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DRAFT FINAL DETERMINATION OF RISK-BASED ACTION STANDARDS FOR DOE AREAS VOLUME II - ATTACHMENTS

For the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH UNIVERSITY OF CALIFORNIA AT DAVIS, CALIFORNIA

Prepared for:

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Weiss Associates
Environmental and Geologic Services

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University of California at Davis, California

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ATTACHMENTS

Attachment A Data Tables

Table A1a	Contaminants of Potential Concern in Surface Soil, OU-1
Table A1b	Radionuclides of Potential Concern in Surface Soil, OU-1
Table A2a	Contaminants of Potential Concern in Subsurface Soil, OU-1
Table A2b	Radionuclides of Concern in Subsurface Soil, OU-1
Table A3a	Contaminants of Potential Concern in Surface Soil, OU-2
Table A3b	Radionuclides of Concern in Subsurface Soil, OU-2
Table A4a	Contaminants of Potential Concern in Subsurface Soil, OU-2
Table A4b	Radionuclides of Concern in Subsurface Soil, OU-2
Table A5a	Contaminants of Potential Concern in Surface Soil, OU-3
Table A5b	Radionuclides of Concern in SubSurface Soil, OU-3
Table A6a	Contaminants of Potential Concern in Subsurface Soil, OU-3
Table A6b	Radionuclides of Concern in Subsurface Soil, OU-3
Table A7a	Contaminants of Potential Concern in Surface Soil, OU-4
Table A7b	Radionuclides of Concern in Surface Soil, OU-4
Table A8a	Contaminants of Potential Concern in Subsurface Soil, OU-4
Table A8b	Radionuclides of Concern in Subsurface Soil, OU-4
Table A9a	Consolidated List of Chemical Contaminants of Concern in Site Soil
Table A9b	Consolidated List of Radionuclides of Concern in Site Soil
Table A10a	Identification of Contaminants of Concern in Surface Water
Table A10b	Identification of Radionuclides of Concern For Surface Water Pathways
Table A11a	Putah Creek Downstream (PCD) Chemical Sampling Results
Table A11b	Putah Creek Downstream (PCD) Radionuclide Sampling Results
Table A12a	Putah Creek Upstream (PCU) Chemical Sampling Results
Table A12b	Putah Creek Upstream (PCU) Radionuclide Sampling Results
Table A13a	UC Davis Outfall (STPO) Chemical Sampling Results
Table A13b	UC Davis Outfall (STPO) Radionuclide Sampling Results
Table A14a	Storm Water Runoff Chemical Sampling Results from Stations SWL-1 and SWL-2
Table A14b	Storm Water Runoff Radionuclide Sampling Results from Locations SWL-1 and SWL-2

Attachment B	Calculation of Background Concentrations
Attachment C	Outdoor Air Volatilization Calculations
Attachment D	Fugitive Dust Emissions and Transport Modeling, including Calculation of Offsite/Onsite Soil Concentration Ratios
Attachment E	Storm Water Runoff Modeling including Calculation of Putah Creek surface Water/Onsite Soil Concentration Ratios
Attachment F	Vadose Zone and Ground Water Modeling, including Calculation of onsite Ground water/onsite Soil Using both NUFT and RESRAD, and Offsite Ground water/onsite Soil Concentration Ratios
Attachment G	Biological Media Uptake Support Calculations
Attachment H	Surface Water Pathway Risk Contributions for Radionuclides
Attachment I	Chemical Action Standard Support Calculations
Attachment J	RESRAD Model Approach, Input Parameters, Adjustments for Scenarios 2 and 3.

ATTACHMENT A

DATA TABLES – DOE AREAS, DAVIS, CALIFORNIA

Table A-1a. Contaminants of Potential Concern in Surface Soil, OU-1

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min Det Limit	Max Det Limit	95% UCL	RME
General Chemical										
Formaldehyde	mg/kg	1	7	1.6	1.6	N/A	1	1	NC	1.6
Metals										
Antimony	mg/kg	3	9	0.25	0.38	0.74a	0.22	1.1	NC	<BKG
Arsenic	mg/kg	9	9	1.7	7.2	9.46	2	2.2	NC	<BKG
Barium	mg/kg	9	9	39	200	237	9.9	40	NC	<BKG
Beryllium	mg/kg	7	9	0.24	0.47	0.66	0.99	1.1	NC	<BKG
Cadmium	mg/kg	1	9	0.28	0.28	0.46a	1.1	1.1	NC	<BKG
Chromium	mg/kg	9	9	24	230	178	2	22	NC	230
Chromium, Hexavalent (+6)	mg/kg	1	9	0.22	0.22	0.099	0.2	0.2	NC	0.22
Cobalt	mg/kg	9	9	4.4	24	29	0.99	10	NC	<BKG
Copper	mg/kg	9	9	8.3	62	50	0.99	5	NC	62
Iron	mg/kg	9	9	6300	40000	42000	11	110	NC	<BKG
Lead	mg/kg	9	9	1.8	21	10.1	0.6	6.7	NC	21
Manganese	mg/kg	9	9	150	880	720	3	34	NC	880
Mercury	mg/kg	9	9	0.22	0.57	0.49	0.09	0.11	NC	0.57
Molybdenum	mg/kg	3	9	0.47	0.88	2b	0.99	1.1	NC	<BKG
Nickel	mg/kg	9	9	46	300	326	0.99	11	NC	<BKG
Selenium	mg/kg	1	9	0.84	0.84	1	1.1	1.1	NC	<BKG
Vanadium	mg/kg	9	9	12	72	73	0.99	10	NC	<BKG
Zinc	mg/kg	9	9	21	130	82	4	4.5	NC	130
Pesticides and PCBs										
4,4'-DDD	mg/kg	5	10	0.0033	0.24	N/A	0.0037	0.099	NC	0.24
4,4'-DDE	mg/kg	1	10	0.014	0.014	N/A	0.0037	0.0037	NC	0.014
Alpha-Chlordane	mg/kg	9	10	0.0043	0.8	N/A	0.0018	0.049	NC	0.8
Gamma-Chlordane	mg/kg	9	10	0.0012	0.74	N/A	0.0018	0.049	NC	0.74
Semivolatile Organics										
Bis(2-Ethylhexyl)phthalate	mg/kg	1	7	0.1	0.1	N/A	0.37	0.37	NC	0.1
Volatile Organics										
Acetone	mg/kg	1	6	0.003	0.003	N/A	0.011	0.011	NC	0.003

Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Background concentration calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background.
N/A = Not available; no background data available for this analyte.

Table A-1b. Radionuclides of Concern in Surface Soil, OU-1

Isotope	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min MDA	Max MDA	95% UCL	RME
Radionuclides										
Actinium-228	pCi/g	10	11	0.38 ±0.32	0.66 ±0.23	0.71	0.11	0.5	0.53	<BKG
Americium-241	pCi/g	1	1	0.021 ±0.018	0.021 ±0.018	N/A	0.018	0.018	NC	0.021
Bismuth-212	pCi/g	3	11	-0.6 ±0.34	0.47 ±0.32	N/A	0.21	1	0.35	0.35
Bismuth-214	pCi/g	10	11	0.14 ±0.16	0.59 ±0.16	0.57	0.064	0.23	0.44	<BKG
Carbon-14	pCi/g	1	11	-4.1 ±6.3	3.9 ±3.1	0.87	0.94	12	0.43	<BKG
Cesium-137	pCi/g	5	11	-0.005 ±0.055	23 ±2.3	0.053	0.029	0.11	5.89	5.8
Cobalt-60	pCi/g	0	11	-0.023 ±0.024	0.021 ±0.031	0.016	0.032	0.13	0.01	<BKG
Lead-210	pCi/g	0	11	-2 ±7.9	5.4 ±9.4	N/A	1.2	16	1.88	1.8
Lead-212	pCi/g	11	11	0.333 ±0.097	0.59 ±0.14	0.74	0.053	0.16	0.5	<BKG
Lead-214	pCi/g	11	11	0.263 ±0.094	0.6 ±0.13	0.75	0.059	0.21	0.49	<BKG
Plutonium-241	pCi/g	0	1	0.1 ±1.5	0.1 ±1.5	N/A	2.1	2.1	NC	0.1
Potassium-40	pCi/g	11	11	6.3 ±1.2	12 ±2.2	13.6	0.36	1.6	10.37	<BKG
Radium-223	pCi/g	0	8	-0.32 ±0.28	0.47 ±0.68	N/A	0.79	1.7	NC	0.47
Radium-226	pCi/g	12	22	-0.3 ±0.98	1.16 ±0.34	0.77	0.094	2	0.65	<BKG
Strontium-90	pCi/g	6	11	-0.14 ±0.24	20.3 ±1.3	N/A	0.31	1.1	6.94	6.9
Thallium-208	pCi/g	9	11	0.059 ±0.063	0.196 ±0.064	0.21	0.033	0.12	0.15	<BKG
Thorium-228	pCi/g	1	1	0.55 ±0.13	0.55 ±0.13	0.71	0.11	0.11	NC	<BKG
Thorium-230	pCi/g	1	1	0.57 ±0.11	0.57 ±0.11	0.8	0.034	0.034	NC	<BKG
Thorium-232	pCi/g	1	1	0.51 ±0.11	0.51 ±0.11	0.64	0.037	0.037	NC	<BKG
Thorium-234	pCi/g	0	11	0.03 ±0.75	0.94 ±0.43	N/A	0.88	3.7	0.66	0.66
Tritium	pCi/g	1	2	-2.7 ±5	91.1 ±8.4	0.023	3.5	10	NC	91
Uranium-233/234	pCi/g	1	1	0.489 ±0.08	0.489 ±0.08	0.66	0.026	0.026	NC	<BKG
Uranium-235	pCi/g	1	12	-0.16 ±0.24	0.1 ±0.3	0.071	0.017	0.47	0.01	<BKG
Uranium-238	pCi/g	1	1	0.418 ±0.073	0.418 ±0.073	0.63	0.018	0.018	NC	<BKG

Number Sampled = Number of samples in data set.
Number Detected = Number of samples in data set containing concentrations above MDA.
Min [] = Minimum detected activity in data set.
Max [] = Maximum detected activity in data set.
Background = Background activity calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
N/A = Not available; no background data available for this analyte.
Min MDA = Minimum MDA in data set.
Max MDA = Maximum MDA in data set.
NC = Not calculated, <10 samples in sample set.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background, not an isotope of concern for this OU.
RME = Reasonable maximum exposure concentration.
MDA = Minimum detectable activity
pCi/g = picocuries per gram

Table A-2a. Contaminants of Potential Concern in Subsurface Soil, OU-1

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min Det Limit	Max Det Limit	95% UCL	RME
General Chemical										
Formaldehyde	mg/kg	1	56	1.4	1.4	N/A	1	1	NC	1.4
Metals										
Antimony	mg/kg	13	58	0.25	2.2	0.74a	0.22	1.2	0.94	0.94
Arsenic	mg/kg	58	58	0.84	9.7	9.46	1.9	3.1	6.62	<BKG
Barium	mg/kg	58	58	13	270	237	9.7	15	180.26	<BKG
Beryllium	mg/kg	50	57	0.26	0.54	0.66	0.97	1.2	0.4	<BKG
Cadmium	mg/kg	7	58	0.27	7.1	0.46a	0.98	1.5	NC	7.1
Chromium	mg/kg	58	58	7.1	250	178	2	47	143.02	<BKG
Chromium, Hexavalent (+6)	mg/kg	2	46	0.048	0.08	0.099	0.2	0.5	NC	<BKG
Cobalt	mg/kg	58	58	0.66	29	29	0.97	1.5	21.73	<BKG
Copper	mg/kg	58	58	7.4	890	50	0.97	1.5	104.46	100
Iron	mg/kg	58	58	520	46000	42000	9.9	250	34,969.03	<BKG
Lead	mg/kg	58	58	2.7	74	10.1	0.65	9.2	13.16	13
Manganese	mg/kg	58	58	29	1000	720	2.9	75	655.36	<BKG
Mercury	mg/kg	54	58	0.11	5.2	0.49	0.09	0.15	0.65	0.65
Molybdenum	mg/kg	47	58	0.25	5.9	2b	0.97	1.5	0.96	<BKG
Nickel	mg/kg	58	58	7	420	326	0.98	12	238.98	<BKG
Selenium	mg/kg	16	58	0.63	1.6	1	0.99	1.2	1.09	1.0
Silver	mg/kg	4	58	0.2	2.7	0.52a	0.98	1	NC	2.7
Thallium	mg/kg	1	58	0.26	0.26	1.36a	1.1	1.1	NC	<BKG
Vanadium	mg/kg	58	58	2.6	82	73	0.97	1.5	61.16	<BKG
Zinc	mg/kg	58	58	15	730	82	3.9	84	139.67	140
Pesticides and PCBs										
4,4'-DDD	mg/kg	21	59	0.00048	0.14	N/A	0.0033	0.035	0.04	0.04
4,4'-DDE	mg/kg	7	59	0.00069	0.014	N/A	0.0036	0.0039	NC	0.014
4,4'-DDT	mg/kg	2	59	0.0022	0.0037	N/A	0.0036	0.0037	NC	0.0037
Alpha-Chlordane	mg/kg	39	59	0.00056	1.7	N/A	0.0017	0.18	0.19	0.19
Arochlor-1260	mg/kg	2	15	1	1.3	N/A	0.033	0.033	NC	1.3
Dieldrin	mg/kg	7	59	0.00041	0.07	N/A	0.0034	0.0037	NC	0.07
Endosulfan I	mg/kg	3	59	0.0002	0.002	N/A	0.0018	0.002	NC	0.002
Endosulfan Sulfate	mg/kg	1	59	0.011	0.011	N/A	0.0036	0.0036	NC	0.011
Gamma-Chlordane	mg/kg	39	59	0.00067	1.9	N/A	0.0017	0.18	0.21	0.21
Heptachlor	mg/kg	7	59	0.0013	0.096	N/A	0.0017	0.0018	NC	0.096
Heptachlor Epoxide	mg/kg	1	59	0.0013	0.0013	N/A	0.0018	0.0018	NC	0.0013
Methoxychlor	mg/kg	1	59	0.0011	0.0011	N/A	0.018	0.018	NC	0.0011
Semivolatile Organics										
2-Methylnaphthalene	mg/kg	4	58	0.16	1900	N/A	0.37	1800	NC	1900
Acenaphthene	mg/kg	4	58	0.44	3300	N/A	0.37	1800	NC	3300
Anthracene	mg/kg	4	58	0.42	1500	N/A	0.37	1800	NC	1500
Benzo(a)anthracene	mg/kg	4	58	0.24	660	N/A	0.37	1800	NC	660
Benzo(a)pyrene	mg/kg	4	58	0.06	140	N/A	0.37	18	NC	140
Benzo(b)fluoranthene	mg/kg	4	58	0.054	96	N/A	0.37	1800	NC	96

Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Background concentration calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background.
N/A = Not available; no background data available for this analyte.

(1) Data set does not meet risk assessment data quality objectives; considered questionable.

Table A-2a. Contaminants of Potential Concern in Subsurface Soil, OU-1 (Continued)

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min Det Limit	Max Det Limit	95% UCL	RME
Semivolatile Organics										
Benzo(g,h,i)perylene	mg/kg	2	58	0.45	0.49	N/A	2.6	2.6	NC	0.49
Benzo(k)fluoranthene	mg/kg	4	58	0.084	36	N/A	0.37	18	NC	36
Bis(2-Ethylhexyl)phthalate	mg/kg	10	57	0.026	4.1	N/A	0.34	2.6	1.73	1.7
Carbazole	mg/kg	4	58	0.099	410	N/A	0.37	18	NC	410
Chrysene	mg/kg	5	58	0.019	630	N/A	0.35	1800	NC	630
Di-n-Butylphthalate	mg/kg	1	58	0.031	0.031	N/A	0.35	0.35	NC	0.031
Di-n-Octylphthalate	mg/kg	1	58	0.037	0.037	N/A	0.36	0.36	NC	0.037
Dibenzo(a,h)anthracene	mg/kg	3	58	0.29	18	N/A	2.6	18	NC	18
Dibenzofuran	mg/kg	4	58	0.34	2100	N/A	0.37	1800	NC	2100
Fluoranthene	mg/kg	5	58	0.031	4000	N/A	0.34	1800	NC	4000
Fluorene	mg/kg	4	58	0.54	3100	N/A	0.37	1800	NC	3100
Indeno(1,2,3-cd)pyrene	mg/kg	3	58	0.58	27	N/A	2.6	18	NC	27
Naphthalene	mg/kg	4	58	0.12	2600	N/A	0.37	1800	NC	2600
Pentachlorophenol	mg/kg	2	58	0.63	0.66	N/A	6.4	6.4	NC	0.66
Phenanthrene	mg/kg	5	58	0.026	9500	N/A	0.34	1800	NC	9500
Pyrene	mg/kg	6	58	0.023	3900	N/A	0.36	1800	NC	3900
Volatile Organics										
2-Butanone	mg/kg	4	51	0.003	0.006	N/A	0.011	0.012	NC	0.006
2-Hexanone	mg/kg	1	51	0.075	0.075	N/A	0.0099	0.0099	NC	0.075
Acetone	mg/kg	20	44	0.003	1.2	N/A	0.0099	1.2	0.23	0.23
Benzene	mg/kg	1	66	0.001	0.001	N/A	0.00099	0.00099	NC	0.001
Carbon Tetrachloride	mg/kg	1	51	0.004	0.004	N/A	0.012	0.012	NC	0.004
Ethylbenzene	mg/kg	1	66	1.2	1.2	N/A	1.2	1.2	NC	1.2
Methylene Chloride	mg/kg	1	51	0.004	0.004	N/A	0.011	0.011	NC	0.004
Styrene	mg/kg	1	51	0.8	0.8	N/A	1.2	1.2	NC	0.8
Toluene	mg/kg	3	66	0.0017	0.49	N/A	0.00098	0.011	NC	0.49
Xylenes (Total)	mg/kg	1	51	6.2	6.2	N/A	1.2	1.2	NC	6.2

Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Background concentration calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background.
N/A = Not available; no background data available for this analyte.

(1) Data set does not meet risk assessment data quality objectives; considered questionable.

Table A-2b. Radionuclides of Concern in Subsurface Soil, OU-1

Isotope	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min MDA	Max MDA	95% UCL	RME
Radionuclides										
Actinium-228	pCi/g	53	62	-0.53 ±0.092	5.5 ±6	0.71	0.098	9.1	0.69	<BKG
Americium-241	pCi/g	2	2	0.022 ±0.02	0.027 ±0.019	N/A	0.01	0.02	NC	0.027
Bismuth-212	pCi/g	18	62	-2.9 ±0.15	1.5 ±13	N/A	0.18	18	0.32	0.32
Bismuth-214	pCi/g	56	62	-1.3 ±0.066	1.68 ±4.1	0.57	0.051	6.3	0.53	<BKG
Carbon-14	pCi/g	1	62	-6.3 ±2.7	117 ±6.4	0.87	4.8	11	3.32	3.3
Cesium-137	pCi/g	4	62	-0.81 ±0.02	0.119 ±1.4	0.053	0.026	2.4	0.01	<BKG
Cobalt-60	pCi/g	0	62	-0.44 ±0.0099	0.07 ±0.74	0.016	0.02	2.4	0.0	<BKG
Lead-210	pCi/g	8	62	-49 ±0.66	61 ±98	N/A	0.91	160	3.37	3.3
Lead-212	pCi/g	55	62	-1 ±0.064	1.2 ±3.1	0.74	0.048	4.7	0.51	<BKG
Lead-214	pCi/g	56	62	-0.6 ±0.066	4.3 ±3.3	0.75	0.051	4.8	0.76	0.76
Plutonium-241	pCi/g	0	2	-0.2 ±1.5	0.3 ±1.6	N/A	2	2.3	NC	0.3
Potassium-40	pCi/g	55	62	-2 ±1.2	16.7 ±24	13.6	0.31	38	10.38	<BKG
Radium-223	pCi/g	0	62	-9 ±0.17	0.3 ±12	N/A	0.42	38	0.03	0.03
Radium-226	pCi/g	89	124	-3 ±0.22	17 ±33	0.77	0.043	47	NC	17
Strontium-90	pCi/g	35	62	-0.17 ±0.36	16700 ±170	N/A	0.34	35	848.95	850
Thallium-208	pCi/g	52	62	-1.7 ±0.034	0.6 ±1.9	0.21	0.027	3.1	0.17	<BKG
Thorium-228	pCi/g	2	2	0.71 ±0.13	0.76 ±0.14	0.71	0.09	0.092	NC	0.76
Thorium-230	pCi/g	2	2	0.54 ±0.11	0.66 ±0.11	0.8	0.042	0.044	NC	<BKG
Thorium-232	pCi/g	2	2	0.496 ±0.11	0.71 ±0.1	0.64	0.033	0.04	NC	0.71
Thorium-234	pCi/g	1	62	-10 ±0.37	39.5 ±24	N/A	0.85	75	2.35	2.3
Tritium	pCi/g	0	7	-2.2 ±0.87	2.8 ±10	0.023	1.6	20	NC	2.8
Uranium-233/234	pCi/g	2	2	0.461 ±0.092	0.616 ±0.08	0.66	0.026	0.033	NC	<BKG
Uranium-235	pCi/g	2	64	-7.8 ±0.025	2.6 ±5.8	0.071	0.017	11	0.12	0.12
Uranium-238	pCi/g	2	2	0.511 ±0.082	0.556 ±0.087	0.63	0.017	0.025	NC	<BKG

Number Sampled = Number of samples in data set.
Number Detected = Number of samples in data set containing concentrations above MDA.
Min [] = Minimum detected activity in data set.
Max [] = Maximum detected activity in data set.
Background = Background activity calculations presented in Attachment B.
a =Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
Min MDA = Minimum MDA in data set.
Max MDA = Maximum MDA in data set.
NC = Not calculated, <10 samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background, not an isotope of concern for this OU.
MDA = Minimum detectable acitvity.
N/A = Not available; no background data for this compound.
pCi/g = picocuries per gram.

Table A-3a. Contaminants of Potential Concern in Surface Soil, OU-2

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min Det Limit	Max Det Limit	95% UCL	RME
Metals										
Chromium	mg/kg	4	4	150	230	178	22	23.7	NC	230
Semivolatile Organics										
Bis(2-Ethylhexyl)phthalate	mg/kg	1	2	0.031	0.031	N/A	0.36	0.36	NC	0.031
Volatile Organics										
Acetone	mg/kg	2	4	0.004	0.006	N/A	0.011	0.012	NC	0.006

Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Background concentration calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background.
N/A = Not available; no background data available for this analyte.

Table A-3b. Radionuclides of Concern in Surface Soil, OU-2

Isotope	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min MDA	Max MDA	95% UCL	RME
Radionuclides										
Actinium-228	pCi/g	4	4	0.443 ±0.1	0.56 ±0.11	0.71	0.11	0.18	NC	<BKG
Americium-241	pCi/g	1	4	0.005 ±0.015	0.024 ±0.022	N/A	0.021	0.027	NC	0.024
Bismuth-212	pCi/g	3	4	0.18 ±0.25	0.38 ±0.24	N/A	0.2	0.35	NC	0.38
Bismuth-214	pCi/g	4	4	0.302 ±0.094	0.492 ±0.082	0.57	0.069	0.11	NC	<BKG
Cesium-137	pCi/g	1	4	-0.012 ±0.019	0.054 ±0.028	0.053	0.031	0.052	NC	0.054
Cobalt-60	pCi/g	0	4	-0.011 ±0.017	0.008 ±0.015	0.016	0.027	0.046	NC	<BKG
Lead-210	pCi/g	0	4	-1.3 ±3.5	1.4 ±2.6	N/A	3.6	5.6	NC	1.4
Lead-212	pCi/g	4	4	0.419 ±0.068	0.523 ±0.094	0.74	0.056	0.082	NC	<BKG
Lead-214	pCi/g	4	4	0.472 ±0.087	0.547 ±0.073	0.75	0.064	0.094	NC	<BKG
Plutonium-241	pCi/g	0	4	-0.4 ±2.4	1.5 ±2.5	N/A	2.6	3.9	NC	1.5
Potassium-40	pCi/g	4	4	10.2 ±1.5	11.7 ±1.4	13.6	0.42	0.63	NC	<BKG
Radium-223	pCi/g	0	4	-0.35 ±0.2	0.04 ±0.17	N/A	0.51	0.9	NC	0.04
Radium-226	pCi/g	5	8	0 ±0.61	1.73 ±0.36	0.77	0.13	0.86	NC	1.7
Strontium-90	pCi/g	0	4	0.13 ±0.28	0.35 ±0.26	N/A	0.42	0.52	NC	0.35
Thallium-208	pCi/g	4	4	0.14 ±0.043	0.171 ±0.037	0.21	0.03	0.045	NC	<BKG
Thorium-234	pCi/g	0	4	0.47 ±0.51	0.55 ±0.51	N/A	1.3	1.9	NC	0.55
Uranium-235	pCi/g	0	4	0.02 ±0.15	0.12 ±0.15	0.071	0.18	0.25	NC	0.12

Number Sampled = Number of samples in data set.
Number Detected = Number of samples in data set containing concentrations above MDA.
Min [] = Minimum detected activity in data set.
Max [] = Maximum detected activity in data set.
Background = Background activity calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
N/A = Not available; no background data available for this analyte.
Min MDA = Minimum MDA in data set.
Max MDA = Maximum MDA in data set.
NC = Not calculated, <10 samples in sample set.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background, not an isotope of concern for this OU.
RME = Reasonable maximum exposure concentration.
MDA = Minimum detectable activity
pCi/g = picocuries per gram

Table A-4a. Contaminants of Potential Concern in Subsurface Soil, OU-2

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min Det Limit	Max Det Limit	95% UCL	RME
Metals										
Arsenic	mg/kg	10	10	2.9	8	9.46	2	2.5	6.52	<BKG
Barium	mg/kg	10	10	120	220	237	10	13	194.61	<BKG
Chromium	mg/kg	58	58	50	300	178	2	2.9	124.56	<BKG
Cobalt	mg/kg	10	10	9.2	25	29	1	1.3	21.98	<BKG
Copper	mg/kg	10	10	21	160	50	1	1.3	89.19	89
Iron	mg/kg	10	10	20000	40000	42000	200	250	35,595.38	<BKG
Lead	mg/kg	10	10	3	10	10.1	6.1	7.6	9.73	<BKG
Manganese	mg/kg	10	10	450	870	720	61	76	699.63	<BKG
Mercury	mg/kg	6	10	0.11	0.19	0.49	0.1	0.12	NC	<BKG
Molybdenum	mg/kg	10	10	0.26	0.65	2b	1	1.3	0.45	<BKG
Nickel	mg/kg	10	10	72	180	326	1	1.3	139.34	<BKG
Vanadium	mg/kg	10	10	40	75	73	1	1.3	65.3	<BKG
Zinc	mg/kg	10	10	38	360	82	4	92	159.68	160
Pesticides and PCBs										
4,4'-DDD	mg/kg	1	10	0.00032	0.00032	N/A	0.0039	0.0039	NC	0.00032
4,4'-DDT	mg/kg	1	10	0.0018	0.0018	N/A	0.0039	0.0039	NC	0.0018
Semivolatile Organics										
2-Methylnaphthalene	mg/kg	1	58	0.44	0.44	N/A	0.34	0.34	NC	0.44
Acenaphthene	mg/kg	1	58	5.8	5.8	N/A	6.7	6.7	NC	5.8
Anthracene	mg/kg	3	58	0.021	5.6	N/A	0.38	6.7	NC	5.6
Benzo(a)anthracene	mg/kg	5	58	0.022	25	N/A	0.33	6.7	NC	25
Benzo(a)pyrene	mg/kg	3	58	0.029	22	N/A	0.38	6.7	NC	22
Benzo(b)fluoranthene	mg/kg	2	58	0.13	15	N/A	0.38	6.7	NC	15
Benzo(g,h,i)perylene	mg/kg	2	58	0.044	8.8	N/A	0.38	6.7	NC	8.8
Benzo(k)fluoranthene	mg/kg	2	58	0.027	20	N/A	0.4	6.7	NC	20
Bis(2-Ethylhexyl)phthalate	mg/kg	31	58	0.019	7.8	N/A	0.33	1.5	0.82	0.82
Carbazole	mg/kg	1	58	2.4	2.4	N/A	0.34	0.34	NC	2.4
Chrysene	mg/kg	6	58	0.038	28	N/A	0.33	6.7	NC	28
Di-n-Butylphthalate	mg/kg	1	58	1.2	1.2	N/A	1.2	1.2	NC	1.2
Di-n-Octylphthalate	mg/kg	1	58	0.021	0.021	N/A	0.38	0.38	NC	0.021
Dibenzo(a,h)anthracene	mg/kg	2	58	0.052	1.9	N/A	0.34	0.38	NC	1.9
Dibenzofuran	mg/kg	1	58	0.6	0.6	N/A	0.34	0.34	NC	0.6
Diethyl Phthalate	mg/kg	1	58	0.12	0.12	N/A	0.4	0.4	NC	0.12
Fluoranthene	mg/kg	5	58	0.026	35	N/A	0.33	6.7	NC	35
Fluorene	mg/kg	1	58	1	1	N/A	0.34	0.34	NC	1
Indeno(1,2,3-cd)pyrene	mg/kg	2	58	0.045	8.5	N/A	0.38	6.7	NC	8.5
Naphthalene	mg/kg	1	58	1.1	1.1	N/A	0.34	0.34	NC	1.1
Phenanthrene	mg/kg	5	58	0.026	17	N/A	0.38	6.7	NC	17
Pyrene	mg/kg	6	58	0.023	43	N/A	0.33	6.7	NC	43
Volatile Organics										
2-Butanone	mg/kg	5	58	0.006	0.008	N/A	0.012	0.012	NC	0.008
Acetone	mg/kg	11	32	0.004	0.051	N/A	0.01	0.012	0.02	0.02

Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Background concentration calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background.
N/A = Not available; no background data available for this analyte.

(1) Data set does not meet risk assessment data quality objectives; considered questionable.

Table A-4a. Contaminants of Potential Concern in Subsurface Soil, OU-2 (Continued)

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min Det Limit	Max Det Limit	95% UCL	RME
Volatile Organics										
Benzene	mg/kg	6	58	0.004	0.005	N/A	0.012	0.012	NC	0.005
Toluene	mg/kg	1	58	0.004	0.004	N/A	0.012	0.012	NC	0.004
Xylenes (Total)	mg/kg	1	58	0.003	0.003	N/A	0.01	0.01	NC	0.003

Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Background concentration calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution
<BKG = Site concentration is lower than background.
N/A = Not available; no background data available for this analyte.

(1) Data set does not meet risk assessment data quality objectives; considered questionable.

