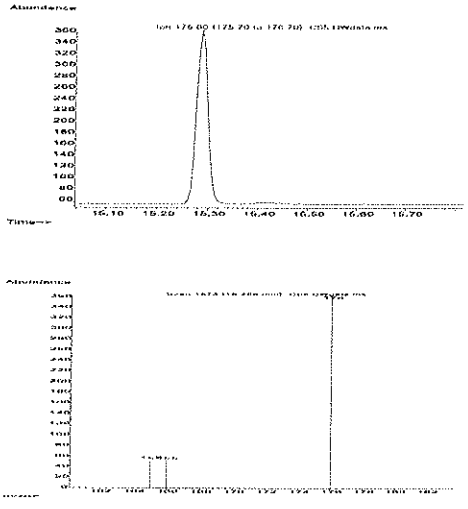
<d12-Perylene>

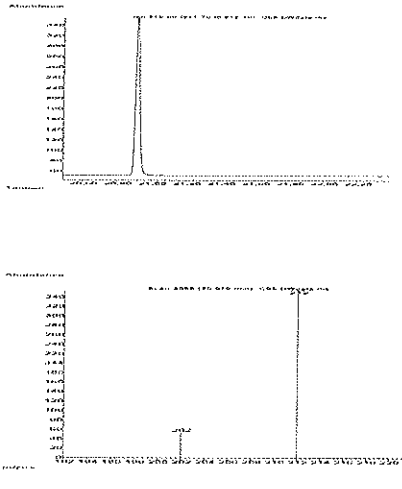


- Internal Standard

<d10-Fluorene>



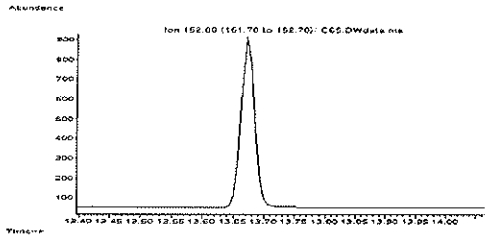
<d10-Pyrene>

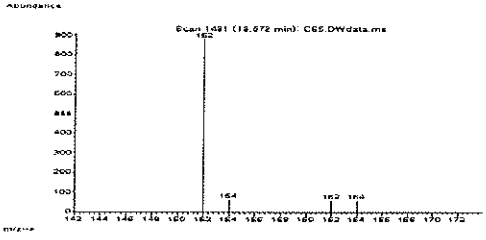


5535

- Target Standard

<Acenaphthylene>





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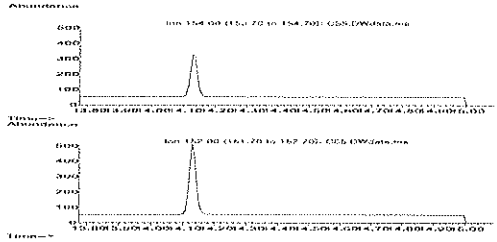
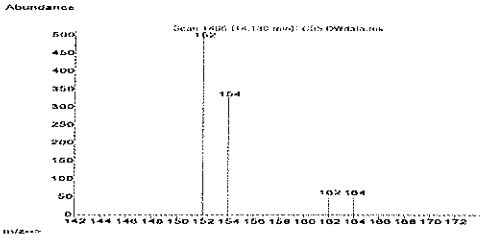
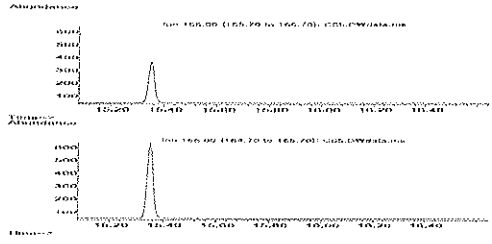
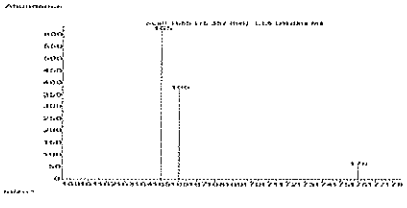


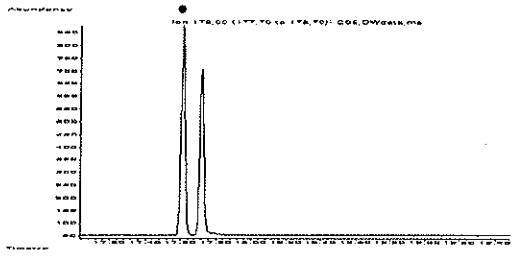


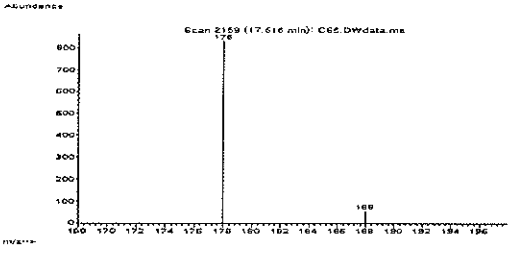
<Fluorene>





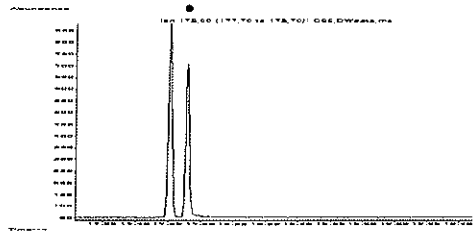
<Phenanthrene>

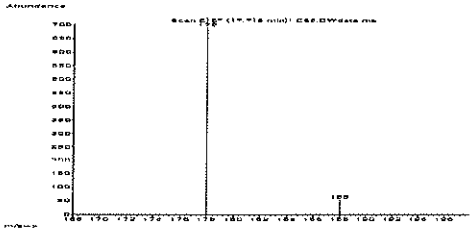




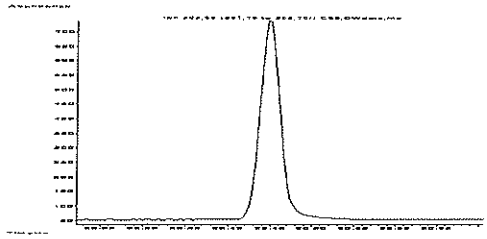
4536

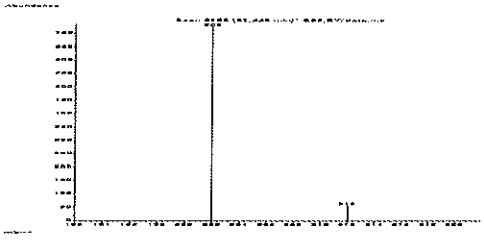
<Anthracene>



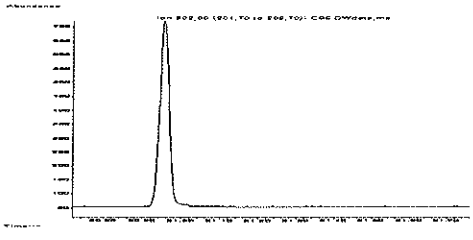


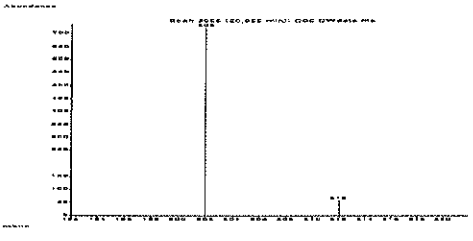
<Fluoranthene>



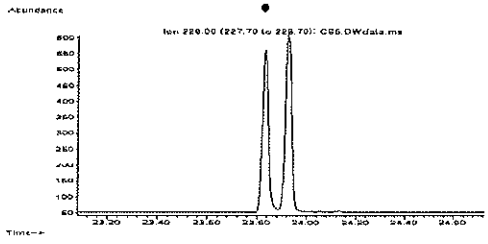


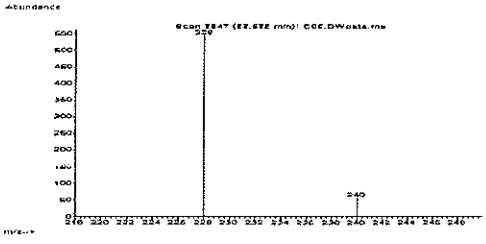
<Pyrene>





<Benz(a)anthracene>





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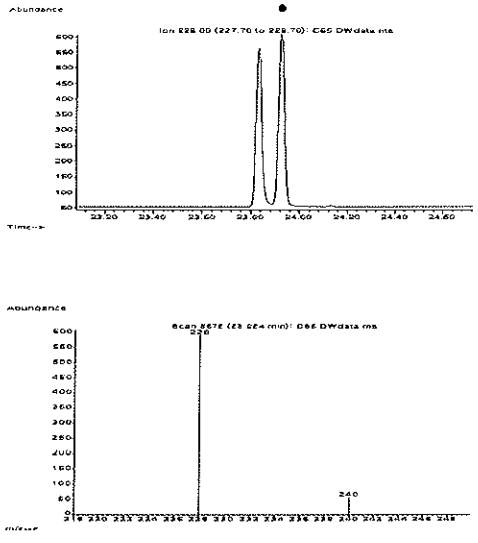
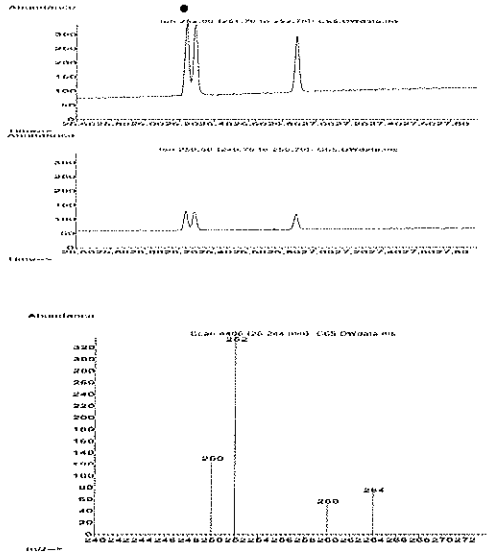
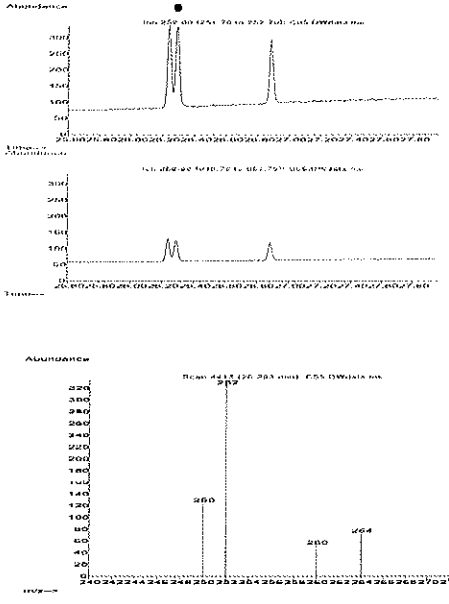
<Chrysene>



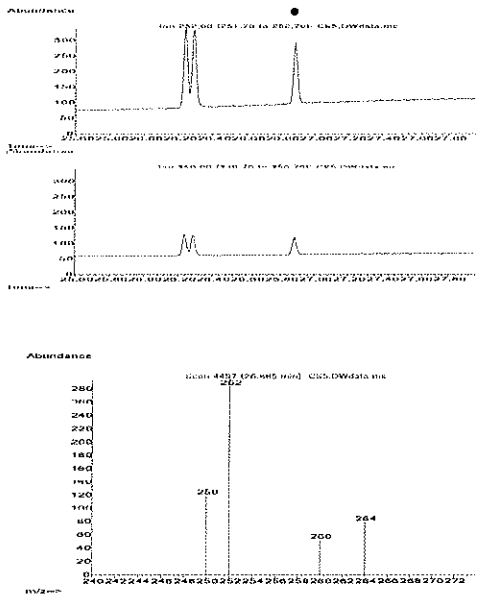
<Benzo(b)fluoranthene>



<Benzo(k)fluoranthene>

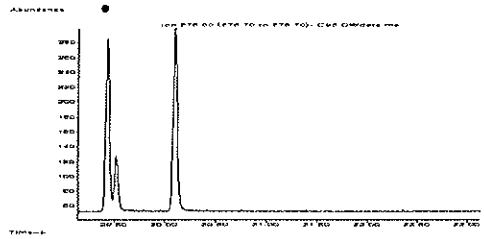


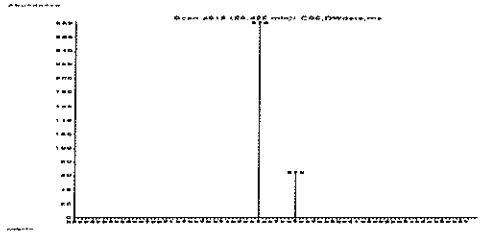
<Benzo(a)pyrene>



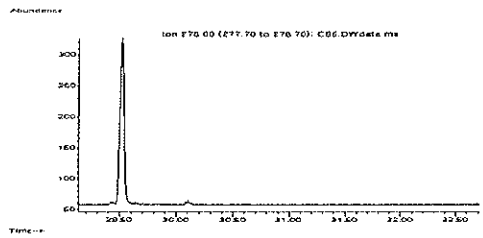
4538

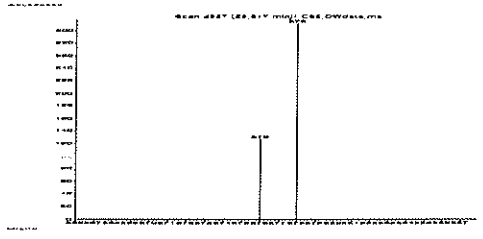
<Indeno(1,2,3-c,d)pyrene>



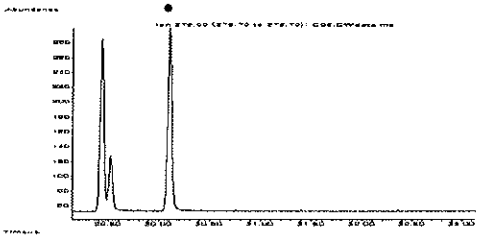


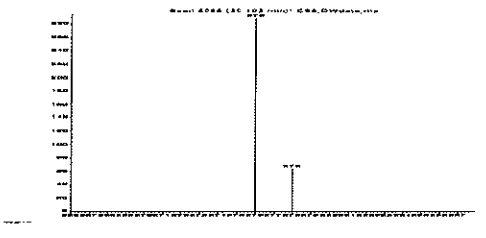
<Dibenz(a,h)anthracene>





<Benzo(g,h,i)perylene>

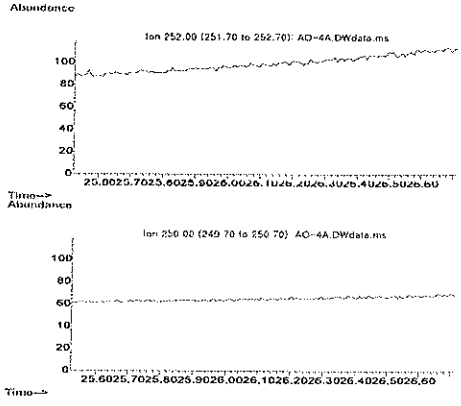


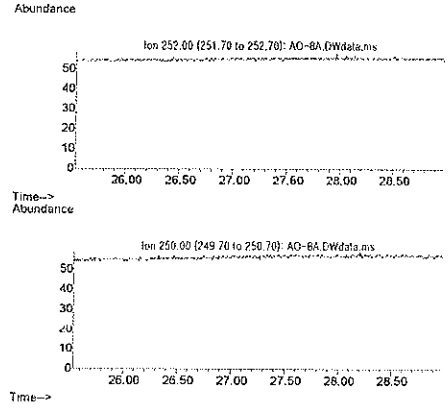


4539

<Benzo(a)pyrene>

- Drinking water well : 15-286 - Monitoring Well : B09-177MW

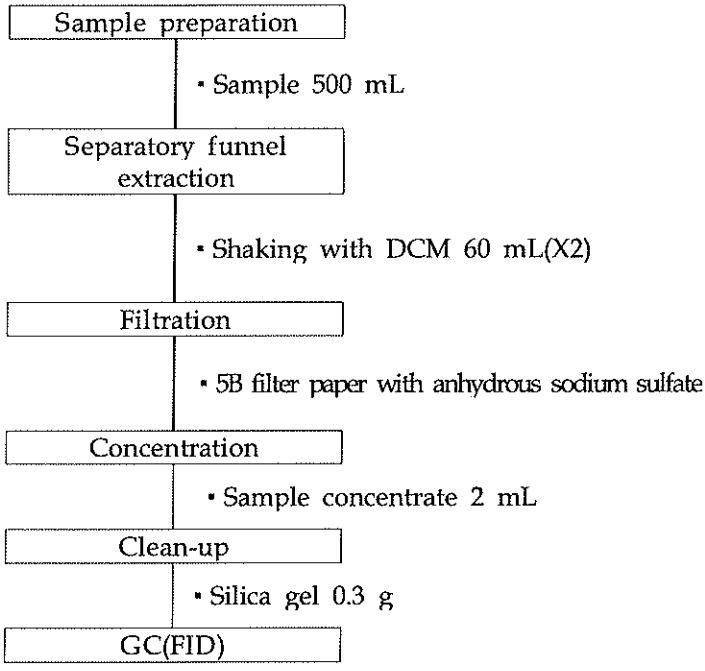




9540

❑ TPHs

○ Analytical method (Korean Official Testing Method for Water)