Table A-4b. Radionuclides of Concern in Subsurface Soil, OU-2

Isotope	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min MDA	Max MDA	95% UCL	RME
Radionuclides										
Actinium-228	pCi/g	28	29	0.156 ±0.074	0.93 ±0.24	0.71	0.089	0.37	0.65	<BKG
Americium-241	pCi/g	23	48	0 ±0.016	0.95 ±0.42	N/A	0.011	0.22	0.07	0.07
Bismuth-212	pCi/g	15	29	0.07 ±0.14	1.05 ±0.4	N/A	0.16	0.52	0.42	0.42
Bismuth-214	pCi/g	29	29	0.204 ±0.069	6.52 ±0.57	0.57	0.05	0.17	1.51	1.5
Carbon-14	pCi/g	0	10	-4.7 ±5.2	16 ±22	0.87	9.8	37	2.54	2.5
Cesium-137	pCi/g	1	29	-0.057 ±0.015	0.434 ±0.041	0.053	0.021	0.11	0.04	<BKG
Cobalt-60	pCi/g	0	29	-0.026 ±0.011	0.017 ±0.028	0.016	0.023	0.099	0.0	<BKG
Lead-210	pCi/g	5	29	-19 ±0.81	15 ±27	N/A	1.1	43	3.08	3.0
Lead-212	pCi/g	29	29	0.181 ±0.051	0.94 ±0.12	0.74	0.043	0.12	0.62	<BKG
Lead-214	pCi/g	29	29	0.294 ±0.067	7.73 ±0.18	0.75	0.046	0.17	1.79	1.7
Plutonium-241	pCi/g	0	48	-2.1 ±1.8	2.1 ±2.5	N/A	2.1	4.7	0.38	0.38
Potassium-40	pCi/g	29	29	4.53 ±0.63	15.3 ±2	13.6	0.29	1	11.66	<BKG
Radium-223	pCi/g	0	29	-0.37 ±0.16	0.37 ±0.55	N/A	0.4	1.5	0.05	0.05
Radium-226	pCi/g	76	87	0.045 ±0.24	106.2 ±1.1	0.77	0.046	1.5	4.69	4.6
Strontium-90	pCi/g	40	58	0.01 ±0.35	77.3 ±0.43	N/A	0.26	0.73	8.91	8.9
Thallium-208	pCi/g	29	29	0.076 ±0.024	0.253 ±0.08	0.21	0.022	0.093	0.19	<BKG
Thorium-234	pCi/g	1	29	-0.09 ±0.48	1.41 ±0.64	N/A	1.1	5.5	0.69	0.69
Uranium-235	pCi/g	0	29	-0.12 ±0.066	0.15 ±0.26	0.071	0.16	0.44	0.04	<BKG

Number Sampled = Number of samples in data set.
Number Detected = Number of samples in data set containing concentrations above MDA.
Min [] = Minimum detected activity in data set.
Max [] = Maximum detected activity in data set.
Background = Background activity calculations presented in Attachment B.
a =Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
Min MDA = Minimum MDA in data set.
Max MDA = Maximum MDA in data set.
NC = Not calculated, <10 samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background, not an isotope of concern for this OU.
MDA = Minimum detectable acitvity.
N/A = Not available; no background data for this compound.
pCi/g = picocuries per gram.

Table A-5a. Contaminants of Potential Concern in Surface Soil, OU-3

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min Det Limit	Max Det Limit	95% UCL	RME
Metals										
Arsenic	mg/kg	13	13	4.2	8.4	9.46	10	10	7.91	<BKG
Barium	mg/kg	13	13	89.6	205	237	200	200	155.94	<BKG
Beryllium	mg/kg	12	13	0.23	0.52	0.66	5	5	0.43	<BKG
Chromium	mg/kg	13	13	72	218	178	10	10	154.56	<BKG
Chromium, Hexavalent (+6)	mg/kg	17	18	0.034	0.16	0.099	0.2	0.27	0.1	0.1
Cobalt	mg/kg	13	13	11.7	23.4	29	50	50	21.87	<BKG
Copper	mg/kg	13	13	18	44.1	50	25	25	34.78	<BKG
Iron	mg/kg	13	13	21000	42200	42000	100	100	38,753.3	<BKG
Lead	mg/kg	13	13	4.1	10.8	10.1	3	3	8.45	<BKG
Manganese	mg/kg	13	13	499	882	720	15	15	677.91	<BKG
Mercury	mg/kg	9	13	0.1	1	0.49	0.2	0.2	NC	1
Nickel	mg/kg	13	13	109	318	326	40	40	256.41	<BKG
Selenium	mg/kg	3	13	0.49	0.62	1	5	5	NC	<BKG
Vanadium	mg/kg	13	13	34.7	64.9	73	5	5	58.12	<BKG
Zinc	mg/kg	13	13	45.9	130	82	20	20	78.41	<BKG
Pesticides and PCBs										
4,4'-DDE	mg/kg	1	13	0.0013	0.0013	N/A	0.0038	0.0038	NC	0.0013
Alpha-BHC	mg/kg	1	13	0.011	0.011	N/A	0.0019	0.0019	NC	0.011
Alpha-Chlordane	mg/kg	5	13	0.0025	0.23	N/A	0.0018	0.01	NC	0.23
Chlordane (1)	mg/kg	15	15	0.014	15	N/A	0.042	0.87	3.01	3.0
Delta-BHC	mg/kg	1	13	0.0014	0.0014	N/A	0.0019	0.0019	NC	0.0014
Gamma-BHC	mg/kg	1	13	0.0018	0.0018	N/A	0.0019	0.0019	NC	0.0018
Gamma-Chlordane	mg/kg	5	13	0.0024	0.26	N/A	0.0018	0.01	NC	0.26
Heptachlor	mg/kg	1	12	0.0066	0.0066	N/A	0.0018	0.0018	NC	0.0066
Semivolatile Organics										
Bis(2-Ethylhexyl)phthalate	mg/kg	2	2	0.037	0.045	N/A	0.35	0.4	NC	0.045
Di-n-Butylphthalate	mg/kg	2	2	0.13	0.13	N/A	0.35	0.4	NC	0.13

Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Background concentration calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background.
N/A = Not available; no background data available for this analyte.

(1) Data set does not meet risk assessment data quality objectives; considered questionable.

Table A-5b. Radionuclides of Concern in Surface Soil, OU-3

Isotope	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min MDA	Max MDA	95% UCL	RME
Radionuclides										
Actinium-228	pCi/g	28	28	0.27 ±0.11	0.62 ±0.16	0.71	0.11	0.4	0.51	<BKG
Bismuth-212	pCi/g	22	28	0.08 ±0.26	0.62 ±0.32	N/A	0.087	0.56	0.4	0.4
Bismuth-214	pCi/g	28	28	0.296 ±0.082	0.73 ±0.19	0.57	0.059	0.19	0.45	<BKG
Carbon-14	pCi/g	1	13	-4.6 ±8.3	11.3 ±4	0.87	1.8	12	3.67	3.6
Cesium-137	pCi/g	5	28	-0.013 ±0.02	0.159 ±0.042	0.053	0.025	0.094	0.03	<BKG
Cobalt-60	pCi/g	0	28	-0.011 ±0.02	0.028 ±0.02	0.016	0.019	0.091	0.01	<BKG
Lead-210	pCi/g	1	28	-0.8 ±2.3	3.3 ±2.4	N/A	0.93	5.6	1.08	1.0
Lead-212	pCi/g	28	28	0.317 ±0.066	0.72 ±0.11	0.74	0.048	0.13	0.56	<BKG
Lead-214	pCi/g	28	28	0.379 ±0.073	0.7 ±0.11	0.75	0.056	0.17	0.53	<BKG
Potassium-40	pCi/g	28	28	10 ±1.4	13 ±1.7	13.6	0.3	1.1	11.63	<BKG
Radium-223	pCi/g	0	15	-0.2 ±0.22	0.32 ±0.26	N/A	0.48	0.92	0.04	0.04
Radium-226	pCi/g	21	43	-0.38 ±0.61	1.39 ±0.67	0.77	0.087	0.95	0.54	<BKG
Strontium-90	pCi/g	11	28	-0.8 ±1.1	5.66 ±0.81	N/A	0.41	2	1.5	1.5
Thallium-208	pCi/g	28	28	0.116 ±0.04	0.272 ±0.093	0.21	0.029	0.092	0.17	<BKG
Thorium-234	pCi/g	0	28	0.31 ±0.43	0.93 ±0.4	N/A	0.91	6.4	0.65	0.65
Uranium-235	pCi/g	0	28	-0.126 ±0.08	0.14 ±0.15	0.071	0.17	0.37	0.03	<BKG

Number Sampled = Number of samples in data set.
Number Detected = Number of samples in data set containing concentrations above MDA.
Min [] = Minimum detected activity in data set.
Max [] = Maximum detected activity in data set.
Background = Background activity calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
N/A = Not available; no background data available for this analyte.
Min MDA = Minimum MDA in data set.
Max MDA = Maximum MDA in data set.
NC = Not calculated, <10 samples in sample set.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background, not an isotope of concern for this OU.
RME = Reasonable maximum exposure concentration.
MDA = Minimum detectable activity
pCi/g = picocuries per gram

Table A-6a. Contaminants of Potential Concern in Subsurface Soil, OU-3

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min Det Limit	Max Det Limit	95% UCL	RME
Metals										
Arsenic	mg/kg	21	21	5.5	8.8	9.46	10	10	8.0	<BKG
Barium	mg/kg	21	21	75.6	219	237	200	200	182.61	<BKG
Beryllium	mg/kg	21	21	0.26	0.55	0.66	5	5	0.47	<BKG
Chromium	mg/kg	21	21	53.7	262	178	10	10	138.53	<BKG
Chromium, Hexavalent (+6)	mg/kg	24	24	0.034	0.29	0.099	0.2	0.27	0.16	0.16
Cobalt	mg/kg	21	21	16.2	27.9	29	50	50	23.2	<BKG
Copper	mg/kg	21	21	19.3	46.8	50	25	25	40.92	<BKG
Iron	mg/kg	21	21	22600	46600	42000	100	100	41,319.32	<BKG
Lead	mg/kg	21	21	5.1	8.9	10.1	3	3	8.23	<BKG
Manganese	mg/kg	21	21	379	1010	720	15	15	705.75	<BKG
Mercury	mg/kg	7	21	0.12	0.26	0.49	0.2	0.2	NC	<BKG
Nickel	mg/kg	21	21	62.9	280	326	40	40	223.5	<BKG
Selenium	mg/kg	8	21	0.46	0.72	1	5	5	NC	<BKG
Vanadium	mg/kg	21	21	48.8	77.5	73	5	5	64.75	<BKG
Zinc	mg/kg	21	21	42.8	100	82	20	20	74.8	<BKG
Pesticides and PCBs										
4,4'-DDE	mg/kg	1	21	0.0012	0.0012	N/A	0.0039	0.0039	NC	0.0012
Semivolatile Organics										
Bis(2-Ethylhexyl)phthalate	mg/kg	2	2	0.051	0.065	N/A	0.38	0.41	NC	0.065
Di-n-Butylphthalate	mg/kg	2	2	0.15	0.16	N/A	0.38	0.41	NC	0.16
Volatile Organics										
Acetone	mg/kg	1	2	0.032	0.032	N/A	0.011	0.011	NC	0.032

Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Background concentration calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background.
N/A = Not available; no background data available for this analyte.

(1) Data set does not meet risk assessment data quality objectives; considered questionable.

Table A-6b. Radionuclides of Concern in Subsurface Soil, OU-3

Isotope	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min MDA	Max MDA	95% UCL	RME
Radionuclides										
Actinium-228	pCi/g	21	21	0.302 ±0.097	0.83 ±0.22	0.71	0.12	0.31	0.61	<BKG
Bismuth-212	pCi/g	8	21	0.05 ±0.33	0.56 ±0.18	N/A	0.072	0.56	0.37	0.37
Bismuth-214	pCi/g	21	21	0.299 ±0.064	0.64 ±0.13	0.57	0.058	0.15	0.5	<BKG
Carbon-14	pCi/g	1	21	-1.6 ±2.3	16.4 ±12	0.87	3	16	3.07	3.0
Cesium-137	pCi/g	0	21	-0.031 ±0.013	0.025 ±0.03	0.053	0.022	0.079	0.0	<BKG
Cobalt-60	pCi/g	0	21	-0.015 ±0.013	0.027 ±0.02	0.016	0.02	0.079	0.0	<BKG
Lead-210	pCi/g	0	21	-0.31 ±0.91	1.54 ±2.94	N/A	4.6	5.5	0.88	0.88
Lead-212	pCi/g	20	20	0.327 ±0.078	0.75 ±0.12	0.74	0.048	0.1	0.64	<BKG
Lead-214	pCi/g	20	20	0.326 ±0.055	0.72 ±0.11	0.75	0.057	0.14	0.57	<BKG
Potassium-40	pCi/g	20	20	9.2 ±1.4	16.4 ±1.8	13.6	0.32	0.81	11.99	<BKG
Radium-226	pCi/g	19	21	0.18 ±0.28	5.11 ±0.4	0.77	0.072	0.56	1.36	1.3
Strontium-90	pCi/g	0	21	-0.5 ±0.17	0.9 ±1	N/A	0.29	1.7	0.01	0.01
Thallium-208	pCi/g	20	20	0.091 ±0.035	0.226 ±0.071	0.21	0.03	0.074	0.19	<BKG
Thorium-234	pCi/g	0	21	0.45 ±0.47	1.24 ±0.38	N/A	5.2	6.7	0.85	0.85
Uranium-235	pCi/g	0	20	-0.1 ±0.09	0.12 ±0.19	0.071	0.13	0.3	0.04	<BKG

Number Sampled = Number of samples in data set.
Number Detected = Number of samples in data set containing concentrations above MDA.
Min [] = Minimum detected activity in data set.
Max [] = Maximum detected activity in data set.
Background = Background activity calculations presented in Attachment B.
a =Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
Min MDA = Minimum MDA in data set.
Max MDA = Maximum MDA in data set.
NC = Not calculated, <10 samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background, not an isotope of concern for this OU.
MDA = Minimum detectable acitvity.
N/A = Not available; no background data for this compound.
pCi/g = picocuries per gram.

Table A-7a. Contaminants of Potential Concern in Surface Soil, OU-4

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min Det Limit	Max Det Limit	95% UCL	RME
General Chemical										
Formaldehyde	mg/kg	1	1	0.35	0.35	N/A	0.12	0.12	NC	0.35
Metals										
Barium	mg/kg	1	1	27.1	27.1	237	40	40	NC	<BKG
Chromium	mg/kg	1	1	32.2	32.2	178	2	2	NC	<BKG
Cobalt	mg/kg	1	1	5.9	5.9	29	10	10	NC	<BKG
Copper	mg/kg	1	1	11.5	11.5	50	5	5	NC	<BKG
Iron	mg/kg	1	1	12200	12200	42000	20	20	NC	<BKG
Lead	mg/kg	1	1	3.1	3.1	10.1	0.6	0.6	NC	<BKG
Manganese	mg/kg	1	1	124	124	720	3	3	NC	<BKG
Nickel	mg/kg	1	1	32.8	32.8	326	8	8	NC	<BKG
Vanadium	mg/kg	1	1	23.8	23.8	73	10	10	NC	<BKG
Zinc	mg/kg	1	1	21.8	21.8	82	4	4	NC	<BKG

Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Background concentration calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background.
N/A = Not available; no background data available for this analyte.

Table A-7b. Radionuclides of Concern in Surface Soil, OU-4

Isotope	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min MDA	Max MDA	95% UCL	RME
Radionuclides										
Actinium-228	pCi/g	1	1	0.309 ±0.071	0.309 ±0.071	0.71	0.089	0.089	NC	<BKG
Bismuth-212	pCi/g	1	1	0.19 ±0.13	0.19 ±0.13	N/A	0.17	0.17	NC	0.19
Bismuth-214	pCi/g	1	1	0.236 ±0.05	0.236 ±0.05	0.57	0.052	0.052	NC	<BKG
Carbon-14	pCi/g	1	1	2.97 ±0.65	2.97 ±0.65	0.87	0.58	0.58	NC	2.9
Cesium-137	pCi/g	0	1	0.002 ±0.016	0.002 ±0.016	0.053	0.022	0.022	NC	<BKG
Cobalt-60	pCi/g	0	1	-0.0032 ±0.0099	-0.0032 ±0.0099	0.016	0.023	0.023	NC	<BKG
Lead-210	pCi/g	0	1	1 ±1.8	1 ±1.8	N/A	2.5	2.5	NC	1
Lead-212	pCi/g	1	1	0.266 ±0.047	0.266 ±0.047	0.74	0.043	0.043	NC	<BKG
Lead-214	pCi/g	1	1	0.287 ±0.045	0.287 ±0.045	0.75	0.046	0.046	NC	<BKG
Potassium-40	pCi/g	1	1	7.96 ±0.98	7.96 ±0.98	13.6	0.29	0.29	NC	<BKG
Radium-226	pCi/g	0	2	-0.16 ±0.33	0.049 ±0.063	0.77	0.11	0.47	NC	<BKG
Strontium-90	pCi/g	0	1	0.02 ±0.18	0.02 ±0.18	N/A	0.31	0.31	NC	0.02
Thallium-208	pCi/g	1	1	0.099 ±0.025	0.099 ±0.025	0.21	0.025	0.025	NC	<BKG
Thorium-234	pCi/g	0	1	0.36 ±0.27	0.36 ±0.27	N/A	0.85	0.85	NC	0.36
Uranium-235	pCi/g	0	1	0.032 ±0.086	0.032 ±0.086	0.071	0.13	0.13	NC	<BKG

Number Sampled = Number of samples in data set.
Number Detected = Number of samples in data set containing concentrations above MDA.
Min [] = Minimum detected activity in data set.
Max [] = Maximum detected activity in data set.
Background = Background activity calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
N/A = Not available; no background data available for this analyte.
Min MDA = Minimum MDA in data set.
Max MDA = Maximum MDA in data set.
NC = Not calculated, <10 samples in sample set.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background, not an isotope of concern for this OU.
RME = Reasonable maximum exposure concentration.
MDA = Minimum detectable activity
pCi/g = picocuries per gram

Table A-8a. Contaminants of Potential Concern in Subsurface Soil, OU-4

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min Det Limit	Max Det Limit	95% UCL	RME
General Chemical										
Formaldehyde	mg/kg	1	7	2.2	2.2	N/A	1	1	NC	2.2
Metals										
Arsenic	mg/kg	7	7	7.6	8.6	9.46	2.3	2.4	NC	<BKG
Barium	mg/kg	7	7	170	270	237	11	12	NC	270
Beryllium	mg/kg	7	7	0.36	0.45	0.66	1.1	1.2	NC	<BKG
Chromium	mg/kg	7	7	96	120	178	2.3	23	NC	<BKG
Cobalt	mg/kg	7	7	23	27	29	1.1	1.2	NC	<BKG
Copper	mg/kg	7	7	53	60	50	1.1	1.2	NC	60
Iron	mg/kg	7	7	32000	39000	42000	110	120	NC	<BKG
Lead	mg/kg	7	7	7.8	9.3	10.1	6.8	7.1	NC	<BKG
Manganese	mg/kg	7	7	560	790	720	34	36	NC	790
Mercury	mg/kg	2	7	0.14	0.35	0.49	0.11	0.11	NC	<BKG
Molybdenum	mg/kg	7	7	0.29	0.51	2b	1.1	1.2	NC	<BKG
Nickel	mg/kg	7	7	220	260	326	1.1	1.2	NC	<BKG
Vanadium	mg/kg	7	7	57	66	73	1.1	1.2	NC	<BKG
Zinc	mg/kg	7	7	75	110	82	4.5	4.7	NC	110

Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Background concentration calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background.
N/A = Not available; no background data available for this analyte.

(1) Data set does not meet risk assessment data quality objectives; considered questionable.

Table A-8b. Radionuclides of Concern in Subsurface Soil, OU-4

Isotope	Units	Number Detected	Number Sampled	Min []	Max []	Background	Min MDA	Max MDA	95% UCL	RME
Radionuclides										
Actinium-228	pCi/g	7	7	0.47 ±0.11	0.59 ±0.13	0.71	0.12	0.18	NC	<BKG
Bismuth-212	pCi/g	5	7	0.21 ±0.17	0.44 ±0.25	N/A	0.21	0.31	NC	0.44
Bismuth-214	pCi/g	7	7	0.306 ±0.073	0.343 ±0.085	0.57	0.075	0.1	NC	<BKG
Carbon-14	pCi/g	0	7	-4.4 ±5.6	2.1 ±6.4	0.87	10	12	NC	2.1
Cesium-137	pCi/g	0	7	-0.024 ±0.017	0.003 ±0.023	0.053	0.03	0.044	NC	<BKG
Cobalt-60	pCi/g	0	7	-0.011 ±0.01	0.009 ±0.016	0.016	0.019	0.042	NC	<BKG
Lead-210	pCi/g	0	7	-4.5 ±7.1	5.5 ±9.1	N/A	9.5	12	NC	5.5
Lead-212	pCi/g	7	7	0.442 ±0.07	0.514 ±0.085	0.74	0.056	0.075	NC	<BKG
Lead-214	pCi/g	7	7	0.349 ±0.061	0.431 ±0.077	0.75	0.059	0.087	NC	<BKG
Potassium-40	pCi/g	7	7	9.3 ±1.4	12.4 ±1.6	13.6	0.35	0.51	NC	<BKG
Radium-223	pCi/g	0	7	-0.05 ±0.17	0.16 ±0.21	N/A	0.47	0.66	NC	0.16
Radium-226	pCi/g	10	14	0.38 ±0.16	0.91 ±0.59	0.77	0.078	0.81	0.73	<BKG
Strontium-90	pCi/g	5	7	0.07 ±0.14	0.45 ±0.17	N/A	0.22	0.26	NC	0.45
Thallium-208	pCi/g	7	7	0.118 ±0.036	0.167 ±0.044	0.21	0.032	0.047	NC	<BKG
Thorium-234	pCi/g	0	7	0.19 ±0.33	0.51 ±0.44	N/A	0.96	1.3	NC	0.51
Uranium-235	pCi/g	0	7	-0.091 ±0.12	0.1 ±0.15	0.071	0.19	0.24	NC	0.1

Number Sampled = Number of samples in data set.
Number Detected = Number of samples in data set containing concentrations above MDA.
Min [] = Minimum detected activity in data set.
Max [] = Maximum detected activity in data set.
Background = Background activity calculations presented in Attachment B.
a =Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
Min MDA = Minimum MDA in data set.
Max MDA = Maximum MDA in data set.
NC = Not calculated, <10 samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background, not an isotope of concern for this OU.
MDA = Minimum detectable acitvity.
N/A = Not available; no background data for this compound.
pCi/g = picocuries per gram.

Table A-9a. Consolidated List of Chemical Contaminants of Concern

Analyte	Surface Soil (<3ft) Reasonable Maximum Exposure Concentration (mg/kg)				Subsurface Soil (>=3ft) Reasonable Maximum Exposure Concentration (mg/kg)				Background Levels
	OU1	OU2	OU3	OU4	OU1	OU2	OU3	OU4	
General Chemical									
Formaldehyde	1.6	-	-	0.35	1.4	-	-	2.2	N/A
Metals									
Antimony	<BKG	-	-	-	0.94	-	-	-	0.74a
Arsenic	<BKG	-	<BKG	-	<BKG	<BKG	<BKG	<BKG	9.46
Barium	<BKG	-	<BKG	<BKG	<BKG	<BKG	<BKG	270	237
Beryllium	<BKG	-	<BKG	-	<BKG	-	<BKG	<BKG	0.66
Cadmium	<BKG	-	-	-	7.1	-	-	-	0.46a
Chromium	230	230	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	178
Chromium, Hexavalent	0.22	-	0.1	-	<BKG	-	0.16	-	0.099
Cobalt	<BKG	-	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	29
Copper	62	-	<BKG	<BKG	100	89	<BKG	60	50
Iron	<BKG	-	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	42000
Lead	21	-	<BKG	<BKG	13	<BKG	<BKG	<BKG	10.1
Manganese	880	-	<BKG	<BKG	<BKG	<BKG	<BKG	790	720
Mercury	0.57	-	1	-	0.65	<BKG	<BKG	<BKG	0.49
Molybdenum	<BKG	-	-	-	<BKG	<BKG	-	<BKG	2b
Nickel	<BKG	-	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	326
Selenium	<BKG	-	<BKG	-	1.0	-	<BKG	-	1
Silver	-	-	-	-	2.7	-	-	-	0.52a
Thallium	-	-	-	-	<BKG	-	-	-	1.36a

<BKG = Site concentration lower than background.
Background calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentration detected).
N/A = Not available. No background data available for this analyte.
- = not positively detected

Table A-9a. Consolidated List of Chemical Contaminants of Concern (Continued)

Analyte	Surface Soil (<3ft) Reasonable Maximum Exposure Concentration (mg/kg)				Subsurface Soil (>=3ft) Reasonable Maximum Exposure Concentration (mg/kg)				Background Levels
	OU1	OU2	OU3	OU4	OU1	OU2	OU3	OU4	
Metals									
Vanadium	<BKG	-	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	73
Zinc	130	-	<BKG	<BKG	140	160	<BKG	110	82
Pesticides and PCBs									
4,4'-DDD	0.24	-	-	-	0.04	0.00032	-	-	N/A
4,4'-DDE	0.014	-	0.0013	-	0.014	-	0.0012	-	N/A
4,4'-DDT	-	-	-	-	0.0037	0.0018	-	-	N/A
Alpha-BHC	-	-	0.011	-	-	-	-	-	N/A
Alpha-Chlordane	0.8	-	0.23	-	0.19	-	-	-	N/A
Arochlor-1260	-	-	-	-	1.3	-	-	-	N/A
Chlordane	-	-	3.0	-	-	-	-	-	N/A
Delta-BHC	-	-	0.0014	-	-	-	-	-	N/A
Dieldrin	-	-	-	-	0.07	-	-	-	N/A
Endosulfan I	-	-	-	-	0.002	-	-	-	N/A
Endosulfan Sulfate	-	-	-	-	0.011	-	-	-	N/A
Gamma-BHC	-	-	0.0018	-	-	-	-	-	N/A
Gamma-Chlordane	0.74	-	0.26	-	0.21	-	-	-	N/A
Heptachlor	-	-	0.0066	-	0.096	-	-	-	N/A
Heptachlor Epoxide	-	-	-	-	0.0013	-	-	-	N/A
Methoxychlor	-	-	-	-	0.0011	-	-	-	N/A
Semivolatile Organics									

<BKG = Site concentration lower than background.
Background calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentration detected).
N/A = Not available. No background data available for this analyte.
- = not positively detected

Table A-9a. Consolidated List of Chemical Contaminants of Concern (Continued)

Analyte	Surface Soil (<3ft) Reasonable Maximum Exposure Concentration (mg/kg)				Subsurface Soil (>=3ft) Reasonable Maximum Exposure Concentration (mg/kg)				Background Levels
	OU1	OU2	OU3	OU4	OU1	OU2	OU3	OU4	
Semivolatile Organics									
2-Methylnaphthalene					1900	0.44			N/A
Acenaphthene					3300	5.8			N/A
Anthracene					1500	5.6			N/A
Benzo(a)anthracene					660	25			N/A
Benzo(a)pyrene					140	22		-	N/A
Benzo(b)fluoranthene					96	15			N/A
Benzo(g,h,i)perylene					0.49	8.8			N/A
Benzo(k)fluoranthene					36	20			N/A
Bis(2-Ethylhexyl)phthal	0.1	0.031	0.045		1.7	0.82	0.065		N/A
Carbazole					410	2.4			N/A
Chrysene					630	28			N/A
Di-n-Butylphthalate			0.13		0.031	1.2	0.16		N/A
Di-n-Octylphthalate					0.037	0.021			N/A
Dibenzo(a,h)anthracene					18	1.9			N/A
Dibenzofuran					2100	0.6			N/A
Diethyl Phthalate						0.12			N/A
Fluoranthene					4000	35			N/A
Fluorene					3100	1			N/A
Indeno(1,2,3-cd)pyrene					27	8.5			N/A
Naphthalene	-	-	-	-	2600	1.1	-		N/A

<BKG = Site concentration lower than background.
Background calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentration detected)
N/A = Not available. No background data available for this analyte.
- = not positively detected

Table A-9a. Consolidated List of Chemical Contaminants of Concern (Continued)

Analyte	Surface Soil (<3ft) Reasonable Maximum Exposure Concentration (mg/kg)				Subsurface Soil (>=3ft) Reasonable Maximum Exposure Concentration (mg/kg)				Background Levels
	OU1	OU2	OU3	OU4	OU1	OU2	OU3	OU4	
Semivolatile Organics									
Pentachlorophenol	-	-	-	-	0.66	-	-	-	N/A
Phenanthrene	-	-	-	-	9500	17	-	-	N/A
Pyrene	-	-	-	-	3900	43	-	-	N/A
Volatile Organics									
2-Butanone	-	-	-	-	0.006	0.008	-	-	N/A
2-Hexanone	-	-	-	-	0.075	-	-	-	N/A
Acetone	0.003	0.006	-	-	0.23	0.02	0.032	-	N/A
Benzene	-	-	-	-	0.001	0.005	-	-	N/A
Carbon Tetrachloride	-	-	-	-	0.004	-	-	-	N/A
Ethylbenzene	-	-	-	-	1.2	-	-	-	N/A
Methylene Chloride	-	-	-	-	0.004	-	-	-	N/A
Styrene	-	-	-	-	0.8	-	-	-	N/A
Toluene	-	-	-	-	0.49	0.004	-	-	N/A
Xylenes (Total)	-	-	-	-	6.2	0.003	-	-	N/A

<BKG = Site concentration lower than background.
Background calculations presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentration detected).
N/A = Not available. No background data available for this analyte.
- = not positively detected

Table A-9b. Consolidated List of Radionuclides of Concern

Analyte	Surface Soil (<3ft) Reasonable Maximum Exposure Concentration (pCi/L)				Subsurface Soil (>=3ft) Reasonable Maximum Exposure Concentration (pCi/L)				Background Levels
	OU1	OU2	OU3	OU4	OU1	OU2	OU3	OU4	
Radionuclides									
Actinium-228	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	0.71
Americium-241	0.021	0.024	-	-	0.027	0.07	-	-	N/A
Bismuth-212	0.35	0.38	0.4	0.19	0.32	0.42	0.37	0.44	N/A
Bismuth-214	<BKG	<BKG	<BKG	<BKG	<BKG	1.5	<BKG	<BKG	0.57
Carbon-14	<BKG	-	3.6	2.9	3.3	2.5	3.0	2.1	0.87
Cesium-137	5.8	0.054	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	0.053
Cobalt-60	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	0.016
Lead-210	1.8	1.4	1.0	1	3.3	3.0	0.88	5.5	N/A
Lead-212	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	0.74
Lead-214	<BKG	<BKG	<BKG	<BKG	0.76	1.7	<BKG	<BKG	0.75
Plutonium-241	0.1	1.5	-	-	0.3	0.38	-	-	N/A
Potassium-40	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	13.6
Radium-223	0.47	0.04	0.04	-	0.03	0.05	-	0.16	N/A
Radium-226	<BKG	1.7	<BKG	<BKG	17	4.6	1.3	<BKG	0.77
Strontium-90	6.9	0.35	1.5	0.02	850	8.9	0.01	0.45	N/A
Thallium-208	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	<BKG	0.21
Thorium-228	<BKG	-	-	-	0.76	-	-	-	0.71
Thorium-230	<BKG	-	-	-	<BKG	-	-	-	0.8
Thorium-232	<BKG	-	-	-	0.71	-	-	-	0.64
Thorium-234	0.66	0.55	0.65	0.36	2.3	0.69	0.85	0.51	N/A

<BKG = Site concentration lower than background.
Background concentration presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentration detected).
N/A = Not available. No brackground data available for this analyte.
- = activity of all samples less than MDA.

Table A-9b. Consolidated List of Radionuclides of Concern (Continued)

Analyte	Surface Soil (<3ft) Reasonable Maximum Exposure Concentration (pCi/L)				Subsurface Soil (>=3ft) Reasonable Maximum Exposure Concentration (pCi/L)				Background Levels
	OU1	OU2	OU3	OU4	OU1	OU2	OU3	OU4	
Radionuclides									
Tritium	91	-	-	-	2.8	-	-	-	0.023
Uranium-233/234	<BKG	-	-	-	<BKG	-	-	-	0.66
Uranium-235	<BKG	0.12	<BKG	<BKG	0.12	<BKG	<BKG	0.1	0.071
Uranium-238	<BKG	-	-	-	<BKG	-	-	-	0.63

<BKG = Site concentration lower than background
Background concentration presented in Attachment B.
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentration detected).
N/A = Not available. No brackground data available for this analyte.
- = activity of all samples less than MDA.

Table A-10a. Identification of Contaminants Concern (COC) in Surface Water

Chemical	Units	Putah Creek Upstream (PCU) Max []	Putah Creek Downstream (PCD) Max []	UCD Treatment Plant Outfall (STPO) Max []	LEHR Storm Water (SWL-1, SWL-2) Max []	USEPA Water Quality Criteria a, b	Surface Soil LEHR Site above BKG?	Decision Code	COC?
General Chemical									
Formaldehyde	mg/L	ND <500	0.37	2.1	ND <1	None	Yes	5	Yes
Metals									
Antimony	mg/L	0.1	0.07	0.11	0.156	0.088	No	1	No
Arsenic	mg/L	0.0065	0.0074	0.0074	0.0016	0.360	No	1	No
Barium	mg/L	0.114	0.12	0.147	0.0097	None	No	1	No
Beryllium	mg/L	0.006	0.006	0.006	ND <0.02	None	No	1	No
Cadmium	mg/L	0.002	0.002	0.002	ND <0.001	0.011	No	1	No
Chromium	mg/L	0.06	0.08	0.11	0.0072	0.180 [h]	Yes	2	Yes
Chromium, Hexavalent (+6)	mg/L	0.043	0.042	0.045	0.01	0.015	Yes	2	Yes
Cobalt	mg/L	0.01	0.0012	0.002	ND <0.01	None	No	1	No
Copper	mg/L	0.04	0.05	0.03	0.0098	0.040	Yes	2	Yes
Iron	mg/L	0.301	0.317	0.506	0.909	1.0	No	1	No
Lead	mg/L	0.0073	0.01	0.0112	0.0384	0.170	Yes	2	Yes
Manganese	mg/L	0.0124	0.0132	0.0218	0.0192	None	Yes	1	No
Mercury	mg/L	0.0009	0.00027	0.00063	ND <0.0002	0.0021	Yes	4	No
Molybdenum	mg/L	0.06	0.05	0.11	ND <0.01	None	No	1	No
Nickel	mg/L	0.07	0.31	0.13	0.006	3.1	No	1	No
Selenium	mg/L	ND <0.01	0.0038	0.054	ND <0.003	0.020	No	1	No
Silver	mg/L	ND <0.04	0.08	0.08	ND <0.01	0.016	No	1	No
Thallium	mg/L	0.09	0.08	0.1	ND <0.01	0.040	No	1	No
Vanadium	mg/L	0.0134	0.02	0.0123	0.0029	None	No	1	No
Zinc	mg/L	0.06	1.19	0.1	0.112	0.250	Yes	2	Yes
Pesticides and PCBs									
4,4'-DDD	mg/L	0.000022	0.000093	0.000051	ND <0.000022	0.0011 [c]	Yes	4	No
4,4'-DDE	mg/L	0.000005	0.000005	0.000012	ND <0.000022	0.0011 [c]	Yes	4	No
4,4'-DDT	mg/L	0.000015	ND <0.0001	ND <0.0001	ND <0.000022	0.0011 [c]	No	1	No
Aldrin	mg/L	ND <0.00005	0.000037	0.000015	ND <0.000011	0.003 [c]	No	1	No

Table A-10a. Identification of Contaminants Concern (COC) in Surface Water (Continued)

Chemical	Units	Putah Creek Upstream (PCU) Max []	Putah Creek Downstream (PCD) Max []	UCD Treatment Plant Outfall (STPO) Max []	LEHR Storm Water (SWL-1, SWL-2) Max []	USEPA Water Quality Criteria a, b	Surface Soil LEHR Site above BKG?	Decision Code	COC?
Pesticides and PCBs									
Alpha-BHC	mg/L	0.000055	0.000038	0.000042	ND <0.000011	0.0020 [f]	Yes	4	No
Alpha-Chlordane	mg/L	ND <0.00005	ND <0.000051	0.000017	0.000015	0.0024 [d]	Yes	2	Yes
Beta-BHC	mg/L	0.000024	0.000008	0.000042	ND <0.000011	0.0020 [f]	No	1	No
Delta-BHC	mg/L	0.000055	0.000012	0.00035	ND <0.000011	0.0020 [f]	Yes	4	No
Dieldrin	mg/L	0.000015	0.000043	0.000027	ND <0.000022	0.0025 [c]	No	1	No
Endosulfan I	mg/L	0.000103	0.000062	0.000055	ND <0.000011	0.00022 [c]	No	1	No
Endosulfan II	mg/L	0.000007	ND <0.0001	0.000007	ND <0.000022	0.00022 [c]	No	1	No
Endrin	mg/L	ND <0.0001	ND <0.0001	0.000056	ND <0.000022	None	No	1	No
Endrin Aldehyde	mg/L	ND <0.0001	0.000041	ND <0.0001	ND <0.000022	None	No	1	No
Gamma-BHC	mg/L	0.000026	0.000019	0.000066	ND <0.000011	0.0020 [c]	Yes	4	No
Gamma-Chlordane	mg/L	ND <0.00005	ND <0.000051	ND <0.00005	0.000013	0.0024 [d]	Yes	2	Yes
Heptachlor	mg/L	0.000026	0.000032	0.000018	ND <0.000011	0.00052 [c]	Yes	4	No
Semivolatile Organics									
2-Chlorophenol	mg/L	ND <0.012	ND <0.011	0.0046	ND <0.01	None	No	1	No
4-Nitrophenol	mg/L	ND <0.029	ND <0.029	ND <0.029	0.0008	None	No	1	No
Benzyl Butyl Phthalate	mg/L	ND <0.012	ND <0.011	ND <0.012	0.002	0.003	No	1	No
Bis(2-Chloroisopropyl)Ether	mg/L	ND <0.0057	0.0036	0.0057	NS	None	No	1	No
Bis(2-Ethylhexyl)phthalate	mg/L	0.021	0.0126	0.021	0.001	0.360	Yes	2	Yes
Di-n-Butylphthalate	mg/L	0.13	0.059	0.0049	ND <0.01	None	Yes	5	Yes
Diethyl Phthalate	mg/L	0.002	0.001	0.001	ND <0.01	None	No	1	No
Pyrene	mg/L	ND <0.012	ND <0.011	ND <0.012	0.0007	None	No	1	No
Volatile Organics									
1,1,1-Trichloroethane	mg/L	ND <0.0038	ND <0.0038	0.00033	ND <0.001	None	No	1	No
Acetone	mg/L	0.02	0.018	0.036	0.017	None	Yes	2	Yes
Benzene	mg/L	ND <0.0044	ND <0.0044	ND <0.0044	0.0001	None	No	1	No
Bromochloromethane	mg/L	ND <0.001	ND <0.001	0.00098	ND <0.001	None	No	1	No
Bromodichloromethane	mg/L	0.0071	0.0058	0.013	ND <0.001	None	No	1	No

Table A-10a. Identification of Contaminants Concern (COC) in Surface Water (Continued)

Chemical	Units	Putah Creek Upstream (PCU) Max []	Putah Creek Downstream (PCD) Max []	UCD Treatment Plant Outfall (STPO) Max []	LEHR Storm Water (SWL-1, SWL-2) Max []	USEPA Water Quality Criteria a, b	Surface Soil LEHR Site above BKG?	Decision Code	COC?
Volatile Organics									
Bromoform	mg/L	ND <0.0047	0.0012	0.0075	0.0003	None	No	1	No
Chloroform	mg/L	0.019	0.014	0.033	ND <0.001	1.240 [g]	No	1	No
Dibromochloromethane	mg/L	0.0027	0.0034	0.0091	ND <0.001	None	No	1	No
Ethylbenzene	mg/L	ND <0.0072	ND <0.0072	ND <0.0072	0.0007	0.00018	No	1	No
Methylene Chloride	mg/L	ND <0.0028	0.0033	0.04	ND <0.002	5.5	No	1	No
Toluene	mg/L	ND <0.006	0.0017	ND <0.006	0.00099	None	No	1	No
Xylenes (total)	mg/L	ND <0.001	ND <0.001	ND <0.001	0.0008	None	No	1	No

Table A-10a. Identification of Contaminants Concern (COC) in Surface Water (Continued)

Notes:

Max [] = Maximum detected concentration in data set.
UCD = University of California, Davis.
a = United States Environmental Protection Agency (USEPA) National Ambient Water Quality Criteria (AWQC) Freshwater Aquatic Life Protection maximum concentration, 1 hour average, April 1996 and California Inland Surface Water Plan, Aquatic Life Protection maximum concentration, 1 hour coverage.
In case of discrepancy between Federal and State, lower concentration reported.
b = Metals concentrations based on average surface water hardness of 250 mg/L CaCO3.
c = Instantaneous maximum value.
d = Ambient Water Quality Criteria reported for Chlordane. Chlordane is comprised of alpha and gamma isomers.
e = Concentration for DDT used.
f = Concentration for g-BHC (Lindane) reported.
g = Value set at chronic toxicity level, USEPA AWQC.
h = Value for Chromium III reported, USEPA AWQC.
NS = Not sampled.
BKG = Background concentration, presented in Attachment B of the Determination of Risk-Based Standards for DOE Areas.

Assumptions/Limitations:

Data set used for surface water analysis based on sampling events from 11/9/90 to 5/29/96.
Data set used for LEHR site storm water based on sampling events from 11/15/94 to 3/12/96.
Contract required detection limits reported, instrument detection limits may be lower.
Constituents present in soils at >3ft bgs do not contribute to surface water discharge to Putah Creek.

Decision Codes:

1 = Not present above BKG or method detection limits in site surface soils. Not considered a COPEC.
2 = Detected in site soil and detected in storm water. Considered a COPEC.
3 = Detected in site soil, not detected in storm water and method detection limit > Ambient Water Quality Criteria. Considered a COPEC.
4 = Detected in site soil, not detected in storm water and method detection limit < Ambient Water Quality Criteria. Not considered a COPEC.
5 = Detected in site soil, not detected in storm water and no Ambient Water Quality Criteria. Considered a COPEC.

Table A-10b. Identification of Radionuclide Contaminants of Concern (COC) in Surface Water

Isotope	Units	Putah Creek Upstream (PCU) Maximum Activity ±Error a	Putah Creek Downstream (PCD) Maximum Activity ±Error	UCD Treatment Plant Outfall (STPO) Maximum Activity ±Error	LEHR Storm Water SWL-1, SWL-2 Maximum Activity ±Error	USEPA Water Quality Criteria b	Surface Soil LEHR Site >MDA	Decision Code	COC ?
Radionuclides									
Actinium-228	pCi/L	17.8 ±7	12 ±22	7.4 ±9.6	18 ±21	None	Yes	2	Yes
Americium-241	pCi/L	0.039 ±0.035	0.051 ±0.038	0.097 ±0.075	0.033 ±0.027	None	Yes	2	Yes
Bismuth-212	pCi/L	14 ±16	9 ±42	5 ±38	33 ±49	None	Yes	2	Yes
Bismuth-214	pCi/L	21 ±14	33 ±47	17.2 ±6.1	4 ±12	None	Yes	2	Yes
Carbon-14	pCi/L	122 ±31	68 ±56	88 ±82	32 ±83	None	Yes	2	Yes
Cesium-134	pCi/L	1.7 ±3.5	2 ±15	1.8 ±3.6	1.4 ±4	None	No	1	No
Cesium-137	pCi/L	2.7 ±1.9	2.8 ±4.9	2.6 ±5.1	4.1 ±6.3	None	Yes	2	Yes
Cobalt-57	pCi/L	1 ±2.5	6.2 ±9.9	1.2 ±2.4	1 ±2.7	None	No	1	No
Cobalt-60	pCi/L	7 ±17	2.5 ±3.9	5.9 ±4.8	2.7 ±3.9	None	No	1	No
Gamma Spectral Analysis	pCi/L	0 ±0	0 ±0	0 ±0	NS	None	No		No
Lead-210	pCi/L	160 ±250	190 ±290	90 ±280	100 ±290	None	Yes	2	Yes
Lead-212	pCi/L	16 ±47	33 ±40	4.8 ±5.3	6.6 ±9.5	None	Yes	2	Yes
Lead-214	pCi/L	15 ±4.9	17.5 ±5.3	12.9 ±4.9	7 ±11	None	Yes	2	Yes
Plutonium-241	pCi/L	7.2 ±3.3	1 ±2.5	6.7 ±2.9	1 ±3	None	No	1	No
Potassium-40	pCi/L	320 ±330	41 ±73	42 ±77	42 ±71	None	Yes	2	Yes
Radium-223	pCi/L	-28 ±7.1	33 ±20	13 ±19	NS	None	No	1	No
Radium-226	pCi/L	10 ±120	0.86 ±0.24	31 ±56	90 ±120	None	Yes	2	Yes
Strontium-90	pCi/L	6.9 ±3.1	4.2 ±3.2	5.4 ±3.2	0.24 ±0.34	None	Yes	1	No
Thallium-208	pCi/L	22 ±32	16 ±25	6.3 ±7.1	7.4 ±7.6	None	Yes	2	Yes
Thorium-234	pCi/L	50 ±120	330 ±310	40 ±100	36 ±71	None	No	1	No
Tritium	pCi/L	1341 ±604	2030 ±320	1724 ±512	150 ±220	None	Yes	2	Yes
Uranium-235	pCi/L	15 ±27	40 ±110	17 ±25	14 ±27	None	Yes	2	Yes

Table A-10b. Identification of Radionuclide Contaminants of Concern (COC) in Surface Water (Continued)

Notes:

a = Negative value reported when background activity greater than measured activity.
b = US Environmental Protection Agency National Ambient Water Quality Criteria (AWQC) Freshwater Aquatic Life Protection, maximum concentration, 1 hour average, April 1996 and California Inland Surfce Water Plan,Aquatic Life protection maximum concentration, 1 hour coverage. In case of discrepancy between Federal and State, lower concentration reported.
NS = Not sampled.
MDA = Minimum detectable activity.
pCi/L = picocuries per liter.

Assumptions/Limitations:

Data set used for surface water analysis based in sampling events from 11/9/90 to 5/29/96.
Data set used for Site storm water based on sampling events from 11/15/94 to 3/12/96.
Contract required detection limits reported and used in surface soil MDA evaluation, instrument detection limits may be lower.
Constituents present in soils at >3ft bgs do not contribute to surface water discharge to Putah Creek.

Decision Codes:

1 = Not present above BKG in site surface soils. Not considered a ROPEC.
2 = Present in site soils above BKG and detected in storm water. Considered a ROPEC.

Table A-11a. Putah Creek Downstream (PCD) Chemical Sampling Results

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Avg []	Min Det Limit	Max Det Limit	95% UCL	RME
General Chemical										
Formaldehyde	mg/L	2	21	0.28	0.37	0.325	0	0	NC	0.37
Metals										
Antimony	mg/L	12	30	0.002	0.07	0.012125	0	0.005	0.02	0.02
Arsenic	mg/L	10	30	0.001	0.0074	0.00348	0.002	0.002	0.0	<BKG
Barium	mg/L	29	30	0.03	0.12	0.06847931	0	0.02	0.08	0.08
Beryllium	mg/L	2	30	0.001	0.006	0.0035	0	0	NC	0.006
Cadmium	mg/L	3	30	0.001	0.002	0.00133333	0	0	NC	0.002
Chromium	mg/L	18	30	0.0012	0.08	0.01256111	0	0.01	0.02	0.02
Chromium, Hexavalent (+6)	mg/L	4	28	0.004	0.042	0.02125	0	0.01	NC	0.042
Cobalt	mg/L	2	30	0.0011	0.0012	0.00115	0.01	0.01	NC	0.0012
Copper	mg/L	12	30	0.0014	0.05	0.00831667	0	0.01	0.02	0.02
Iron	mg/L	13	15	0.0191	0.317	0.11378462	0.1	0.1	0.16	0.16
Lead	mg/L	8	30	0.001	0.01	0.004	0	0.002	NC	0.01
Manganese	mg/L	6	6	0.002	0.0132	0.0087	0.01	0.015	NC	0.013
Mercury	mg/L	1	30	0.00027	0.00027	0.00027	0.0002	0.0002	NC	0.00027
Molybdenum	mg/L	14	30	0.0012	0.05	0.01226429	0	0.01	0.02	0.02
Nickel	mg/L	16	30	0.0016	0.31	0.02299375	0	0.02	0.06	0.06
Selenium	mg/L	1	30	0.0038	0.0038	0.0038	0.003	0.003	NC	0.0038
Silver	mg/L	1	30	0.08	0.08	0.08	0	0	NC	0.08
Thallium	mg/L	4	30	0.001	0.08	0.0211	0	0.01	NC	0.08
Vanadium	mg/L	13	30	0.0026	0.02	0.0075	0	0.01	0.01	0.01
Zinc	mg/L	24	30	0.002	1.19	0.0632625	0	0.02	0.15	0.15
Pesticides and PCBs										
4,4'-DDD	mg/L	2	27	0.000023	0.000093	0.000058	0	0	NC	0.000093
4,4'-DDE	mg/L	1	27	0.000005	0.000005	0.000005	0	0	NC	0.000005
Aldrin	mg/L	2	27	0.000006	0.000037	0.0000215	0	0	NC	0.000037
Alpha-BHC	mg/L	6	27	0.000005	0.000038	1.3167E-05	0	0	NC	0.000038
Beta-BHC	mg/L	1	27	0.000008	0.000008	0.000008	0	0	NC	0.000008
Delta-BHC	mg/L	1	27	0.000012	0.000012	0.000012	0	0	NC	0.000012
Dieldrin	mg/L	2	27	0.000012	0.000043	0.0000275	0	0	NC	0.000043
Endosulfan I	mg/L	2	27	0.000026	0.000062	0.000044	0	0	NC	0.000062
Endrin Aldehyde	mg/L	1	27	0.000041	0.000041	0.000041	0	0	NC	0.000041
Gamma-BHC	mg/L	2	27	0.000011	0.000019	0.000015	0	0.00001	NC	0.000019
Heptachlor	mg/L	1	27	0.000032	0.000032	0.000032	0	0	NC	0.000032
Semivolatile Organics										
Bis(2-Chloroisopropyl)Ether	mg/L	1	12	0.0036	0.0036	0.0036	0	0	NC	0.0036
Bis(2-Ethylhexyl)phthalate	mg/L	5	22	0.00098	0.0126	0.004756	0	0.01	NC	0.013
Di-n-Butylphthalate	mg/L	3	22	0.003	0.059	0.02213333	0	0.011	NC	0.059
Diethyl Phthalate	mg/L	1	24	0.001	0.001	0.001	0.01	0.01	NC	0.001
Volatile Organics										
Acetone	mg/L	4	6	0.0028	0.018	0.008275	0.005	0.005	NC	0.018
Bromodichloromethane	mg/L	8	27	0.00022	0.0058	0.00229	0	0.001	NC	0.0058
Bromoform	mg/L	2	27	0.00021	0.0012	0.000705	0.001	0.001	NC	0.0012
Chloroform	mg/L	17	27	0.00026	0.014	0.00472706	0	0.001	0.01	0.01

Concentrations in mg/L for sample location PCD.
Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Avg [] = Average of positively detected concentration in data set.
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.

Table A-11a. Putah Creek Downstream (PCD) Chemical Sampling Results (Continued)

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Avg []	Min Det Limit	Max Det Limit	95% UCL	RME
Volatile Organics										
Dibromochloromethane	mg/L	4	27	0.00031	0.0034	0.0015525	0	0.001	NC	0.0034
Methylene Chloride	mg/L	6	25	0.00076	0.0033	0.00184333	0	0.002	NC	0.0033
Toluene	mg/L	1	28	0.0017	0.0017	0.0017	0.001	0.001	NC	0.0017

Concentrations in mg/L for sample location PCD.
Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Avg [] = Average of positively detected concentration in data set.
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.

Table A-11b. Putah Creek Downstream (PCD) Radionuclide Sampling Results

Isotope	Units	Number Detected	Number Sampled	Min []	Max []	Avg []	Min MDA	Max MDA	95% UCL	RME
Radionuclides										
Actinium-228	pCi/L	0	13	-34 ±17	12 ±22	0.5615385	13	120	6.6	6.6
Americium-241	pCi/L	3	11	-0.014 ±0.04	0.051 ±0.038	0.0188091	0.015	0.085	0.03	0.03
Bismuth-212	pCi/L	0	6	-16 ±17	9 ±42	-1.666667	21	73	NC	9
Bismuth-214	pCi/L	2	13	-3 ±57	33 ±47	10.884615	8.2	63	15.79	16
Carbon-14	pCi/L	1	15	-23 ±82	68 ±56	9.3066667	12	130	22.65	23
Cesium-134	pCi/L	0	4	-0.66 ±0.76	2 ±15	1.01	2.8	25	NC	2
Cesium-137	pCi/L	0	13	-4.3 ±5.2	2.8 ±4.9	-0.353846	3.2	27	0.68	0.68
Cobalt-57	pCi/L	0	4	-0.6 ±7.4	6.2 ±9.9	1.775	2.7	16	NC	6.2
Cobalt-60	pCi/L	0	13	-4.4 ±2.2	2.5 ±3.9	-0.625385	3.2	30	0.25	0.25
Gamma Spectral Analysis	pCi/L	0	13	0 ±9.1	0 ±0	0	0.1	33	0.0	<BKG
Lead-210	pCi/L	0	6	-110 ±280	190 ±290	10.366667	150	410	NC	190
Lead-212	pCi/L	0	13	-3.2 ±9.9	33 ±40	4.6846154	7.1	55	9.31	9.3
Lead-214	pCi/L	1	13	-4.6 ±8.3	17.5 ±5.3	3.5615385	7.9	62	6.62	6.6
Plutonium-241	pCi/L	0	11	-1.2 ±6.9	1 ±2.5	-0.163636	1.6	4.2	0.19	0.19
Potassium-40	pCi/L	0	13	-60 ±250	41 ±73	-1.692308	42	390	11.88	12
Radium-223	pCi/L	0	2	5 ±19	33 ±20	19	60	60	NC	33
Radium-226	pCi/L	4	18	-160 ±110	0.86 ±0.24	-11.90433	0.13	180	4.07	4.0
Strontium-90	pCi/L	4	28	-0.3 ±3.1	4.2 ±3.2	0.4775	0	1.7	0.8	0.8
Thallium-208	pCi/L	0	13	-2.3 ±7.1	16 ±25	2.2076923	4.2	34	4.58	4.5
Thorium-234	pCi/L	0	12	-36 ±46	330 ±310	29.5	120	740	79.23	79
Tritium	pCi/L	8	28	-150 ±170	2030 ±320	279.96429	0	500	445.5	450
Uranium-235	pCi/L	0	13	-17 ±22	40 ±110	1.2230769	24	160	8.28	8.2

Number Sampled = Number of samples in data set.
Number Detected = Number of samples in data set containing concentrations above MDA.
Min [] = Minimum detected activity in data set.
Max [] = Maximum detected activity in data set.
Avg [] = Average detected activity in data set.
Min MDA = Minimum MDA in data set.
Max MDA = Maximum MDA in data set.
NC = Not calculated, <10 samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background, not a isotope of concern for this OU.
N/A = Not available; no background data available for this analyte.
MDA = Minimum detectable activity
pCi/L = picocuries per liter

Table A-12a. Putah Creek Upstream (PCU) Chemical Sampling Results

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Avg []	Min Det Limit	Max Det Limit	95% UCL	RME
Metals										
Antimony	mg/L	11	31	0.0012	0.1	0.02080909	0	0.005	0.04	0.04
Arsenic	mg/L	10	31	0.0015	0.0065	0.00298	0.002	0.002	0.0	<BKG
Barium	mg/L	31	31	0.03	0.114	0.07586452	0	0.02	0.08	0.08
Beryllium	mg/L	5	31	0.001	0.006	0.0026	0	0	NC	0.006
Cadmium	mg/L	5	31	0.001	0.002	0.0018	0	0	NC	0.002
Chromium	mg/L	19	31	0.0013	0.06	0.01143158	0	0.01	0.02	0.02
Chromium, Hexavalent (+6)	mg/L	7	30	0.004	0.043	0.015	0	0.01	NC	0.043
Cobalt	mg/L	3	31	0.0011	0.01	0.0062	0	0.01	NC	0.01
Copper	mg/L	13	31	0.0019	0.04	0.00841538	0	0.01	0.01	0.01
Iron	mg/L	13	16	0.0391	0.301	0.1023	0.1	0.1	0.14	0.14
Lead	mg/L	7	31	0.002	0.0073	0.00434286	0	0.002	NC	0.0073
Manganese	mg/L	5	5	0.0015	0.0124	0.00556	0.01	0.015	NC	0.012
Mercury	mg/L	2	31	0.0004	0.0009	0.00065	0	0	NC	0.0009
Molybdenum	mg/L	11	31	0.0011	0.06	0.01604545	0	0.01	0.03	0.03
Nickel	mg/L	21	31	0.0011	0.07	0.01204286	0	0.02	0.02	0.02
Thallium	mg/L	7	31	0.002	0.09	0.0348	0	0.01	NC	0.09
Vanadium	mg/L	13	31	0.0026	0.0134	0.00648462	0	0.01	0.01	0.01
Zinc	mg/L	26	31	0.0016	0.06	0.01647692	0	0.02	0.02	0.02
Pesticides and PCBs										
4,4'-DDD	mg/L	3	30	0.000014	0.000022	0.000018	0	0	NC	0.000022
4,4'-DDE	mg/L	1	30	0.000005	0.000005	0.000005	0	0	NC	0.000005
4,4'-DDT	mg/L	2	30	0.000013	0.000015	0.000014	0	0	NC	0.000015
Alpha-BHC	mg/L	5	30	0.000006	0.000055	0.0000224	0	0.00001	NC	0.000055
Beta-BHC	mg/L	1	30	0.000024	0.000024	0.000024	0	0	NC	0.000024
Delta-BHC	mg/L	3	30	0.00002	0.000055	3.2667E-05	0	0	NC	0.000055
Dieldrin	mg/L	2	30	0.000015	0.000015	0.000015	0	0	NC	0.000015
Endosulfan I	mg/L	3	30	0.000026	0.000103	0.000074	0	0	NC	0.0001
Endosulfan II	mg/L	2	30	0.000006	0.000007	0.0000065	0	0	NC	0.000007
Gamma-BHC	mg/L	5	30	0.000004	0.000026	0.0000138	0	0.00001	NC	0.000026
Heptachlor	mg/L	1	30	0.000026	0.000026	0.000026	0	0	NC	0.000026
Semivolatile Organics										
Bis(2-Ethylhexyl)phthalate	mg/L	7	22	0.0007	0.021	0.00734	0	0.012	NC	0.021
Di-n-Butylphthalate	mg/L	4	26	0.002	0.13	0.0433525	0	0.021	NC	0.13
Diethyl Phthalate	mg/L	2	27	0.001	0.002	0.0015	0.011	0.011	NC	0.002
Volatile Organics										
Acetone	mg/L	2	5	0.0028	0.02	0.0114	0.005	0.005	NC	0.02
Bromodichloromethane	mg/L	1	30	0.0071	0.0071	0.0071	0	0	NC	0.0071
Chloroform	mg/L	6	30	0.002	0.019	0.00598333	0	0.001	NC	0.019
Dibromochloromethane	mg/L	1	30	0.0027	0.0027	0.0027	0	0	NC	0.0027

Concentrations in mg/L for sample location PCU.
Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Avg [] = Average of positively detected concentration in data set.
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.