○ GC/FID condition

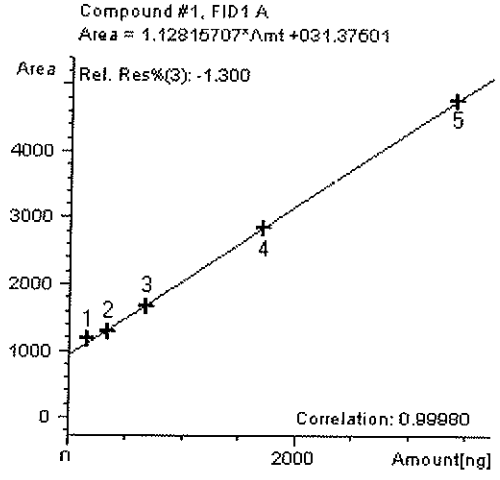
Separation column	HP5 5% Phenyl methyl siloxane (30m×320um×0.25um)
Oven temperature program	50℃, 1min 15℃/min to 200℃, 5℃/min to 310℃ 310℃, 15min
Injection temperature	280℃
Split injection(1:20)	2 uL
Carrier gas flow	1.5 mL/min(N_2)

4/541

❍ **Calibrations** : 170, 340, 680, 1,700, 3,400 ng

Compound	Calibration Curve	Response Factor	Recovery(%)
TPHs	y=1.12815707*x+931.37501	1.000	73.0±3.55

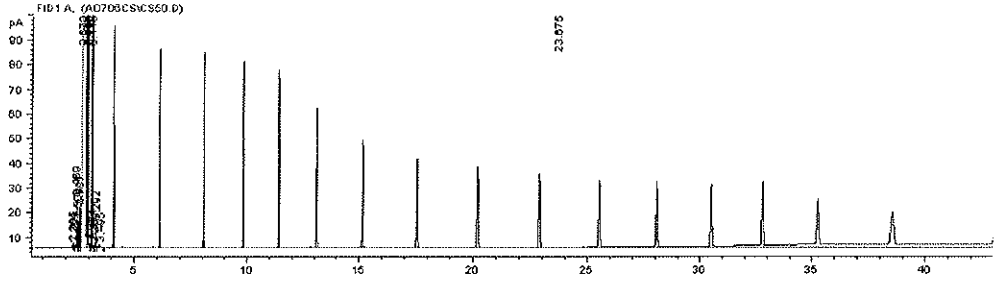
❍ Calibration curves



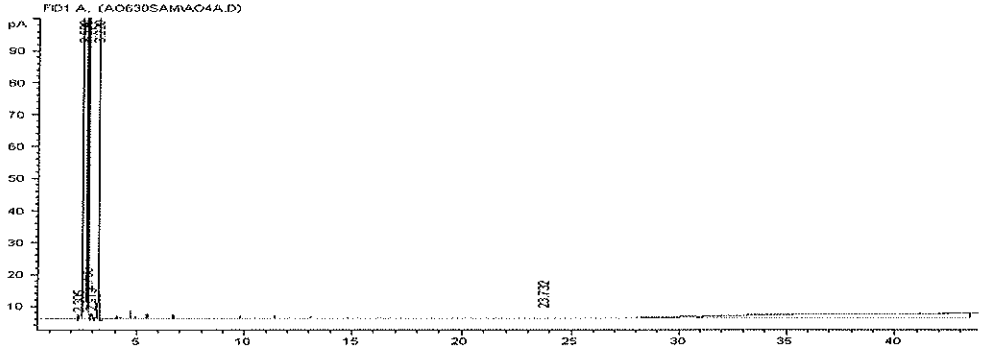
4542

❍ Chromatogram

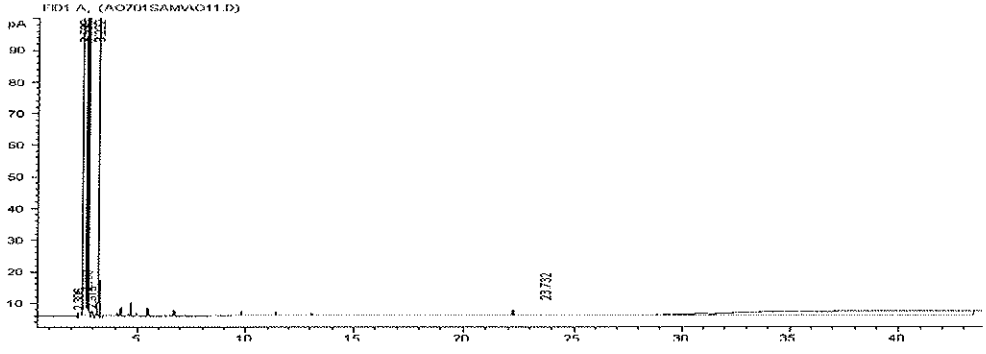
- Standard 1,700 ng



- Drinking water well : 15-286



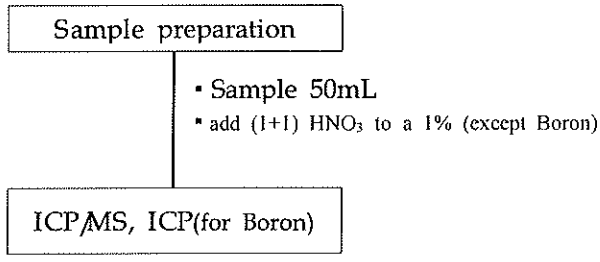
- Monitoring Well : B03-463MW



4543

❑ Metals

❍ Analytical method (Korean Official Testing Method for Drinking Water (ES 15400 3a and 05400 2a))



❍ ICP/MS and ICP conditions

	ICP/MS	ICP
RF Power	1.2 KW	1.0
Nebulizer gas flow	0.96 L/min	1.2 L/min
Plasma gas flow	16.0 L/min	12.0 L/min

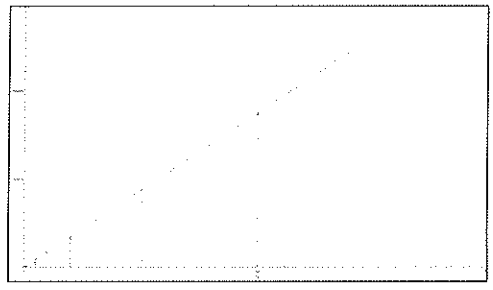
4544

❍ **Calibrations** : (Ba, Al, Cr, Mn, Fe, Cu, Zn, As, Se, Cd, Pb) 1, 5, 10, 20, 50, 100 μg/L
(B) 0.005, 0.02, 0.05, 0.1, 0.2 mg/L (Hg) 0.1, 0.2, 0.5, 1.0 μg/L

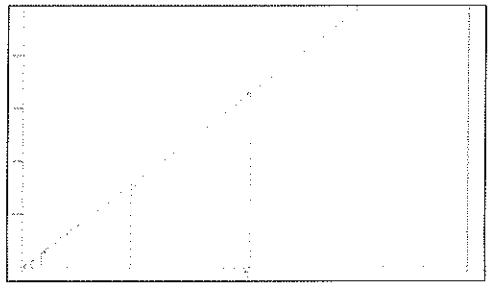
Compound	Calibration Curve	Response Factor
Barium (Ba)	y= 17497.3x	0.99999
Aluminium (Al)	y= 3244.06x	0.99963
Chromium (Cr)	y= 2453.04x	0.99988
Manganese (Mn)	y= 7741.69x	0.99999
Iron (Fe)	y= 109.455x	0.99988
Copper (Cu)	y= 2078.92	0.99999
Zinc (Zn)	y= 791.076x	0.99922
Arsenic (As)	y= 1026.63x	0.99999
Selenium (Se)	y= 84.8246x	0.99993
Cadmium (Cd)	y= 1980.25x	0.99999
Lead (Pb)	y= 15991.6x	0.99999
Boron (B)	y= 79806x+97.68	0.99986
Mercury (Hg)	y= 6410.62x	0.99822