Table A-12b. Putah Creek Upstream (PCU) Radionuclide Sampling Results

Isotope	Units	Number Detected	Number Sampled	Min []	Max []	Avg []	Min MDA	Max MDA	95% UCL	RME
Radionuclides										
Actinium-228	pCi/L	1	12	-17.1 ±3	17.8 ±7	2.3416667	9.6	160	7.17	7.1
Americium-241	pCi/L	3	9	0 ±84	0.039 ±0.035	0.0196667	0.012	0.079	NC	0.039
Bismuth-212	pCi/L	0	7	-161 ±87	14 ±16	-23.34857	19	300	NC	14
Bismuth-214	pCi/L	3	12	-1.9 ±5.3	21 ±14	5.7583333	5.8	89	9.62	9.6
Carbon-14	pCi/L	2	16	-39 ±47	122 ±31	9.1875	12	130	25.37	25
Cesium-134	pCi/L	0	3	-1.6 ±3.5	1.7 ±3.5	-0.1	7.5	7.8	NC	1.7
Cesium-137	pCi/L	1	12	-5 ±67	2.7 ±1.9	0.05	1.9	31	1.07	1.0
Cobalt-57	pCi/L	0	3	-1.5 ±1.8	1 ±2.5	-0.5	4.1	4.7	NC	1
Cobalt-60	pCi/L	0	12	-2.8 ±2.9	7 ±17	0.6875	1.6	37	1.93	1.9
Gamma Spectral Analysis	pCi/L	0	14	0 ±84	0 ±0	0	0.1	103	0.0	<BKG
Lead-210	pCi/L	0	7	-240 ±301	160 ±250	-14.31429	79	11000	NC	160
Lead-212	pCi/L	1	12	-3.6 ±9.6	16 ±47	3.6833333	5.9	71	6.4	6.4
Lead-214	pCi/L	2	12	-6.2 ±5.1	15 ±4.9	2.5083333	6.2	80	5.25	5.2
Plutonium-241	pCi/L	1	9	-1.3 ±8	7.2 ±3.3	1.2888889	1.6	3.6	NC	7.2
Potassium-40	pCi/L	1	12	-52 ±44	320 ±330	28	31	470	77.46	77
Radium-223	pCi/L	0	1	-28 ±7.1	-28 ±7.1	-28	66	66	NC	<BKG
Radium-226	pCi/L	2	17	-1110 ±510	10 ±120	-70.47882	0.06	770	42.89	43
Strontium-90	pCi/L	5	29	-0.49 ±0.95	6.9 ±3.1	0.5606897	0	1.7	1.05	1.0
Thallium-208	pCi/L	1	12	-2.6 ±6.4	22 ±32	3.4083333	2.8	46	6.77	6.7
Thorium-234	pCi/L	0	11	-320 ±350	50 ±120	-43.90909	71	1000	13.18	13
Tritium	pCi/L	3	30	-100 ±7800	1341 ±604	110.16667	0	500	212.17	210
Uranium-235	pCi/L	0	12	-20 ±12	15 ±27	-4.35	18	200	1.98	1.9

Number Sampled = Number of samples in data set.
Number Detected = Number of samples in data set containing concentrations above MDA.
Min [] = Minimum detected activity in data set.
Max [] = Maximum detected activity in data set.
Avg [] = Average detected activity in data set.
Min MDA = Minimum MDA in data set.
Max MDA = Maximum MDA in data set.
NC = Not calculated, <10 samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background, not a isotope of concern for this OU.
N/A = Not available; no background data available for this analyte.
MDA = Minimum detectable activity
pCi/L = picocuries per liter

Table A-13a. UCD Outfall (STPO) Chemical Sampling Results

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Avg []	Min Det Limit	Max Det Limit	95% UCL	RME
General Chemical										
Formaldehyde	mg/L	4	29	0.49	2.1	1.43	0	0	NC	2.1
Metals										
Antimony	mg/L	12	36	0.001	0.11	0.0133	0	0.005	0.03	0.03
Arsenic	mg/L	16	35	0.0021	0.0074	0.0047125	0.002	0.002	0.01	0.01
Barium	mg/L	30	36	0.02	0.147	0.03358	0	0.02	0.04	0.04
Beryllium	mg/L	2	36	0.001	0.006	0.0035	0	0	NC	0.006
Cadmium	mg/L	4	36	0.001	0.002	0.00175	0	0	NC	0.002
Chromium	mg/L	22	36	0.002	0.11	0.01502727	0	0.01	0.02	0.02
Chromium, Hexavalent (+6)	mg/L	11	35	0.01	0.045	0.01781818	0	0	0.02	0.02
Cobalt	mg/L	3	36	0.0013	0.002	0.00166667	0.01	0.01	NC	0.002
Copper	mg/L	21	36	0.0031	0.03	0.00890952	0	0.01	0.01	0.01
Iron	mg/L	15	17	0.0206	0.506	0.13168667	0.1	0.1	0.19	0.19
Lead	mg/L	13	36	0.001	0.0112	0.00276154	0	0.002	0.0	<BKG
Manganese	mg/L	5	5	0.0044	0.0218	0.009	0.01	0.015	NC	0.022
Mercury	mg/L	2	36	0.00025	0.00063	0.00044	0.0002	0.0002	NC	0.00063
Molybdenum	mg/L	22	36	0.0058	0.11	0.03329091	0	0.01	0.04	0.04
Nickel	mg/L	16	36	0.0014	0.13	0.01156875	0	0.02	0.03	0.03
Selenium	mg/L	8	36	0.0036	0.054	0.0155125	0	0.003	NC	0.054
Silver	mg/L	3	36	0.03	0.08	0.05333333	0	0	NC	0.08
Thallium	mg/L	5	36	0.001	0.1	0.03354	0	0.01	NC	0.1
Vanadium	mg/L	18	36	0.0056	0.0123	0.00967222	0	0.01	0.01	0.01
Zinc	mg/L	34	36	0.0162	0.1	0.03714118	0	0.02	0.04	0.04
Pesticides and PCBs										
4,4'-DDD	mg/L	5	35	0.00003	0.000051	0.000045	0	0	NC	0.000051
4,4'-DDE	mg/L	3	35	0.000006	0.000012	8.3333E-06	0	0	NC	0.000012
Aldrin	mg/L	3	35	0.000007	0.000015	0.000011	0	0	NC	0.000015
Alpha-BHC	mg/L	9	35	0.000004	0.000042	1.8444E-05	0	0	NC	0.000042
Alpha-Chlordane	mg/L	2	17	0.000014	0.000017	0.0000155	0.000011	0.000011	NC	0.000017
Beta-BHC	mg/L	3	35	0.000017	0.000042	0.000026	0	0.00001	NC	0.000042
Delta-BHC	mg/L	10	35	0.000013	0.00035	0.0000783	0	0	0.0	<BKG
Dieldrin	mg/L	3	35	0.000006	0.000027	1.3333E-05	0	0	NC	0.000027
Endosulfan I	mg/L	1	35	0.000055	0.000055	0.000055	0	0	NC	0.000055
Endosulfan II	mg/L	2	35	0.000004	0.000007	0.0000055	0	0	NC	0.000007
Endrin	mg/L	1	35	0.000056	0.000056	0.000056	0	0	NC	0.000056
Gamma-BHC	mg/L	10	35	0.000006	0.000066	0.0000249	0	0.000011	0.0	<BKG
Heptachlor	mg/L	2	35	0.000012	0.000018	0.000015	0	0	NC	0.000018
Semivolatile Organics										
2-Chlorophenol	mg/L	1	33	0.0046	0.0046	0.0046	0	0	NC	0.0046
Bis(2-Chloroisopropyl)Ether	mg/L	1	18	0.0057	0.0057	0.0057	0	0	NC	0.0057
Bis(2-Ethylhexyl)phthalate	mg/L	18	31	0.001	0.021	0.00603222	0	0.012	0.01	0.01
Di-n-Butylphthalate	mg/L	7	28	0.002	0.0049	0.00357143	0	0.012	NC	0.0049
Diethyl Phthalate	mg/L	1	33	0.001	0.001	0.001	0.01	0.01	NC	0.001
Volatile Organics										
1,1,1-Trichloroethane	mg/L	1	35	0.00033	0.00033	0.00033	0.001	0.001	NC	0.00033

Concentrations in mg/L for sample location STPO.
Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Avg [] = Average of positively detected concentration in data set.
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.

Table A-13a. UCD Outfall (STPO) Chemical Sampling Results (Continued)

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Avg []	Min Det Limit	Max Det Limit	95% UCL	RME
Volatile Organics										
Acetone	mg/L	8	9	0.0022	0.036	0.0111375	0.005	0.005	NC	0.036
Bromochloromethane	mg/L	1	17	0.00098	0.00098	0.00098	0.001	0.001	NC	0.00098
Bromodichloromethane	mg/L	16	35	0.0009	0.013	0.00274375	0	0.001	0.0	<BKG
Bromoform	mg/L	5	35	0.0018	0.0075	0.0038	0.001	0.001	NC	0.0075
Chloroform	mg/L	35	35	0.0022	0.033	0.00604571	0	0.001	0.01	0.01
Dibromochloromethane	mg/L	6	35	0.0032	0.0091	0.00516667	0	0.001	NC	0.0091
Methylene Chloride	mg/L	25	34	0.00056	0.04	0.0067184	0	0.01	0.01	0.01

Concentrations in mg/L for sample location STPO.
Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Avg [] = Average of positively detected concentration in data set.
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.

Table A-13b. UCD Outfall (STPO) Radionuclide Sampling Results

Isotope	Units	Number Detected	Number Sampled	Min []	Max []	Avg []	Min MDA	Max MDA	95% UCL	RME
Radionuclides										
Actinium-228	pCi/L	0	14	-4 ±3.9	7.4 ±9.6	1.1214286	12	45	2.91	2.9
Americium-241	pCi/L	3	11	0 ±190	0.097 ±0.075	0.0268182	0.014	0.21	0.04	0.04
Bismuth-212	pCi/L	0	7	-8 ±46	5 ±38	-0.428571	21	71	NC	5
Bismuth-214	pCi/L	1	14	-4 ±3.9	17.2 ±6.1	3.05	6.9	21	5.67	5.6
Carbon-14	pCi/L	1	17	-20 ±60	88 ±82	19.588235	12	130	31.66	32
Cesium-134	pCi/L	0	4	0.8 ±3.6	1.8 ±3.6	1.1	2.5	7.2	NC	1.8
Cesium-137	pCi/L	0	14	-5.6 ±3.1	2.6 ±5.1	-0.571429	2.3	10	0.59	0.59
Cobalt-57	pCi/L	0	4	-1.6 ±2.5	1.2 ±2.4	-0.275	2.7	4.6	NC	1.2
Cobalt-60	pCi/L	0	14	-1.7 ±2.9	5.9 ±4.8	-0.015	2.3	10	0.87	0.87
Gamma Spectral Analysis	pCi/L	0	18	0 ±190	0 ±0	0	0	31	0.0	<BKG
Lead-210	pCi/L	0	7	-60 ±270	90 ±280	9.7857143	150	410	NC	90
Lead-212	pCi/L	0	14	-4 ±3.9	4.8 ±5.3	1.1571429	6.6	16	2.45	2.4
Lead-214	pCi/L	0	14	-7.9 ±8.1	12.9 ±4.9	0.3	7.3	19	2.78	2.7
Plutonium-241	pCi/L	1	11	-2.1 ±2.2	6.7 ±2.9	0.3818182	1.4	4.3	1.61	1.6
Potassium-40	pCi/L	0	14	-24 ±67	42 ±77	7	40	120	16.15	16
Radium-223	pCi/L	0	1	13 ±19	13 ±19	13	55	55	NC	13
Radium-226	pCi/L	4	20	-480 ±120	31 ±56	-23.755	0.1	170	17.87	18
Strontium-90	pCi/L	5	35	-0.59 ±0.54	5.4 ±3.2	0.274	0	2.9	0.56	0.56
Thallium-208	pCi/L	0	14	-1.2 ±2.7	6.3 ±7.1	1.4785714	3.8	12	2.46	2.4
Thorium-234	pCi/L	0	12	-60 ±270	40 ±100	-3.666667	95	180	12.47	12
Tritium	pCi/L	6	35	-120 ±170	1724 ±512	119.71429	0	500	217.7	220
Uranium-235	pCi/L	0	14	-20 ±60	17 ±25	-3.4	19	41	1.28	1.2

Number Sampled = Number of samples in data set.
Number Detected = Number of samples in data set containing concentrations above MDA.
Min [] = Minimum detected activity in data set.
Max [] = Maximum detected activity in data set.
Avg [] = Average detected activity in data set.
Min MDA = Minimum MDA in data set.
Max MDA = Maximum MDA in data set.
NC = Not calculated, <10 samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background, not a isotope of concern for this OU.
N/A = Not available; no background data available for this analyte.
MDA = Minimum detectable activity
pCi/L = picocuries per liter

Table A-14a. Storm Water Runoff from Stations SWL-1 and SWL-2 Chemical Sampling Results

Chemical	Units	Number Detected	Number Sampled	Min []	Max []	Avg []	Min Det Limit	Max Det Limit	95% UCL	RME
Metals										
Antimony	mg/L	8	8	0.0023	0.156	0.0752125	0	0.005	NC	0.16
Arsenic	mg/L	2	8	0.0014	0.0016	0.0015	0.002	0.002	NC	0.0016
Barium	mg/L	8	8	0.003	0.0097	0.0058	0.02	0.02	NC	0.0097
Chromium	mg/L	5	8	0.0018	0.0072	0.00378	0.01	0.01	NC	0.0072
Chromium, Hexavalent (+6)	mg/L	4	8	0.001	0.01	0.006125	0.01	0.01	NC	0.01
Copper	mg/L	8	8	0.0019	0.0098	0.00495	0.01	0.01	NC	0.0098
Iron	mg/L	6	8	0.0294	0.909	0.31891667	0.1	0.1	NC	0.91
Lead	mg/L	8	8	0.007	0.0384	0.0205125	0	0.002	NC	0.038
Manganese	mg/L	2	2	0.0177	0.0192	0.01845	0.015	0.015	NC	0.019
Nickel	mg/L	6	8	0.0016	0.006	0.00335	0.02	0.02	NC	0.006
Vanadium	mg/L	4	8	0.001	0.0029	0.00155	0.01	0.01	NC	0.0029
Zinc	mg/L	8	8	0.0608	0.112	0.0843	0	0.02	NC	0.11
Pesticides and PCBs										
Alpha-Chlordane	mg/L	1	8	0.000015	0.000015	0.000015	0.00001	0.00001	NC	0.000015
Gamma-Chlordane	mg/L	1	8	0.000013	0.000013	0.000013	0.00001	0.00001	NC	0.000013
Semivolatile Organics										
4-Nitrophenol	mg/L	1	8	0.0008	0.0008	0.0008	0.026	0.026	NC	0.0008
Benzyl Butyl Phthalate	mg/L	4	8	0.0007	0.002	0.001125	0.01	0.01	NC	0.002
Bis(2-Ethylhexyl)phthalate	mg/L	4	5	0.0005	0.001	0.0007875	0.01	0.01	NC	0.001
Pyrene	mg/L	1	8	0.0007	0.0007	0.0007	0.01	0.01	NC	0.0007
Volatile Organics										
Acetone	mg/L	5	7	0.0046	0.017	0.01068	0.005	0.005	NC	0.017
Benzene	mg/L	1	10	0.0001	0.0001	0.0001	0.0001	0.0001	NC	0.0001
Bromoform	mg/L	1	10	0.0003	0.0003	0.0003	0.0003	0.0003	NC	0.0003
Ethylbenzene	mg/L	2	10	0.0004	0.0007	0.00055	0.0001	0.0001	NC	0.0007
Toluene	mg/L	3	10	0.0002	0.00099	0.00046333	0.0001	0.001	NC	0.00099
Xylenes (total)	mg/L	2	10	0.0006	0.0008	0.0007	0.0003	0.0003	NC	0.0008

Concentrations in mg/L for sample location SWL-1 and SWL-2.
Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Avg [] = Average of positively detected concentration in data set.
NC = Not calculated, <10 positively detected samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.

Table A-14b. Storm Water Runoff from Stations SWL-1 and SWL-2 Radionuclide Sampling Results

Isotope	Units	Number Detected	Number Sampled	Min []	Max []	Avg []	Min MDA	Max MDA	95% UCL	RME
Radionuclides										
Actinium-228	pCi/L	0	8	-1.2 ±7.4	18 ±21	5.1875	14	42	NC	18
Americium-241	pCi/L	2	8	0.008 ±0.022	0.033 ±0.027	0.017375	0.015	0.098	NC	0.033
Bismuth-212	pCi/L	0	3	0 ±9.2	33 ±49	12	24	60	NC	33
Bismuth-214	pCi/L	0	8	-6 ±28	4 ±12	-1.475	8.5	21	NC	4
Carbon-14	pCi/L	0	8	-57 ±76	32 ±83	-7.75	110	130	NC	32
Cesium-134	pCi/L	0	5	-1.7 ±5.8	1.4 ±4	-0.48	2.6	7.5	NC	1.4
Cesium-137	pCi/L	0	8	-3.8 ±5	4.1 ±6.3	-0.125	2.6	11	NC	4.1
Cobalt-57	pCi/L	0	5	-1.6 ±1.7	1 ±2.7	0.02	2.8	5	NC	1
Cobalt-60	pCi/L	0	8	-4.4 ±3.8	2.7 ±3.9	-0.76375	3	11	NC	2.7
Lead-210	pCi/L	0	3	-10 ±270	100 ±290	53.333333	160	410	NC	100
Lead-212	pCi/L	0	8	-3.1 ±5.1	6.6 ±9.5	2.75	7.6	15	NC	6.6
Lead-214	pCi/L	0	8	-4 ±65	7 ±11	-0.1375	7.9	19	NC	7
Plutonium-241	pCi/L	0	8	-1.1 ±2.4	1 ±3	-0.2625	1.2	4.5	NC	1
Potassium-40	pCi/L	0	8	-13 ±29	42 ±71	7.75	38	120	NC	42
Radium-226	pCi/L	0	13	-80 ±110	90 ±120	-7.802231	0.23	180	12.97	13
Strontium-90	pCi/L	0	8	-0.17 ±0.81	0.24 ±0.34	-0.01875	0.57	1.6	NC	0.24
Thallium-208	pCi/L	0	8	-0.5 ±2.9	7.4 ±7.6	1.875	4.1	11	NC	7.4
Thorium-234	pCi/L	0	5	-39 ±78	36 ±71	6.2	150	200	NC	36
Tritium	pCi/L	0	8	-90 ±100	150 ±220	0	170	290	NC	150
Uranium-235	pCi/L	0	8	-15 ±21	14 ±27	-1.3875	23	45	NC	14

Number Sampled = Number of samples in data set.
Number Detected = Number of samples in data set containing concentrations above MDA.
Min [] = Minimum detected activity in data set.
Max [] = Maximum detected activity in data set.
Avg [] = Average detected activity in data set.
Min MDA = Minimum MDA in data set.
Max MDA = Maximum MDA in data set.
NC = Not calculated, <10 samples in sample set.
RME = Reasonable maximum exposure concentration.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution.
<BKG = Site concentration is lower than background, not a isotope of concern for this OU.
N/A = Not available; no background data available for this analyte.
MDA = Minimum detectable activity
pCi/L = picocuries per liter

ATTACHMENT B

CALCULATION OF BACKGROUND CONCENTRATIONS

CALCULATION OF BACKGROUND CONCENTRATIONS

1.1 Methodology

Statistical methods were used to characterize background concentrations, calculate background values, and estimate the uncertainties in these background values for metals and radionuclides. Soil analytic results from the LEHR site were compared to the background concentrations determined here. The 80% lower confidence limit on the 95th quantile (or percentile) was selected to determine the background values when sufficient data were available. The methodology for metals is presented below followed by the methodology for radionuclides.

1.1.1 Metals

Background metals concentration data were tested to decide whether the underlying population can be modeled by the lognormal distribution[1]. The data were log transformed and tested by the Shapiro-Wilk *W* test (Gilbert, 1987) to establish normality of the transformed data. The transformed data sets that passed the *W* test with a reasonable significance level ($\alpha = 0.05$) were assumed to be drawn from a lognormal population.

Two statistics of the transformed data, the sample mean, $\bar{X}$, and the sample standard deviation, S_x, were calculated. These statistics were used to estimate quantiles (or percentiles) of the untransformed lognormal population distribution by the following formula (Gilbert, 1987):

$$\hat{X}_p = \bar{X} + Z_p S_x$$

where Z_p cuts off 100(1-p)% of the upper tail of the normal distribution.

A percentile approach was selected to establish the cutoff value for background metals concentrations because it presents a reasonably low probability of making decision errors. For example: concentrations of metals in soil samples that are greater than the 95th percentile cutoff value will be falsely concluded to be above background about five percent of the time (called a

[1] The histograms of naturally-occurring metals concentrations in soil can likely be modeled by lognormal density functions (EPA, 1992), which are used to model many types of environmental data (Ellgas, 1996).

"type I error" in statistical hypothesis testing). The Z_p value cutting off 95% of the upper tail of the normal distribution is 1.645.

Sample data were used to estimate the true 95th percentile of the background metals distributions. Transformed data fitting the normal model were used to calculate the upper confidence limit (UCL) on the estimated 95th percentile by use of the following formula (Gilbert, 1987):

$$UCL_{1-\frac{\alpha}{2}}\left(\hat{X}_p\right) = \bar{X} + S_x K_{1-\frac{\alpha}{2},p}$$

where

$\alpha = 20\%$

$p = 95\%$

K = estimating factor for specified x, p from Table A3 (Gilbert, 1987)

The 80% lower confidence limit (LCL) on the 95th percentile was selected as the background value to conservatively estimate the true 95th percentile of the metals distributions. The 80% LCL on the estimated 95th percentile was approximated by assuming that, at the tail of the normal distribution, interpolation and extrapolation are approximately linear; therefore,

$$LCL_{1-\frac{\alpha}{2}}(\hat{X}p) = \hat{X}p - [\exp(\bar{X} + S_x K_{1-\frac{\alpha}{2}},p) - \hat{X}p] = 2\hat{X}p - \exp(\bar{X} + S_x K_{1-\frac{\alpha}{2}},p)$$

Converting these transformed confidence limits back into the original untransformed space introduces a bias into the statistics. The approximate bias factor is (Gilbert, 1987):

$$\exp\left(\frac{S_x^2}{2n}\right)$$

2

where

n = sample size

The background data for 20 metals were inspected for outlying data points and non-detect results. Non-detect sample results were assigned a numerical value equal to one half the detection limit if the data contained less than 50% non-detect results (mercury, selenium). One data point was removed from the beryllium data set because the concentration was found to be below the 1% lower percentile of the log transformed data set when modeled by the normal distribution. Two data points were removed from the manganese data set because the data were flagged for concentrations measured above the calibration limits of the laboratory analytical instrument (the accuracy of these two data points is in question).

The 80% LCL on the 95th percentile was not calculated for antimony, cadmium, molybdenum, silver, and thallium, due to the lack of detected concentrations. Instead, the upper guidance limit was calculated (twice the maximum detected concentration).

All of the remaining data sets were found have reasonable significance levels when tested by the Shapiro-Wilk *W* test on the log transformed data. Log normal distributions were assumed and the 80% LCL on the 95th percentile was calculated as the background value for each. The Results of these calculations are summarized in Table B-1.

Radionuclides

Background radionuclide concentration data were tested to decide whether the underlying population can be modeled by the normal distribution. The data were tested by the Shapiro-Wilk *W* test (Gilbert, 1987) to establish normality. Data sets that passed the *W* test with a reasonable significance level ($\alpha = 0.05$) were assumed to be drawn from a normal population.

The sample mean and standard deviation statistics were used to estimate percentiles of the normal population distribution using the following formula (Gilbert, 1987):

$$\hat{X}_p = \bar{X} + Z_p S_x$$

where Z_p cuts off 100(1-p)% of the upper tail of the normal distribution. The Z_p value cutting off 95% of the upper tail of the normal distribution is 1.645.

Data fitting the normal model were used to calculate the upper confidence limit (UCL) on the estimated 95th percentile by use of the following formula (Gilbert, 1987):

$$UCL_{1-\frac{\alpha}{2}}\left(\hat{X}_p\right) = \bar{X} + S_x K_{1-\frac{\alpha}{2},p}$$

where

$\alpha = 20\%$

$p = 95\%$

K = estimating factor for specified α, p from Table A3 of Gilbert (Gilbert, 1987).

The 80% LCL on the estimated 95th percentile was approximated by assuming that, at the tail of the normal distribution, interpolation and extrapolation are approximately linear; therefore,

$$LCL_{1-\frac{\alpha}{2}}\left(\hat{X}_p\right) = 2\hat{X}_p - \left(\bar{X} + S_x \times K_{1-\frac{\alpha}{2},p}\right)$$

Two data points were removed from actinium-228, bismuth-214, carbon-14, lead-212, lead-214, potassium-40, thallium-208, thorium-232 and uranium-235 data sets because they were found to be above the 99% upper percentile of the data set when modeled by the normal distribution. Four data points were removed from the thorium-230 data set because they were above the 99% upper percentile of the data set when modeled by a normal distribution.

All of the data sets were found to have reasonable significance levels when tested by the Shapiro-Wilk *W* test. Normal distributions were assumed and the 80% LCL on the 95th percentile was calculated as the background value for each. The results of these calculations are summarized in Table B-2.

Table B-1. Background Soil Statistics for Metals.

Compound	Lognormal ? (Y/N)	95'th Quantile (mg/kg)	80 % Lower Confidence Limit on 95'th Quantile (mg/kg)	80 % Upper Confidence Limit on 95'th Quantile (mg/kg)
Antimony	N/A	N/A	N/A	N/A
Arsenic	Borderline	10.47	9.46	11.5
Barium	Y	284	237	331
Beryllium	Y	0.78	0.66	0.90
Cadmium	N/A	N/A	N/A	N/A
Chromium	Y	223	178	268
Hexavalent Chromium	Y	0.147	0.099	0.19
Cobalt	Y	33	29	37
Copper	Y	60	50	69
Iron	Borderline	45,000	42,000	49,000
Lead	Borderline	11.5	10.1	13
Manganese	Y	785	720	850
Mercury	Y	1.09	0.49	1.7
Molybdenum	N/A	N/A	N/A	N/A
Nickel	Y	423	326	519
Selenium	Y	1.48	1.0	1.9
Silver	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A
Vanadium	Y	81	73	89
Zinc	Y	94	82	106

notes:

N/A = Not Applicable. Not enough data to calculate statistics. For these compounds, background has been set at twice the maximum detected value from the background data set, if positively detected, or at the detection limit for compounds with no positive detections.

Table B-2. Radiological Background Soil Statistics.

Isotope	Normal ? (Y/N)	95'th Quantile (pCi/g)	Maximum MDA (pCi/g)	Minimum MDA (pCi/g)	80 % Lower Confidence Limit on 95'th Quantile (pCi/g)	80 % Upper Confidence Limit on 95'th Quantile (pCi/g)
Actinium-228	Y	0.76	0.71	0.14	0.71	0.81
Bismuth-214	Y	0.62	0.44	0.083	0.57	0.67
Carbon-14	Y	1.81b	12	6	0.87	2.76
Cesium-137	Y	0.075	0.27	0.033	0.053	0.1
Cobalt-60	Y	0.023b	0.21	0.028	0.016	0.03
Gross Alpha	Y	13.4	6.7	4.1	11.8	14.9
Gross Beta	Y	18.6	5.6	4.9	17.4	19.8
Lead-212	Y	0.81	0.43	0.06	0.74	0.87
Lead-214	Y	0.83	0.47	0.072	0.75	0.9
Potassium-40	Y	14.4	1.7	0.42	13.6	15.2
Radium-226	Y	0.88	0.68	0.11	0.77	0.98
Strontium-90	Y	0.52b	1.7	0.61	0.36	0.67
Thallium-208	Y	0.23	0.24	0.04	0.21	0.25
Thorium-228	Y	0.77	0.28	0.058	0.71	0.82
Thorium-230	Y	0.84	0.097	0.021	0.8	0.87
Thorium-232	Y	0.68	0.09	0.014	0.64	0.72
Uranium-233/234	Y	0.71	0.046	0.016	0.66	0.75
Uranium-235	Y	0.079	0.041	0.0066	0.071	0.087
Uranium-238	Y	0.67	0.053	0.0086	0.63	0.71

notes:

Normal? = Does the Shapiro Wilk test indicate the distribution is normal?
MDA = Minimum Detectable Activity.
a = Tritium results are in units of pCi/L.
b = Isotopes with 95'th quantile below the MDA.

ATTACHMENT C

OUTDOOR AIR VOLATILIZATION CALCULATIONS

OUTDOOR AIR VOLATILIZATION CALCULATIONS

An outdoor air model was used to predict concentrations of VOCs that may transport to air from soil below the LEHR site. The model was used to determine the ratio of the concentration in air to the concentration in soil for VOCs detected in soil samples from OUs 1, 2, 3 and 4. Air/soil concentration ratios were calculated for a subset of the detected VOCs. The VOCs were divided into groups based on the order of magnitude of the Henry's Law constant, H, divided by the water/soil partition coefficient, K_d. The H/K_d ratio is the driving parameter that defines the diffusive vapor flux equation used in the air model. The compound with the most conservative (largest) H/K_d ratio was used in the model to determine the air/soil concentration ratio for all VOCs within the same H/K_d order of magnitude. The H/K_d values for each VOC, H/K_d ranges and the air/soil concentration ratio results are summarized in Table C-1. The calculations of concentrations in air for each representative compound are presented in spreadsheet form in the Calculations section of this attachment. A description of the air model is presented below.

1.1 Air Exposure Model

The outdoor air model is based on subsurface diffusive vaport transport with a simple conservative box model to describe vaport accumulation in outdoor air. The diffusive vapor flux expression presented in section A.1.5, pages A-9 through A-12, of the Air/Superfund National Technical Guidance Series, Assessing Potential Indoor Air Impacts for Superfund Sites (EPA, 1992) was used to describe vapor transport from the soil source. The vapor flux expression was derived from the one dimensional porous medium mass balance expression:

$$\frac{\partial C_a}{\partial t} = \alpha \frac{\partial^2 C_a}{\partial z^2} - \mu C_a \qquad (1)$$

Where C_a is the chemical concentration in the soil pores, α is the effective diffusion coefficient, z is the depth below ground surface, μ is the first order degradation rate constant and t is time. The effective diffusion coefficient is expressed as:

$$\alpha = \frac{D_g}{\frac{\rho_b K_d}{H} + \frac{\theta_m}{H} + \theta_a} + \frac{D_l}{\rho_b K_d + \theta_m + \theta_a H} \qquad (2)$$

Where D_g is the effective diffusion coefficient in air, D_l is the effective diffusion coefficient in water, ρ_b is the bulk density of the soil. K_d is the water/soil partition coefficient, H is Henry's Law constant, θ_m is the moisture-filled soil porosity and θ_a is the air-filled soil porosity.

The time average mass flux ($N_{a,average}$) over the time interval t is expressed as:

$$N_{a,average} = \frac{2D_g HC_{so}}{\left[(\pi\alpha t)^{1/2}(K_d)\right]} \bullet \theta^{-\mu t} \qquad (3)$$

Where Cso is the contaminant concentration in soil. The above time average mass flux expression was used to determine the exposure concentration assuming no contaminant degradation ($\theta^{-\mu t} = 1$) and a time interval t equal to the exposure duration used in the risk assessment.

1.2 Outdoor Air Exposure Model

The outdoor air concentration ($C_{outdoor}$) at the on-site receptor location was calculated using the expression:

$$C_{outdoor} = \frac{N_{a,average} \times \Gamma}{U_{air} \times \delta}$$

Where Γ is the width of the source area parallel to the wind, U_{air} is the ambient wind speed and δ is the ambient air mixing height. Γ was conservatively assumed to be the largest linear dimension of DOE OUs 1 through 4. The diagonal distance from the southwest corner to the northeast corner of OU 3 was selected as this parameter. The 95th upper confidence limit of wind speed data collected at the LEHR site during 1995 was used as the ambient wind speed U_{air}.

The conceptual model is presented in Figure C-1. Subsurface vapors enter the box model and mix only up to the mixing height, which is assumed to be the height of a typical receptor. Contaminant vapors accumulate within the box model as the air mass travels across the width of the source area. Concentrations reach a maximum at the downwind end of the source area where the receptor is assumed to be located. The downwind maximum concentration is used as the exposure concentration for volatile contaminants.

1.3 References

American Society for Testing and Materials, 1995. Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites, E 1739-95.

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Stephens, D.B., 1996, *Vadose Zone Hydrology*, CRC Lewis Publishers, Boca Raton, Florida.

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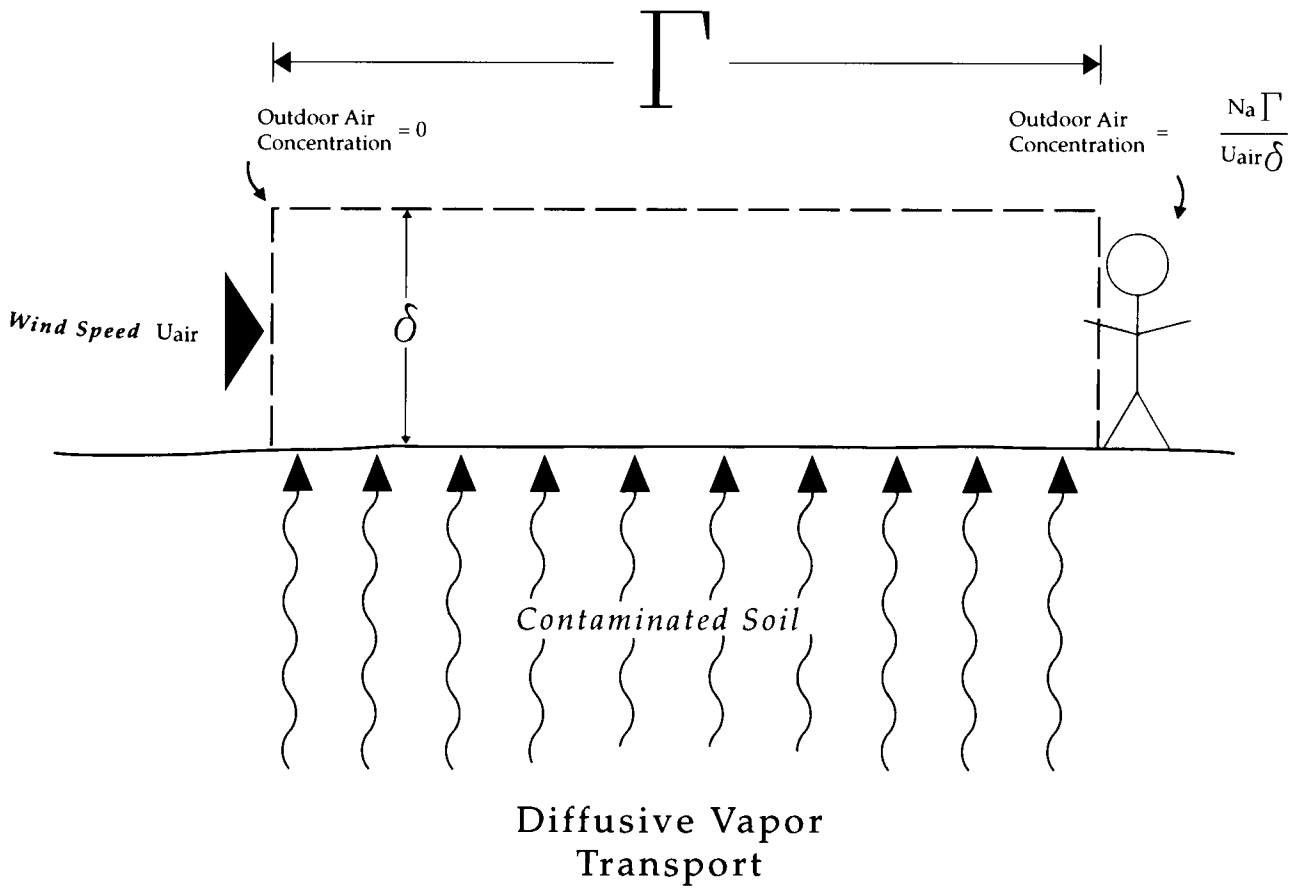

Figure C-1. Outdoor Air Conceptual Model, Volitile Organic Compounds

ATTACHMENT C

CALCULATIONS

Table C-1. Volatile Contaminants of Concern in Soil and Their Associated Henry's Law Constants and Kd Values.

Analyte	Henry's Law Constant (atm*m3/mol)	Henry's Law Constant (unitless)	Kd (ml/g)	H'/Kd (1)/(ml/g)	H'/Kd Ranges	Diffusivity in Air (mg/m3)	Diffusivity in Water (mg/m3)	Outdoor Air Conc. Ratio (mg/m3)/(mg/kg)
Methylene Chloride	2.0E-03	8.3E-03	5.30E-02	1.57E-01	0.1-1.0	1.0E-01	1.2E-05	3.66E-03
Carbon Tetrachloride	2.4E-02	1.0E-01	6.60E-01	1.51E-01		8.0E-02	8.8E-06	3.66E-03
Benzene	5.6E-03	2.3E-02	3.90E-01	5.97E-02	0.01-0.1	8.8E-02	9.8E-06	1.84E-03
Xylenes (total)	7.0E-03	2.9E-02	1.40E+00	2.08E-02		7.0E-03	8.4E-06	1.84E-03
Ethyl Benzene	6.4E-03	2.7E-02	1.30E+00	2.05E-02		7.5E-02	7.8E-06	1.84E-03
Toluene	6.4E-03	2.7E-02	1.50E+00	1.77E-02		7.8E-02	8.6E-06	1.84E-03
Acetone	2.1E-05	8.7E-05	7.19E-03	1.21E-02		1.0E-01	1.1E-05	1.84E-03
Styrene	4.7E-03	2.0E-02	2.20E+00	8.89E-03	0.001-0.01	7.1E-02	8.0E-06	6.30E-03
2-Butanone	2.7E-05	1.1E-04	2.42E-02	4.64E-03		9.0E-02	9.8E-06	6.30E-03
2-Hexanone	1.1E-05	4.6E-05	2.98E-01	1.54E-04	0.0001-0.001	1.0E-01	1.0E-05	6.00E-05
Formaldehyde	1.7E-07	6.9E-07	2.78E-02	2.50E-05	0.00001-0.0001	1.0E-01	1.0E-05	4.32E-06

Source of Henry's Law Constant (except formaldehyde):
US Department of Energy, 1996 RESRAD-BASELINE for Windows, Version 2.20, Radiological Health Risk Section, Environmental Assessments Division, Argonne National Laboratory.
Source of Henry's Law Constant for Formaldehyde:
Montgomery, 1991, Groundwater Chemical Desk Reference, Volume 2, Lewis Publishers.
Unit Conversion - Assume STP (1 atm, 20 degrees C).
Air Concentration Calculations Presented in Attachment C, Calculations Section.
Kd Values from Ketter, 1993; Lyman, et al., 1990; CalEPA, 1994; Stephens, 1996; U.S. DOE, 1996; 1990; Weiss Associates, 1997.

Determination of Methylene Chloride Concentration in Outdoor Air from Soil Data

Commercial Receptor

	Soil Specific Parameters		
DBS 96	ρ_b	1.9	Bulk Density(g/cm^3) or (kg/L)
DBS 96	θ_a	0.25	Air Content (v/v)
DBS 96	θ_m	0.04	Water Content (v/v)
DBS 96	θ	0.29	Porosity (v/v)
	Diffusivity Parameters		
US DOE 1996	H	8.30E-03	Henry's Constant for Methylene Chloride
US DOE 1996	D_g	1.00E-01	Air Diffusion Coefficient (cm^2/s)
US DOE 1996	D_l	1.70E-05	Water Diffusion Coefficient (cm^2/s)
US DOE 1996	Kd	5.30E-02	Distribution Coefficient (cm3/g)
Calculated	a	5.93E-03	Effective Diffusion Coefficient soil (cm^2/s)
Prediction of Flux From Concentration in Soil			
Assumed	Csoil	100	Concentration in Soil (mg/kg)
Weiss 1997	t	788400000	Exposure Duration (sec) - 25 years
Calculated	N_a	8.17E-04	Average Diffusive Vapor Flux Predicted by Concentration in Soil (ug/cm^2-sec)
	Outdoor Air Concentration		
ASTM 95	δ	200	Ambient Air Mixing height (cm)
Weiss 1997	Γ	20000	Width of Source Area Parallel to Wind (cm)
Weiss 1997	Uair	223	Ambient Wind Speed (cm/sec)
Calculated	C_{indoor}	366	Outdoor Air Concentration (ug/m^3)

Formulas

$$a = \frac{D_g}{\frac{\rho_b K_d}{H} + \frac{\theta_m}{H} + \theta_a} + \frac{D_l}{\rho_b K_d + \theta_m + \theta_a H}$$

$$N_a = \frac{2 D_g H C_{soil}}{\left[(\pi\ a\ t)^{1/2} (K_d)\right]} \times 1^a$$

$$C_{outdoor} = \frac{N_a \times \Gamma}{U_{air} \times \delta}$$

Notes:
a = Time dependent biodegradation term reduces to a value of 1 when no biodegradation is assumed.

ASTM 95 = American Society for Testing and Materials, 1995. Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites, E 1739-95.

DBS 96 = Daniel B. Stephens and Associates, Inc., 1996. Hydraulic Properties of LEHR/UC Davis Soil Samples, prepared for Battelle PNL/ITEH, Davis, California.

US DOE 96 = U.S. Department of Energy, 1996 RESRAD-BASELINE for Windows, Version 2.20, Radiological Health Risk Section, Environmental Assessments Division, Argone National Laboratory.

Calculations: Effective diffusivity, diffusive vapor flux and outdoor air concentration calculations from Air/Superfund 1992 guidance. Formulas presented above.

Air Superfund 1992 = USEPA 1992, Air/Superfund National Technical Guidance Study Series, Assessing Potential Indoor Air Impacts for Superfund Sites. EPA-451/R-92-002.

Determination of Benzene Concentration in Outdoor Air from Soil Data

Commercial Receptor

	Soil Specific Parameters		
DBS 96	ρ_b	1.9	Bulk Density(g/cm^3) or (kg/L)
DBS 96	θ_a	0.25	Air Content (v/v)
DBS 96	θ_m	0.04	Water Content (v/v)
DBS 96	θ	0.29	Porosity (v/v)
	Diffusivity Parameters		
US DOE 1996	H	2.30E-02	Henry's Constant for Benzene
US DOE 1996	D_g	8.80E-02	Air Diffusion Coefficient (cm^2/s)
US DOE 1996	D_l	9.80E-06	Water Diffusion Coefficient (cm^2/s)
US DOE 1996	Kd	3.90E-01	Distribution Coefficient (cm3/g)
Calculated	a	2.59E-03	Effective Diffusion Coefficient soil (cm^2/s)
Prediction of Flux From Concentration in Soil			
Assumed	Csoil	100	Concentration in Soil (mg/kg)
Weiss 1997	t	788400000	Exposure Duration (sec) - 25 years
Calculated	N_a	4.10E-04	Average Diffusive Vapor Flux Predicted by Concentration in Soil (ug/cm^2-sec)
	Outdoor Air Concentration		
ASTM 95	δ	200	Ambient Air Mixing height (cm)
Weiss 1997	Γ	20000	Width of Source Area Parallel to Wind (cm)
Weiss 1997	Uair	223	Ambient Wind Speed (cm/sec)
Calculated	C_{indoor}	184	Outdoor Air Concentration (ug/m^3)

Formulas

$$a = \frac{D_g}{\frac{\rho_b K_d}{H} + \frac{\theta_m}{H} + \theta_a} + \frac{D_l}{\rho_b K_d + \theta_m + \theta_a H}$$

$$N_a = \frac{2 D_g H C_{soil}}{\left[(\pi\ a\ t)^{1/2} (K_d)\right]} \times 1^a$$

$$C_{outdoor} = \frac{N_a \times \Gamma}{U_{air} \times \delta}$$

Notes:
a = Time dependent biodegradation term reduces to a value of 1 when no biodegradation is assumed.

ASTM 95 = American Society for Testing and Materials, 1995. Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites, E 1739-95.

DBS 96 = Daniel B. Stephens and Associates, Inc., 1996. Hydraulic Properties of LEHR/UC Davis Soil Samples, prepared for Battelle PNL/ITEH, Davis, California.

US DOE 96 = U.S. Department of Energy, 1996 RESRAD-BASELINE for Windows, Version 2.20, Radiological Health Risk Section, Environmental Assessments Division, Argone National Laboratory.

Calculations: Effective diffusivity, diffusive vapor flux and outdoor air concentration calculations from Air/Superfund 1992 guidance. Formulas presented above.

Air Superfund 1992 = USEPA 1992, Air/Superfund National Technical Guidance Study Series, Assessing Potential Indoor Air Impacts for Superfund Sites. EPA-451/R-92-002.

Determination of Styrene Concentration in Outdoor Air from Soil Data

Commercial Receptor

	Soil Specific Parameters		
DBS 96	ρ_b	1.9	Bulk Density(g/cm^3) or (kg/L)
DBS 96	θ_a	0.25	Air Content (v/v)
DBS 96	θ_m	0.04	Water Content (v/v)
DBS 96	θ	0.29	Porosity (v/v)
	Diffusivity Parameters		
US DOE 1996	H	2.00E-02	Henry's Constant for Styrene
US DOE 1996	D_g	7.10E-02	Air Diffusion Coefficient (cm^2/s)
US DOE 1996	D_l	8.00E-06	Water Diffusion Coefficient (cm^2/s)
US DOE 1996	Kd	2.20E+00	Distribution Coefficient (cm3/g)
Calculated	a	3.38E-04	Effective Diffusion Coefficient soil (cm^2/s)
Prediction of Flux From Concentration in Soil			
Assumed	Csoil	100	Concentration in Soil (mg/kg)
Weiss 1997	t	788400000	Exposure Duration (sec) - 25 years
Calculated	N_a	1.41E-04	Average Diffusive Vapor Flux Predicted by Concentration in Soil (ug/cm^2-sec)
	Outdoor Air Concentration		
ASTM 95	δ	200	Ambient Air Mixing height (cm)
Weiss 1997	Γ	20000	Width of Source Area Parallel to Wind (cm)
Weiss 1997	Uair	223	Ambient Wind Speed (cm/sec)
Calculated	C_{indoor}	63	Outdoor Air Concentration (ug/m^3)

Formulas

$$a = \frac{D_g}{\frac{\rho_b K_d}{H} + \frac{\theta_m}{H} + \theta_a} + \frac{D_l}{\rho_b K_d + \theta_m + \theta_a H}$$

$$N_a = \frac{2 D_g H C_{soil}}{\left[(\pi\ a\ t)^{1/2} (K_d)\right]} \times 1^a$$

$$C_{outdoor} = \frac{N_a \times \Gamma}{U_{air} \times \delta}$$

Notes:
a = Time dependent biodegradation term reduces to a value of 1 when no biodegradation is assumed.

ASTM 95 = American Society for Testing and Materials, 1995. Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites, E 1739-95.

DBS 96 = Daniel B. Stephens and Associates, Inc., 1996. Hydraulic Properties of LEHR/UC Davis Soil Samples, prepared for Battelle PNL/ITEH, Davis, California.

US DOE 96 = U.S. Department of Energy, 1996 RESRAD-BASELINE for Windows, Version 2.20, Radiological Health Risk Section, Environmental Assessments Division, Argone National Laboratory.

Calculations: Effective diffusivity, diffusive vapor flux and outdoor air concentration calculations from Air/Superfund 1992 guidance. Formulas presented above.

Air Superfund 1992 = USEPA 1992, Air/Superfund National Technical Guidance Study Series, Assessing Potential Indoor Air Impacts for Superfund Sites. EPA-451/R-92-002.

Determination of 2-Hexanone Concentration in Outdoor Air from Soil Data

Commercial Receptor

	Soil Specific Parameters		
DBS 96	ρ_b	1.9	Bulk Density(g/cm^3) or (kg/L)
DBS 96	θ_a	0.25	Air Content (v/v)
DBS 96	θ_m	0.04	Water Content (v/v)
DBS 96	θ	0.29	Porosity (v/v)
	Diffusivity Parameters		
US DOE 1996	H	4.60E-05	Henry's Constant for 2-Hexanone
US DOE 1996	D_g	1.00E-01	Air Diffusion Coefficient (cm^2/s)
US DOE 1996	D_l	1.00E-05	Water Diffusion Coefficient (cm^2/s)
US DOE 1996	Kd	2.98E-01	Distribution Coefficient (cm3/g)
Calculated	a	2.41E-05	Effective Diffusion Coefficient soil (cm^2/s)
Prediction of Flux From Concentration in Soil			
Assumed	Csoil	100	Concentration in Soil (mg/kg)
Weiss 1997	t	788400000	Exposure Duration (sec) - 25 years
Calculated	N_a	1.26E-05	Average Diffusive Vapor Flux Predicted by Concentration in Soil (ug/cm^2-sec)
	Outdoor Air Concentration		
ASTM 95	δ	200	Ambient Air Mixing height (cm)
Weiss 1997	Γ	20000	Width of Source Area Parallel to Wind (cm)
Weiss 1997	Uair	223	Ambient Wind Speed (cm/sec)
Calculated	C_{indoor}	6	Outdoor Air Concentration (ug/m^3)

Formulas

$$a = \frac{D_g}{\frac{\rho_b K_d}{H} + \frac{\theta_m}{H} + \theta_a} + \frac{D_l}{\rho_b K_d + \theta_m + \theta_a H}$$

$$N_a = \frac{2 D_g H C_{soil}}{\left[(\pi\ a\ t)^{1/2} (K_d)\right]} \times 1^a$$

$$C_{outdoor} = \frac{N_a \times \Gamma}{U_{air} \times \delta}$$

Notes:
a = Time dependent biodegradation term reduces to a value of 1 when no biodegradation is assumed.

ASTM 95 = American Society for Testing and Materials, 1995. Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites, E 1739-95.

DBS 96 = Daniel B. Stephens and Associates, Inc., 1996. Hydraulic Properties of LEHR/UC Davis Soil Samples, prepared for Battelle PNL/ITEH, Davis, California.

US DOE 96 = U.S. Department of Energy, 1996 RESRAD-BASELINE for Windows, Version 2.20, Radiological Health Risk Section, Environmental Assessments Division, Argone National Laboratory.

Calculations: Effective diffusivity, diffusive vapor flux and outdoor air concentration calculations from Air/Superfund 1992 guidance. Formulas presented above.

Air Superfund 1992 = USEPA 1992, Air/Superfund National Technical Guidance Study Series, Assessing Potential Indoor Air Impacts for Superfund Sites. EPA-451/R-92-002.

Determination of Formaldehyde Concentration in Outdoor Air from Soil Data

Commercial Receptor

	Soil Specific Parameters		
DBS 96	ρ_b	1.9	Bulk Density(g/cm^3) or (kg/L)
DBS 96	θ_a	0.25	Air Content (v/v)
DBS 96	θ_m	0.04	Water Content (v/v)
DBS 96	θ	0.29	Porosity (v/v)
	Diffusivity Parameters		
US DOE 1996	H	6.94E-07	Henry's Constant for Formaldehyde
US DOE 1996	D_g	1.00E-01	Air Diffusion Coefficient (cm^2/s)
US DOE 1996	D_l	1.00E-05	Water Diffusion Coefficient (cm^2/s)
US DOE 1996	Kd	2.78E-02	Distribution Coefficient (cm3/g)
Calculated	a	1.08E-04	Effective Diffusion Coefficient soil (cm^2/s)
Prediction of Flux From Concentration in Soil			
Assumed	Csoil	100	Concentration in Soil (mg/kg)
Weiss 1997	t	788400000	Exposure Duration (sec) - 25 years
Calculated	N_a	9.63E-07	Average Diffusive Vapor Flux Predicted by Concentration in Soil (ug/cm^2-sec)
	Outdoor Air Concentration		
ASTM 95	δ	200	Ambient Air Mixing height (cm)
Weiss 1997	Γ	20000	Width of Source Area Parallel to Wind (cm)
Weiss 1997	Uair	223	Ambient Wind Speed (cm/sec)
Calculated	C_{indoor}	4.32E-01	Outdoor Air Concentration (ug/m^3)

Formulas

$$a = \frac{D_g}{\frac{\rho_b K_d}{H} + \frac{\theta_m}{H} + \theta_a} + \frac{D_l}{\rho_b K_d + \theta_m + \theta_a H}$$

$$N_a = \frac{2 D_g H C_{soil}}{\left[(\pi\ a\ t)^{1/2} (K_d)\right]} \times 1^a$$

$$C_{outdoor} = \frac{N_a \times \Gamma}{U_{air} \times \delta}$$

Notes:
a = Time dependent biodegradation term reduces to a value of 1 when no biodegradation is assumed.

ASTM 95 = American Society for Testing and Materials, 1995. Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites, E 1739-95.

DBS 96 = Daniel B. Stephens and Associates, Inc., 1996. Hydraulic Properties of LEHR/UC Davis Soil Samples, prepared for Battelle PNL/ITEH, Davis, California.

US DOE 96 = U.S. Department of Energy, 1996 RESRAD-BASELINE for Windows, Version 2.20, Radiological Health Risk Section, Environmental Assessments Division, Argone National Laboratory.

Calculations: Effective diffusivity, diffusive vapor flux and outdoor air concentration calculations from Air/Superfund 1992 guidance. Formulas presented above.

Air Superfund 1992 = USEPA 1992, Air/Superfund National Technical Guidance Study Series, Assessing Potential Indoor Air Impacts for Superfund Sites. EPA-451/R-92-002.

ATTACHMENT D

ONSITE PARTICULATE LOADING AND OFFSITE PARTICULATE DISPERSING AND DEPOSITION

ONSITE PARTICULATE LOADING AND OFFSITE PARTICULATE DISPERSING AND DEPOSITION

Potential emission of COCs at the LEHR site may result from resuspension of contaminated surface soils through wind erosion. Resuspended COCs may be dispersed by the wind and result in exposure through inhalation of fugitive dust or ingestion of soil contaminated through deposition of resuspended COCs. To estimate outdoor exposure-point concentrations of COCs in air and deposition rates of COCs to receptor soil for Scenarios 2 and 3, an exposure model must be applied that estimates the resuspension rate of contaminated surface soil through wind erosion, and their subsequent dispersion and deposition. The modeled ambient outdoor concentrations and soil concentrations may then be used to estimate the potential hazard and risk from ingestion of these compounds. This attachment provides a detailed description of the following estimates:

- The resuspension rate of contaminated surface soils through wind erosion;
- Annual average onsite exposure-point concentrations in ambient air using a simple box model;
- Annual average offsite exposure-point concentrations in ambient air using the USEPA Short Term Industrial Source Complex Model (ISCST3); and
- Offsite exposure-point concentrations in soil due to particulate deposition loading using ISCST3.

1.1 Particulate Resuspension Rate Model

The particulate resuspension rate model used for this risk assessment is based upon the U.S. EPA's guidance document entitled *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites* (Cowherd, 1985). Cowherd provides a methodology for the rapid, worst-case assessment of inhalation exposure to respirable particulate emissions, defined as airborne particles equal to or smaller than 10 μ-meters aerodynamic diameter (PM_{10}). PM_{10} particulate emission rates from LEHR site fugitive sources are estimated using the equation developed for estimating respirable particle emissions for wind erosion of surfaces with an "unlimited reservoir" of erodible particles, adjusted for site specific data using the following formula:

$$E_{10} = 0.036 \times (1 - V) \times \left(\frac{[u]}{u_t}\right)^3 \times F(x) \qquad \text{(D-1)}$$

of COCs to receptor soil an emission rate must be calculated for Total Suspended Particulates (TSPs), defined as airborne particles equal to or smaller than 30 -meters aerodynamic diameter (PM_{30}). The PM_{30} emission rate is estimated from the PM_{10} emission rate assuming a conservative particle size distribution derived for western mining operations (Fugitive Dust Model, 1992a). From Table 2-3 of the Fugitive Dust Model (FDM) Second Validation Study, the mass fraction of particulates with aerodynamic diameter equal to or smaller than 10 μ-meters is 0.27. The PM_{30} emission rate is then estimated as:

$$\begin{aligned} E_{30} &= E_{10} / 0.27 \\ &= 2.54\times10^{-8}\ g/(m^2\text{-sec}) / 0.27 \\ &= 9.42\times10^{-8}\ g/(m^2\text{-sec}) \end{aligned} \qquad \text{(D-2)}$$

The total emissions of airborne particles equal to or smaller than 30 μ-meters aerodynamic diameter is therefore estimated to be 9.42×10^{-8} g/(m^2-sec). Table 2-3 of the FDM Second Validation Study, further breaks out the mass fractions of TSP as 0.263 for particulates with aerodynamic diameter between 10 μ-meters and 20 μ-meters, and 0.467 for particulates with aerodynamic diameter between 20 μ-meters and 30 μ-meters. The particle size distribution used as input for the ISCST3 modeling is further discussed in the next section.

1.2 Particulate Size Distribution

The ISCST3 model requires a particle size distribution when estimating exposure point concentrations and deposition rates resulting from particulate emission sources. The particle size distribution will affect processes, which determine dispersion as well as wet and dry deposition rates. For this study, two sources were used to determine the particle size distribution. As described in the previous section, Table 2-3 of the FDM Second Validation Study (USEPA, 1992a), was used to estimate the particle size distribution for the particulate aerodynamic diameter ranges of 0-10 μ-meters, 10-20 μ-meters, 20-30 μ-meters. To further break out the mass fraction of particulates below 10 μ-meters, the mean of 27 dust composite samples collected in California was used (California Air Resource Board, 1989). These data estimated a mass fraction of 0.523 for particulates with aerodynamic diameters below 10 μ-meters, a mass fraction of 0.107 for particulates with aerodynamic diameters below 2.5 μ-meters, and a mass fraction of 0.045 for particulates with aerodynamic diameters below 1 μ-meter.

To be conservative, the FDM distribution is used to estimate the particle size distribution for the particulate aerodynamic diameter ranges of 0-10 μ-meters, 10-20 μ-meters, 20-30 μ-meters and the CARB study particle size distribution was used only to further break out the size distribution ratios for particulates with aerodynamic diameters below 10 μ-meters. This is conservative because the emission rate calculation provides an estimation of PM_{10} emission only, and assuming a smaller mass fraction of particulates with aerodynamic diameters below 10 μ-meters (27% rather than 52.3%) results in a more conservative estimate of the PM_{30} emission rate (see equation D-2). The resulting particle size distribution is therefore:

0-1 μ-meters = 2.3%

1-2.5 μ-meters = 3.2%

2.5-10 μ-meters = 21.5%

10-20 μ-meters = 26.3%

20-30 μ-meters = 46.7%

When modeling PM_{10} emissions for estimating inhalation exposure point concentrations, particulate emissions greater than 10 μ-meters are not of concern and are neglected. The resulting particle size distribution when modeling PM_{10} emissions is therefore:

0-1 μ-meters = 8.6%

1-2.5 μ-meters = 11.9%

2.5-10 μ-meters = 79.5%

1.3 Particulate Fate and Transport Modeling

1.3.1 Onsite Exposure Point Modeling

A simple box model was applied to estimate outdoor air exposure-point concentrations of COCs resulting from resuspended fugitive source area soil. This approach is applicable to the prediction of local short- and long-term exposure-point concentrations resulting from any area source. The box model used to estimate onsite COC exposure point concentrations in outdoor air was taken from the recent American Society for Testing and Materials (ASTM) *Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (ASTM, 1995) and recommended by the U.S. EPA (1992b). The ASTM box model has the form:

$$C_{outdoor} = \frac{F \bullet L}{U_w \bullet H_m}, \qquad \text{(D-3)}$$

where

C_{onsite} = onsite COC concentration resulting from the particulate emission sources, $\mu g/m^3$,

F = annual average particulate emission rate per unit contaminated surface, $g/(m^2\text{-sec})$,

L = maximum downwind length of the COC emission source (site specific), m,

U_W = average wind speed within the mixing zone, (95% UCL of LEHR site meteorological tower mean annual windspeed at 3 m = 2.23 m/s), and

H_m = ambient air mixing zone height, 1.6 m.

Although the ASTM box model is simple to apply, it is also very conservative. As a result, it is used as a screening method only. Actual air concentrations corresponding to measured COC particulate emissions are expected to be lower than those estimated by application of this model. The maximum plausible downwind length of a particulate emission source was estimated based upon the estimated source area boundaries of OU-1, OU-2, OU-3, and OU-4 shown in Figure 2-1. The longest potential downwind length of a particulate source at the LEHR site is estimated to be 200 m for OU3, the former Western Dog Pens.

The exposure-point concentration estimated using equation D-3 represents the total PM_{10} exposure-point concentration due to particulate resuspension emissions. To estimate the PM_{10} exposure-point concentrations of COCs from surface soil, the modeling results are used to estimate a conversion factor [(mg/m^3)/(mg/kg)] to convert COC surface soil concentrations (mg/kg) to respirable exposure-point concentration of COCs (mg/m^3). The estimated air exposure-point screening concentration for onsite outdoor air, using equation D-3 and the PM_{10} emission rate estimated in Section D-1 above, and the COC surface soil concentrations to COC PM_{10} exposure-point concentration conversion factor are presented in Table D-1.

1.3.2 Industrial Source Complex Short Term (ISCST3) Modeling

The U.S. EPA ISCST3 model was used to estimate offsite concentrations and deposition rates resulting from the PM_{10} and PM_{30} emission rates estimated in Section D-1 above. The current version of ISCST3 (U.S. EPA model date 96113), includes an area source algorithm capable of estimating particulate receptor concentrations and deposition rates resulting from dispersion, and wet/dry removal processes. In addition to the PM_{10} and PM_{30} emission rates estimated in Section D-1, and the particle size distribution discussed in Section D-2, the ISCST3 requires the following:

1. Modeling options which determine specific modeling algorithms to be applied;
2. Fugitive dust emissions source geometry, shown in Figure 2-1;
3. Discrete receptor locations of concern for scenarios 2 and 3 in the risk assessment, also shown in Figure 2-1; and
4. Meteorological information which provides hourly data of windspeed and direction, ambient temperature, stability, mixing heights and precipitation.

Tables D-2 and D-3 summarize the ISCST3 inputs for the PM_{10} and PM_{30} models investigated. The PM_{10} modeling investigation uses the PM_{10} emission rate and particle size distribution to estimate offsite receptor inhalation exposure to respirable particulate emissions. The PM_{30} modeling investigation 2 uses the PM_{30} emission rate and particle size distribution to estimate offsite receptor annual average deposition rates for use in estimating concentrations in soil contaminated through deposition of resuspended COCs. The modeling options, the fugitive dust

emissions sources, the receptor locations and the meteorological information used in the modeling are identical for both modeling investigations. The two investigations differ only in the emission rate and particle size distribution for PM_{10} and PM_{30} modeling scenarios.

Modeling options selected for the determination at risk-based action levels included the calculation of both receptor point concentration and total deposition rates, assuming regulatory default options, rural dispersion parameters, plume depletion through wet and dry deposition processes, and flat terrain. Fugitive dust emissions sources are approximated by the ISCST3 model as rectangles and entered with respect to the x and y coordinates of their southwest corner, the x- and y-side lengths, and a y-axis rotation angle. The fugitive dust emissions source locations of concern are plotted using this convention in Figure D-5. The source ID's for the LEHR emission sources modeled are:

DOE LEHR Operable Unit	ISCST3 Source ID
OU1 - Southwest Trenches	OU1SWT
OU1 - Disposal Box	OU1Box
OU2 - Ra/Sr Leach Systems	OU2LSa & OU2LSb
OU3 - Western Dog Pens	OU3Pen
OU3 - Former North Chemical Dispensing area	OU3NCD
OU4 - Seven Septic Tanks	OU4ST1, OU4ST2, OU4ST3, OU4ST4, OU4ST5, OU4ST6, & OU4ST7

The fugitive dust emission rates for the PM_{10} and PM_{30} modeling scenarios are detailed in sections D-1 and D-2 above, and are outlined in Tables D-2 and D-3, respectively. The particulate grain density was assumed to be 2.65 g/cm^3, based upon site specific data. The liquid and frozen scavenging coefficients were calculated as a function of the particle diameter from Figure 1-11 of the ISCST3 User's Guide, Volume 2 (U.S. EPA, 1995b).

The discrete receptor locations of concern in the risk assessment are shown in Figure 2-1. They consist of two potential receptors on property not under DOE control which could potentially be developed for residential uses. The first receptor location is south of the LEHR facility, approximately 75 ft south of Putah Creek. The second receptor location is to the north-east of the LEHR facility, approximately 1,200 ft from the LEHR site boundary.

For ISCST3 particulate emission source modeling which uses the wet and dry deposition algorithms, the meteorological information required includes hourly data of windspeed and direction, ambient temperature, stability, mixing heights, wet and dry deposition parameters and precipitation. The input meteorological data file is created using the U.S. EPA meteorological preprocessor, PCRAMMET (U.S. EPA, 1995c). PCRAMMET is a meteorological preprocessor used for preparing National Weather Service (NWS) data for use in the EPA's short term air quality dispersion models, including ISCST3 (U.S. EPA, 1995c). The program requires input files for:

1. Surface air meteorological data, which include hourly data of windspeed and direction, ambient temperature, barometric pressure, ceiling height and cloud cover information;
2. Upper air meteorological data, which include twice daily mixing height data, and
3. Precipitation data, which include hourly precipitation event data.