4545

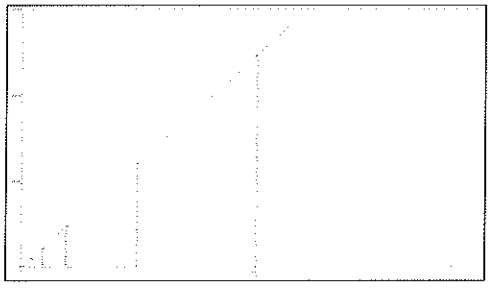
❍ Calibration curves



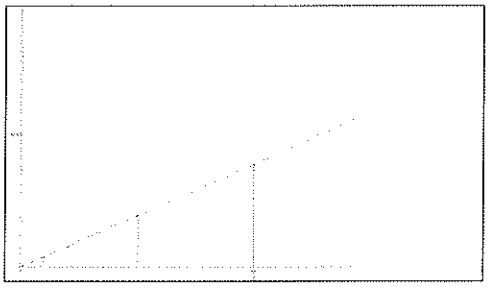
Ba



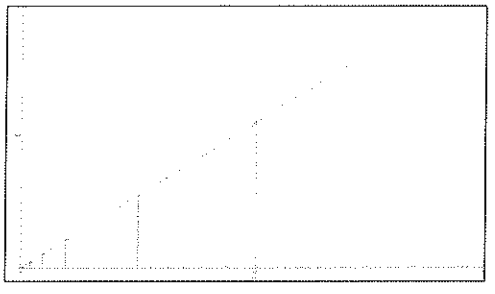
Al



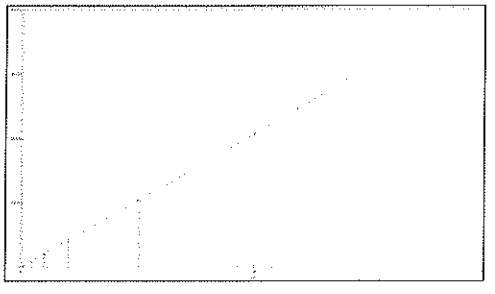
Cr



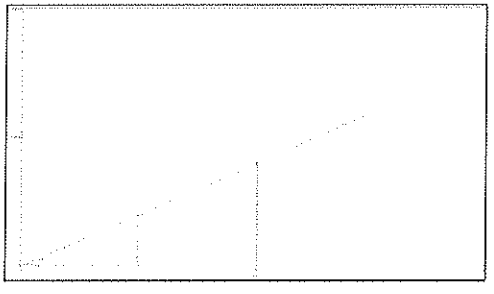
Mn



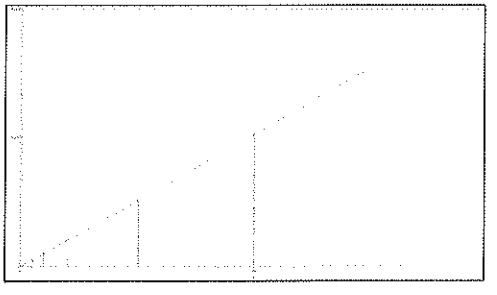
Fe



Cu

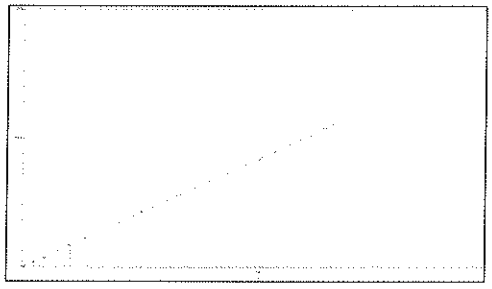


Zn

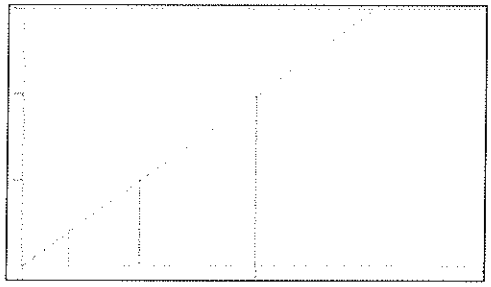


As

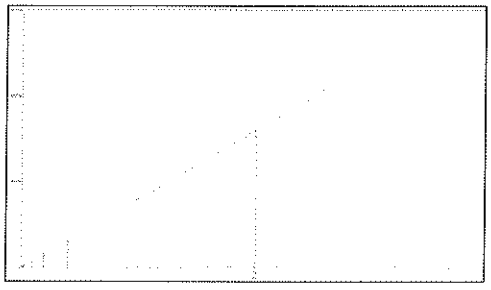
4546



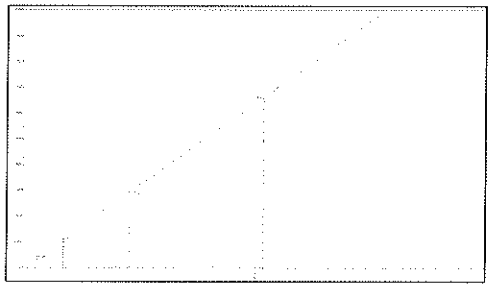
Se



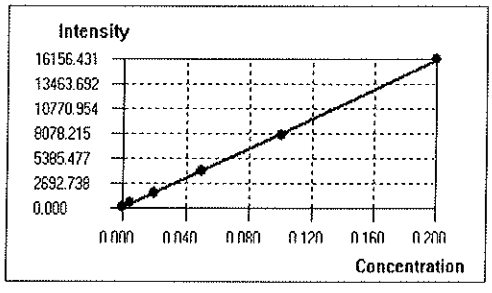
Cd



Pb



Hg



B

4547

Summary of Groundwater Test Result at Cp Carroll

		Sample ID	12-247	13-279	14-283	15-286	16-289	20-575	B09-176MW	B09-177MW	B09-178MW	B07-217MW	B07-218MW
		Sampling date	6/3/2011	6/3/2011	6/2/2011	6/3/2011	6/2/2011	6/2/2011	6/8/2011	6/9/2011	6/9/2011	6/12/2011	6/13/2011
		Location	Supply Well	Supply Well	Supply Well	Supply Well	Supply Well	Supply Well	Helipad	Helipad	Helipad	Landfarm	Landfarm
Herbicide	2,4-D	ug/L	< 0.569	< 0.588	< 0.571	< 0.568	< 0.589	< 0.551	< 0.604	< 0.604	< 1.15	< 0.599	< 0.615
	2,4,5-T	ug/L	< 0.569	< 0.588	< 0.571	0.0579 J	< 0.589	< 0.551	< 0.604	< 0.604	2.13	< 0.599	< 0.615
	2,4,5-TP (Silvex)	ug/L	< 0.569	< 0.588	< 0.571	< 0.568	< 0.589	< 0.551	< 0.604	< 0.604	< 1.15	< 0.599	< 0.615
	2,4-DB	ug/L	< 0.569	< 0.588	< 0.571	< 0.568	< 0.589	< 0.551	< 0.604	< 0.604	< 1.15	< 0.599	< 0.615
	Dicamba	ug/L	< 0.569	< 0.588	< 0.571	< 0.568	< 0.589	< 0.551	< 0.604	< 0.604	< 1.15	< 0.599	< 0.615
Dioxin	2,3,7,8-TCDD	ng/L	< 0.00499	< 0.00506	< 0.00501	< 0.00500	< 0.00498	< 0.00502	< 0.00496	< 0.00498	< 0.00499	< 0.00509	< 0.00507
	1,2,3,7,8-PeCDD	ng/L	< 0.0250	< 0.0253	< 0.0251	< 0.0250	< 0.0249	< 0.0251	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	1,2,3,4,7,8-HxCDD	ng/L	< 0.0250	< 0.0253	< 0.0251	< 0.0250	< 0.0249	< 0.0251	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	1,2,3,6,7,8-HxCDD	ng/L	< 0.0250	< 0.0253	< 0.0251	< 0.0250	< 0.0249	< 0.0251	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	1,2,3,7,8,9-HxCDD	ng/L	< 0.0250	< 0.0253	< 0.0251	< 0.0250	< 0.0249	< 0.0251	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	1,2,3,4,6,7,8-HpCDD	ng/L	< 0.0250	< 0.0253	0.00431 EMPC	< 0.0250	< 0.0249	< 0.0251	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	OCDD	ng/L	< 0.0499	< 0.0506	0.0206 EMPC	< 0.0500	< 0.0498	< 0.0502	< 0.0496	< 0.0498	< 0.0499	< 0.0509	< 0.0507
Furan	2,3,7,8-TCDF	ng/L	< 0.00499	< 0.00506	< 0.00501	< 0.00500	< 0.00498	0.000763 EMPC	< 0.00496	< 0.00498	< 0.00499	< 0.00509	< 0.00507
	1,2,3,7,8-PeCDF	ng/L	< 0.0250	< 0.0253	< 0.0251	< 0.0250	< 0.0249	0.00108 EMPC	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	2,3,4,7,8-PeCDF	ng/L	< 0.0250	0.000425 J	0.000962 EMPC	< 0.0250	< 0.0249	< 0.0251	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	1,2,3,4,7,8-HxCDF	ng/L	< 0.0250	< 0.0253	0.00124 J	< 0.0250	< 0.0249	< 0.0251	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	1,2,3,6,7,8-HxCDF	ng/L	< 0.0250	< 0.0253	0.00130 J	< 0.0250	< 0.0249	< 0.0251	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	2,3,4,6,7,8-HxCDF	ng/L	< 0.0250	< 0.0253	< 0.0251	< 0.0250	< 0.0249	< 0.0251	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	1,2,3,7,8,9-HxCDF	ng/L	< 0.0250	< 0.0253	< 0.0251	< 0.0250	< 0.0249	< 0.0251	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	1,2,3,4,6,7,8-HpCDF	ng/L	< 0.0250	< 0.0253	0.00285 J	< 0.0250	< 0.0249	< 0.0251	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	1,2,3,4,7,8,9-HpCDF	ng/L	< 0.0250	< 0.0253	< 0.0251	< 0.0250	< 0.0249	< 0.0251	< 0.0248	< 0.0249	< 0.0250	< 0.0255	< 0.0254
	OCDF	ng/L	< 0.0499	< 0.0506	0.0156 J	< 0.0500	< 0.0498	< 0.0502	< 0.0496	< 0.0498	< 0.0499	< 0.0509	< 0.0507
	WHO-2005 TEQ (ND=0)	*ng/L*	*0*	*0.000127*	*0.000287*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	WHO-2005 TEQ w/EMPC (ND=0)	*ng/L*	*0*	*0.000127*	*0.000625*	*0*	*0*	*0.000109*	*0*	*0*	*0*	*0*	*0*

NOTES:

1. *J:* Estimated amount detected between the method detection limit and lower calibration limit
2. *EMPC:* Estimated maximum possible concentration due to ion ratio failure

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Summary of Groundwater Test Result at Cp Carroll

		Sample ID	B07-219MW	B07-220MW	B07-221MW	B03-463MW	B03-464MW	B03-465MW	B03-466MW	B03-467MW	B03-468MW	B09-193MW	B09-221MW
		Sampling date	6/11/2011	6/12/2011	6/12/2011	6/10/2011	6/15/2011	6/16/2011	6/14/2011	6/15/2011	6/16/2011	6/14/2011	6/10/2011
		Location	Landfarm	Landfarm	Landfarm	Area D	Area D	Area D	Area D	Area D	Area D	Area D	Area D
Herbicide	2,4-D	ug/L	< 0.614	< 0.600	< 0.593	< 1.17	< 0.590	< 0.606	< 0.582	< 0.593	< 0.617	< 0.601	< 0.612
	2,4,5-T	ug/L	< 0.614	< 0.600	< 0.593	2.83	< 0.590	< 0.606	1.02	0.308 J	< 0.617	< 0.601	< 0.612
	2,4,5-TP (Silvex)	ug/L	< 0.614	< 0.600	< 0.593	< 1.17	< 0.590	< 0.606	< 0.582	< 0.593	< 0.617	< 0.601	< 0.612
	2,4 DB	ug/L	< 0.614	< 0.600	< 0.593	< 1.17	< 0.590	< 0.606	< 0.582	< 0.593	< 0.617	< 0.601	< 0.612
	Dicamba	ug/L	< 0.614	< 0.600	< 0.593	< 1.17	< 0.590	< 0.606	< 0.582	< 0.593	< 0.617	< 0.601	< 0.612
Dioxin	2,3,7,8-TCDD	ng/L	< 0.00498	< 0.00502	< 0.00499	< 0.00498	< 0.00499	< 0.00507	< 0.00504	< 0.00506	< 0.00503	< 0.00508	< 0.00497
	1,2,3,7,8-PeCDD	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	< 0.0252	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	1,2,3,4,7,8-HxCDD	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	< 0.0252	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	1,2,3,6,7,8-HxCDD	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	< 0.0252	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	1,2,3,7,8,9-HxCDD	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	< 0.0252	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	1,2,3,4,6,7,8-HpCDD	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	< 0.0252	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	OCDD	ng/L	< 0.0498	< 0.0502	< 0.0499	< 0.0498	< 0.0499	< 0.0507	< 0.0504	< 0.0506	< 0.0503	< 0.0508	< 0.0497
Furan	2,3,7,8-TCDF	ng/L	< 0.00498	< 0.00502	< 0.00499	< 0.00498	< 0.00499	< 0.00507	< 0.00504	< 0.00506	< 0.00503	< 0.00508	< 0.00497
	1,2,3,7,8-PeCDF	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	< 0.0252	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	2,3,4,7,8-PeCDF	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	0.00205 EMPC	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	1,2,3,4,7,8-HxCDF	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	< 0.0252	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	1,2,3,6,7,8-HxCDF	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	< 0.0252	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	2,3,4,6,7,8-HxCDF	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	< 0.0252	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	1,2,3,7,8,9-HxCDF	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	< 0.0252	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	1,2,3,4,6,7,8-HpCDF	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	< 0.0252	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	1,2,3,4,7,8,9-HpCDF	ng/L	< 0.0249	< 0.0251	< 0.0249	< 0.0249	< 0.0249	< 0.0253	< 0.0252	< 0.0253	< 0.0251	< 0.0254	< 0.0248
	OCDF	ng/L	< 0.0498	< 0.0502	< 0.0499	< 0.0498	< 0.0499	< 0.0507	< 0.0504	< 0.0506	< 0.0503	< 0.0508	< 0.0497
	WHO-2005 TEQ (ND=0)	*ng/L*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	WHO-2005 TEQ w/EMPC (ND=0)	*ng/L*	*0*	*0*	*0*	*0*	*0*	*0*	*0.000615*	*0*	*0*	*0*	*0*

NOTES:

1. J: Estimated amount detected between the method de
2. EMPC: Estimated maximum possible concentration dur

Primary Sample: 2 of 2

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APPENDIX C

FOCUSED HUMAN HEALTH RISK ASSESSMENT

C–1. INTRODUCTION.

a. The health threat from a site can be estimated through the use of risk assessment techniques. These estimates are useful in supporting whether health effects could be anticipated from the evaluated use of the site. Such calculations have also proved valuable in developing and supporting planning decisions about the need for remedial actions on sites thought or known to be affected by activities involving chemical releases.

b. This appendix presents a focused human health risk assessment performed for evaluating the health implications of hypothetical industrial workers, utility/maintenance workers, construction workers, soldiers in training, and an adult resident on the suspected site of a former Drum Disposal site at Camp Carroll, Taegu, South Korea. The risk assessment is focused to these sites to address health concerns from exposure to the materials which could have been disposed of at these sites. The receptors evaluated represent a range of present and future site users. The risks to an adult resident are also presented as a point of comparison. The residual contamination at the site is believed to be in the subsurface due to the operation of the disposal trench; however, surficial exposures are also evaluated for this site because the area is presently used for industrial operations (helipads, helicopter maintenance, and material storage). A focused risk assessment evaluates the health implications from a specific suspected source or affected receptor type. This assessment is considered focused since it was performed to evaluate the health consequences of an exposure to a specific suspected contaminant source. This approach attempts to provide evidence of the existence of the contaminant source and provides an understanding of the potential health threats that may be posed by the exposure to any residual chemicals at the site.

c. This focused risk assessment will follow the same methods used for conducting baseline risk assessments at U.S. Environmental Protection Agency (USEPA) hazardous waste sites.

d. Three points about a risk assessment should be emphasized.

(1) First, an estimate of carcinogenic risk or noncarcinogenic hazard is dependent upon the assumptions and numerical values used in the risk characterization, toxicity evaluation, and exposure assessment components. Risk assessment estimates should not be taken as absolute measures of an individual's

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probability of an adverse health effect. Rather, the estimates should be viewed as a threshold of concern for the receptor populations. Since most exposure parameters incorporate methods are designed to be very conservative and protective of human health with built-in safety factors in order to address uncertainties and be consistent with the public health principle of prevention. Since the process is protectively designed, the risk values generated represent estimates of risk that are most likely an overestimate.

(2) Second, these estimates do not indicate that an adverse outcome actually will occur; they only indicate the likelihood or probability that such outcomes might occur under very specific exposure conditions. However, the flexibility to adjust exposure assumptions and values allows risk managers to analyze a number of different exposure conditions and reach a more informed decision than if a risk assessment was not conducted.

(3) Third, a comprehensive risk assessment is only one of several tools that can provide useful information for risk management decisions. Results of a risk assessment only contribute to a final risk management solution; they are not the final solution. When all uncertainties associated with the assumptions and exposure values are identified, however, a comprehensive risk assessment can assist policy developers and risk managers in reaching a more informed risk management decision about available management options.

C–2. METHODOLOGY AND ORGANIZATION OF DOCUMENT. The methodology employed for this risk assessment follows USEPA guidance. Four steps in the risk assessment process are outlined below. These steps are discussed in more detail in Sections C-3 through C-6.

a. Identification of Chemicals of Concern (Section C–3). This section provides site-related data in the affected media along with background chemical data for those media. In this study, the exposure media being quantitatively evaluated include soil (surface and subsurface), groundwater, and drinking water. Detailed summaries and statistical analyses of these data are provided in this section. Chemicals with detections in the applicable environmental media greater than the screening criteria were evaluated in the risk assessment. Chemicals not detected or not detected above the screening criteria in any sample in a media were eliminated from further evaluation in that media. This section discusses the additional reasons for eliminating chemicals from further evaluation in the risk assessment.

b. Exposure Assessment (Section C–4). For human exposure to occur, a pathway must be complete. That is, all of the following must be present: a source, a transport media (for example, soil), an exposure point (location), and an exposure route (for example, ingestion). This section includes derivation and presentation of the

exposures expected at the site and used in the human health risk assessment. Examples of scenarios which may be active on this site are hypothetical construction workers. Chemical-intake values are calculated based on exposure pathways, specific exposure values, and assumptions. Equations used to calculate intakes for all applicable exposure pathways are presented in this section.

c. Toxicity Assessment (Section C–5). This section presents the toxicity values used in the human health risk calculations. Reference to the appropriate data sources, such as the Integrated Risk Information System (IRIS) (USEPA, 2007) or California's Office of Environmental Health Hazard Assessment (State of California, 2011), are provided to support the toxicity values.

d. Risk Characterization (Section C–6). This section presents the risk calculations for all complete human health exposure pathways. Noncarcinogenic and carcinogenic risk estimates are summarized for each receptor and exposure pathway. In all scenarios, the calculated risk values apply to a hypothetical individual on the site and represents an upper-bound (reasonable maximum) risk estimate. Thus, the calculated risk is not directly applicable to actual individuals living and/or working on the site. All of the exposure assumptions have been chosen to protect the maximum reasonably exposed individual. This provides a conservative estimate of risk, which tends to overestimate the risk to any actual individual.

C–3. IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPCs).

a. Introduction. The results from the strategically placed sampling were used in this evaluation. While the samples with in a borehole location were chosen to evaluate specific exposure scenarios, the locations of the boreholes were chosen to be biased towards finding contamination to address the concern that chemicals were buried on one or more of the sites and to identify the types of chemicals that may have been disposed of. Groundwater and drinking water samples were obtained from the existing wells on and around the sites. Soil samples were obtained using direct push technology and collected for depth intervals consisting of: 0-0.5 meters; 0.5-2 meters; 3-5 meters; and either just above and below the first encountered groundwater or just above bedrock refusal in dry boreholes. These samples were collected from June to August 2011 to characterize the residual and/or source contamination. The results for the sampling were provided as laboratory data sheets and appear in Appendix B. All samples were analyzed for metals, volatile organics, semivolatile organics, herbicides, dioxin/furans, and pesticides (USEPA, 1996). All reported detections were considered as reported and nondetected substances of chemicals that were not deleted through screening were considered at one-half the detection limit for consideration in the risk evaluation.

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b. Data Pattern. Since this area was reported as having an industrial use in the past, the sporadic distribution of the data was not unexpected. However, the data in a few discrete areas are worth special note. The area around boreholes E11-118 and E11-124 appears to contain a concentration of pesticides that is significantly higher than other general areas of the Phase I site. The results of the surface soil sample of borehole E11-155 contained an arsenic concentration that was one-two orders of magnitude higher than those of the surrounding boreholes. The results of the S3 depth (2.0-3.4 meters below ground surface (bgs)) of borehole E11-160 showed low concentrations of multiple semivolatile organic compounds (mostly polyaromatic hydrocarbons, and chlorinated phenols, benzenes, and toluenes). This sample is noteworthy because other samples in the area only showed a few detections of these compounds.

c. Data Reduction Evaluation Considerations and Calculation of the Exposure Point Concentration. The maximum concentration found for each chemical was compared to the USEPA Residential Screening Levels (RSLs) to develop the list of chemicals that would be retained for further evaluation. Chemicals whose maximum concentrations did not exceed its RSL were eliminated from further consideration. Removing analytes from further consideration is consistent with USEPA Risk Assessment Guidance (USEPA, 1989). Chemicals, which were not detected at any sample location within a phase, were not considered; these were also eliminated from further consideration. Chemicals which did not have corresponding RSLs were retained if not eliminated for another reason.

(1) This section contains the data evaluation for the Phase I data. Tables C-1 and C-2 list the chemicals evaluated for the Phase I site that were included in the analytical suite. These tables compare the maximum detected concentration for each chemical with its corresponding RSL.

(a) The data were evaluated to compare the site data set to the chemicals resulting from the analysis of the analytical blanks. Analysis of analytical blanks was used to evaluate the possibility that some chemicals in the site data set have resulted from the analysis and are not related to site activities. Chemicals in the site data set will be eliminated from further consideration if the concentration in the site data set is at a concentration less than ten times that found in the analysis of the blank sample.

(b) The frequency of detections was not used to eliminate chemicals from this data set due to the limited amount of historical analytical data on the site.