1995 surface air meteorological data were obtained in the MET144 Surface Data Record Format for the Sacramento/Executive Airport (Station ID: 23232), the closest meteorological station which collects adequate data for use with the ISCST3 model. Data gaps in the MET144 file were filled per EPA protocol (Atkinson/Lee, 1992). The 1995 upper air meteorological data was obtained in the PCRAMMET Mixing Height Data Records format for the Oakland/WSO Airport (Station ID: 23230), the only station in Northern California which collects twice daily mixing height data. Data gaps in the mixing height data file were also filled per EPA protocol (Atkinson/Lee, 1992). 1995 precipitation data were obtained in the NCDC TD-3240 Hourly Precipitation / Variable Length Format for the DAVIS 2 WSW EXP FARM (Station ID: 04229402). Minor modifications were made to the TD-3240 hourly precipitation codes to solve errors in the PCRAMMET calculation runs. These changes had no effect on the precipitation data. In addition to the meteorological data input files, the PCRAMMET program requires a number of site specific modeling parameters to complete its calculations. These are listed at the end of Tables D-2 and D-3 and were selected based upon the PCRAMMET User's Guide (U.S. EPA, 1995c).

The PCRAMMET program calculates hourly values of stability, mixing heights, wet and dry deposition parameters and precipitation values. The PCRAMMET output includes the ASCII formatted meteorological file for input in the ISCST3 model, together with a summary file listing program inputs and potential errors. This output files are presented at the end of this attachment. Errors resulted for the LEHR meteorological file resulting in the calculation of mixing heights below 10 m. This results from the PCRAMMET algorithm which calculates hourly mixing height data from the twice daily mixing height input data file. Under certain conditions an interpolation is made from zero to the next mixing height data point, often resulting in unrealistically low mixing heights. To correct for this, an adjustment was made to the final ASCII formatted output meteorological file such that the minimum mixing height was not below the 5th percentile of all the hourly mixing heights calculated for the year (the minimum mixing height is thus 87.1 meters in the final LEHR meteorological file). While this change would have a large effect on the results of hourly maximum particulate concentrations and deposition rates, the final effect on the annual average particulate concentrations and deposition rates was less than 0.1%.

The ISCST3 output files for PM_{10} and PM_{30} modeling, resulting from the input data detailed above and summarized in Tables D-2 and D-3, are included at the end of this attachment. To estimate the PM_{10} exposure-point concentrations of COCs from LEHR fugitive source area contaminated surface soil, the ISCST3 modeling results are used to estimate a conversion factor [(mg/m^3)/(mg/kg)] to convert source area COC surface soil concentrations (mg/kg), to respirable exposure-point concentration of COCs (mg/m^3). The ISCST3 air exposure-point screening concentration for offsite outdoor air, and the source area COC surface soil concentrations to COC PM_{10} exposure-point concentration conversion factor are presented in Table D-1. The ISCST3 modeling results for PM_{30} deposition rate estimate an annual average particulate deposition rate (g/m^2-yr) also presented in Table D-1. To estimate the resulting average concentrations of COCs in offsite surface soils, the ISCST3 modeling results are used to estimate a conversion factor [(mg/kg)/(mg/kg)] to convert source area COC surface soil concentrations (mg/kg), to offsite COC surface soil concentrations (mg/kg). This conversion rate is also presented in Table D-1 and the estimation methodology is outlined below.

1.3.3 Calculation of Offsite Soil Concentration Conversion Factor

To estimate the 30 year average concentrations of COCs in offsite surface soil resulting from the deposition rate estimated for the LEHR particulate emission sources using ISCST3 model, a conversion factor [(mg/kg)/(mg/kg)] is needed to convert LEHR source area COC surface soil concentrations (mg/kg), to offsite COC surface soil concentrations (mg/kg). The conversion factor was calculated assuming the annual average particulate deposition rate, estimated using the ISCST3 model, remains constant over a thirty year period. The deposition factor was estimated using the following equation, which follows the California Air Toxics Hot-Spots methodology for estimating soil concentration resulting from particulate deposition, assuming no decay or resuspension (CAPCOA, 1992):

$$CF_{deposition} = \frac{F_{ISCST3} \times t_{exposure}}{2 \times l_{mix} \times d_{bulk}} \times \frac{1000\,mg\,Onsite\,Soil}{1\,g\,Particulate} \times \frac{1\,kg\,Onsite\,Soil}{10^6\,mg\,Onsite\,Soil} \qquad \text{(D-4)}$$

where

$CF_{deposition}$ = conversion factor, which, when multiplied by the onsite source area COC soil concentration, estimates the concentrations of COCs in offsite surface soil resulting from deposition from LEHR particulate emission sources, (mg/kg)/(mg/kg);

F_{ISCST3} = ISCST3 estimated PM_{30} annual average offsite receptor particulate deposition rate per unit receptor surface, g/(m^2-yr);

$t_{exposure}$ = exposure interval for calculating soil ingestion, 30 years;

l_{mix} = soil mixing depth, 0.15 m;

d_{bulk} = offsite soil bulk density, 1,650 kg/m^3 (site specific), and

2 = conversion factor to get average value over 30 year period versus maximum value at end of 30 year period.

The offsite soil concentrations contaminated through deposition of resuspended COCs from onsite fugitive sources are calculated by multiplying the onsite soil concentration for a specific COC (mg-COC/kg-onsite soil) by the conversion factor $CF_{deposition}$. The resulting product is an estimate of the soil concentration for a specific COC in the receptor soil (mg-COC/kg-offsite soil).

The onsite COC soil concentration to offsite COC soil concentration conversion factors for the two offsite receptor locations are presented in Table D-1.

1.4 References

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U.S. EPA (1995a), *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models: Volume 1 - User Instructions*, , U.S. Environmental Protection Agency, Research Triangle Park (EPA-454/B-95-003a) (September, 1995).

U.S. EPA (1995b), *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models: Volume II Description of Model Algorithm*, , U.S. Environmental Protection Agency, Research Triangle Park (EPA-454/B-95-003b) (September, 1995).

U.S. EPA (1995c), *PCRAMMET User's Guide*, U.S. Environmental Protection Agency, Research Triangle Park (October, 1995).

Table D-1: Particulate Modeling Results.

Particulate Size Range	Particulate Emission Rate	Onsite Modeling Result[3] Ambient Air Concentration	
(μm)[1]	(g/m²-sec)[2]	(μg/m³)	(mg/m³) / (mg/kg)
0-10 μm	2.54E-08	1.43	1.43E-09

Particulate Size Range	Particulate Emission Rate	Offsite Modeling Result (East of DOE Property)[4] Ambient Air Concentration		Particulate Deposition Rate[5]	
(μm)[1]	(g/m²-sec)[2]	(μg/m³)	(mg/m³) / (mg/kg)	(g/m²-yr)	(mg/kg) / (mg/kg)
0-10 μm	2.54E-08	0.00058	5.80E-13		
0-30 μm	9.42E-08			0.0013	7.88E-08

Particulate Size Range	Particulate Emission Rate	Offsite Modeling Result (South of Putah Creek)[4] Ambient Air Concentration		Particulate Deposition Rate[5]	
(μm)[1]	(g/m²-sec)[2]	(μg/m³)	(mg/m³) / (mg/kg)	(g/m²-yr)	(mg/kg) / (mg/kg)
0-10 μm	2.54E-08	0.0031	3.10E-12		
0-30 μm	9.42E-08			0.011	6.67E-07

Notes:
1 - Particle size distribution assumes 27% by mass PM-0 to PM-10 and 73% PM-10 to PM-30 based upon USEPA User's Guide for the Fugitive Dust Model : Second Validation Study, January 1991.
2 - PM-10 particulate emission rate estimated using the Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites (Cowherd, 1985), assuming unlimited erosion potential, adjusted for site specific data. PM-30 emission rate esimated based upon assumed particle size distribution (emission rate of PM-10 / 0.27 = emission rate of PM-30).
3 - Estimated using ASTM RBCA box model (1996), adjusted for site specific data.
4 - Estimated using the USEPA Industrial Source Complex Model (ISCST3), using 1995 meteorology data and assuming wet and dry deposition processes.
5 - Soil concentration estimated from ISCST3 deposition rate assuming no resuspension, no chemical degradation, a 15 cm soil mixing depth, and a soil bulk density of 1.65 g/cm³.

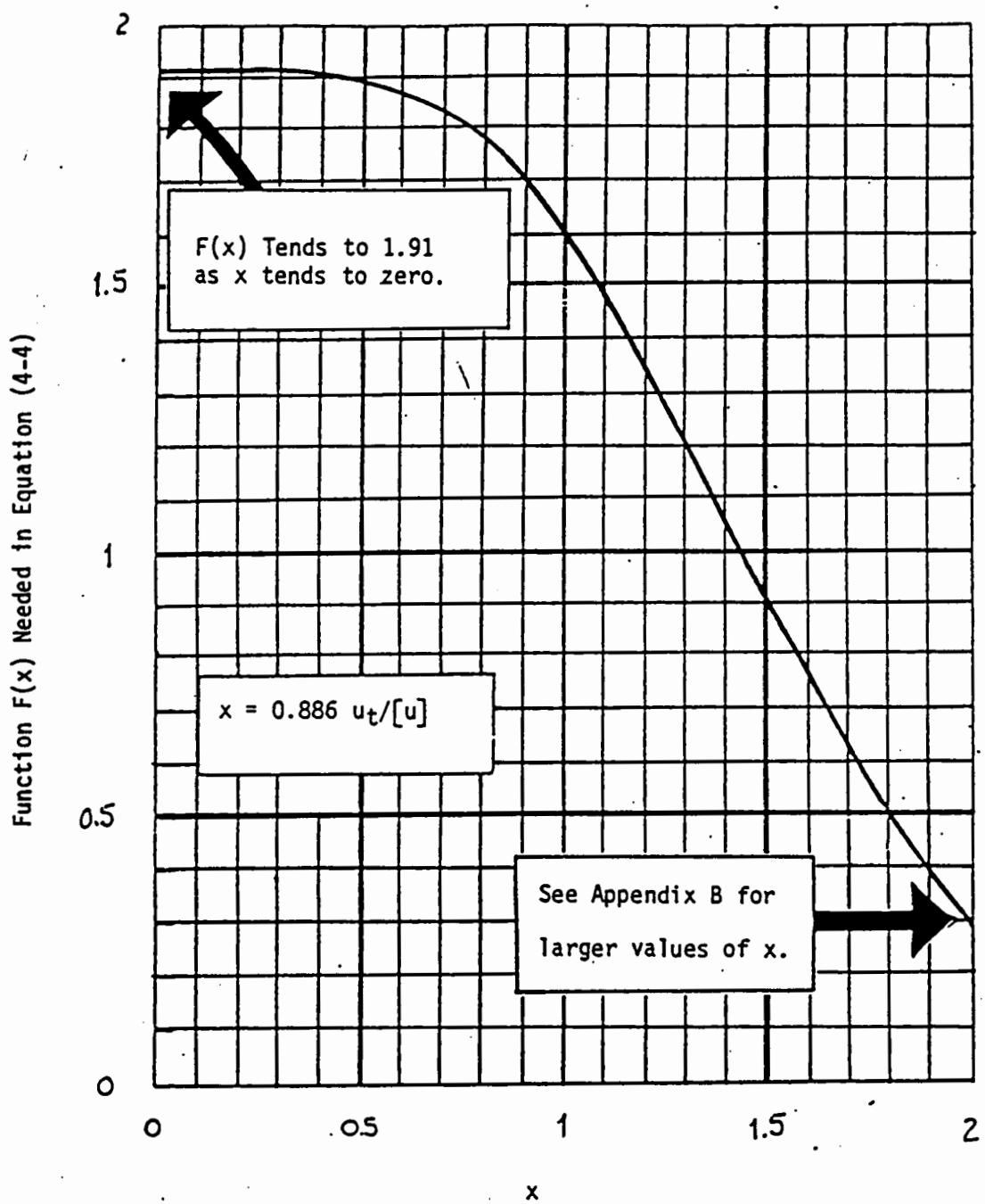


Figure 4-3. Graph of Function F(X) Needed to Estimate Unlimited Erosion

Figure D-1: Reproduction of Figure 4-3 from Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites (Cowherd, 1985). For values of x greater than 2, F(x) may be approximated by $F(x) = 0.18\,(8x^3 + 12x)\exp(-x^2)$.

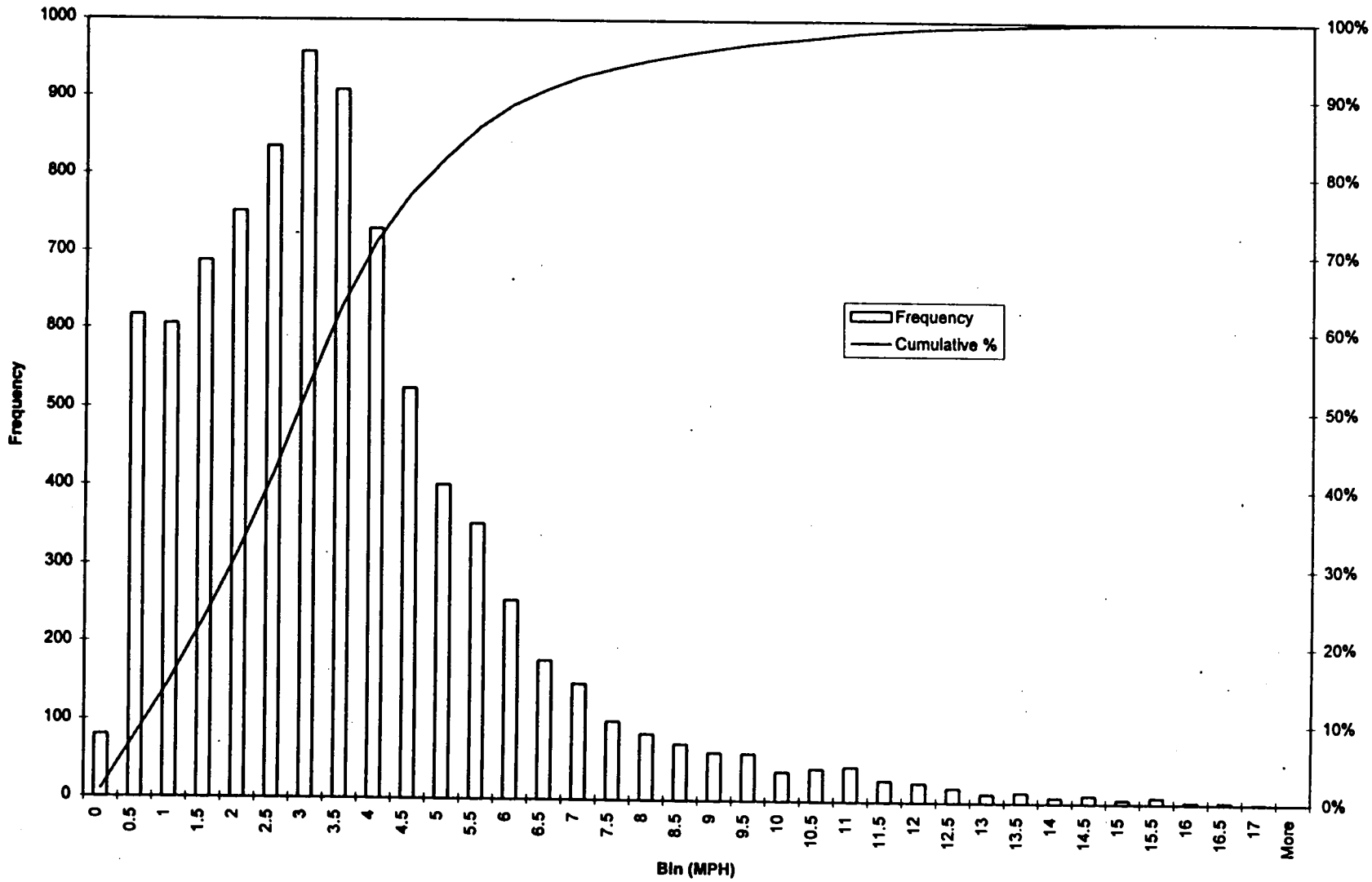
Figure D-2: 95% UCL Calculation Using Gilbert, 1987; Section 13.2: Characterizing Lognormal populations: Confidence Limits of the Mean. As recommended by U.S. EPA Supplemental Guidance to RAGS: Calculating the Concentration Term (PB92-963373, May 1992).

$n=$	8671	
$Y=$	0.7920	Arithmetic mean of the transformed data (Equation 13.1).
$S^2_y=$	1.5622	Variance of the transformed data (Equation 13.2).
$S_y=$	1.25	Standard Deviation of the transformed data.
$\alpha=$	95%	Confidence level.
$H=$	2.447	From Gilbert Table A12 for n=101.

$UL_{0.95}$	4.98	MPH	Upper one sided confidence limit for a lognormal distribution.
	2.23	m/s	Gilbert Equation 13.13

Average =	1.47	m/s
Max =	7.42	m/s
Median =	1.29	m/s

Figure D-3: Histogram of 1995 LEHR Site Meteorological Tower Hourly Windspeed Data



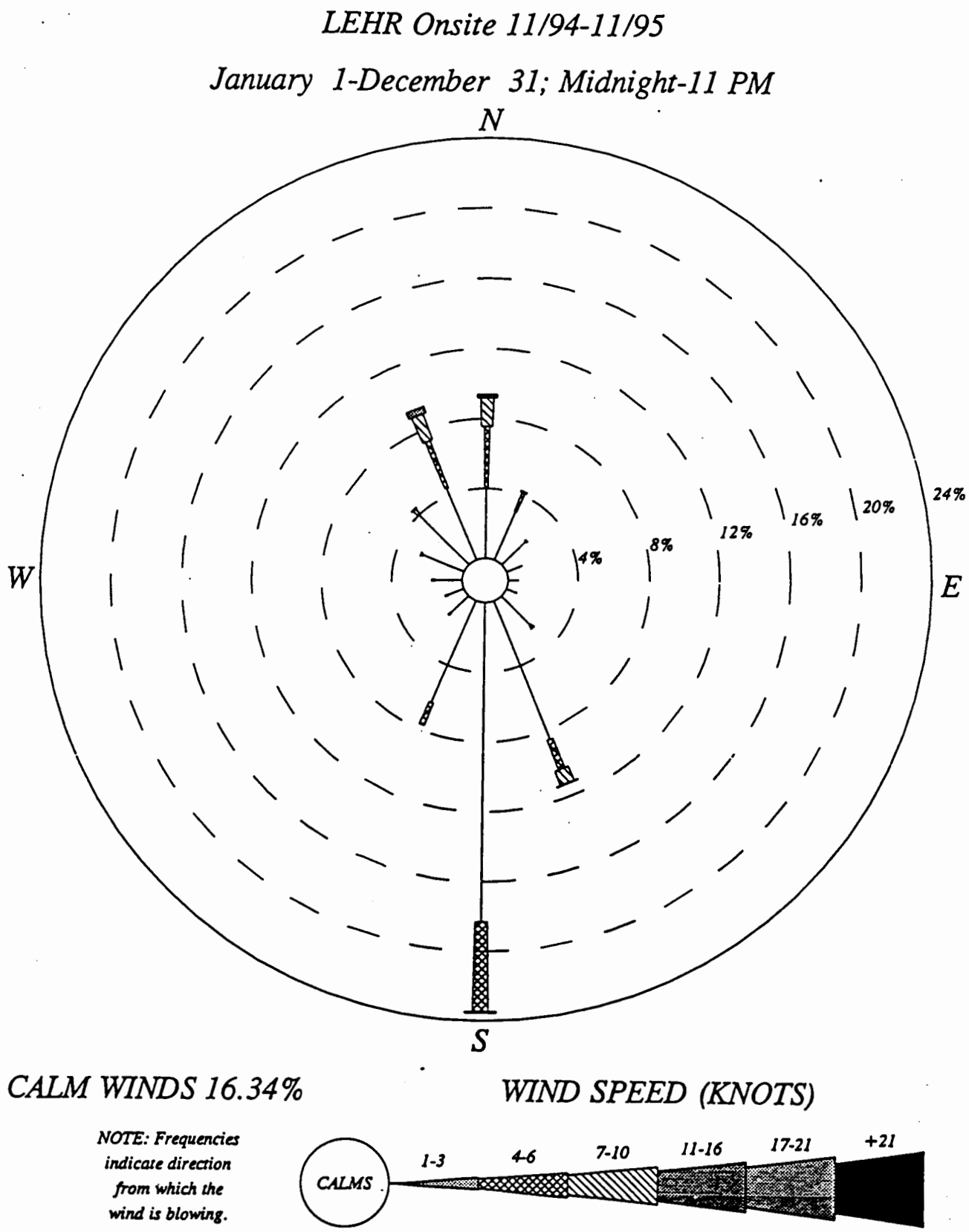


Figure D-4: Windrose for 1995 LEHR Site Meteorological Station Hourly Windspeed Data

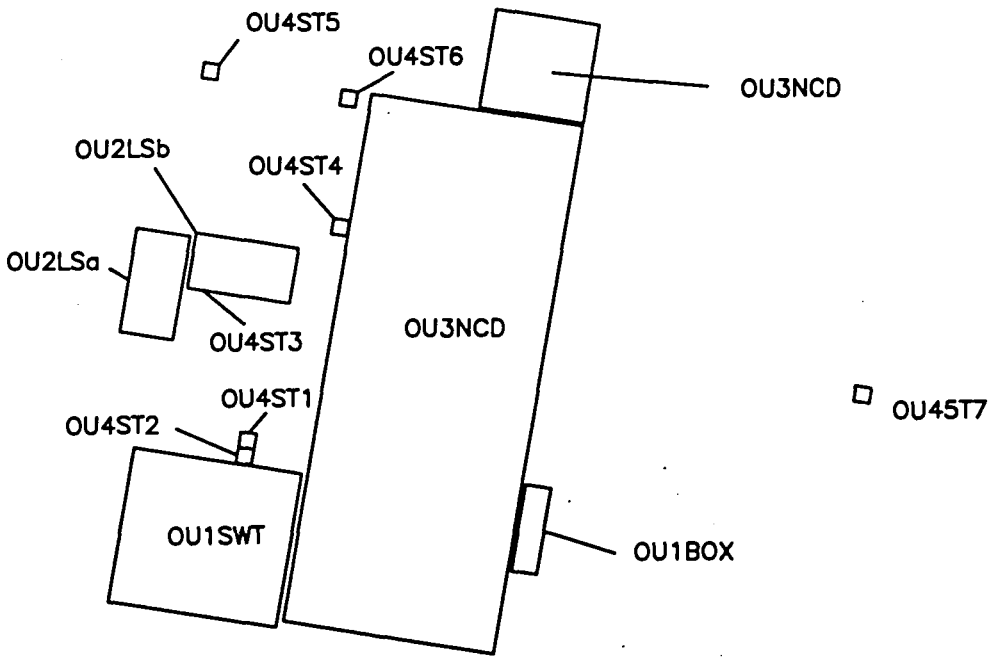


Figure D–5: Fugitive Dust emission source locations as plotted using the ISCST3 input source geometry

Table D-2: ISCST3 Modeling Inputs for Calculation of PM_{10} Concentrations, LEHR Facility, Davis, California.

Averaging time for calculating concentration	Annual					
Modeling Options	DFAULT:	Regulatory default options used.				
	CONC:	Concentration values are calculated.				
	DEPOS:	Total deposition values are calculated.				
	RURAL:	Uses rural dispersion parameters.				
	DRYDPLT:	Plume depletion due to dry deposition is included.				
	WETDPLT:	Plume depletion due to wet deposition is included.				
	TERRHGTS FLAT:	Uses flat terrain calculations.				
Fugitive Dust Area Sources (Coordinate system origin at South-West corner of the LEHR facility. See figure 2-1)	Source ID	X-Coord. (meters)	Y-Coord. (meters)	X-side (meters)	Y-side (meters)	Rotation (deg.)
	OU1SWT	-9.1	8.1	54	50	9.3
	OU1Box	118.2	17.2	8	28	9.3
	OU2LSa	-5.6	95	17	34	9.3
	OU2LSb	15.7	109.1	33	18	9.3
	OU3Pen	46.5	1.5	67	172	9.3
	OU3NCD	108.1	166.7	33	32	9.3
	OU4ST1	31.3	52.5	5	5	9.3
	OU4ST2	32.3	57.6	5	5	9.3
	OU4ST3	15.7	109.1	5	5	9.3
	OU4ST4	61.6	126.3	5	5	9.3
	OU4ST5	20.2	176.8	5	5	9.3
	OU4ST6	64.2	167.7	5	5	9.3
	OU4ST7	226.3	71.7	5	5	9.3
Fugitive Dust Area Source Emission Rate	2.54×10^{-8} g/m^2-sec [Particulate emission rate estimated using Cowherd-1985, assuming unlimited erosion potential.					
Fugitive Dust Particle Size Distribution						
Particle Diameter (μm)	0-1	1-2.5	2.5-10			
Mass Fraction (%)	8.6%	11.9%	79.5%			
Grain Density (g/cm^3)	2.65	2.65	2.65			
Liquid Scavenging Coefficient (10^{-4}-sec^{-1})/(mm-hr^{-1})	6.4	6.4	6.4			
Frozen Scavenging Coefficient (10^{-4}-sec^{-1})/(mm-hr^{-1})	2.2	2.2	2.2			
Discrete Receptor Locations	X-Coord. (meters)	Y-Coord. (meters)	Receptor Height (meters)			
Scenario 3: South of Putah Creek	80	-155	1.6			
Scenario 2: East of DOE Property	615	244	1.6			
Meteorological Information (PCRAMMET inputs)						
Anemometer Height	10 meters					
Surface Air Meteorological Data Station	1995 data from Sacramento/Executive Airport (Station ID: 23232). Data gaps filled per EPA protocol (Atkinson/Lee, 1992).					
Upper Air Meteorological Data Station	1995 data from Oakland/WSO Airport (Station ID: 23230). Data gaps filled per EPA protocol (Atkinson/Lee, 1992).					
Precipitation Data Station	1995 data from DAVIS 2 WSW EXP FARM (Station ID: 04229402)					
Min. Obukhov length	2 meters					
Anemometer height	10 meters					
Roughness length, measurement site	0.15 meters					
Roughness length, application site	0.05 meters					
Noon time albedo	0.19					
Bowen ratio	0.75					
Anthropogenic heat flux	0 W/m^2					
Fraction net radiation absorbed by ground	0.15					

Table D-3: ISCST3 Modeling Inputs for Calculation of PM_{10} Concentrations, LEHR Facility, Davis, California.

Averaging time for calculating deposition	Annual					
Modeling Options	DFAULT:	Regulatory default options used.				
	CONC:	Concentration values are calculated.				
	DEPOS:	Total deposition values are calculated.				
	RURAL:	Uses rural dispersion parameters.				
	DRYDPLT:	Plume depletion due to dry deposition is included.				
	WETDPLT:	Plume depletion due to wet deposition is included.				
	TERRHGTS FLAT:	Uses flat terrain calculations.				
Fugitive Dust Area Sources (Coordinate system origin at South-West corner of the LEHR facility. See figure 2-1)	Source ID	X-Coord. (meters)	Y-Coord. (meters)	X-side (meters)	Y-side (meters)	Rotation (deg.)
	OU1SWT	-9.1	8.1	54	50	9.3
	OU1Box	118.2	17.2	8	28	9.3
	OU2LSa	-5.6	95	17	34	9.3
	OU2LSb	15.7	109.1	33	18	9.3
	OU3Pen	46.5	1.5	67	172	9.3
	OU3NCD	108.1	166.7	33	32	9.3
	OU4ST1	31.3	52.5	5	5	9.3
	OU4ST2	32.3	57.6	5	5	9.3
	OU4ST3	15.7	109.1	5	5	9.3
	OU4ST4	61.6	126.3	5	5	9.3
	OU4ST5	20.2	176.8	5	5	9.3
	OU4ST6	64.2	167.7	5	5	9.3
	OU4ST7	226.3	71.7	5	5	9.3
Fugitive Dust Area Source Emission Rate	9.42×10^{-8} (g/m^2-sec) [Scaled from PM-10 emission rate estimated using Cowherd-1985, assuming unlimited erosion potential.					
Fugitive Dust Particle Size Distribution						
Particle Diameter (μm)	0-1	1-2.5	2.5-10	10-20	20-30	
Mass Fraction (%)	2.3%	3.2%	21.5%	26.3%	46.7%	
Grain Density (g/cm^3)	2.65	2.65	2.65	2.65	2.65	
Liquid Scavenging Coefficient (10^{-4}-sec^{-1})/(mm-hr^{-1})	6.4	6.4	6.4	6.4	6.4	
Frozen Scavenging Coefficient (10^{-4}-sec^{-1})/(mm-hr^{-1})	2.2	2.2	2.2	2.2	2.2	
Discrete Receptor Locations	X-Coord. (meters)		Y-Coord. (meters)		Receptor Height (meters)	
Scenario 3: South of Putah Creek	80		-155		1.6	
Scenario 2: East of DOE Property	615		244		1.6	
Meteorological Information (PCRAMMET inputs)						
Anemometer Height	10 meters					
Surface Air Meteorological Data Station	1995 data from Sacramento/Executive Airport (Station ID: 23232). Data gaps filled per EPA protocol (Atkinson/Lee, 1992).					
Upper Air Meteorological Data Station	1995 data from Oakland/WSO Airport (Station ID: 23230). Data gaps filled per EPA protocol (Atkinson/Lee, 1992).					
Precipitation Data Station	1995 data from DAVIS 2 WSW EXP FARM (Station ID: 04229402)					
Min. Obukhov length	2 meters					
Anemometer height	10 meters					
Roughness length, measurement site	0.15 meters					
Roughness length, application site	0.05 meters					
Noon time albedo	0.19					
Bowen ratio	0.75					
Anthropogenic heat flux	0 W/m^2					
Fraction net radiation absorbed by ground	0.15					

PCRAMMET OUTPUT FILES

```
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PCRAMMET
VERSION: 95300
*********************

The following data were used for output file: C:\EXINTER\davis-95.ASC

WET                                    Wet deposition calculations
C:\EXINTER\LEHR-97\OAKSFO95.MIX        Mixing height data file
C:\EXINTER\LEHR-97\SAC-EX95.FIL        Hourly surface data file
CD144                                  Surface data format
    38.517                             Station latitude (decimal degrees)
   121.500                             Station longitude (decimal degrees)
         8                             Station time zone
C:\EXINTER\LEHR-97\DAVISHP5.NCD        Precipitation data file
     2.000                             Min. Obukhov length (m)
    10.000                             Anemometer height (m)
    0.1500                             Roughness length (m), measurement site
    0.0500                             Roughness length (m), application site
     0.190                             Noon time albedo
     0.750                             Bowen ratio
     0.000                             Anthropogenic heat flux (W/m^2)
     0.150                             Fraction net rad'n absorbed by ground

The following messages were written by PCRAMMET:

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Rural Mixing Height < 10 m (  2.4) for (yy/mm/dd/hh) 95/02/19/07
Rural Mixing Height < 10 m (  2.0) for (yy/mm/dd/hh) 95/02/20/07
Rural Mixing Height < 10 m (  3.8) for (yy/mm/dd/hh) 95/02/21/07
Rural Mixing Height < 10 m (  6.3) for (yy/mm/dd/hh) 95/02/22/07
Rural Mixing Height < 10 m (  2.6) for (yy/mm/dd/hh) 95/02/28/07
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Rural Mixing Height < 10 m (  4.4) for (yy/mm/dd/hh) 95/04/01/06
Rural Mixing Height < 10 m (  5.3) for (yy/mm/dd/hh) 95/04/03/06
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Rural Mixing Height < 10 m (  9.4) for (yy/mm/dd/hh) 95/05/21/05
Rural Mixing Height < 10 m (  7.9) for (yy/mm/dd/hh) 95/05/23/05
Rural Mixing Height < 10 m (  9.7) for (yy/mm/dd/hh) 95/05/24/05
Rural Mixing Height < 10 m (  9.2) for (yy/mm/dd/hh) 95/05/28/05
Rural Mixing Height < 10 m (  9.1) for (yy/mm/dd/hh) 95/05/29/05
Rural Mixing Height < 10 m (  9.5) for (yy/mm/dd/hh) 95/05/30/05
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Rural Mixing Height < 10 m (  8.7) for (yy/mm/dd/hh) 95/06/22/05
Rural Mixing Height < 10 m ( 10.0) for (yy/mm/dd/hh) 95/06/24/05
Rural Mixing Height < 10 m (  5.4) for (yy/mm/dd/hh) 95/06/26/05
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Rural Mixing Height < 10 m (  8.3) for (yy/mm/dd/hh) 95/07/05/05
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Rural Mixing Height < 10 m (  7.0) for (yy/mm/dd/hh) 95/07/09/05
Rural Mixing Height < 10 m (  5.9) for (yy/mm/dd/hh) 95/07/10/05
Rural Mixing Height < 10 m (  6.5) for (yy/mm/dd/hh) 95/07/11/05
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Rural Mixing Height < 10 m (  4.3) for (yy/mm/dd/hh) 95/09/19/06
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Rural Mixing Height < 10 m (  3.8) for (yy/mm/dd/hh) 95/09/23/06
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Rural Mixing Height < 10 m (  6.1) for (yy/mm/dd/hh) 95/11/18/07
Rural Mixing Height < 10 m (  4.4) for (yy/mm/dd/hh) 95/11/19/07
Rural Mixing Height < 10 m (  2.9) for (yy/mm/dd/hh) 95/11/20/07
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PCRAMMET processed   8760 hours of CD144  data
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ISCST3 PM_{10} MODELING OUTPUT FILES

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************************************************
CO STARTING

** ExInter File Name:   I:\LEHR\RISK\AIR-MOD\FIX-MIX2\PM-10\LEHR-95W.XIN
** File Creation Date:  April 09, 1997, 01:17 PM
** Last Modified Date:  April 17, 1997, 11:36 AM

** User-supplied Comments
** Area Sources: OU1 (SW Trench & Disp. Box), OU2, OU3, OU4.
** Conc. & Dep. for 2 offsite receptors (S. of Creak & E. of DOE).

** Model Run Title
CO TITLEONE  LEHR Particulate deposition model
CO TITLETWO  Emission rate based on Cowherd. Filled met/precip data for 1995.

** Short Term and Overall Averaging Times
CO AVERTIME  ANNUAL

** Modeling Options Keywords
CO MODELOPT  DFAULT CONC DEPOS RURAL DRYDPLT WETDPLT

** Pollutant Identifier
CO POLLUTID  PM10

** Flat versus Elevated Terrain
CO TERRHGTS FLAT

** Flagpole Receptors
CO FLAGPOLE 1.6

** Check the Input File and Run the ISC3 Dispersion Model
CO RUNORNOT  RUN

** Error File Output
   ERRORFIL C:\ISCST3\PM10-95W.ERR

CO FINISHED
************************************************


************************************************
** Source Information Pathway
************************************************
SO STARTING

** GENERIC AREA SOURCES
** Type and Location of the Source
** Area Emission Rate, Release Height, X-side Length, Y-side Length, Angle
** Deposition Parameters (If Applicable)

SO LOCATION OU1SWT AREA -9.1 8.1 0
SO SRCPARAM OU1SWT 2.54e-008 0 54 50 9.3

** Particle Size Distribution
SO PARTDIAM OU1SWT 1 2.5 10
SO MASSFRAX OU1SWT 0.086 0.119 0.795
SO PARTDENS OU1SWT 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU1SWT 6.4 6.4 6.4
SO PARTSICE OU1SWT 2.2 2.2 2.2

SO LOCATION OU1Box AREA 118.2 17.2 0
SO SRCPARAM OU1Box 2.54e-008 0 8 28 9.3

** Particle Size Distribution
SO PARTDIAM OU1Box 1 2.5 10
SO MASSFRAX OU1Box 0.086 0.119 0.795
SO PARTDENS OU1Box 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU1Box 6.4 6.4 6.4
SO PARTSICE OU1Box 2.2 2.2 2.2

SO LOCATION OU2LSa AREA -5.6 95 0
SO SRCPARAM OU2LSa 2.54e-008 0 17 34 9.3
```

```
** Particle Size Distribution
SO PARTDIAM OU2LSa 1 2.5 10
SO MASSFRAX OU2LSa 0.086 0.119 0.795
SO PARTDENS OU2LSa 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU2LSa 6.4 6.4 6.4
SO PARTSICE OU2LSa 2.2 2.2 2.2

SO LOCATION OU2LSb AREA 15.7 109.1 0
SO SRCPARAM OU2LSb 2.54e-008 0 33 18 9.3

** Particle Size Distribution
SO PARTDIAM OU2LSb 1 2.5 10
SO MASSFRAX OU2LSb 0.086 0.119 0.795
SO PARTDENS OU2LSb 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU2LSb 6.4 6.4 6.4
SO PARTSICE OU2LSb 2.2 2.2 2.2

SO LOCATION OU3Pen AREA 46.5 1.5 0
SO SRCPARAM OU3Pen 2.54e-008 0 67 172 9.3

** Particle Size Distribution
SO PARTDIAM OU3Pen 1 2.5 10
SO MASSFRAX OU3Pen 0.086 0.119 0.795
SO PARTDENS OU3Pen 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU3Pen 6.4 6.4 6.4
SO PARTSICE OU3Pen 2.2 2.2 2.2

SO LOCATION OU3NCD AREA 108.1 166.7 0
SO SRCPARAM OU3NCD 2.54e-008 0 33 32 9.3

** Particle Size Distribution
SO PARTDIAM OU3NCD 1 2.5 10
SO MASSFRAX OU3NCD 0.086 0.119 0.795
SO PARTDENS OU3NCD 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU3NCD 6.4 6.4 6.4
SO PARTSICE OU3NCD 2.2 2.2 2.2

SO LOCATION OU4ST1 AREA 31.3 52.5 0
SO SRCPARAM OU4ST1 2.54e-008 0 5 5 9.3

** Particle Size Distribution
SO PARTDIAM OU4ST1 1 2.5 10
SO MASSFRAX OU4ST1 0.086 0.119 0.795
SO PARTDENS OU4ST1 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU4ST1 6.4 6.4 6.4
SO PARTSICE OU4ST1 2.2 2.2 2.2

SO LOCATION OU4ST2 AREA 32.3 57.6 0
SO SRCPARAM OU4ST2 2.54e-008 0 5 5 9.3

** Particle Size Distribution
SO PARTDIAM OU4ST2 1 2.5 10
SO MASSFRAX OU4ST2 0.086 0.119 0.795
SO PARTDENS OU4ST2 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU4ST2 6.4 6.4 6.4
SO PARTSICE OU4ST2 2.2 2.2 2.2

SO LOCATION OU4ST3 AREA 15.7 109.1 0
SO SRCPARAM OU4ST3 2.54e-008 0 5 5 9.3

** Particle Size Distribution
SO PARTDIAM OU4ST3 1 2.5 10
SO MASSFRAX OU4ST3 0.086 0.119 0.795
SO PARTDENS OU4ST3 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU4ST3 6.4 6.4 6.4
SO PARTSICE OU4ST3 2.2 2.2 2.2

SO LOCATION OU4ST4 AREA 61.6 126.3 0
SO SRCPARAM OU4ST4 2.54e-008 0 5 5 9.3

** Particle Size Distribution
```

```
** Data Collected in 1995 at OAKLAND/WSO_AP      CA
ME UAIRDATA 23230 1995 OAKLAND/WSO_AP

ME FINISHED
************************************************


************************************************
** Terrain Grid Pathway
************************************************
TG STARTING

TG FINISHED
************************************************


************************************************
** Output Options Pathway
************************************************
OU STARTING

OU FINISHED

************************************
*** SETUP Finishes Successfully ***
************************************
```

```
*** ISCST3 - VERSION 96113 ***     ***  LEHR Particulate deposition model                                  ***        04/17/97
                                    ***  Emission rate based on Cowherd. Filled met/precip data for 1995.   ***        23:56:31
                                                                                                                        PAGE   1
**MODELOPTs: CONC   DEPOS                RURAL  FLAT   FLGPOL DFAULT                                          DRYDPL WETDPL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.
**Model Is Setup For Calculation of Total DEPOSition Values.

  --  SCAVENGING/DEPOSITION LOGIC --
 *Model Uses DRY DEPLETION.  DDPLETE =  T
**Model Uses WET DEPLETION.  WDPLETE =  T
**SCAVENGING Data Provided.  LWGAS,LWPART =  F T
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. "Upper Bound" Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Accepts FLAGPOLE Receptor Heights.

**Model Calculates ANNUAL Averages Only

**This Run Includes:   13 Source(s);      1 Source Group(s); and      2 Receptor(s)

**The Model Assumes A Pollutant Type of:  PM10

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of ANNUAL Averages by Receptor

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    10.00 ;    Decay Coef. =   0.0000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                  ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: PM10-95w.in                          ;  **Output Print File: PM10-95w.out
**Detailed Error/Message File:   C:\ISCST3\PM10-95W.ERR
```

```
*** ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                          ***    04/17/97
                                  *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***    23:56:31
                                                                                                          PAGE   2
• ODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL
```

*** AREA SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC /METER**2)	COORD (SW CORNER) X (METERS)	Y (METERS)	BASE ELEV. (METERS)	RELEASE HEIGHT (METERS)	X-DIM OF AREA (METERS)	Y-DIM OF AREA (METERS)	ORIENT. OF AREA (DEG.)	INIT. SZ (METERS)	EMISSION RATE SCALAR VARY BY
OU1SWT	3	0.25400E-07	-9.1	8.1	0.0	0.00	54.00	50.00	9.30	0.00	
U1BOX	3	0.25400E-07	118.2	17.2	0.0	0.00	8.00	28.00	9.30	0.00	
U2LSA	3	0.25400E-07	-5.6	95.0	0.0	0.00	17.00	34.00	9.30	0.00	
OU2LSB	3	0.25400E-07	15.7	109.1	0.0	0.00	33.00	18.00	9.30	0.00	
OU3PEN	3	0.25400E-07	46.5	1.5	0.0	0.00	67.00	172.00	9.30	0.00	
U3NCD	3	0.25400E-07	108.1	166.7	0.0	0.00	33.00	32.00	9.30	0.00	
U4ST1	3	0.25400E-07	31.3	52.5	0.0	0.00	5.00	5.00	9.30	0.00	
U4ST2	3	0.25400E-07	32.3	57.6	0.0	0.00	5.00	5.00	9.30	0.00	
OU4ST3	3	0.25400E-07	15.7	109.1	0.0	0.00	5.00	5.00	9.30	0.00	
OU4ST4	3	0.25400E-07	61.6	126.3	0.0	0.00	5.00	5.00	9.30	0.00	
U4ST5	3	0.25400E-07	20.2	176.8	0.0	0.00	5.00	5.00	9.30	0.00	
U4ST6	3	0.25400E-07	64.2	167.7	0.0	0.00	5.00	5.00	9.30	0.00	
OU4ST7	3	0.25400E-07	226.3	71.7	0.0	0.00	5.00	5.00	9.30	0.00	

```
* ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                          ***      04/17/97
                                 *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      23:56:31
                                                                                                          PAGE   3
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL


                                   *** SOURCE IDs DEFINING SOURCE GROUPS ***

 GROUP ID                                          SOURCE IDs


 ALL      OU1SWT  , OU1BOX  , OU2LSA  , OU2LSB  , OU3PEN  , OU3NCD  , OU4ST1  , OU4ST2  , OU4ST3  , OU4ST4  , OU4ST5  , OU4ST6  ,
          OU4ST7  ,
```

```
*** ISCST3 - VERSION 96113 ***     *** LEHR Particulate deposition model                          ***      04/17/97
                                   *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      23:56:31
                                                                                                            PAGE   4
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                   DRYDPL WETDPL

                                        *** SOURCE PARTICULATE/GAS DATA ***


*** SOURCE ID = OU1SWT  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.08600,   0.11900,   0.79500,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,


        *** SOURCE ID = OU1BOX  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.08600,   0.11900,   0.79500,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,


        *** SOURCE ID = OU2LSA  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.08600,   0.11900,   0.79500,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,
```

```
*** ISCST3 - VERSION 96113 ***     *** LEHR Particulate deposition model                          ***      04/17/97
                                   *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      23:56:31
                                                                                                            PAGE   6
MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                   DRYDPL WETDPL

                                        *** SOURCE PARTICULATE/GAS DATA ***


* SOURCE ID = OU4ST1  ; SOURCE TYPE = AREA     ***

      MASS FRACTION =
        0.08600,   0.11900,   0.79500,

      PARTICLE DIAMETER (MICRONS) =
        1.00000,   2.50000,  10.00000,

      PARTICLE DENSITY (G/CM**3) =
        2.65000,   2.65000,   2.65000,

      SCAV COEF [LIQ] 1/(S-MM/HR)=
       0.64E+01,  0.64E+01,  0.64E+01,

      SCAV COEF [ICE] 1/(S-MM/HR)=
       0.22E+01,  0.22E+01,  0.22E+01,


      *** SOURCE ID = OU4ST2  ; SOURCE TYPE = AREA     ***

      MASS FRACTION =
        0.08600,   0.11900,   0.79500,

      PARTICLE DIAMETER (MICRONS) =
        1.00000,   2.50000,  10.00000,

      PARTICLE DENSITY (G/CM**3) =
        2.65000,   2.65000,   2.65000,

      SCAV COEF [LIQ] 1/(S-MM/HR)=
       0.64E+01,  0.64E+01,  0.64E+01,

      SCAV COEF [ICE] 1/(S-MM/HR)=
       0.22E+01,  0.22E+01,  0.22E+01,


      *** SOURCE ID = OU4ST3  ; SOURCE TYPE = AREA     ***

      MASS FRACTION =
        0.08600,   0.11900,   0.79500,

      PARTICLE DIAMETER (MICRONS) =
        1.00000,   2.50000,  10.00000,

      PARTICLE DENSITY (G/CM**3) =
        2.65000,   2.65000,   2.65000,

      SCAV COEF [LIQ] 1/(S-MM/HR)=
       0.64E+01,  0.64E+01,  0.64E+01,

      SCAV COEF [ICE] 1/(S-MM/HR)=
       0.22E+01,  0.22E+01,  0.22E+01,
```

```
*** ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                          ***    04/17/97
                                  *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***    23:56:31
                                                                                                          PAGE   7
* MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL

                                   *** SOURCE PARTICULATE/GAS DATA ***


*** SOURCE ID = OU4ST4  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.08600,   0.11900,   0.79500,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,


        *** SOURCE ID = OU4ST5  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.08600,   0.11900,   0.79500,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,


        *** SOURCE ID = OU4ST6  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.08600,   0.11900,   0.79500,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,
```

```
*** ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                          ***      04/17/97
                                  *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      23:56:31
                                                                                                           PAGE   8
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL

                                        *** SOURCE PARTICULATE/GAS DATA ***


        *** SOURCE ID = OU4ST7  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.08600,   0.11900,   0.79500,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,
```

```
*** ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                          ***    04/17/97
                                  *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***    23:56:31
                                                                                                          PAGE   9
*MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL

                                  *** DISCRETE CARTESIAN RECEPTORS ***
                                    (X-COORD, Y-COORD, ZELEV, ZFLAG)
                                              (METERS)

  (     80.0,     -155.0,       0.0,       1.6);          (     615.0,     244.0,       0.0,       1.6);
```

```
*** ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                          ***    04/17/97
                                  *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***    23:56:31
                                                                                                          PAGE  10
*MODELOPTs: CONC   DEPOS                RURAL  FLAT   FLGPOL DFAULT                                DRYDPL WETDPL
```

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

```
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1
```

NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
(METERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

*** WIND PROFILE EXPONENTS ***

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

```
*** ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                          ***    04/17/97
                                  *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***    23:56:31
                                                                                                          PAGE  11
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL
```

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: C:\ISCST3\DAVIS-95.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,i4,f7.2)
SURFACE STATION NO.: 23232 UPPER AIR STATION NO.: 23230
NAME: SACRAMENTO/EXECUTIVE_ARPT NAME: OAKLAND/WSO_AP
YEAR: 1995 YEAR: 1995

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	IPCODE	PRATE (mm/HR)
95	1	1	1	181.0	0.00	277.6	6	174.6	672.0	0.0000	0.0	0.0500	0	0.00
95	1	1	2	178.0	0.00	277.0	6	193.2	672.0	0.0000	0.0	0.0500	0	0.00
95	1	1	3	184.0	0.00	277.6	6	211.7	672.0	0.0000	0.0	0.0500	0	0.00
95	1	1	4	183.0	0.00	278.7	5	230.3	672.0	0.0000	0.0	0.0500	0	0.00
95	1	1	5	183.0	0.00	278.7	4	248.9	248.9	0.0000	0.0	0.0500	37	0.00
95	1	1	6	182.0	0.00	278.7	4	267.5	267.5	0.0000	0.0	0.0500	37	0.42
95	1	1	7	185.0	0.00	278.7	4	286.0	286.0	0.0000	0.0	0.0500	37	0.42
95	1	1	8	183.0	0.00	278.7	4	304.6	304.6	0.0000	0.0	0.0500	37	0.42
95	1	1	9	177.0	0.00	279.3	4	323.2	323.2	0.0000	0.0	0.0500	37	0.00
95	1	1	10	181.0	0.00	279.8	4	341.7	341.7	0.0000	0.0	0.0500	0	0.00
95	1	1	11	184.0	0.00	280.4	4	360.3	360.3	0.0000	0.0	0.0500	0	0.00
95	1	1	12	146.0	4.12	281.5	4	378.9	378.9	0.3579	-243.4	0.0500	0	0.00
95	1	1	13	153.0	3.09	283.7	3	397.4	397.4	0.2949	-32.6	0.0500	0	0.00
95	1	1	14	139.0	5.14	282.6	4	416.0	416.0	0.4396	-889.7	0.0500	0	0.00
95	1	1	15	162.0	4.12	282.6	4	416.0	416.0	0.3491	-999.0	0.0500	0	0.00
95	1	1	16	164.0	5.14	281.5	4	416.0	416.0	0.4224	256.5	0.0500	0	0.00
95	1	1	17	141.0	5.14	281.5	4	414.8	414.8	0.4224	256.5	0.0500	0	0.00
95	1	1	18	137.0	3.09	280.9	5	407.6	434.2	0.2266	53.6	0.0500	0	0.00
95	1	1	19	154.0	2.57	280.4	5	400.5	449.8	0.1510	18.4	0.0500	0	0.00
95	1	1	20	147.0	3.60	279.3	4	393.3	393.3	0.2666	57.3	0.0500	0	0.00
95	1	1	21	140.0	2.57	278.7	5	386.1	481.1	0.1286	11.4	0.0500	0	0.00
95	1	1	22	162.0	2.06	278.7	6	378.9	496.7	0.0529	2.0	0.0500	0	0.00
95	1	1	23	150.0	2.06	278.2	6	371.7	512.4	0.0529	2.0	0.0500	0	0.00
95	1	1	24	150.0	0.00	277.0	7	364.5	528.0	0.0000	0.0	0.0500	0	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
*** ISCST3 - VERSION 96113 ***     ***  LEHR Particulate deposition model                          ***        04/17/97
                                   ***  Emission rate based on Cowherd. Filled met/precip data for 1995.  ***        23:56:31
                                                                                                              PAGE  12
 ODELOPTs: CONC   DEPOS                RURAL  FLAT   FLGPOL DFAULT                                    DRYDPL WETDPL

                          *** THE ANNUAL (  8760 HRS) AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP: ALL      ***
                              INCLUDING SOURCE(S):      OU1SWT  , OU1BOX  , OU2LSA  , OU2LSB  , OU3PEN  , OU3NCD  , OU4ST1  ,
      OU4ST2  , OU4ST3  , OU4ST4  , OU4ST5  , OU4ST6  , OU4ST7  ,

                                     *** DISCRETE CARTESIAN RECEPTOR POINTS ***

                                 ** CONC OF PM10     IN MICROGRAMS/M**3                          **

    X-COORD (M)   Y-COORD (M)        CONC                      X-COORD (M)   Y-COORD (M)        CONC
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
          80.00       -155.00       0.00308 µg/m3                615.00        244.00       0.00058 µg/m3
```

South of Putah Creek

East of DOE Facility

```
*** ISCST3 - VERSION 96113 ***     ***  LEHR Particulate deposition model                                  ***        04/17/97
                                   ***  Emission rate based on Cowherd. Filled met/precip data for 1995.   ***        23:56:31
                                                                                                                      PAGE  13
**MODELOPTs: CONC   DEPOS                RURAL  FLAT   FLGPOL DFAULT                                          DRYDPL WETDPL

                          *** THE ANNUAL (  8760 HRS)   TOTAL DEPOSITION      VALUES FOR SOURCE GROUP: ALL      ***
                              INCLUDING SOURCE(S):      OU1SWT  , OU1BOX  , OU2LSA  , OU2LSB  , OU3PEN  , OU3NCD  , OU4ST1
      OU4ST2  , OU4ST3  , OU4ST4  , OU4ST5  , OU4ST6  , OU4ST7  ,

                                   *** DISCRETE CARTESIAN RECEPTOR POINTS ***

                                 ** DEPO OF PM10     IN GRAMS/M**2                              **

    X-COORD (M)   Y-COORD (M)        DEPO                      X-COORD (M)   Y-COORD (M)        DEPO
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
          80.00       -155.00       0.00111                        615.00        244.00       0.00016
```

```
*** ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                          ***    04/17/97
                                  *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***    23:56:31
                                                                                                          PAGE  14
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL

                                        *** THE SUMMARY OF MAXIMUM PERIOD (  8760 HRS) RESULTS ***

                                   ** CONC OF PM10     IN MICROGRAMS/M**3                          **

                                                                                                   NETWORK
GROUP ID                      AVERAGE CONC              RECEPTOR  (XR, YR, ZELEV, ZFLAG)   OF TYPE GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL       1ST HIGHEST VALUE IS      0.00308 AT (     80.00,    -155.00,      0.00,      1.60)  DC      NA
          2ND HIGHEST VALUE IS      0.00058 AT (    615.00,     244.00,      0.00,      1.60)  DC      NA
          3RD HIGHEST VALUE IS      0.00000 AT (      0.00,       0.00,      0.00,      0.00)
          4TH HIGHEST VALUE IS      0.00000 AT (      0.00,       0.00,      0.00,      0.00)
          5TH HIGHEST VALUE IS      0.00000 AT (      0.00,       0.00,      0.00,      0.00)
          6TH HIGHEST VALUE IS      0.00000 AT (      0.00,       0.00,      0.00,      0.00)

 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
                      BD = BOUNDARY
```

```
*** ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                                   ***     04/17/97
                                  *** Emission rate based on Cowherd. Filled met/precip data for 1995.    ***     23:56:31
                                                                                                                  PAGE  15
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                            DRYDPL WETDPL

                                   *** THE SUMMARY OF MAXIMUM PERIOD (  8760 HRS) RESULTS ***


                                ** DEPO OF PM10      IN GRAMS/M**2                                   **

                                                                                                       NETWORK
GROUP ID                        TOTAL DEPO              RECEPTOR  (XR, YR, ZELEV, ZFLAG)   OF TYPE   GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL      1ST HIGHEST VALUE IS      0.00111 AT (     80.00,      -155.00,      0.00,      1.60)  DC       NA
         2ND HIGHEST VALUE IS      0.00016 AT (    615.00,       244.00,      0.00,      1.60)  DC       NA
         3RD HIGHEST VALUE IS      0.00000 AT (      0.00,         0.00,      0.00,      0.00)
         4TH HIGHEST VALUE IS      0.00000 AT (      0.00,         0.00,      0.00,      0.00)
         5TH HIGHEST VALUE IS      0.00000 AT (      0.00,         0.00,      0.00,      0.00)
         6TH HIGHEST VALUE IS      0.00000 AT (      0.00,         0.00,      0.00,      0.00)

 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
                      BD = BOUNDARY
```

```
*** ISCST3 - VERSION 96113 ***    ***  LEHR Particulate deposition model                          ***      04/17/97
                                  ***  Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      23:56:31
                                                                                                            PAGE  16
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL

*** Message Summary : ISCST3 Model Execution ***

 --------- Summary of Total Messages --------

A Total of            0 Fatal Error Message(s)
A Total of            0 Warning Message(s)
A Total of         3184 Informational Message(s)

A Total of         3184 Calm Hours Identified


   ******** FATAL ERROR MESSAGES ********
              ***  NONE  ***


   ********   WARNING MESSAGES   ********
              ***  NONE  ***


   ************************************
   *** ISCST3 Finishes Successfully ***
   ************************************
```

ISCST3 PM_{30} MODELING OUTPUT FILES

```
** Particle Size Distribution
SO PARTDIAM OU2LSa 1 2.5 10 20 30
SO MASSFRAX OU2LSa 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU2LSa 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU2LSa 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU2LSa 2.2 2.2 2.2 2.2 2.2

SO LOCATION OU2LSb AREA 15.7 109.1 0
SO SRCPARAM OU2LSb 9.42e-008 0 33 18 9.3

** Particle Size Distribution
SO PARTDIAM OU2LSb 1 2.5 10 20 30
SO MASSFRAX OU2LSb 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU2LSb 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU2LSb 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU2LSb 2.2 2.2 2.2 2.2 2.2

SO LOCATION OU3Pen AREA 46.5 1.5 0
SO SRCPARAM OU3Pen 9.42e-008 0 67 172 9.3

** Particle Size Distribution
SO PARTDIAM OU3Pen 1 2.5 10 20 30
SO MASSFRAX OU3Pen 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU3Pen 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU3Pen 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU3Pen 2.2 2.2 2.2 2.2 2.2

SO LOCATION OU3NCD AREA 108.1 166.7 0
SO SRCPARAM OU3NCD 9.42e-008 0 33 32 9.3

** Particle Size Distribution
SO PARTDIAM OU3NCD 1 2.5 10 20 30
SO MASSFRAX OU3NCD 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU3NCD 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU3NCD 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU3NCD 2.2 2.2 2.2 2.2 2.2

SO LOCATION OU4ST1 AREA 31.3 52.5 0
SO SRCPARAM OU4ST1 9.42e-008 0 5 5 9.3

** Particle Size Distribution
SO PARTDIAM OU4ST1 1 2.5 10 20 30
SO MASSFRAX OU4ST1 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU4ST1 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU4ST1 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU4ST1 2.2 2.2 2.2 2.2 2.2

SO LOCATION OU4ST2 AREA 32.3 57.6 0
SO SRCPARAM OU4ST2 9.42e-008 0 5 5 9.3

** Particle Size Distribution
SO PARTDIAM OU4ST2 1 2.5 10 20 30
SO MASSFRAX OU4ST2 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU4ST2 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU4ST2 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU4ST2 2.2 2.2 2.2 2.2 2.2

SO LOCATION OU4ST3 AREA 15.7 109.1 0
SO SRCPARAM OU4ST3 9.42e-008 0 5 5 9.3

** Particle Size Distribution
SO PARTDIAM OU4ST3 1 2.5 10 20 30
SO MASSFRAX OU4ST3 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU4ST3 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU4ST3 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU4ST3 2.2 2.2 2.2 2.2 2.2

SO LOCATION OU4ST4 AREA 61.6 126.3 0
SO SRCPARAM OU4ST4 9.42e-008 0 5 5 9.3

** Particle Size Distribution
```

```
**************************************************
** Control Options Pathway
**************************************************
CO STARTING

** ExInter File Name:    D:\PROJECTS\LEHR\RISK\AIR-MOD\FIX-MIX2\PM-30\LEHR-95W.XIN
** File Creation Date:  April 09, 1997, 01:17 PM
** Last Modified Date:  April 17, 1997, 09:32 PM

** User-supplied Comments
** Area Sources: OU1 (SW Trench & Disp. Box), OU2, OU3, OU4.
** Conc. & Dep. for 2 offsite receptors (S. of Creak & E. of DOE).

** Model Run Title
CO TITLEONE  LEHR Particulate deposition model
CO TITLETWO  Emission rate based on Cowherd. Filled met/precip data for 1995.