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Table C-1. Soil

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	Chemical retained?	Note
Units	ug/kg	mg/kg	mg/kg	Y/N	
Volatile Organic Chemicals					
1,1,1,2-Tetrachloroethane	ND	ND	1.90E+00	N	ND-(Not detected)
1,1,1-Trichloroethane	ND	ND	8.70E+03	N	ND
1,1,2,2-Tetrachloroethane	ND	ND	5.60E-01	N	ND
1,1,2-Trichloroethane	ND	ND	1.10E+00	N	ND
1,1-Dichloroethane	ND	ND	3.30E+00	N	ND
1,1-Dichloroethene	ND	ND	2.40E+02	N	ND
1,1-Dichloropropene	ND	ND	Not applicable (NA)	N	ND
1,2,3-Trichlorobenzene	280	0.28	4.90E+01	N	<RSL
1,2,3-Trichloropropane	ND	ND	5.00E-03	N	ND
1,2,4-Trichlorobenzene	921	0.921	2.20E+01	N	<RSL
1,2,4-Trimethylbenzene	1390	1.39	6.20E+01	N	<RSL
1,2-Dibromo-3-chloropropane	ND	ND	5.40E-03	N	ND
1,2-Dibromoethane	ND	ND	3.40E-02	N	ND
1,2-Dichlorobenzene	ND	ND	1.90E+03	N	ND
1,2-Dichloroethane	ND	ND	4.30E-01	N	ND
1,2-Dichloropropane	ND	ND	9.40E-01	N	ND
1,3,5-Trimethylbenzene	736	0.736	7.80E+02	N	<RSL
1,3-Dichlorobenzene	ND	ND	2.40E+00	N	ND
1,3-Dichloropropane	ND	ND	1.60E+03	N	ND
1,4-Dichlorobenzene	85.7	0.0857	2.40E+00	N	<RSL
2,2-Dichloropropane	ND	ND	NA	N	ND
2-Butanone (MEK)	67.4	0.0674	2.80E+04	N	<RSL
2-Chlorotoluene	ND	ND	1.60E+03	N	ND
2-Hexanone	5.61	0.00561	2.10E+02	N	<RSL
4-Chlorotoluene	ND	ND	1.60E+03	N	ND
4-Isopropyltoluene	433	0.433	2.10E+03	N	<RSL
4-Methyl-2-pentanone (Methyl isobutyl ketone)	ND	ND	5.30E+03	N	ND
Acetone	250	0.25	6.10E+04	N	<RSL
Benzene	117	0.117	1.10E+00	N	<RSL
Bromobenzene	ND	ND	3.00E+02	N	ND

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Bromochloromethane	ND	ND	1.60E+02	N	ND
Bromodichloromethane	ND	ND	2.70E-01	N	ND
Bromoform	ND	ND	6.20E+01	N	ND
Bromomethane	ND	ND	7.30E+00	N	ND
Carbon disulfide	ND	ND	8.20E+02	N	ND
Carbon tetrachloride	ND	ND	6.10E-01	N	ND
Chlorobenzene	8.36	0.00836	2.90E+02	N	<RSL
Chloroethane	ND	ND	1.50E+01	N	ND
Chloroform	ND	ND	2.90E-01	N	ND
Chloromethane	ND	ND	1.20E+02	N	ND
cis-1,2-Dichloroethene	215	0.215	1.60E+02	N	<RSL
cis-1,3-Dichloropropene	ND	ND	1.70E+00	N	ND
Dibromochloromethane	ND	ND	6.80E-01	N	ND
Dibromomethane	ND	ND	3.40E-01	N	ND
Dichlorodifluoromethane	ND	ND	9.40E+01	N	ND
Ethyl Benzene	45.1	0.0451	5.40E+00	N	<RSL
Hexachlorobutadiene	ND	ND	6.20E+00	N	ND
Isopropylbenzene (Cumene)	ND	ND	2.10E+03	N	ND
m,p-Xylene	988	0.988	6.00E+02	N	<RSL
Methyl iodide	4.01	0.00401	7.8E+02	N	<RSL
Methylene chloride	9.47	0.00947	1.10E+01	N	<RSL
Naphthalene	7660	7.66	3.60E+00	Y	
n-Butylbenzene	ND	ND	NA	N	ND
n-Propylbenzene	ND	ND	3.40E+03	N	ND
o-Xylene	695	0.695	6.00E+02	N	<RSL
sec-Butylbenzene	ND	ND	NA	N	ND
Styrene	ND	ND	6.30E+03	N	ND
tert-Butyl methyl ether (MTBE)	ND	ND	4.30E+01	N	ND
tert-Butylbenzene	ND	ND	NA	N	ND
Tetrachloroethene	18000	18	5.50E-01	Y	
Toluene	8.55	0.00855	5.00E+03	N	<RSL
trans-1,2-Dichloroethene	0.953	0.000953	1.50E+02	N	<RSL
trans-1,3-Dichloropropene	ND	ND	1.70E+00	N	ND
trans-1,4-Dichloro-2-butene	ND	ND	6.90E-03	N	ND
Trichloroethene	186	0.186	2.80E+00	N	<RSL
Trichlorofluoromethane	ND	ND	7.90E+02	N	ND
Vinyl chloride	ND	ND	6.00E-02	N	ND

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Semivolatile Organic Chemicals					
1,2,4-Trichlorobenzene	301	0.301	2.20E+01	N	<RSL
1,2-Dichlorobenzene	ND	ND	1.90E+03	N	ND
1,3-Dichlorobenzene	ND	ND	2.40E+00	N	ND
1,4-Dichlorobenzene	157	0.157	2.40E+00	N	<RSL
2,4,5-Trichlorophenol	ND	ND	6.10E+03	N	ND
2,4,6-Trichlorophenol	ND	ND	4.40E+01	N	ND
2,4-Dichlorophenol	ND	ND	1.80E+02	N	ND
2,4-Dimethylphenol	ND	ND	1.20E+03	N	ND
2,4-Dinitrotoluene	ND	ND	1.60E+00	N	ND
2,6-Dinitrotoluene	ND	ND	6.10E+01	N	ND
2-Chloronaphthalene	ND	ND	6.30E+03	N	ND
2-Chlorophenol	ND	ND	3.90E+02	N	ND
2-Methylnaphthalene	2140	2.14	3.10E+02	N	<RSL
2-Methylphenol (Cresol)	ND	ND	7.50E+03	N	ND
2-Nitroaniline	ND	ND	6.10E+02	N	ND
2-Nitrophenol	ND	ND	NA	N	ND
3 and/or 4-Methylphenol	ND	ND	7.50E+06	N	ND
3-Nitroaniline	ND	ND	2.40E+01	N	ND
4-Bromophenyl phenyl ether	ND	ND	NA	N	ND
4-Chloro-3-methylphenol	ND	ND	NA	N	ND
4-Chloroaniline	ND	ND	2.40E+00	N	ND
4-Chlorophenyl phenyl ether	ND	ND	NA	N	ND
4-Nitroaniline	ND	ND	2.40E+01	N	ND
4-Nitrophenol	ND	ND	NA	N	ND
Acenaphthene	ND	ND	3.40E+03	N	ND
Acenaphthylene	ND	ND	NA	N	ND
Anthracene	ND	ND	1.70E+04	N	ND
Benzo(a)anthracene	ND	ND	1.50E-01	N	ND
Benzo(a)pyrene	ND	ND	1.50E-02	N	ND
Benzo(b)fluoranthene	ND	ND	3.80E-01	N	ND
Benzo(g,h,i)perylene	ND	ND	No screening criteria (NC)	N	ND
Benzo(k)fluoranthene	ND	ND	1.50E+00	N	ND
Bis(2-Chloroethoxy)methane	ND	ND	1.80E+02	N	ND
Bis(2-Chloroethyl)ether	ND	ND	2.10E-01	N	ND
Bis(2-Chloroisopropyl)ether	ND	ND	NA	N	ND
Bis(2-Ethylhexyl)phthalate	671	0.671	3.50E+01	N	<RSL
Butyl benzyl phthalate	ND	ND	2.60E+02	N	ND
Chrysene	ND	ND	1.50E+01	N	ND
Dibenz(a,h)anthracene	ND	ND	1.50E-02	N	ND

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Dibenzofuran	ND	ND	7.80E+01	N	ND
Diethyl phthalate	ND	ND	4.90E+04	N	ND
Dimethyl phthalate (Phthalic Acid)	616	0.616	6.10E+04	N	<RSL
Di-n-butyl phthalate	30.8	0.0308	6.10E+03	N	<RSL
Di-n-octyl phthalate	ND	ND	NA	N	ND
Fluoranthene	35.2	0.0352	2.30E+03	N	<RSL
Fluorene	ND	ND	2.30E+03	N	ND
Hexachlorobenzene	ND	ND	3.00E-01	N	ND
Hexachlorobutadiene	ND	ND	6.20E+00	N	ND
Hexachlorocyclo pentadiene	ND	ND	3.70E+02	N	ND
Hexachloroethane	ND	ND	3.50E+01	N	ND
Indeno(1,2,3-cd)pyrene	ND	ND	1.50E-01	N	ND
Isophorone	ND	ND	5.10E+02	N	ND
Naphthalene	281	0.281	3.60E+00	N	<RSL
Nitrobenzene	ND	ND	4.80E+00	N	ND
n-Nitrosodi-n-propylamine	ND	ND	6.90E-02	N	ND
Pentachlorophenol	ND	ND	8.90E-01	N	ND
Phenanthrene	ND	ND	NC	N	ND
Phenol	ND	ND	1.80E+04	N	ND
Pyrene	ND	ND	1.70E+03	N	ND
Organophosphous Pesticides					
Bolstar	ND	ND	NA	N	ND
Chlorpyrifos	ND	ND	1.8E+02	N	ND
Coumaphos	ND	ND	NA	N	ND
Demeton	ND	ND	2.4	N	ND
Diazinon	ND	ND	4.3E+01	N	ND
Dichlorvos	ND	ND	1.7	N	ND
Dimethoate	ND	ND	1.2E+01	N	ND
Disulfoton	ND	ND	2.4	N	ND
EPN	ND	ND	NA	N	ND
Ethoprop	ND	ND	NA	N	ND
Ethyl Parathion	ND	ND	NA	N	ND
Fensulfothion	ND	ND	NA	N	ND
Fenthion	ND	ND	NA	N	ND
Malathion	ND	ND	1.2E+03	N	ND
Methyl Azinphos (Guthion)	ND	ND	NA	N	ND
Methyl Parathion	ND	ND	1.5E+01	N	ND
Merphos	ND	ND	1.8	N	ND
Mevinphos	ND	ND	NA	N	ND

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Monocrotophos	ND	ND	NA	N	ND
Naled	ND	ND	1.2E+02	N	ND
Phorate	ND	ND	1.2E+01	N	ND
Ronnel	ND	ND	3.1E+03	N	ND
Sulfotep	ND	ND	NA	N	ND
Stirophos	ND	ND	2.0E+01	N	ND
TEPP	ND	ND	NA	N	ND
Tokuthion	ND	ND	NA	N	ND
Trichloronate	ND	ND	NA	N	ND
Organochlorine Pesticides					
4,4'-DDD	10700	10.7	2.00E+00	Y	
4,4'-DDE	68.9	0.0689	1.40E+00	N	<RSL
4,4'-DDT	2990	2.99	1.70E+00	Y	
Aldrin	ND	ND	2.90E-02	N	ND
alpha-BHC	4880	4.88	7.70E-02	Y	
alpha-chlordane	ND	ND	1.60E+00	N	ND
beta-BHC	ND	ND	2.70E-01	N	ND
Chlordane	ND	ND	1.60E+00	N	ND
delta-BHC	5360	5.36	2.70E-01	Y	
Dieldrin	0.918	0.000918	3.00E-02	N	<RSL
Endosulfan I	0.531	0.000531	3.70E+02	N	<RSL
Endosulfan II	ND	ND	3.70E+02	N	ND
Endosulfan sulfate	ND	ND	3.70E+02	N	ND
Endrin	ND	ND	1.80E+01	N	ND
Endrin aldehyde	1.57	0.00157	1.80E+01	N	<RSL
Endrin ketone	ND	ND	1.80E+01	N	ND
gamma-BHC (lindane)	163000	163	5.20E-01	Y	
gamma-chlordane	0.858	0.000858	1.60E+00	N	<RSL
Heptachlor	ND	ND	1.10E-01	N	ND
Heptachlor epoxide	ND	ND	5.30E-02	N	ND
Methoxychlor	ND	ND	3.10E+02	N	ND
Toxaphene	ND	ND	4.40E-01	N	ND
Herbicides					
2,4,5-T		ND	6.1E+02	N	ND
2,4,5-TP (Silvex)		ND	4.9E+02	N	ND
2,4'-D		ND	6.9E+02	N	ND
2,4-DB		ND	4.9E+02	N	ND
Dicamba		ND	1.8E+03	N	ND

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Metals					
Arsenic		39	3.90E-01	Y	
Barium		409	1.50E+04	N	<RSL
Cadmium		2.76	7.00E+01	N	<RSL
Chromium		16.7	1.20E+05	N	<RSL
Lead		138	4.00E+02	N	<RSL
Mercury		0.0147	1.00E+01	N	<RSL
Selenium		1.35	3.90E+02	N	<RSL
Silver		0.533	3.90E+02	N	<RSL
Dioxin (I-TEQ)					
I-TEQ (TCDD Equivalent)	1.16E-03	1.16E-06	4.5E-06	N	<RSL

Table C-2. Groundwater

Parameter	Maximium Detected	Maximum Detected	USEPA RSL	MCL	Chemical retained?	Note
Units	mg/L	ug/L	ug/L	ug/L	Y/N	
Volatile Organic Chemicals						
1,1,1-Trichloroethane	ND	ND	2.4E-01	5	N	ND
1,1-Dichloroethene	ND	ND	2.4	-	N	ND
Benzene	ND	ND	4.1E-01	5	N	ND
Bromodichloromethane	ND	ND	1.2E-01	80	N	ND
Bromoform	ND	ND	1.2E-01	80	N	ND
Carbon tetrachloride	ND	ND	4.4E-01	5	N	ND
Chloroform	ND	ND	1.9E-01	80	N	ND
cis-1,2-Dichloroethene	ND	ND	7.3E+01	70	N	ND
Dibromochloromethane	ND	ND	1.5E-01	80	N	ND
Ethyl Benzene	ND	ND	1.5	700	N	ND
m,p-Xylene	ND	ND	2.0E+02	-	N	ND
Methylene chloride	ND	ND	4.8	5	N	ND
o-Xylene	ND	ND	2.0E+02	-	N	ND
Tetrachloroethene	0.211	211	1.1E-01	5	Y	
Toluene	ND	ND	2.3E+03	1000	N	ND
trans-1,2-Dichloroethene	ND	ND	1.1E+02	100	N	ND
Trichloroethene	0.001	1	2	5	N	<RSL

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Semivolatile Organic Chemicals	ng/L					
Acenaphthalene	ND	ND	2.2E+03	-	N	ND
Acenaphthene	ND	ND	2.2E+03	-	N	ND
Fluorene	ND	ND	1.5E+03	-	N	ND
Phenanthrene	ND	ND	NC	-	N	ND
Anthracene	ND	ND	1.1E+04	-	N	ND
Fluoranthene	ND	ND	1.5E+03	-	N	ND
Pyrene	ND	ND	1.1E+03	-	N	ND
Benzo(a)anthracene	ND	ND	2.9E-02	-	N	ND
Chrysene	ND	ND	2.9	-	N	ND
Benzo(b)fluoranthene	ND	ND	2.9E-02	-	N	ND
Benzo(k)fluoranthene	ND	ND	2.9E-01	-	N	ND
Benzo(a)pyrene	ND	ND	2.9E-03	-	N	ND
Benzo(g,h,i)perylene	ND	ND	NC	-	N	ND
Dibenz(a,h)anthracene	ND	ND	2.9E-03	-	N	ND
Indeno(1,2,3-cd)pyrene	ND	ND	2.9E+02	-	N	ND
Total Polyaromatic hydrocarbon	ND	ND	NA	-	N	ND
Naphthalene		0.29	1.4E-01	-	Y	Data from Area D USACE, 2011
Organochlorine Pesticides	ng/L					
4,4'-DDD	ND	ND	2.8E-01	-	N	ND
4,4'-DDE	ND	ND	2.0E-01	-	N	ND
4,4'-DDT	ND	ND	2.0E-01	-	N	ND
Aldrin	ND	ND	4.0E-03	-	N	ND
alpha-BHC	69.8	0.0698	1.1E-02	-	Y	
alpha-chlordane	ND	ND	1.9E-01	2	N	ND
beta-BHC	0.8	0.0008	3.7E-02	-	N	<RSL
delta-BHC	290	0.29	3.7E-02	-	Y	
Dieldrin	3.4	0.0034	4.2E-03	-	N	<RSL
Endosulfan I	1.9	0.0019	2.2E+02	-	N	<RSL
Endosulfan II	3.5	0.0035	2.2E+02	-	N	<RSL
Endrin	2.2	0.0022	1.1E+01	2	N	<RSL
gamma-BHC (lindane)	2726.0	2.726	6.1E-02	2.0E-01	Y	
gamma-chlordane	ND	ND	1.9E-01	2	N	ND
Heptachlor	ND	ND	1.5E-02	0.4	N	ND
Heptachlor epoxide	1.4	0.0014	7.4E-03	0.2	N	<RSL
Trans-nonachlor	ND	ND	NA	-	N	ND

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Cis-nonachlor	ND	ND	NA	-	N	ND
Hexachlorobenzene(HCB)	ND	ND	4.2E-02	1	N	ND
Oxychlordane	ND	ND	NA	-	N	ND
Mirex	ND	ND	3.7E-03	-	N	ND
Pentachlorbenzene	ND	ND	2.9E+01	-	N	ND
Herbicides						
2,4,5-T		0	3.7E+02	-	N	ND
2,4'-D		0	3.7E+02	70	N	ND
Metals	mg/L					
Aluminum	0.18	180	3.7E+04	-	N	<RSL
Arsenic	ND	ND	4.5E-02	10	N	ND
Barium	0.06	60	7.3E+03	2000	N	<RSL
Boron	ND	ND	7.3E+03	-	N	ND
Cadmium	ND	ND	1.8E+01	5	N	ND
Chromium	ND	ND	5.5E+04	-	N	ND
Copper	ND	ND	1.5E+03	1300	N	ND
Iron	0.25	250	2.6E+04	-	N	<RSL
Lead	ND	ND	-	15	N	ND
Mercury	ND	ND	6.3E-01	2	N	ND
Manganese	0.021	21	8.8E+02	-	N	<RSL
Selenium	ND	ND	1.8E+02	50	N	ND
Zinc	0.117	117	1.1E+04	-	N	<RSL
Dioxin (I-TEQ)						
I-TEQ (TCDD Equivalent)		1.0E-09	5.2E-07	3.0E-05	N	<RSL

(c) Soil has a natural concentration of certain chemicals (background). While there is some differing opinions as to whether anthropogenic chemicals (those released into the environment by man but not by the operation/site under evaluation (i.e., chemicals released in vehicle exhaust from a highway near the site)) should be included in the evaluation, most environmental professionals will agree that concentrations from the natural constituent of the soil should not be considered in evaluating the health effects from exposure to a site. Most of the chemicals affected by this issue belong to the metals group. At this site, arsenic is at a concentration high enough to be retained for further evaluation if it is also higher than the region's background concentration for that chemical. Natural arsenic has been evaluated in the general area of Camp Carroll (Jung et al., 2002; Kim et al., 2011). Jung et al. reported that control soil samples contained a range of 5.1-25.3 mg/kg arsenic, while Kim et al. reported that the natural soils in Korea can have arsenic concentrations that range from 8.8-387 mg/kg. Since

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the Phase I soils samples show an overall average concentration of 4.11 mg/kg with averages by depth that ranged from 5.39-1.92 mg/kg, we are considering the arsenic concentrations observed in Phase I due to background concentrations. Therefore, arsenic was eliminated from further evaluation as a COPC.

(d) After eliminating nonsite-related chemicals from the risk assessment, the data was divided by depth (Tables C-3 through C-7). Exposure point concentrations (EPCs) were calculated as the upper 95th confidence limit (95th UCL) on the arithmetic mean concentration for that COPC.

Table C-3. Soil at Depth S1 Ground Surface to 0.5 Meters Below Ground Surface

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	Chemical retained?	Note
Units	ug/kg	mg/kg	mg/kg	Y/N	
Volatile Organic Chemicals					ND-(Not detected)
Naphthalene	0.55	0.00055	3.60E+00	N	
Tetrachloroethene	6.9	0.0069	5.50E-01	N	
Semivolatile Organic Chemicals					
No COPCs in this group/depth					
Organophosphous Pesticides					
No COPCs in this group/depth					
Organochlorine Pesticides					
4,4'-DDD	34.9	0.0349	2.00E+00	N	
4,4'-DDT	450	0.450	1.70E+00	N	
alpha-BHC	0.743	0.000743	7.70E-02	N	
delta-BHC	0.63	0.00063	2.70E-01	N	
gamma-BHC (lindane)	13.5	0.0135	5.20E-01	N	
Herbicides					
No COPCs in this group/depth					

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Metals					
No COPCs in this group/depth					
Dioxin (I-TEQ)					
No COPCs in this group/depth					

Note for Table C-3:
All the chemicals presented in Table C-3 for Phase I at the S1 depth were eliminated from consideration as COPCs since they were either considered natural background or detected at concentrations less than the health-based screening concentration for each chemical.

Table C-4. Soil at Depth S2 – 2 to 5 Meters Below Ground Surface

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	Chemical retained?	Note
Units	ug/kg	mg/kg	mg/kg	Y/N	
Volatile Organic Chemicals					ND-(Not detected)
Naphthalene	7660	7.66	3.60E+00	Y	
Tetrachloroethene	18000	18	5.50E-01	Y	
Semivolatile Organic Chemicals					
No COPCs in this group/depth					
Organophosphous Pesticides					
No COPCs in this group/depth					
Organochlorine Pesticides					
4,4'-DDD	10700	10.7	2.00E+00	Y	
4,4'-DDT	2990	2.99	1.70E+00	Y	
alpha-BHC	4880	4.88	7.70E-02	Y	
delta-BHC	5360	5.36	2.70E-01	Y	
gamma-BHC (lindane)	163000	163	5.20E-01	Y	

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Herbicides					
No COPCs in this group/depth					
Metals					
No COPCs in this group/depth					
Dioxin (I-TEQ)					
No COPCs in this group/depth					

Note for Table C-4:
The COPCs presented in Table C-4 for Phase I at the S2 depth that were retained for further evaluation are:

- Naphthalene
- Tetrachloroethene
- DDD
- DDT
- alpha-PHC
- delta-BHC
- gamma-BHC (lindane)

Table C-5. Soil at Depth S3 Just Above the First Pheatic Surface or Direct Push Technology Refusal

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	Chemical retained?	Note
Units	ug/kg	mg/kg	mg/kg	Y/N	
Volatile Organic Chemicals					ND-(Not detected)
Naphthalene	8.51	0.00851	3.60E+00	N	
Tetrachloroethene	52.8	0.0528	5.50E-01	N	
Semivolatile Organic Chemicals					
No COPCs in this group/depth					
Organophosphous Pesticides					
No COPCs in this group/depth					

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Organochlorine Pesticides					
4,4'-DDD	147	0.147	2.00E+00	N	
4,4'-DDT	64.3	0.0643	1.70E+00	N	
alpha-BHC	53.5	0.0535	7.70E-02	N	
delta-BHC	61.3	0.0613	2.70E-01	N	
gamma-BHC (lindane)	1130	1.13	5.20E-01	Y	
Herbicides					
No COPCs in this group/depth					
Metals					
No COPCs in this group/depth					
Dioxin (I-TEQ)					
No COPCs in this group/depth					

Note for Table C-5:
The only COPC presented in Table C-5 for Phase I that was detected at the S3 level is gamma-BHC (lindane).

Table C-6. Soil at Depth S4 Just Below the First Phreatic Surface

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	Chemical retained?	Note
Units	ug/kg	mg/kg	mg/kg	Y/N	
Volatile Organic Chemicals					ND-(Not detected)
Naphthalene	0.55	0.00055	3.60E+00	N	
Tetrachloroethene	8.68	0.00868	5.50E-01	N	
Semivolatile Organic Chemicals					
No COPCs in this group/depth					
Organophosphous Pesticides					

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No COPCs in this group/depth					
Organochlorine Pesticides					
4,4'-DDD	1.84	0.00184	2.00E+00	N	
4,4'-DDT	1.98	0.00198	1.70E+00	N	
alpha-BHC	22.5	0.0225	7.70E-02	N	
delta-BHC	43.3	0.0433	2.70E-01	N	
gamma-BHC (lindane)	728	0.728	5.20E-01	Y	
Herbicides					
No COPCs in this group/depth					
Metals					
No COPCs in this group/depth					
Dioxin (I-TEQ)					
No COPCs in this group/depth					

Note for Table C-6:
The only COPC presented in Table C-6 for Phase I that was detected at the S4 level is gamma-BHC (lindane).

Table C-7. Phase I Site Groundwater Results

Parameter	Maximium Detected	Maximum Detected	USEPA RSL	MCL	Chemical retained?	Note
Units	mg/L	ug/L	ug/L	ug/L	Y/N	
Volatile Organic Chemicals						
Tetrachloroethene	0.211	211	1.1E-01	5	Y	
Semivolatile Organic Chemicals	ng/L					
Naphthalene		0.29	1.4E-01	-	Y	Data from Area D USACE, 2011

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Organochlorine Pesticides	ng/L					
alpha-BHC	69.8	0.0698	1.1E-02	-	Y	
delta-BHC	290	0.29	3.7E-02	-	Y	
gamma-BHC (lindane)	2726.0	2.726	6.1E-02	2.0E-01	Y	
Herbicides						
No COPCs in this group/depth						
Metals						
No COPCs in this group/depth						
Dioxin (I-TEQ)						
No COPCs in this group/depth						

Note for Table C-7:
The COPCs presented in Table C-7 that were detected in the Phase I site groundwater are:

- Tetrachloroethene
- Naphthalene
- alpha-BHC
- delta-BHC
- gamma-BHC (lindane)

(2) This section contains the data evaluation for the Phase II data. Tables C-8 and C-9 list the chemicals evaluated for the Phase II site risk assessment that were included in the analytical suite. These tables compare the maximum detected concentration for each chemical with its corresponding RSL.

(a) The data were evaluated to compare the site data set to the chemicals resulting from the analysis of the analytical blanks. The analysis of analytical blanks is used to evaluate the possibility that some chemicals in the site data set have resulted from the analysis and are not related to site activities. Chemicals in the site data set will be eliminated from further consideration if the concentration in the site data set is at a concentration less than ten times that found in the analysis of the blank sample.

Table C-8. Phase II Site Soil Results

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	Chemical retained?	Note
Units	ug/kg	mg/kg	mg/kg	Y/N	
Volatile Organic Chemicals					
1,1,1,2-Tetrachloroethane	ND	ND	1.90E+00	N	ND-(Not detected)
1,1,1-Trichloroethane	ND	ND	8.70E+03	N	ND
1,1,2,2-Tetrachloroethane	ND	ND	5.60E-01	N	ND
1,1,2-Trichloroethane	ND	ND	1.10E+00	N	ND
1,1-Dichloroethane	3	3.00E-03	3.30E+00	N	ND
1,1-Dichloroethene	ND	ND	2.40E+02	N	ND
1,1-Dichloropropene	ND	ND	NA	N	ND
1,2,3-Trichlorobenzene	89.5	8.95E-02	4.90E+01	N	<RSL
1,2,3-Trichloropropane	ND	ND	5.00E-03	N	ND
1,2,4-Trichlorobenzene	295	0.295	2.20E+01	N	<RSL
1,2,4-Trimethylbenzene	22.7	2.27E-02	6.20E+01	N	<RSL
1,2-Dibromo-3-chloropropane	ND	ND	5.40E-03	N	ND
1,2-Dibromoethane	ND	ND	3.40E-02	N	ND
1,2-Dichlorobenzene	ND	ND	1.90E+03	N	ND
1,2-Dichloroethane	ND	ND	4.30E-01	N	ND
1,2-Dichloropropane	ND	ND	9.40E-01	N	ND
1,3,5-Trimethylbenzene	ND	ND	7.80E+02	N	ND
1,3-Dichlorobenzene	9.26	9.26E-03	2.40E+00	N	<RSL
1,3-Dichloropropane	ND	ND	1.60E+03	N	ND
1,4-Dichlorobenzene	339	0.339	2.40E+00	N	<RSL
2,2-Dichloropropane	ND	ND	NA	N	ND
2-Butanone (MEK)	28	0.028	2.80E+01	N	<RSL
2-Chlorotoluene	10.4	1.04E-02	1.60E+03	N	<RSL
2-Hexanone	4.44	4.44E-03	2.10E+02	N	<RSL
4-Chlorotoluene	19.7	1.97E-02	1.60E+03	N	<RSL
4-Isopropyltoluene	ND	ND	2.10E+03	N	ND
4-Methyl-2-pentanone (Methyl isobutyl ketone)	ND	ND	5.30E+03	N	ND
Acetone	98.8	9.88E-02	6.10E+04	N	<RSL
Benzene	6.69	6.69E-03	1.10E+00	N	<RSL
Bromobenzene	ND	ND	3.00E+02	N	ND

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Bromochloromethane	ND	ND	1.60E+02	N	ND
Bromodichloromethane	ND	ND	2.70E-01	N	ND
Bromoform	ND	ND	6.20E+01	N	ND
Bromomethane	ND	ND	7.30E+00	N	ND
Carbon disulfide	6.67	6.67E-03	8.20E+02	N	<RSL
Carbon tetrachloride	ND	ND	6.10E-01	N	ND
Chlorobenzene	278	0.278	2.90E+02	N	<RSL
Chloroethane	10.7	1.07E-02	1.50E+01	N	ND
Chloroform	26.7	2.67E-02	2.90E-01	N	<RSL
Chloromethane	ND	ND	1.20E+02	N	ND
cis-1,2-Dichloroethene	558	0.558	1.60E+02	N	<RSL
cis-1,3-Dichloropropene	ND	ND	1.70E+00	N	ND
Dibromochloromethane	ND	ND	6.80E-01	N	ND
Dibromomethane	ND	ND	3.40E-01	N	ND
Dichlorodlfluoromethane	ND	ND	9.40E+01	N	ND
Ethyl Benzene	ND	ND	5.40E+00	N	ND
Hexachlorobutadiene	ND	ND	6.20E+00	N	ND
Isopropylbenzene (Cumene)	ND	ND	2.10E+03	N	ND
m,p-Xylene	ND	ND	6.00E+02	N	ND
Methyl iodide	7.92	7.92E-03	7.8E+02	N	<RSL
Methylene chloride	30.9	3.09E-02	1.10E+01	N	<RSL
Naphthalene	2560	2.56E+00	3.60E+00	N	<RSL
n-Butylbenzene	ND	ND	NA	N	ND
n-Propylbenzene	ND	ND	3.40E+03	N	ND
o-Xylene	18.7	1.87E-02	6.00E+02	N	<RSL
sec-Butylbenzene	ND	ND	NA	N	ND
Styrene	ND	ND	6.30E+03	N	ND
tert-Butyl methyl ether (MTBE)	ND	ND	4.30E+01	N	ND
tert-Butylbenzene	ND	ND	NA	N	ND
Tetrachloroethene	32300	32.3E+00	5.50E-01	Y	
Toluene	21300	21.3E+00	5.00E+03	N	<RSL
trans-1,2-Dichloroethene	4.37	4.37E-03	1.50E+02	N	<RSL
trans-1,3-Dichloropropene	ND	ND	1.70E+00	N	ND
trans-1,4-Dichloro-2-butene	ND	ND	6.90E-03	N	ND
Trichloroethene	587	0.587	2.80E+00	N	<RSL
Trichlorofluoromethane	ND	ND	7.90E+02	N	ND

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Vinyl chloride	56.1	5.61E-02	6.00E-02	N	<RSL
Semivolatile Organic Chemicals					
1,2,4-Trichlorobenzene	35.4	3.54E-02	2.20E+01	N	<RSL
1,2-Dichlorobenzene	ND	ND	1.90E+03	N	ND
1,3-Dichlorobenzene	ND	ND	2.40E+00	N	ND
1,4-Dichlorobenzene	ND	ND	2.40E+00	N	ND
2,4,5-Trichlorophenol	ND	ND	6.10E+03	N	ND
2,4,6-Trichlorophenol	ND	ND	4.40E+01	N	ND
2,4-Dichlorophenol	ND	ND	1.80E+02	N	ND
2,4-Dimethylphenol	ND	ND	1.20E+03	N	ND
2,4-Dinitrotoluene	ND	ND	1.60E+00	N	ND
2,6-Dinitrotoluene	ND	ND	6.10E+01	N	ND
2-Chloronaphthalene	ND	ND	6.30E+03	N	ND
2-Chlorophenol	ND	ND	3.90E+02	N	ND
2-Methylnaphthalene	1450	1.45	3.10E+02	N	<RSL
2-Methylphenol (Cresol)	30.9	3.09E-02	7.50E+03	N	<RSL
2-Nitroaniline	ND	ND	6.10E+02	N	ND
2-Nitrophenol	ND	ND	NA	N	ND
3 and/or 4-Methylphenol	37.8	3.78E-02	7.50E+06	N	<RSL
3-Nitroaniline	ND	ND	2.40E+01	N	ND
4-Bromophenyl phenyl ether	ND	ND	NA	N	ND
4-Chloro-3-methylphenol	ND	ND	NA	N	ND
4-Chloroaniline	ND	ND	2.40E+00	N	ND
4-Chlorophenyl phenyl ether	ND	ND	NA	N	ND
4-Nitroaniline	ND	ND	2.40E+01	N	ND
4-Nitrophenol	ND	ND	NA	N	ND
Acenaphthene	ND	ND	3.40E+03	N	ND
Acenaphthylene	ND	ND	NA	N	ND
Anthracene	ND	ND	1.70E+04	N	ND
Benzo(a)anthracene	ND	ND	1.50E-01	N	ND
Benzo(a)pyrene	56.7	5.67E-02	1.50E-02	Y	
Benzo(b)fluoranthene	ND	ND	3.80E-01	N	ND
Benzo(g,h,i)perylene	73.4	7.34E-02	NC	N	Dropped due to lack of toxicological criteria (DLTC)
Benzo(k)fluoranthene	ND	ND	1.50E+00	N	ND

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Bis(2-Chloroethoxy) methane	ND	ND	1.80E+02	N	ND
Bis(2-Chloroethyl)ether	ND	ND	2.10E-01	N	ND
Bis(2-Chloroisopropyl) ether	ND	ND	NA	N	ND
Bis(2-Ethylhexyl)phthalate	602	0.602	3.50E+01	N	<RSL
Butyl benzyl phthalate	ND	ND	2.60E+02	N	ND
Chrysene	ND	ND	1.50E+01	N	ND
Dibenz(a,h)anthracene	ND	ND	1.50E-02	N	ND
Dibenzofuran	60.2	6.02E-02	7.80E+01	N	<RSL
Diethyl phthalate	ND	ND	4.90E+04	N	ND
Dimethyl phthalate (Phthalic Acid)	ND	ND	6.10E+04	N	ND
Di-n-butyl phthalate	ND	ND	6.10E+03	N	ND
Di-n-octyl phthalate	ND	ND	NA	N	ND
Fluoranthene	ND	ND	2.30E+03	N	ND
Fluorene	ND	ND	2.30E+03	N	ND
Hexachlorobenzene	ND	ND	3.00E-01	N	ND
Hexachlorobutadiene	ND	ND	6.20E+00	N	ND
Hexachlorocyclo pentadiene	ND	ND	3.70E+02	N	ND
Hexachloroethane	ND	ND	3.50E+01	N	ND
Indeno(1,2,3-cd)pyrene	ND	ND	1.50E-01	N	ND
Isophorone	ND	ND	5.10E+02	N	ND
Naphthalene	193	0.193	3.60E+00	N	<RSL
Nitrobenzene	ND	ND	4.80E+00	N	ND
n-Nitrosodi-n-propylamine	ND	ND	6.90E-02	N	ND
Pentachlorophenol	ND	ND	8.90E-01	N	ND
Phenanthrene	ND	ND	NC	N	ND
Phenol	ND	ND	1.80E+04	N	ND
Pyrene	ND	ND	1.70E+03	N	ND
Organophosphous Pesticides					
Bolstar	ND	ND	NA	N	ND
Chlorpyrifos	ND	ND	1.8E+02	N	ND
Coumaphos	ND	ND	NA	N	ND
Demeton	ND	ND	2.4	N	ND
Diazinon	ND	ND	4.3E+01	N	ND
Dichlorvos	ND	ND	1.7	N	ND
Dimethoate	ND	ND	1.2E+01	N	ND
Disulfoton	ND	ND	2.4	N	ND
EPN	ND	ND	NA	N	ND

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Ethoprop	ND	ND	NA	N	ND
Ethyl Parathion	ND	ND	NA	N	ND
Fensulfothion	ND	ND	NA	N	ND
Fenthion	ND	ND	NA	N	ND
Malathion	ND	ND	1.2E+03	N	ND
Methyl Azinphos (Guthion)	ND	ND	NA	N	ND
Methyl Parathion	ND	ND	1.5E+01	N	ND
Merphos	ND	ND	1.8	N	ND
Mevinphos	ND	ND	NA	N	ND
Monocrotophos	ND	ND	NA	N	ND
Naled	ND	ND	1.2E+02	N	ND
Phorate	ND	ND	1.2E+01	N	ND
Ronnel	ND	ND	3.1E+03	N	ND
Sulfotep	ND	ND	NA	N	ND
Stirophos	ND	ND	2.0E+01	N	ND
TEPP	ND	ND	NA	N	ND
Tokuthion	ND	ND	NA	N	ND
Trichloronate	ND	ND	NA	N	ND
Organochlorine Pesticides					
4,4'-DDD	13500	1.35E+01	2.00E+00	Y	
4,4'-DDE	2830	2.83E+00	1.40E+00	Y	
4,4'-DDT	70200	7.02E+01	1.70E+00	Y	
Aldrin	9.27	9.27E-03	2.90E-02	N	<RSL
alpha-BHC	417	4.17E-01	7.70E-02	Y	
alpha-chlordane	78.7	7.87E-02	1.60E+00	N	<RSL
beta-BHC	112	1.12E-01	2.70E-01	N	<RSL
Chlordane	ND	ND	1.60E+00	N	ND
delta-BHC	427	4.27E-01	2.70E-01	Y	
Dieldrin	336	3.36E-01	3.00E-02	Y	
Endosulfan I	ND	ND	3.70E+02	N	ND
Endosulfan II	ND	ND	3.70E+02	N	ND
Endosulfan sulfate	ND	ND	3.70E+02	N	ND
Endrin	ND	ND	1.80E+01	N	ND
Endrin aldehyde	ND	ND	1.80E+01	N	ND
Endrin ketone	2.31	2.31E-03	1.80E+01	N	<RSL
gamma-BHC (lindane)	13900	1.39E+01	5.20E-01	Y	
gamma-chlordane	93	9.30E-02	1.60E+00	N	<RSL
Heptachlor	4	4.0E-03	1.10E-01	N	<RSL

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Heptachlor epoxide	11.1	1.11E-02	5.30E-02	N	<RSL
Methoxychlor	ND	ND	3.10E+02	N	ND
Toxaphene	ND	ND	4.40E-01	N	ND
Herbicides					
2,4,5-T		ND	6.1E+02	N	ND
2,4,5-TP (Silvex)		ND	4.9E+02	N	ND
2,4'-D		ND	6.9E+02	N	ND
2,4-DB		ND	4.9E+02	N	ND
Dicamba		ND	1.8E+03	N	ND
Metals					
Arsenic		56.2	3.90E-01	Y	
Barium		132	1.50E+04	N	<RSL
Cadmium		1.72	7.00E+01	N	<RSL
Chromium		19.6	1.20E+05	N	<RSL
Lead		34.1	4.00E+02	N	<RSL
Mercury		0.0341	1.00E+01	N	<RSL
Selenium		1.48	3.90E+02	N	<RSL
Silver		2.34	3.90E+02	N	<RSL
Dioxin (I-TEQ)					
I-TEQ (TCDD Equivalent)	1.01E-02	1.01E-05	4.5E-06	Y	

Table C-9. Phase II Site Groundwater Results

Parameter	Maximium Detected	Maximum Detected	USEPA RSL	MCL	Chemical retained?	Note
Units	mg/L	ug/L	ug/L	ug/L	Y/N	
Volatile Organic Chemicals						
Acetone	1.50E-02	1.50E+01	2.20E+04		N	<RSL
Benzene	8.00E-03	8.00E+00	4.1E-01	5	Y	
2-Butanone (MEK)	7.70E-04	7.70E-01	7.10E+03		N	<RSL
Carbon disulfide	2.40E-04	2.40E-01	1.00E+03		N	<RSL
Chlorobenzene	1.50E-02	1.5E+01	9.1E+01	100	N	<RSL
Chloroethane	7.90E-03	7.90E+00	2.1E+4		N	<RSL
Chloroform	5.30E-03	5.30E+00	1.9E-01	80	N	<MCL
Chloromethane	3.00E-04	3.00E-01	1.90E+02		N	<RSL
2-Chlorotoluene	1.90E-03	1.90E+00	7.30E+02		N	<RSL

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Dieldrin	2.18E+01	2.18E-02	3.00E-02	N	<RSL
gamma-BHC (lindane)	3.05E+02	3.05E-01	5.20E-01	N	<RSL
Herbicides					
No COPCs in this group/depth					
Metals					
Arsenic		5.62E+01	3.9E-01	Y	
Dioxin (I-TEQ)		1.01E-05	4.5E-06	Y	

Note for Table C-12:
The COPCs that were retained at the S3 depth are:

- DDD
- DDT
- Arsenic
- Dioxin (I-TEQ)

Table C-13. Soil at Depth S4 Just Below the First Phreatic Surface

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	Chemical retained?	Note
Units	ug/kg	mg/kg	mg/kg	Y/N	
Volatile Organic Chemicals					ND-(Not detected)
Tetrachloroethene	4.89E+02	4.89E-01	5.50E-01	N	
Semivolatile Organic Chemicals					
Benzo(a)pyrene	ND	ND	1.5E-02	N	ND
Organophosphous Pesticides					
No COPCs in this group/depth					
Organochlorine Pesticides					
4,4'-DDD	1.29E+02	1.29E-01	2.00E+00	N	<RSL
4,4'-DDE	4.28E+00	4.28E-03	1.40E+00	N	<RSL
4,4'-DDT	2.90E+01	2.90E-02	1.70E+00	N	<RSL

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alpha-BHC	1.71E+00	1.71E-03	7.70E-02	N	<RSL
delta-BHC	1.58E+00	1.58E-03	2.70E-01	N	<RSL
Dieldrin	ND	ND	3.00E-02	N	ND
gamma-BHC (lindane)	4.38E+01	4.38E-02	5.20E-01	N	<RSL
Herbicides					
No COPCs in this group/depth					
Metals					
Arsenic		2.46E+01	3.9E-01	Y	
Dioxin (I-TEQ)		2.54E-07	4.5E-06	N	

Note for Table C-13:
The COPC retained at the S4 depth is arsenic.

Table C-14. Phase II Site Groundwater Results

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	MCL	Chemical retained?	Note
Units	mg/L	ug/L	ug/L	ug/L	Y/N	
Volatile Organic Chemicals						
Benzene	8.00E-03	8.00E+00	4.1E-01	5	Y	
1,1-Dichloroethane	1.80E-02	1.80E+01	2.4E+00		Y	
Cis-1,2-Dichloroethene	2.80E-01	2.80E+02	7.3E+01	7.0E+01	Y	
Naphthalene	7.00E-03	7.00E+00	1.4E-01		Y	
Tetrachloroethene	5.90E-01	5.90E+02	1.1E-01	5	Y	
1,2,4-Trichlorobenzene	4.00E-01	4.00E+02	2.3E+00	70	Y	
Trichloroethene	7.43E-01	7.43E+02	2.0E+00	5	Y	
Vinyl chloride	6.70E-03	6.70E+00	1.6E-02	2	Y	
Semivolatile Organic Chemicals						
No COPCs in this group/depth						
Organochlorine Pesticides						
alpha-BHC	5.30E-04	5.30E-01	1.1E-02		Y	
beta-BHC	7.60E-04	7.60E-01	3.70E-02		Y	

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delta-BHC	1.10E-03	1.10E+00	3.70E-02		Y	
gamma-BHC (lindane)	4.90E-03	4.90E+00	6.1E-02	2.0E-01	Y	
Dieldrin	4.40E-04	4.40E-01	4.20E-03		Y	
Herbicides						
No COPCs in this group/depth						
Metals						
Manganese	6.46E+00	6.46E+03	8.8E+02		Y	
Dioxin (I-TEQ)						
No COPCs in this group/depth						

Note for Table C-14:
The COPCs that were retained in the Phase II site groundwater are:

- Benzene
- 1,1-Dichloroethane
- cis-1,2-Dichloroethene
- Naphthalene
- Tetrachlorethene
- 1,2,4-Trichlorobenzene
- Trichlorethene
- Vinyl chloride
- alpha-BHC
- beta-BHC
- delta-BHC
- gamma-BHC
- Dieldrin
- Manganese

(3) This section contains the data evaluation for the Phase IIB data. Tables C-15 and C-16 list the chemicals evaluated for the Phase IIB site risk assessment that were included in the analytical suite. These tables compare the maximum detected concentration for each chemical with its corresponding RSL.

(a) The data were evaluated to compare the site data set to the chemicals resulting from the analysis of the analytical blanks. The analysis of analytical blanks is used to evaluate the possibility that some chemicals in the site data set have resulted from the analysis and are not related to site activities. Chemicals in the site data set will be eliminated from further consideration if the concentration in the site data set is at a concentration less than ten times that found in the analysis of the blank sample.

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(b) The frequency of detections was not used to eliminate chemicals from this data set due to the limited amount of historical analytical data on the site. However, benzo(ghi)perylene and phenanthracene were eliminated due to a lack of toxicological criteria.

Table C-15. Phase IIB Site Soil Results

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	Chemical retained?	Note
Units	ug/kg	mg/kg	mg/kg	Y/N	
Volatile Organic Chemicals					
1,1,1,2-Tetrachloroethane	ND	ND	1.90E+00	N	ND-(Not detected)
1,1,1-Trichloroethane	ND	ND	8.70E+03	N	ND
1,1,2,2-Tetrachloroethane	ND	ND	5.60E-01	N	ND
1,1,2-Trichloroethane	ND	ND	1.10E+00	N	ND
1,1-Dichloroethane	ND	ND	3.30E+00	N	ND
1,1-Dichloroethene	ND	ND	2.40E+02	N	ND
1,1-Dichloropropene	ND	ND	NA	N	ND
1,2,3-Trichlorobenzene	ND	ND	4.90E+01	N	ND
1,2,3-Trichloropropane	ND	ND	5.00E-03	N	ND
1,2,4-Trichlorobenzene	ND	ND	2.20E+01	N	ND
1,2,4-Trimethylbenzene	ND	ND	6.20E+01	N	ND
1,2-Dibromo-3-chloropropane	ND	ND	5.40E-03	N	ND
1,2-Dibromoethane	ND	ND	3.40E-02	N	ND
1,2-Dichlorobenzene	ND	ND	1.90E+03	N	ND
1,2-Dichloroethane	ND	ND	4.30E-01	N	ND
1,2-Dichloropropane	ND	ND	9.40E-01	N	ND
1,3,5-Trimethylbenzene	ND	ND	7.80E+02	N	ND
1,3-Dichlorobenzene	ND	ND	2.40E+00	N	ND
1,3-Dichloropropane	ND	ND	1.60E+03	N	ND
1,4-Dichlorobenzene	ND	ND	2.40E+00	N	ND
2,2-Dichloropropane	ND	ND	NA	N	ND
2-Butanone (MEK)	25.1	2.51E-02	2.80E+04	N	<RSL
2-Chlorotoluene	23.3	2.33E-02	1.60E+03	N	<RSL
2-Hexanone	ND	ND	2.10E+02	N	ND
4-Chlorotoluene	52	5.2E-02	1.60E+03	N	<RSL

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4-Isopropyltoluene	ND	ND	2.10E+03	N	ND
4-Methyl-2-pentanone (Methyl isobutyl ketone)	ND	ND	5.30E+03	N	ND
Acetone	108	1.08E-01	6.10E+04	N	<RSL
Benzene	ND	ND	1.10E+00	N	ND
Bromobenzene	ND	ND	3.00E+02	N	ND
Bromochloromethane	ND	ND	1.60E+02	N	ND
Bromodichloromethane	ND	ND	2.70E-01	N	ND
Bromoform	ND	ND	6.20E+01	N	ND
Bromomethane	ND	ND	7.30E+00	N	ND
Carbon disulfide	0.976	9.76E-04	8.20E+02	N	<RSL
Carbon tetrachloride	ND	ND	6.10E-01	N	ND
Chlorobenzene	ND	ND	2.90E+02	N	ND
Chloroethane	ND	ND	1.50E+01	N	ND
Chloroform	2.25	2.25E-03	2.90E-01	N	<RSL
Chloromethane	ND	ND	1.20E+02	N	ND
cis-1,2-Dichloroethene	116	1.16E-01	1.60E+02	N	<RSL
cis-1,3-Dichloropropene	ND	ND	1.70E+00	N	ND
Dibromochloromethane	ND	ND	6.80E-01	N	ND
Dibromomethane	ND	ND	3.40E-01	N	ND
Dichlorodifluoromethane	ND	ND	9.40E+01	N	ND
Ethyl Benzene	ND	ND	5.40E+00	N	ND
Hexachlorobutadiene	ND	ND	6.20E+00	N	ND
Isopropylbenzene (Cumene)	ND	ND	2.10E+03	N	ND
m,p-Xylene	ND	ND	6.00E+02	N	ND
Methyl iodide	5.23	5.23E-03	7.8E+02	N	<RSL
Methylene chloride	38.2	3.82E-02	1.10E+01	N	<RSL
Naphthalene	17	1.70E-02	3.60E+00	N	<RSL
n-Butylbenzene	ND	ND	NA	N	ND
n-Propylbenzene	ND	ND	3.40E+03	N	ND
o-Xylene	ND	ND	6.00E+02	N	ND
sec-Butylbenzene	ND	ND	NA	N	ND
Styrene	ND	ND	6.30E+03	N	ND
tert-Butyl methyl ether (MTBE)	ND	ND	4.30E+01	N	ND
tert-Butylbenzene	ND	ND	NA	N	ND
Tetrachloroethene	27.5	2.75E-02	5.50E-01	N	<RSL
Toluene	2960	2.96E+00	5.00E+03	N	<RSL

trans-1,2-Dichloroethene	ND	ND	1.50E+02	N	ND
trans-1,3-Dichloropropene	ND	ND	1.70E+00	N	ND
trans-1,4-Dichloro-2-butene	ND	ND	6.90E-03	N	ND
Trichloroethene	81.3	8.13E-02	2.80E+00	N	<RSL
Trichlorofluoromethane	ND	ND	7.90E+02	N	ND
Vinyl chloride	ND	ND	6.00E-02	N	ND
Semivolatile Organic Chemicals					
1,2,4-Trichlorobenzene	28.4	2.84E-02	2.20E+01	N	<RSL
1,2-Dichlorobenzene	ND	ND	1.90E+03	N	ND
1,3-Dichlorobenzene	ND	ND	2.40E+00	N	ND
1,4-Dichlorobenzene	ND	ND	2.40E+00	N	ND
2,4,5-Trichlorophenol	41.1	4.11E-02	6.10E+03	N	<RSL
2,4,6-Trichlorophenol	37.9	3.79E-02	4.40E+01	N	<RSL
2,4-Dichlorophenol	31.6	3.16E-02	1.80E+02	N	<RSL
2,4-Dimethylphenol	31.6	3.16E-02	1.20E+03	N	<RSL
2,4-Dinitrotoluene	34.7	3.47E-02	1.60E+00	N	<RSL
2,6-Dinitrotoluene	44.2	4.42E-02	6.10E+01	N	<RSL
2-Chloronaphthalene	34.7	3.47E-02	6.30E+03	N	<RSL
2-Chlorophenol	31.6	3.16E-02	3.90E+02	N	<RSL
2-Methylnaphthalene	34.7	3.47E-02	3.10E+02	N	<RSL
2-Methylphenol (Cresol)	31.6	3.16E-02	7.50E+03	N	<RSL
2-Nitroaniline	34.7	3.47E-02	6.10E+02	N	<RSL
2-Nitrophenol	ND	ND	NA	N	ND
3 and/or 4-Methylphenol	82.1	8.21E-02	7.50E+06	N	<RSL
3-Nitroaniline	28.4	2.84E-02	2.40E+01	N	<RSL
4-Bromophenyl phenyl ether	44.2	4.42E-02	NC	N	DLTC
4-Chloro-3-methylphenol	47.4	4.74E-02	61.0E+02	N	<RSL
4-Chloroaniline	37.9	3.79E-02	2.40E+00	N	<RSL
4-Chlorophenyl phenyl ether	56.8	5.68E-02	NC	N	DLTC
4-Nitroaniline	41.1	4.11E-02	2.40E+01	N	<RSL
4-Nitrophenol	ND	ND	NA	N	ND
Acenaphthene	44.2	4.42E-02	3.40E+03	N	<RSL
Acenaphthylene	47.4	4.74E-02	3.60E+00	N	<RSL
Anthracene	50.5	5.05E-02	1.70E+04	N	<RSL
Benzo(a)anthracene	53.7	5.37E-02	1.50E-01	N	<RSL
Benzo(a)pyrene	53.7	5.37E-02	1.50E-02	Y	
Benzo(b)fluoranthene	56.8	5.68E-02	3.80E-01	N	<RSL
Benzo(g,h,i)perylene	53.7	5.37E-02	NC	N	DLTC

Benzo(k)fluoranthene	63.2	6.32E-02	1.50E+00	N	<RSL
Bis(2-Chloroethoxy)methane	31.6	3.16E-02	1.80E+02	N	<RSL
Bis(2-Chloroethyl)ether	ND	ND	2.10E-01	N	ND
Bis(2-Chloroisopropyl)ether	ND	ND	NA	N	ND
Bis(2-Ethylhexyl)phthalate	708	7.08E-01	3.50E+01	N	<RSL
Butyl benzyl phthalate	60	6.0E-02	2.60E+02	N	<RSL
Chrysene	56.8	5.68E-02	1.50E+01	N	<RSL
Dibenz(a,h)anthracene	47.4	4.74E-02	1.50E-02	Y	
Dibenzofuran	47.4	4.74E-02	7.80E+01	N	<RSL
Diethyl phthalate	56.8	5.68E-02	4.90E+04	N	<RSL
Dimethyl phthalate (Phthalic Acid)	53.7	5.37E-02	6.10E+04	N	<RSL
Di-n-butyl phthalate	63.2	6.32E-02	6.10E+03	N	<RSL
Di-n-octyl phthalate	63.2	6.32E-02	6.10E+03	N	<RSL
Fluoranthene	56.8	5.68E-02	2.30E+03	N	<RSL
Fluorene	53.7	5.37E-02	2.30E+03	N	<RSL
Hexachlorobenzene	44.2	4.42E-02	3.00E-01	N	<RSL
Hexachlorobutadiene	ND	ND	6.20E+00	N	ND
Hexachlorocyclo pentadiene	ND	ND	3.70E+02	N	ND
Hexachloroethane	ND	ND	3.50E+01	N	ND
Indeno(1,2,3-cd)pyrene	50.5	5.05E-02	1.50E-01	N	<RSL
Isophorone	ND	ND	5.10E+02	N	ND
Naphthalene	28.4	2.84E-02	3.60E+00	N	<RSL
Nitrobenzene	ND	ND	4.80E+00	N	ND
n-Nitrosodi-n-propylamine	ND	ND	6.90E-02	N	ND
Pentachlorophenol	68	6.80E-02	8.90E-01	N	<RSL
Phenanthrene	50.5	5.05E-02	NC	N	DLTC
Phenol	ND	ND	1.80E+04	N	ND
Pyrene	53.7	5.37E-02	1.70E+03	N	<RSL
Organophosphous Pesticides					
Bolstar	ND	ND	NA	N	ND
Chlorpyrifos	ND	ND	1.8E+02	N	ND
Coumaphos	ND	ND	NA	N	ND
Demeton	ND	ND	2.4	N	ND
Diazinon	ND	ND	4.3E+01	N	ND
Dichlorvos	ND	ND	1.7	N	ND
Dimethoate	ND	ND	1.2E+01	N	ND

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Disulfoton	ND	ND	2.4	N	ND
EPN	ND	ND	NA	N	ND
Ethoprop	ND	ND	NA	N	ND
Ethyl Parathion	ND	ND	NA	N	ND
Fensulfothion	ND	ND	NA	N	ND
Fenthion	ND	ND	NA	N	ND
Malathion	ND	ND	1.2E+03	N	ND
Methyl Azinphos (Guthion)	ND	ND	NA	N	ND
Methyl Parathion	ND	ND	1.5E+01	N	ND
Merphos	ND	ND	1.8	N	ND
Mevinphos	ND	ND	NA	N	ND
Monocrotophos	ND	ND	NA	N	ND
Naled	ND	ND	1.2E+02	N	ND
Phorate	ND	ND	1.2E+01	N	ND
Ronnel	ND	ND	3.1E+03	N	ND
Sulfotep	ND	ND	NA	N	ND
Stirophos	ND	ND	2.0E+01	N	ND
TEPP	ND	ND	NA	N	ND
Tokuthion	ND	ND	NA	N	ND
Trichloronate	ND	ND	NA	N	ND
Organochlorine Pesticides					
4,4'-DDD	4560	4.56	2.00E+00	Y	
4,4'-DDE	50.4	0.0504	1.40E+00	N	<RSL
4,4'-DDT	20000	20	1.70E+00	Y	
Aldrin	ND	ND	2.90E-02	N	ND
alpha-BHC	ND	ND	7.70E-02	N	ND
alpha-chlordane	0.607	6.07E-04	1.60E+00	N	<RSL
beta-BHC	ND	ND	2.70E-01	N	ND
Chlordane	ND	ND	1.60E+00	N	ND
delta-BHC	1.29	1.29E-03	2.70E-01	N	<RSL
Dieldrin	3.24	3.24E-03	3.00E-02	N	<RSL
Endosulfan I	ND	ND	3.70E+02	N	ND
Endosulfan II	ND	ND	3.70E+02	N	ND
Endosulfan sulfate	ND	ND	3.70E+02	N	ND
Endrin	ND	ND	1.80E+01	N	ND
Endrin aldehyde	ND	ND	1.80E+01	N	ND
Endrin ketone	ND	ND	1.80E+01	N	ND
gamma-BHC (lindane)	12.6	1.26E-02	5.20E-01	N	<RSL

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gamma-chlordane	0.709	7.09E-04	1.60E+00	N	<RSL
Heptachlor	ND	ND	1.10E-01	N	ND
Heptachlor epoxide	ND	ND	5.30E-02	N	ND
Methoxychlor	ND	ND	3.10E+02	N	ND
Toxaphene	ND	ND	4.40E-01	N	ND
Herbicides					
2,4,5-T		ND	6.1E+02	N	ND
2,4,5-TP (Silvex)		ND	4.9E+02	N	ND
2,4'-D		ND	6.9E+02	N	ND
2,4-DB		ND	4.9E+02	N	ND
Dicamba		ND	1.8E+03	N	ND
Metals					
Arsenic		308	3.90E-01	Y	
Barium		143	1.50E+04	N	<RSL
Cadmium		1.69	7.00E+01	N	<RSL
Chromium		15.4	1.20E+05	N	<RSL
Lead		34.7	4.00E+02	N	<RSL
Mercury		0.0196	1.00E+01	N	<RSL
Selenium		1.69	3.90E+02	N	<RSL
Silver		0.613	3.90E+02	N	<RSL
Dioxin (I-TEQ)					
I-TEQ (TCDD Equivalent)	1.21E-03	1.21E-06	4.5E-06	N	<RSL

Table C-16. Phase IIB Site Groundwater Results

Parameter	Maximium Detected	Maximum Detected	USEPA RSL	MCL	Chemical retained?	Note
Units	mg/L	ug/L	ug/L	ug/L	Y/N	
Volatile Organic Chemicals						
Acetone	3.40E-03	3.40E+00	2.20E+04		N	<RSL
Benzene	1.10E-02	1.10E+01	4.1E-01	5	Y	
2-Butanone (MEK)	6.00E-04	6.00E-01	7.10E+03		N	<RSL
Carbon disulfide	ND	ND	1.00E+03		N	ND
Chlorobenzene	5.40E-03	5.40E+00	9.1E+01	100	N	<RSL
Chloroethane	4.40E-03	4.40E+00	2.1E+4		N	<RSL

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Chloroform	8.60E-04	8.60E-01	1.9E-01	80	N	<MCL
Chloromethane	ND	ND	1.90E+02		N	ND
2-Chlorotoluene	1.90E-02	1.90E+01	7.30E+02		N	<RSL
4-Chlorotoluene	7.00E-04	7.00E-01	7.30E+02		N	<RSL
1,2-Dichlorobenzene	ND	ND	3.70E+02	600	N	ND
1,3-Dichlorobenzene	ND	ND	4.30E-01	75	N	ND
1,4-Dichlorobenzene	2.90E-04	2.90E-01	4.30E-01	75	N	<RSL
Dichlorodifluoromethane	ND	ND	2.00E+02		N	ND
1,1-Dichloroethane	1.20E-02	1.20E+01	2.40E+00		Y	
1,2-Dichloroethane	9.80E-04	9.80E-01	1.50E-01	5	N	<MCL
cis-1,2-Dichloroethene	1.35E+00	1.35E+03	7.30E+01	70	Y	
trans-1,2-Dichloroethene	4.20E-02	4.20E+01	1.10E+02	100	N	<RSL
1,1-Dichloroethene	4.70E-03	4.70E+00	3.40E+02	7	N	<RSL
1,2-Dichloropropane	ND	ND	3.90E-01	5	N	ND
Ethylbenzene	3.20E-04	3.20E-01	1.5E+00	700	N	<RSL
Isopropylbenzene (Cumene)	ND	ND	6.80E+02		N	ND
p-Isopropyltoluene	ND	ND	7.30E+02		N	ND
Methylene chloride	3.40E-03	3.40E+00	4.80E+00	5	N	<RSL
Naphthalene	7.00E-03	7.00E+00	1.40E-01		Y	
Tetrachloroethene	1.60E-01	1.60E+02	1.10E-01	5	Y	
Toluene	4.90E-02	4.90E+01	2.30E+03	1000	N	<RSL
1,2,3-Trichlorobenzene	ND	ND	2.90E+01		N	ND
1,2,4-Trichlorobenzene	1.15E-03	1.15E+00	2.30E+00	70	N	<RSL
1,1,1-Trichloroethane	ND	ND	9.10E+03	200	N	ND
Trichloroethene	2.10E-01	2.10E+02	2.00E+00	5	Y	
Trichlorofluoromethane	ND	ND	1.30E+03		N	ND
1,2,4-Trimethylbenzene	3.20E-04	3.20E-01	1.50E+01		N	<RSL
1,3,5-Trimethylbenzene	ND	ND	3.70E+02		N	ND
Vinyl chloride	5.70E-02	5.70E+01	1.60E-02	2	Y	
m,p-Xylene	9.00E-04	9.00E-01	2.0E+02	1.0E+04	N	<RSL
o-Xylene	8.70E-04	8.70E-01	2.0E+02	1.0E+04	N	<RSL
Organochlorine Pesticides	mg/L					
4,4'-DDD	7.0E-07	7.0E-04	2.8E-01		N	<RSL
4,4'-DDE	6.0E-07	6.0E-04	2.0E-01		N	<RSL
4,4'-DDT	2.3E-06	2.3E-03	2.0E-01		N	<RSL
alpha-BHC	1.40E-04	1.40E-01	1.1E-02		Y	

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alpha-chlordane	ND	ND	1.9E-01	2	N	ND
beta-BHC	5.30E-04	5.30E-01	3.7E-02		Y	
delta-BHC	2.40E-05	2.40E-02	3.7E-02		N	<RSL
Dieldrin	4.80E-05	4.80E-02	4.20E-03		Y	
Endosulfan I	6.0E-07	6.0E-04	2.2E+02		N	<RSL
Endosulfan Sulfate	ND	ND	2.20E+02		N	ND
Endrin	ND	ND	1.1E+01	2	N	ND
Endrin ketone	ND	ND	1.1E+01	2	N	ND
gamma-BHC (lindane)	6.90E-05	6.90E-02	6.1E-02	2.0E-01	N	<MCL
gamma-chlordane	ND	ND	1.9E-01	2	N	ND
Heptachlor	3.10E-05	3.10E-02	1.5E-02	0.4	N	<MCL
Heptachlor epoxide	1.90E-05	1.90E-02	7.4E-03	0.2	N	<MCL
Herbicides						
2,4,5-T		ND	3.7E+02	-	N	ND
2,4'-D		ND	3.7E+02	70	N	ND
Metals	mg/L					
Aluminum	0.52	520	3.7E+04	-	N	<RSL
Barium	0.19	190	7.3E+03	2000	N	<RSL
Boron	0.01	10	7.3E+03	-	N	<RSL
Iron	0.11	110	2.6E+04	-	N	<RSL
Manganese	0.299	299	8.8E+02	-	N	<RSL
Zinc	0.014	14	1.1E+04	-	N	<RSL
Dioxin (I-TEQ)						
I-TEQ (TCDD Equivalent)		1.0E-09	5.2E-07	3.0E-05	N	<RSL

(c) Soil has a natural concentration of certain chemicals (background). While there is some differing opinions as to whether anthropogenic chemicals (those released into the environment by man but not by the operation/site under evaluation (i.e., chemicals released in vehicle exhaust from a highway near the site)) should be included in the evaluation, most environmental professionals will agree that concentrations from the natural constituent of the soil should not be considered in evaluating the health effects from exposure to a site. As stated in the Phase I sample discussion, most of the chemicals affected by this issue belong to the metals group. At this site, arsenic is at a concentration high enough to be retained for further evaluation if it is also higher than the region's background concentration for that chemical. While the evaluation of the total collection of data for this site has a maximum arsenic concentration that is both higher than the screening level and higher than background, some of the arsenic concentrations at individual depths can be considered natural arsenic and deleted from

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further consideration for that depth. Natural arsenic has been evaluated in the general area of Camp Carroll (Jung et al., 2002; Kim et al., 2011). Jung et.al. reported that control soil samples contained a range of 5.1-25.3 mg/kg arsenic while Kim et.al. reported that the natural soils in Korea can have arsenic concentrations that range from 8.8-387 mg/kg.

(d) After eliminating nonsite-related chemicals from the risk assessment, the data was divided by depth (Tables C-17 through C-21). EPCs were calculated as the 95th UCL on the arithmetic mean concentration for that COPC.

Table C-17. Soil at Depth S1 Ground Surface to 0.5 Meters Below Ground Surface

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	Chemical retained?	Note
Units	ug/kg	mg/kg	mg/kg	Y/N	
Volatile Organic Chemicals					ND-(Not detected)
No COPCs in this group/depth					
Semivolatile Organic Chemicals					
Benzo(a)pyrene	ND	ND	1.5E-02	N	ND
Dibenz(a,h)anthracene	ND	ND	1.5E-02	N	ND
Organophosphous Pesticides					
No COPCs in this group/depth					
Organochlorine Pesticides					
4,4'-DDD	12.8	1.28E-02	2.00E+00	N	<RSL
4,4'-DDT	68.4	6.84E-02	1.70E+00	N	<RSL
Herbicides					
No COPCs in this group/depth					

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Metals					
Arsenic		308	3.90E-01	Y	
Dioxin (I-TEQ)					
No COPCs in this group/depth					

Note for Table C-17:
The only COPC presented in Table C-17 for Phase IIB that was detected at the S1 level is arsenic.

Table C-18. Soil at Depth S2 – 2 to 5 Meters Below Ground Surface

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	Chemical retained?	Note
Units	ug/kg	mg/kg	mg/kg	Y/N	
Volatile Organic Chemicals					ND-(Not detected)
No COPCs in this group/depth					
Semivolatile Organic Chemicals					
Benzo(a)pyrene	ND	ND	1.5E-02	N	ND
Dibenz(a,h)anthracene	ND	ND	1.5E-02	N	ND
Organophosphous Pesticides					
No COPCs in this group/depth					
Organochlorine Pesticides					
4,4'-DDD	4560	4.56E+00	2.00E+00	Y	
4,4'-DDT	20000	2.00E+01	1.70E+00	Y	
Herbicides					
No COPCs in this group/depth					

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Metals					
Arsenic		40.1	3.90E-01	Y	
Dioxin (I-TEQ)					
No COPCs in this group/depth					

Note for Table C-18:
The COPCs that were retained at the S2 depth are:

- DDD
- DDT
- Arsenic

Table C-19. Soil at Depth S3 Just Above the First Pheatic Surface or Direct Push Technology Refusal

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	Chemical retained?	Note
Units	ug/kg	mg/kg	mg/kg	Y/N	
Volatile Organic Chemicals					ND-(Not detected)
No COPCs in this group/depth					
Semivolatile Organic Chemicals					
Benzo(a)pyrene	53.7	5.37E-02	1.5E-02	Y	
Dibenz(a,h)anthracene	47.4	4.74E-02	1.5E-02	Y	
Organophosphous Pesticides					
No COPCs in this group/depth					
Organochlorine Pesticides					
4,4'-DDD	23.8	2.38E-02	2.00E+00	N	<RSL
4,4'-DDT	129	1.29E-01	1.70E+00	N	<RSL
Herbicides					
No COPCs in this group/depth					

Metals					
Arsenic		10.1	3.90E-01	Y	Deleted due to background concentration
Dioxin (I-TEQ)					
No COPCs in this group/depth					

Note for Table C-19:
The COPCs that were retained at the S3 depth are:

- Benzo(a) pyrene
- Dibenz(a,h)anthracene

Table C-20. Soil at Depth S4 Just Below the First Phreatic Surface

Parameter	Maximum Detected	Maximum Detected	USEPA RSL	Chemical retained?	Note
Units	ug/kg	mg/kg	mg/kg	Y/N	
Volatile Organic Chemicals					ND-(Not detected)
No COPCs in this group/depth					
Semivolatile Organic Chemicals					
Benzo(a)pyrene	ND	ND	1.5E-02	N	ND
Dibenz(a,h)anthracene	ND	ND	1.5E-02	N	ND
Organophosphous Pesticides					
No COPCs in this group/depth					
Organochlorine Pesticides					
4,4'-DDD	207	2.07E-01	2.00E+00	N	<RSL
4,4'-DDT	1220	1.22E+00	1.70E+00	N	<RSL

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Herbicides					
No COPCs in this group/depth					
Metals					
Arsenic		4.46	3.90E-01	Y	Deleted due to background concentration
Dioxin (I-TEQ)					
No COPCs in this group/depth					

Note for Table C-20:
All the chemicals detected at this depth were eliminated from consideration as chemicals of potential concern since they either were considered natural background or they were detected at concentrations less than the health-based screening concentration for each chemical.

Table C-21. Phase IIB Site Groundwater Results

Parameter	Maximium Detected	Maximum Detected	USEPA RSL	MCL	Chemical retained?	Note
Units	mg/L	ug/L	ug/L	ug/L	Y/N	
Volatile Organic Chemicals						
Benzene	1.10E-02	1.10E+01	4.1E-01	5	Y	
1,1-Dichlorethane	1.20E-02	1.20E+01	2.40E+00		Y	
Cis-1,2-Dichloroethene	1.35E+00	1.35E+03	7.30E+01	70	Y	
Naphthalene	7.00E-03	7.00E+00	1.40E-01		Y	
Tetrachloroethene	1.60E-01	1.60E+02	1.10E-01	5	Y	
Trichloroethene	2.10E-01	2.10E+02	2.00E+00	5	Y	
Vinyl chloride	5.70E-02	5.70E+01	1.60E-02	2	Y	
Semi Volatile Organic Chemicals						
No COPCs in this group/depth						
Organochlorine Pesticides						
alpha-BHC	1.40E-04	1.40E-01	1.1E-02		Y	

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beta-BHC	5.30E-04	5.30E-01	3.7E-02		Y	
Dieldrin	4.80E-05	4.80E-02	4.20E-03		Y	
Herbicides						
No COPCs in this group/depth						
Metals						
No COPCs in this group/depth						
Dioxin (I-TEQ)						
No COPCs in this group/depth						

Note for Table C-21:

The COPCs that were retained in the Phase IIB site groundwater are:

- Benzene
- 1,1-Dichloroethane
- Cis-1,2-Dichloroethene
- Tetrachloroethene
- Trichloroethene
- Vinyl chloride
- Naphthalene
- alpha-BHC
- beta-BHC
- Dieldrin

C-4. EXPOSURE ASSESSMENT.

a. Overview and Characterization of Exposure Setting.

(1) The objective of the exposure assessment is to estimate the type and magnitude of exposures to the COPCs that are present at or migrating from the site. This component of the risk assessment can be performed either qualitatively or quantitatively. Quantitative assessment is preferred when toxicity factors necessary to characterize a COPC are available.

(2) The exposure assessment consists of three steps (USEPA, 1989):

(a) Characterize Exposure Settings. This step contains general information concerning the physical characteristics of the site as it pertains to potential

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considerations affecting exposure. The physical setting involves climate and vegetation. All potentially exposed populations and subpopulations, therein (receptors), are assessed relative to their potential for exposure. This step is a qualitative one aimed at providing a general site perspective and offering insight on the surrounding population.

(b) Identify Exposure Pathways. All exposure pathways (ways in which receptors can be exposed to chemicals that originate from the source) are reviewed in this step. Exposure points of human contact and exposure routes are discussed before quantifying the exposure pathways in the next step.

(c) Quantify Exposure. In this final step, the exposure levels (COPC intakes) are calculated for each exposure pathway and receptor. These calculations follow EPA guidance for assumptions of intake variables or exposure factors for each exposure pathway.

b. Land Use and Potentially Exposed Populations.

(1) Land Use. The three sites evaluated in this document were suspected of being used for burial of containers of Herbicide Orange and other chemicals in the 1960s and 1970s. These sites have had various names over the years but will be referred to as: the west side of the Helipads (Phase I); the east side of the Helipads (Phase IIB); and the Land Farm/Area D site (Phase II). While some documentation can be found for the burial of materials at the Land Farm/Area D site, no documentation could be found for the other two sites and no documentation could be found on the burial of containers of Herbicide Orange on Camp Carroll. The earliest documentation found was a Comprehensive Environmental Engineering Survey performed in 1974 (USAPACEHEA, 1975). Volume IV which dealt with solid and hazardous waste handling, stated that "Political, economical, and topographical restraints have contributed to the delay of disposing [of] the chemicals" referring to a stock of Code H chemicals (solvents, acids, bases, and pesticides) some of which were in deteriorating containers. The report contained a listing of some of the chemical that were geographically co-located in goupings. None of the inventories of the groups showed the existence of Herbicide Orange or any other herbicide. Volume II (USAPACEHEA, 1975) addressed the entomological services and the handling of pesticides. This volume stated that "No unauthorized pesticides were found in the storage area." This is significant since Herbicide Orange was considered a weapon and not authorized for use in general weed control. Had Herbicide Orange been found in pesticide storage, it would have been a major find and most likely noted in the report. In June 1983, a Waste Management Practice Survey (USAPACEHEA, 1983) outlined the handling of wastes. At the time, hazardous waste was handled by a contract through the Defense Property Disposal Office. However, a January 1983 Hazardous Materials Special Study

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Memorandum for Record (USAPACEHEA, 1982 and 1983) discussed the unauthorized burial of chemical products from Area 41 in Area D in March 1978. Confirmation of the unauthorized burial occurred on 16 February 1979 and a decision was made on the same date to remove, re-containerize, and properly dispose of the buried material. As a result, it was reported that approximately 6100 cubic feet of 188 types of various materials weighing between 40 and 100 tons were removed from the Area D burial site from November 1979 to January 1980 (USAPACEHEA, 1982). The excavated material was stored in a diked storage area awaiting appropriate containers. Recontainerization occurred between May and August 1980. No documentation could be found disclosing the location or timing of the final disposal. The current uses of the sites are as a helicopter airfield and open space.

(2) Potentially Exposed Populations. For purposes of this risk assessment, five potentially exposed populations are considered. While the use of this site is not proposed for change in the foreseeable future, it is important to consider the potential current users as well as potential future users. As such, the risk assessment will evaluate the following hypothetical receptors: an industrial worker to model exposures to personnel working in buildings surrounding the airfield; a utility/maintenance worker to model exposures to personnel that repair/install utility lines and those who maintain the grounds of the airfield and the Land Farm/Area D; a construction worker to model exposures to people involved in current or future construction; a training Soldier to model exposures to personnel involved in field training exercises including intrusive activities (e.g., digging foxholes and combat construction); and an adult resident (for comparison only) to address the concerns for exposure following future residential construction whether from BRAC actions or post expansion.

c. Identification of Exposure Pathways.

(1) Exposure Estimates. Exposures are only estimated for plausible completed exposure pathways. A completed exposure pathway has the following four elements. A pathway cannot be completed unless each of the following elements is present:

(a) A source and mechanism for chemical release.

(b) An environmental transport medium.

(c) An exposure point.

(d) A feasible route of exposure to a human receptor.

(2) Sources and Receiving Media.

(a) The chemical sources for this site are the releases from deteriorating of the alleged buried containers and more recent disposal operations in the Land Farm/Area D site. We are also concerned about the potential release of chemicals from the operation of the airfield and the migration of chemicals from the operation of the Land Farm/ Area D site. The sources that contribute to the chemical nature of the soil and groundwater are discussed in the site reports (USEPA, 1989; USACE 1992 and 2004) and will not be duplicated here.

(b) This project does not attempt to characterize the source or the transformations which may occur during transport from the source to the receptors. Measurements were made at or near the receptor's anticipated points of exposure to estimate the type and dose of the chemicals acting upon the receptor. Thus, no determination of the chemical transformations is necessary. Samples collected near or at the suspected source locations were made to attempt to identify the source(s) that contribute most to the receptor's risk.

(3) Exposure Routes. Exposure routes are the means by which a human potentially contacts COPCs. In general, these include inhalation, ingestion, and dermal contact. This assessment considers all three routes in respect to exposure to the anticipated exposure media.

(4) Pathways Not Evaluated. Due to the nature of the anticipated contamination at these sites, a number of pathways could be eliminated. Since no surface water or sediment exists on this site, these pathways were eliminated.

(5) Complete Pathways. Groundwater and subsurface soil is only considered a media of concern for receptors that perform intrusive actions. Surface soil is considered a media of concern for all receptors. While drinking water in this area is provided from a municipal source which derives its water from deeper wells onpost, it is also considered a media of concern. Data for this drinking water pathway is derived from the analyses of the drinking water system and not extrapolated from groundwater results. Vapor intrusion into buildings is evaluated for volatile COPCs in the groundwater for receptors that are located in buildings.

d. Quantification of Exposure.

(1) In this section, each receptor's potential exposures to the COPCs are quantified for each of the complete exposure pathways. In each case, the exposures are calculated following methods recommended in USEPA guidance documents such as the Risk Assessment Guidance for Superfund (USEPA, 1989). These calculations

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generally involve two steps. First, representative chemical concentrations in the environment, or EPCs, are determined for each pathway and receptor. From these EPC values, the amount of chemical, which an exposed person may take into his/her body, is then calculated. This value is referred to as the human intake. This section describes the exposure scenarios, exposure assumptions, and exposure calculation methods used in this risk assessment.

(2) Risk assessment as a whole and the exposure assessment step in particular are designed to be health protective. The exposure calculations require estimates and assumptions about certain human exposure parameters, such as ingestion rates. Generally, values are selected which tend to overestimate exposure (USEPA, 1989, 1991, 1997 and 2004). The USEPA recommends two types of exposure estimates should be used for Superfund type risk assessments: a reasonable maximum exposure (RME) and central tendency exposure (CT). The RME is defined as the highest exposure that could reasonably be expected to occur for a given exposure pathway at a site and is intended to account for both uncertainty in the chemical concentration and variability in the exposure parameters (such as, exposure frequency or averaging time). The CT may be evaluated for comparison purposes and is generally based on mean exposure parameters, but is considered optional to making decisions about health effects. As such, only RME scenarios have been evaluated in this risk assessment. In RME scenarios, the 95th UCL of the mean is calculated for each COPC as the EPC. Should the 95th UCL exceed the maximum detected concentration for any chemical in any media, the maximum detected concentration is used as the EPC for that media. Media concentrations that were reported as nondetected were added into the 95th UCL calculation as one-half the detection limit. The higher concentration of the duplicate sample was used in the 95th UCL calculation to provide a more conservative (health protective) evaluation.

(3) Estimates of pathway-specific human intakes for each COPC involve assumptions about patterns of human exposure to the media being evaluated. These assumptions are integrated with the EPCs to calculate intakes. Intakes are normally expressed as the amount of chemical at the environment-human receptor exchange boundary in milligrams per kilogram of body weight per day (mg/kg-day), which represents an exposure normalized for body weight over time. The total exposure is divided by the time period of interest to obtain an average exposure. The averaging time is a function of the health endpoint. For noncarcinogenic effects, it is the exposure time (specific to the scenario being assessed) and for carcinogenic effects, it is the receptor's assumed lifetime (70 years).

e. Exposure Assumptions.

(1) An important aspect of the exposure assessment is the determination of assumptions regarding how receptors may be exposed to chemicals. The USEPA guidance on exposure factors is extensive and was followed throughout this exposure assessment. Standard scenario default assumptions were used where appropriate.

(2) The exposure scenarios in this assessment consist of an industrial worker, a utility/grounds maintenance worker, a construction worker, a training Soldier, and an adult resident receptor. The exposure assumptions used in these scenarios are intended to approximate the frequency, duration, and manner in which a receptor would be exposed to environmental media. However, each parameter tends to have a safety factor imbedded into its determination such that they tend to overestimate exposure and, therefore, risk. Details of the exposure assumptions and parameters for each exposure scenario are shown in Table C–22.

f. Exposure Scenarios.

(1) Industrial Worker. These receptors spend each day of work at the site (5 days/week for 50 weeks, RME). This exposure period lasts for 25 years. At the recommendation of the USEPA, we are using a value of 5800 cm^2 for the dermal exposure. This approximates the 95^{th} percentile for the exposure of 25 percent of the body surface area.

(2) Utility/Grounds Maintenance Worker. These receptors spend each day of work at the site exposed to the surface soil; however, the year is reduced by half to account for the lack of outdoor work in the colder months (5 days/week for 25 weeks, RME). This individual is also exposed to the subsurface soil (50 days of the year). This exposure period lasts for 25 years. At the recommendation of the USEPA, we are using a value of 5800 cm^2 for the dermal exposure. This approximates the 95^{th} percentile for the exposure of 25 percent of the body surface area.

(3) Construction Worker. These receptors spend each day of the construction project at the site exposed to the surface soil; however, the year is reduced by one quarter to account for the lack of outdoor work in the coldest months (5 days/week for 38 weeks, RME). This individual is also exposed to the subsurface soil (50 days of the year). This exposure period lasts for 1 year. At the recommendation of the USEPA, we are using a value of 5800 cm^2 for the dermal exposure. This approximates the 95^{th} percentile for the exposure of 25 percent of the body surface area.

(4) Training Soldier. These receptors spend each training day exposed to the subsurface soil at the site (14 days/year subsurface soil, best judgement); however, this individual is also exposed to the surface soil at the site for the entire year (350 days).

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