** Short Term and Overall Averaging Times
CO AVERTIME  ANNUAL

** Modeling Options Keywords
CO MODELOPT  DFAULT CONC DEPOS RURAL DRYDPLT WETDPLT

** Pollutant Identifier
CO POLLUTID  PM30

** Flat versus Elevated Terrain
CO TERRHGTS FLAT

** Flagpole Receptors
CO FLAGPOLE 1.6

** Check the Input File and Run the ISC3 Dispersion Model
CO RUNORNOT  RUN

** Error File Output
   ERRORFIL C:\iscst3\PM30-95W.ERR

CO FINISHED
**************************************************


**************************************************
** Source Information Pathway
**************************************************
SO STARTING

** GENERIC AREA SOURCES
** Type and Location of the Source
** Area Emission Rate, Release Height, X-side Length, Y-side Length, Angle
** Deposition Parameters (If Applicable)

SO LOCATION OU1SWT AREA -9.1 8.1 0
SO SRCPARAM OU1SWT 9.42e-008 0 54 50 9.3

** Particle Size Distribution
SO PARTDIAM OU1SWT 1 2.5 10 20 30
SO MASSFRAX OU1SWT 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU1SWT 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU1SWT 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU1SWT 2.2 2.2 2.2 2.2 2.2

SO LOCATION OU1Box AREA 118.2 17.2 0
SO SRCPARAM OU1Box 9.42e-008 0 8 28 9.3

** Particle Size Distribution
SO PARTDIAM OU1Box 1 2.5 10 20 30
SO MASSFRAX OU1Box 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU1Box 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU1Box 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU1Box 2.2 2.2 2.2 2.2 2.2

SO LOCATION OU2LSa AREA -5.6 95 0
SO SRCPARAM OU2LSa 9.42e-008 0 17 34 9.3
```

```
SO PARTDIAM OU4ST4 1 2.5 10 20 30
SO MASSFRAX OU4ST4 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU4ST4 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU4ST4 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU4ST4 2.2 2.2 2.2 2.2 2.2

SO LOCATION OU4ST5 AREA 20.2 176.8 0
SO SRCPARAM OU4ST5 9.42e-008 0 5 5 9.3

** Particle Size Distribution
SO PARTDIAM OU4ST5 1 2.5 10 20 30
SO MASSFRAX OU4ST5 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU4ST5 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU4ST5 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU4ST5 2.2 2.2 2.2 2.2 2.2

SO LOCATION OU4ST6 AREA 64.2 167.7 0
SO SRCPARAM OU4ST6 9.42e-008 0 5 5 9.3

** Particle Size Distribution
SO PARTDIAM OU4ST6 1 2.5 10 20 30
SO MASSFRAX OU4ST6 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU4ST6 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU4ST6 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU4ST6 2.2 2.2 2.2 2.2 2.2

SO LOCATION OU4ST7 AREA 226.3 71.7 0
SO SRCPARAM OU4ST7 9.42e-008 0 5 5 9.3

** Particle Size Distribution
SO PARTDIAM OU4ST7 1 2.5 10 20 30
SO MASSFRAX OU4ST7 0.023 0.032 0.215 0.263 0.467
SO PARTDENS OU4ST7 2.65 2.65 2.65 2.65 2.65
** Scavenging Coefficients
SO PARTSLIQ OU4ST7 6.4 6.4 6.4 6.4 6.4
SO PARTSICE OU4ST7 2.2 2.2 2.2 2.2 2.2

** All Sources in a Single Source Group
SO SRCGROUP ALL

SO FINISHED
************************************************


************************************************
** Receptor Information Pathway
************************************************
RE STARTING

** Discrete Receptors, Cartesian: 2, Polar: 0

** Cartesian:  X and Y Coordinates, Flagpole Receptor Heights
RE DISCCART 80 -155 1.6
RE DISCCART 615 244 1.6

RE FINISHED
************************************************


************************************************
** Meteorological Information Pathway
************************************************
ME STARTING

** Meteorological Data File Name
ME INPUTFIL C:\ISCST3\DAVIS-95.MET

** Anemometer Height
ME ANEMHGHT 10 METERS

** Surface Air Meteorological Data Station 23232
** Data Collected in 1995 at SACRAMENTO/EXECUTIVE_ARPT      CA
ME SURFDATA 23232 1995 SACRAMENTO/EXECUTIVE_ARPT

** Upper Air Meteorological Data Station 23230
```

```
** Data Collected in 1995 at OAKLAND/WSO_AP      CA
ME UAIRDATA 23230 1995 OAKLAND/WSO_AP

ME FINISHED
*************************************************


*************************************************
** Terrain Grid Pathway
*************************************************
TG STARTING

TG FINISHED
*************************************************


*************************************************
** Output Options Pathway
*************************************************
OU STARTING

OU FINISHED

***********************************
*** SETUP Finishes Successfully ***
***********************************
```

```
*** ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                                  ***      04/18/97
                                   *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      00:06:2
                                                                                                                  PAGE
**MODELOPTs: CONC   DEPOS                RURAL  FLAT   FLGPOL DFAULT                                     DRYDPL WETDPL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.
**Model Is Setup For Calculation of Total DEPOSition Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses DRY DEPLETION.  DDPLETE =  T
**Model Uses WET DEPLETION.  WDPLETE =  T
**SCAVENGING Data Provided.  LWGAS,LWPART =  F T
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. "Upper Bound" Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Accepts FLAGPOLE Receptor Heights.

**Model Calculates ANNUAL Averages Only

**This Run Includes:   13 Source(s);      1 Source Group(s); and      2 Receptor(s)

**The Model Assumes A Pollutant Type of:  PM30

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of ANNUAL Averages by Receptor

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    10.00 ;    Decay Coef. =   0.0000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                  ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: PM30-95w.in                                  ;  **Output Print File: PM30-95w.out
**Detailed Error/Message File:   C:\iscst3\PM30-95W.ERR
```

```
*** ISCST3 - VERSION 96113 ***     *** LEHR Particulate deposition model                          ***     04/18/97
                                   *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***     00:06:27
                                                                                                              PAGE   2
MODELOPTs: CONC   DEPOS                RURAL  FLAT   FLGPOL DFAULT                                   DRYDPL WETDPL
```

*** AREA SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC /METER**2)	COORD (SW CORNER) X (METERS)	Y (METERS)	BASE ELEV. (METERS)	RELEASE HEIGHT (METERS)	X-DIM OF AREA (METERS)	Y-DIM OF AREA (METERS)	ORIENT. OF AREA (DEG.)	INIT. SZ (METERS)	EMISSION RATE SCALAR VARY BY
OU1SWT	5	0.94200E-07	-9.1	8.1	0.0	0.00	54.00	50.00	9.30	0.00	
OU1BOX	5	0.94200E-07	118.2	17.2	0.0	0.00	8.00	28.00	9.30	0.00	
OU2LSA	5	0.94200E-07	-5.6	95.0	0.0	0.00	17.00	34.00	9.30	0.00	
OU2LSB	5	0.94200E-07	15.7	109.1	0.0	0.00	33.00	18.00	9.30	0.00	
OU3PEN	5	0.94200E-07	46.5	1.5	0.0	0.00	67.00	172.00	9.30	0.00	
OU3NCD	5	0.94200E-07	108.1	166.7	0.0	0.00	33.00	32.00	9.30	0.00	
OU4ST1	5	0.94200E-07	31.3	52.5	0.0	0.00	5.00	5.00	9.30	0.00	
OU4ST2	5	0.94200E-07	32.3	57.6	0.0	0.00	5.00	5.00	9.30	0.00	
OU4ST3	5	0.94200E-07	15.7	109.1	0.0	0.00	5.00	5.00	9.30	0.00	
OU4ST4	5	0.94200E-07	61.6	126.3	0.0	0.00	5.00	5.00	9.30	0.00	
OU4ST5	5	0.94200E-07	20.2	176.8	0.0	0.00	5.00	5.00	9.30	0.00	
OU4ST6	5	0.94200E-07	64.2	167.7	0.0	0.00	5.00	5.00	9.30	0.00	
OU4ST7	5	0.94200E-07	226.3	71.7	0.0	0.00	5.00	5.00	9.30	0.00	

```
*** ISCST3 - VERSION 96113 ***     *** LEHR Particulate deposition model                          ***      04/18/97
                                   *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      00:06:27
                                                                                                            PAGE   3
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                   DRYDPL WETDPL


                                   *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                                SOURCE IDs


 ALL       OU1SWT  , OU1BOX  , OU2LSA  , OU2LSB  , OU3PEN  , OU3NCD  , OU4ST1  , OU4ST2  , OU4ST3  , OU4ST4  , OU4ST5  , OU4ST6
           OU4ST7  ,
```

```
*** ISCST3 - VERSION 96113 ***     *** LEHR Particulate deposition model                          ***      04/18/97
                                   *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      00:06:27
                                                                                                            PAGE   4
**MODELOPTs: CONC   DEPOS                RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL

                                        *** SOURCE PARTICULATE/GAS DATA ***


*** SOURCE ID = OU1SWT  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,


        *** SOURCE ID = OU1BOX  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,


        *** SOURCE ID = OU2LSA  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,
```

```
** ISCST3 - VERSION 96113 ***     *** LEHR Particulate deposition model                          ***      04/18/97
                                   *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      00:06:27
                                                                                                            PAGE   5
MODELOPTs: CONC   DEPOS                RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL

                                        *** SOURCE PARTICULATE/GAS DATA ***


* SOURCE ID = OU2LSB  ; SOURCE TYPE = AREA     ***

      MASS FRACTION =
        0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

      PARTICLE DIAMETER (MICRONS) =
        1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

      PARTICLE DENSITY (G/CM**3) =
        2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

      SCAV COEF [LIQ] 1/(S-MM/HR)=
       0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

      SCAV COEF [ICE] 1/(S-MM/HR)=
       0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,


      *** SOURCE ID = OU3PEN  ; SOURCE TYPE = AREA     ***

      MASS FRACTION =
        0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

      PARTICLE DIAMETER (MICRONS) =
        1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

      PARTICLE DENSITY (G/CM**3) =
        2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

      SCAV COEF [LIQ] 1/(S-MM/HR)=
       0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

      SCAV COEF [ICE] 1/(S-MM/HR)=
       0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,


      *** SOURCE ID = OU3NCD  ; SOURCE TYPE = AREA     ***

      MASS FRACTION =
        0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

      PARTICLE DIAMETER (MICRONS) =
        1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

      PARTICLE DENSITY (G/CM**3) =
        2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

      SCAV COEF [LIQ] 1/(S-MM/HR)=
       0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

      SCAV COEF [ICE] 1/(S-MM/HR)=
       0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,
```

```
*** ISCST3 - VERSION 96113 ***     *** LEHR Particulate deposition model                          ***      04/18/97
                                   *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      00:06:27
                                                                                                            PAGE   6
**MODELOPTs: CONC   DEPOS                RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL

                                   *** SOURCE PARTICULATE/GAS DATA ***

** SOURCE ID = OU4ST1   ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,

        *** SOURCE ID = OU4ST2   ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,

        *** SOURCE ID = OU4ST3   ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,
```

```
*** ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                          ***    04/18/97
                                  *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***    00:06:27
                                                                                                          PAGE   7
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL

                                        *** SOURCE PARTICULATE/GAS DATA ***


*** SOURCE ID = OU4ST4  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,


        *** SOURCE ID = OU4ST5  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,


        *** SOURCE ID = OU4ST6  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,
```

```
*** ISCST3 - VERSION 96113 ***     *** LEHR Particulate deposition model                          ***      04/18/9
                                   *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      00:06:2
                                                                                                            PAGE
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL

                                        *** SOURCE PARTICULATE/GAS DATA ***


        *** SOURCE ID = OU4ST7  ; SOURCE TYPE = AREA     ***

        MASS FRACTION =
          0.02300,   0.03200,   0.21500,   0.26300,   0.46700,

        PARTICLE DIAMETER (MICRONS) =
          1.00000,   2.50000,  10.00000,  20.00000,  30.00000,

        PARTICLE DENSITY (G/CM**3) =
          2.65000,   2.65000,   2.65000,   2.65000,   2.65000,

        SCAV COEF [LIQ] 1/(S-MM/HR)=
         0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,  0.64E+01,

        SCAV COEF [ICE] 1/(S-MM/HR)=
         0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,  0.22E+01,
```

```
*** ISCST3 - VERSION 96113 ***    ***  LEHR Particulate deposition model                          ***      04/18/97
                                  ***  Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      00:06:27
                                                                                                            PAGE    9
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                   DRYDPL WETDPL

                                   *** DISCRETE CARTESIAN RECEPTORS ***
                                     (X-COORD, Y-COORD, ZELEV, ZFLAG)
                                              (METERS)

   (     80.0,    -155.0,       0.0,       1.6);          (    615.0,     244.0,       0.0,       1.6);
```

```
*** ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                          ***    04/18/9
                                  *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***    00:06:2
                                                                                                            PAGE 1
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL
```

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

```
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1
```

NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
(METERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

*** WIND PROFILE EXPONENTS ***

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

```
*** ISCST3 - VERSION 96113 ***    *** LEHR Particulate deposition model                          ***    04/18/97
                                  *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***    00:06:27
                                                                                                          PAGE  11
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                  DRYDPL WETDPL
```

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: C:\ISCST3\DAVIS-95.MET — FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,i4,f7.2)
SURFACE STATION NO.: 23232 — UPPER AIR STATION NO.: 23230
NAME: SACRAMENTO/EXECUTIVE_ARPT — NAME: OAKLAND/WSO_AP
YEAR: 1995 — YEAR: 1995

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	IPCODE	PRATE (mm/HR)
95	1	1	1	181.0	0.00	277.6	6	174.6	672.0	0.0000	0.0	0.0500	0	0.00
95	1	1	2	178.0	0.00	277.0	6	193.2	672.0	0.0000	0.0	0.0500	0	0.00
95	1	1	3	184.0	0.00	277.6	6	211.7	672.0	0.0000	0.0	0.0500	0	0.00
95	1	1	4	183.0	0.00	278.7	5	230.3	672.0	0.0000	0.0	0.0500	0	0.00
95	1	1	5	183.0	0.00	278.7	4	248.9	248.9	0.0000	0.0	0.0500	37	0.00
95	1	1	6	182.0	0.00	278.7	4	267.5	267.5	0.0000	0.0	0.0500	37	0.42
95	1	1	7	185.0	0.00	278.7	4	286.0	286.0	0.0000	0.0	0.0500	37	0.42
95	1	1	8	183.0	0.00	278.7	4	304.6	304.6	0.0000	0.0	0.0500	37	0.42
95	1	1	9	177.0	0.00	279.3	4	323.2	323.2	0.0000	0.0	0.0500	37	0.00
95	1	1	10	181.0	0.00	279.8	4	341.7	341.7	0.0000	0.0	0.0500	0	0.00
95	1	1	11	184.0	0.00	280.4	4	360.3	360.3	0.0000	0.0	0.0500	0	0.00
95	1	1	12	146.0	4.12	281.5	4	378.9	378.9	0.3579	-243.4	0.0500	0	0.00
95	1	1	13	153.0	3.09	283.7	3	397.4	397.4	0.2949	-32.6	0.0500	0	0.00
95	1	1	14	139.0	5.14	282.6	4	416.0	416.0	0.4396	-889.7	0.0500	0	0.00
95	1	1	15	162.0	4.12	282.6	4	416.0	416.0	0.3491	-999.0	0.0500	0	0.00
95	1	1	16	164.0	5.14	281.5	4	416.0	416.0	0.4224	256.5	0.0500	0	0.00
95	1	1	17	141.0	5.14	281.5	4	414.8	414.8	0.4224	256.5	0.0500	0	0.00
95	1	1	18	137.0	3.09	280.9	5	407.6	434.2	0.2266	53.6	0.0500	0	0.00
95	1	1	19	154.0	2.57	280.4	5	400.5	449.8	0.1510	18.4	0.0500	0	0.00
95	1	1	20	147.0	3.60	279.3	4	393.3	393.3	0.2666	57.3	0.0500	0	0.00
95	1	1	21	140.0	2.57	278.7	5	386.1	481.1	0.1286	11.4	0.0500	0	0.00
95	1	1	22	162.0	2.06	278.7	6	378.9	496.7	0.0529	2.0	0.0500	0	0.00
95	1	1	23	150.0	2.06	278.2	6	371.7	512.4	0.0529	2.0	0.0500	0	0.00
95	1	1	24	150.0	0.00	277.0	7	364.5	528.0	0.0000	0.0	0.0500	0	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
*** ISCST3 - VERSION 96113 ***    ***  LEHR Particulate deposition model                          ***      04/18/97
                                  ***  Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      00:06:27
                                                                                                              PAGE  12
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                   DRYDPL WETDPL

                          *** THE ANNUAL (  8760 HRS) AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP: ALL      ***
                              INCLUDING SOURCE(S):      OU1SWT  , OU1BOX  , OU2LSA  , OU2LSB  , OU3PEN  , OU3NCD  , OU4ST1  ,
      OU4ST2  , OU4ST3  , OU4ST4  , OU4ST5  , OU4ST6  , OU4ST7  ,

                                    *** DISCRETE CARTESIAN RECEPTOR POINTS ***

                              ** CONC OF PM30     IN MICROGRAMS/M**3                          **

    X-COORD (M)   Y-COORD (M)        CONC                      X-COORD (M)   Y-COORD (M)        CONC
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
          80.00       -155.00       0.00969                        615.00        244.00       0.00140
```

```
*** ISCST3 - VERSION 96113 ***     *** LEHR Particulate deposition model                          ***      04/18/97
                                   *** Emission rate based on Cowherd. Filled met/precip data for 1995.  ***  00:06:27
                                                                                                            PAGE  13
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                   DRYDPL WETDPL

                          *** THE ANNUAL (  8760 HRS)  TOTAL DEPOSITION     VALUES FOR SOURCE GROUP: ALL      ***
                              INCLUDING SOURCE(S):     OU1SWT  , OU1BOX  , OU2LSA  , OU2LSB  , OU3PEN  , OU3NCD  , OU4ST1  ,
        OU4ST2  , OU4ST3  , OU4ST4  , OU4ST5  , OU4ST6  , OU4ST7  ,

                                   *** DISCRETE CARTESIAN RECEPTOR POINTS ***

                                 ** DEPO OF PM30     IN GRAMS/M**2                          **

     X-COORD (M)   Y-COORD (M)       DEPO                     X-COORD (M)   Y-COORD (M)       DEPO
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
          80.00       -155.00       0.01119 g/m²-yr                615.00        244.00       0.00132 g/m²-yr
```

South of Pulah Creek

East of DOE property

```
*** ISCST3 - VERSION 96113 ***    ***  LEHR Particulate deposition model                          ***      04/18/97
                                  ***  Emission rate based on Cowherd. Filled met/precip data for 1995.  ***      00:06:27
                                                                                                            PAGE  14
**MODELOPTs: CONC   DEPOS              RURAL  FLAT   FLGPOL DFAULT                                   DRYDPL WETDPL

                                        *** THE SUMMARY OF MAXIMUM PERIOD (  8760 HRS) RESULTS ***

                                     ** CONC OF PM30     IN MICROGRAMS/M**3                        **

                                                                                                   NETWORK
GROUP ID                      AVERAGE CONC                RECEPTOR  (XR, YR, ZELEV, ZFLAG)   OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL       1ST HIGHEST VALUE IS      0.00969 AT (      80.00,     -155.00,      0.00,      1.60)  DC      NA
          2ND HIGHEST VALUE IS      0.00140 AT (     615.00,      244.00,      0.00,      1.60)  DC      NA
          3RD HIGHEST VALUE IS      0.00000 AT (       0.00,        0.00,      0.00,      0.00)
          4TH HIGHEST VALUE IS      0.00000 AT (       0.00,        0.00,      0.00,      0.00)
          5TH HIGHEST VALUE IS      0.00000 AT (       0.00,        0.00,      0.00,      0.00)
          6TH HIGHEST VALUE IS      0.00000 AT (       0.00,        0.00,      0.00,      0.00)

 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
                      BD = BOUNDARY
```

```
*** ISCST3 - VERSION 96113 ***   *** LEHR Particulate deposition model                                    ***      04/18/97
                                 *** Emission rate based on Cowherd. Filled met/precip data for 1995.     ***      00:06:27
                                                                                                                   PAGE  15
**MODELOPTs: CONC    DEPOS            RURAL  FLAT    FLGPOL DFAULT                                        DRYDPL WETDPL

                                 *** THE SUMMARY OF MAXIMUM PERIOD ( 8760 HRS) RESULTS ***

                              ** DEPO OF PM30      IN GRAMS/M**2                                  **

                                                                                            NETWORK
GROUP ID                          TOTAL DEPO          RECEPTOR  (XR, YR, ZELEV, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL      1ST HIGHEST VALUE IS       0.01119 AT (     80.00,      -155.00,       0.00,       1.60)  DC       NA
         2ND HIGHEST VALUE IS       0.00132 AT (    615.00,       244.00,       0.00,       1.60)  DC       NA
         3RD HIGHEST VALUE IS       0.00000 AT (      0.00,         0.00,       0.00,       0.00)
         4TH HIGHEST VALUE IS       0.00000 AT (      0.00,         0.00,       0.00,       0.00)
         5TH HIGHEST VALUE IS       0.00000 AT (      0.00,         0.00,       0.00,       0.00)
         6TH HIGHEST VALUE IS       0.00000 AT (      0.00,         0.00,       0.00,       0.00)

 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
                      BD = BOUNDARY
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 *** ISCST3 - VERSION 96113 ***     *** LEHR Particulate deposition model                                  ***        04/18/97
                                    *** Emission rate based on Cowherd. Filled met/precip data for 1995.   ***        00:06:27
                                                                                                                      PAGE  16
**MODELOPTs: CONC   DEPOS                RURAL  FLAT   FLGPOL DFAULT                                          DRYDPL WETDPL

*** Message Summary : ISCST3 Model Execution ***

 --------- Summary of Total Messages --------

A Total of            0 Fatal Error Message(s)
A Total of            0 Warning Message(s)
A Total of         3184 Informational Message(s)

A Total of         3184 Calm Hours Identified


   ******** FATAL ERROR MESSAGES ********
              ***  NONE  ***


   ********   WARNING MESSAGES   ********
              ***  NONE  ***


   ************************************
   *** ISCST3 Finishes Successfully ***
   ************************************
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ATTACHMENT E

STORM WATER RUNOFF MODELING, INCLUDING CALCULATION OF PUTAH CREEK SURFACE WATER/ONSITE SOIL CONCENTRATION RATIOS

STORM WATER RUNOFF MODELING, INCLUDING CALCULATION OF PUTAH CREEK SURFACE WATER/ONSITE SOIL CONCENTRATION RATIOS

To investigate the potential contribution of contaminants to Putah Creek from the Site, a series of calculations have been made for previously identified Contaminants of Concern (COCs). These values have been used to calculate the ratio between the exposure concentration in Putah Creek and the onsite soils concentration, for the ingestion while swimming and the dermal exposure while swimming pathways. Ultimately, in conjunction with a bioconcentration factor, this approach is used to determine the ratio between concentration in fish and onsite soils for the fish ingestion pathway. Procedures included acquiring precipitation data for the Davis area and site-specific soil data and storm water data, and calculating Putah Creek concentrations possibly contributed by Site. Also, the mass of lead potentially contributed by Site was calculated and results were compared with measured chemical data from Putah Creek.

1.1 Data Set Used

As part of the Ecological Scoping Assessment for the Site facility, a list of COCs in surface water was developed. These compounds have been chosen to determine potential Site impact to Putah Creek, and comprise the list of COCs in Putah Creek (Table E-1).

The Site storm runoff flow for DOE Areas of the Site has been determined from precipitation data collected during 1994 and 1995 at the Davis 2 WSW Experimental Farm Station (Earthinfo, Inc, 1995, 1996). Preliminary Putah Creek flow data have been obtained for the Old Davis Road Station (adjacent to the Site) from the Solano County Water Agency (1996). These data are limited to monthly flow data from March to December 1994, and March to September and November to December 1995 (Table E-2).

Hourly precipitation records from the Davis WSW Experimental Farm Station were reviewed. Storm events were defined as a series of nearly consecutive hourly records above zero inches of precipitation. If more than two consecutive hours passed without rainfall, the storm event was considered to be over. If rainfall did not occur in one hourly period, but continued in the next hourly period, the rainfall was considered part of the previous storm event. Storm event duration was identified in a period to the nearest hour. Thirty-nine storm events with an average precipitation of 0.34 inches were identified for 1994 and 65 storm events with an average precipitation of 0.43 inches were identified for 1995 (Table E-3).

Drainage from DOE areas at the Site generally flows to the southwest to a lift station shown as LS-1 on Figure E-1, through a drainage channel and then to Putah Creek. However, it has generally been observed that rainwater falling on the western dog pens area generally infiltrates, evaporates, or flows to the southwest corner of the Site where it ponds and infiltrates or evaporates. It has also been observed that a small area in the northwest portion of the DOE Areas of the Site drains to the northwest corner of the site, where it ponds and infiltrates or evaporates. Based on these drainage observations, the remaining area, consisting of part of OU-1, OU-2 and the area surrounding OU2, has been considered the area that drains to the southwestern lift station labeled LS-1, subsequently flowing to Putah Creek. This area has been determined to be 4.1 acres (175,000 square ft) and is depicted in Figure E-1. Note that this includes paved areas and buildings that contribute runoff.

1.2 Identification of Contaminant Transport Pathways and Determination of an Appropriate Dilution Factor

In order to calculate the potential impact of COCs from the Site to Putah Creek, the contaminant transport pathway must be identified. Contaminants found in surface soil (<3 ft deep) may potentially have been incorporated into storm water runoff from the Site. This runoff flows to a lift station along the western edge of the Site, through a drainage channel, and into Putah Creek. The identified pathway for COCs to travel from Site to Putah Creek is simplified to a transfer from soil to storm water and from storm water to creek water. Because analytic data from storm water runoff at the Site is available, a relationship between storm water runoff concentrations and the potential Site contribution to creek water concentrations has been established. This relationship is based on:

$$F_s \times C_s = F_c \times C_c$$

Where:

Fs = storm water runoff flow

Cs = storm water runoff concentration

Fc = Putah Creek flow

Cc = Putah Creek concentration

This equation can be expressed as:

$$C_c = [\frac{C_s}{D}]$$

where D = Fc/Fs is the dilution factor. The dilution factor describes the amount of dilution of a contaminant that occurs as the contaminant is transferred from Site surface water to Putah Creek. As the value of D is decreased, the Putah Creek concentration contributed by Site increases. Therefore, a case with minimum dilution represents the conservative case, resulting in higher Putah Creek concentrations.

Monthly average Putah Creek flow values from 1994 to 1995 have been calculated using available data. In addition, yearly average Putah Creek flow values have been calculated for 1994, 1995, and the two year period including 1994 and 1995 using available data (Table E-2). Storm water runoff flow values were calculated using the method outlined in US EPA (1988) for each storm event delineated during 1994 and 1995 (Table E-3). The storm water runoff volume, V_r, (acre-ft) was calculated as follows:

$$V_r = a \times A \times Q_r$$

Where:

a = conversion constant of 0.083,

A = drainage area (acres), and

Q_r = depth of runoff (inches).

The depth of runoff is determined from:

$$Q_r = \frac{(R_t - 0.2 \times S_w)^2}{(R_t + 0.8 \times S_w)}$$

Where:

R_t = total storm rainfall (inches), and

S_w = water retention factor (inches).

The water retention factor is determined from:

$$S_w = \left(1000/CN\right) - 10$$

Where:

CN = the Soil Conservation Service Runoff Curve Number of 86 (from Table 2-6 of US EPA, 1988).

Lastly, for each storm event delineated in 1994 and 1995, the storm water runoff flow, F_s, was calculated by dividing the storm runoff volume, V_r, (cubic ft) by the duration of the storm event, T, (seconds).

For each storm event in 1994 and 1995 that occurred during a month for which Putah Creek Flow data from the Old Davis Road Station were available, the dilution factor was calculated as shown above. Minimum, maximum, and average dilution factors were determined for 1994, 1995, and the two year period (Table E-4) from available data.

1.3 Calculations of Putah Creek Concentration Contributed by Site

For identified COCs, the following concentrations were determined from the Site analytic data set (Tables E-5 and E-6). The maximum and average of surface soil (<3 ft below ground surface) concentrations detected above the detection limit (mg/kg) from samples taken in OU1 and OU2 at the Site were determined. The maximum and average of storm water concentrations (mg/L) detected above the detection limit from samples taken from site storm water drainage were determined. Lastly, the maximum and average Putah Creek concentrations (mg/L) detected above the detection limit from samples taken from Putah Creek upstream and downstream of the Site were determined.

The maximum and average Putah Creek concentrations potentially contributed by DOE Areas at the site, C_{pc}, were calculated as:

$$C_{pc} = C_{st}/D$$

Where:

C_{st} = measured Site storm water concentration

D = dilution factor (calculated in Section 1.2 of this Attachment).

To determine the maximum values of C_{pc}, the maximum value of C_{st} was divided by the minimum value of D. To determine the average values of C_{pc}, the average values of C_{st} and D were used in the calculation. The maximum and average values for C_{pc} were then divided by the measured maximum and average values of surface soil concentrations detected above the detection limit from samples taken in OU1 and OU2 at the Site. This ratio of Putah Creek surface water concentration to DOE Area soil concentration was then used in the exposure and risk calculations.

1.4 Calculation of DOE Area Contribution of Lead in Terms of Mass Loading

To estimate the contribution of lead to Putah Creek, a series of calculations were performed to describe the potential impact in terms of mass loading. The average Putah Creek flow values were used in conjunction with the average Site storm water runoff flow values for 1994, 1995, and the two year period from 1994 to 1995. The maximum and average Putah Creek concentrations (mg/L) of lead detected above the detection limit from samples taken from Putah Creek upstream and downstream of the Site were determined.

The mass loading of lead in Putah Creek water, M_{pc}, is calculated as:

$$M_{pc} = 28.3 \times F_c^{ave} \times C_{pc}^{lead}$$

Where:

F_c = Putah Creek average flow (cubic ft/year)

C_{pc} = Putah Creek lead concentration (mg/L). The unit conversion factor is 28.3.

The mass loading in Site storm water, M_{sw}, is calculated as:

$$M_{sw} = 28.3 \times F_s^{ave} \times C_s^{lead}$$

Where: F_s = Site storm water runoff flow

C_s = LS-1 storm water lead concentration. The unit conversion factor is 28.3.

The potential contribution of lead to the creek from the Site was determined by calculating the ratio between the mass loading in Site storm water, M_{sw}, and the mass loading in Putah Creek water, M_{pc}. This value was multiplied by 100 to be expressed as the percent of lead potentially contributed by Site in Putah Creek by mass. By using average mass loading values, the potential contribution of lead from the Site is estimated as 0.099% for average 1994 flow conditions, and 0.089% for the average 1995 flow conditions, and 0.093% for the average flow conditions for these two years combined (Table E-7).

1.5 References

Earthinfo, Inc. (1996), Earthinfo CD2 Reference Manual for all Earthinfo CD-ROM Databases, Earthinfo, Inc., Boulder, Colorado.

Earthinfo, Inc. (1995), Database Guide for Earthinfo CD2 NCDC Hourly and Fifteen Minute Precipitation, Earthinfo, Inc., Boulder, Colorado.

Solano County Water Agency (1996), Preliminary Lower Putah Creek Flow Monitoring Results for 1994-1995 for the Old Davis Road Station, FAX dated April 5, 1996.

United States, Environmental Protection Agency (1988), Superfund Exposure Assessment Manual, Office of Remedial Response, EPA/540/1-88/001, Oswer Directive 9285.5-1, April.

Weiss Associates (1997), Ecological Scoping Assessment, for the US Department of Energy Areas at the Former Laboratory for Energy-Related Health Research (Site), University of California at Davis, CA.

Table E-1. COCs for Surface Water Pathway

Chemicals	Radionuclides
Acetone	Americium-241
Alpha Chlordane	Bismuth-212
Bis(2-Ethylhexyl)phthalate	Bismuth-214
Chromium	Carbon-14
Chromium, Hexavalent (+6)	Cesium-137
Copper	Cobalt-60
Delta BHC	Lead-210
Di-n-Butylphthalate	Plutonium-241
Formaldehyde	Radium-223
Gamma Chlordane	Radium-226
Lead	Strontium-90
Manganese	Thorium-234
Mercury	Tritium
Zinc	Uranium-235

Table E-2. Putah Creek Flow Data for the Old Davis Road Station (Solano County Water Agency, 1996).

Month	1994 (cubic ft/second)	1995 (cubic ft/second)	1994-1995 Average (cubic ft/second)
January	NA	NA	NC
February	NA	NA	NC
March	4.88	19.70	12.29
April	10.51	45.07	27.79
May	8.10	62.33	35.22
June	3.36	25.65	14.51
July	4.54	21.40	12.97
August	4.25	16.09	10.17
September	4.52	8.93	6.73
October	3.82	NA	NC
November	8.19	19.03	13.61
December	10.71	20.78	15.75
Average for Year(s)[a]	6.29	26.55	15.89

NA = Data Not Available
NC = Not Calculated
[a]Average for 1994 and 1995 are determined from available monthly data from each year. Average for the two year period from 1994 and 1995 is determined from available monthly data from the two years.

Table E-3. Storm Event and Storm Runoff Flow Records from the Davis 2 WSW Experimental Farm Station for 1994 and 1995

Total Storm Rainfall Rt (inches)	Storm Duration T (hours)	Storm Water Runoff Volume Vr (acre-ft)	Storm Water Runoff Flow Vr/T (cubic ft/second)	Date of Storm (M/D/Y)
1994 STORMS				
0.06	3	0.017	0.07	1/5/94
0.73	10	0.027	0.03	1/23/94
0.55	6	0.009	0.02	1/24/94
0.67	14	0.020	0.02	1/25/94
0.30	4	0.000	0.00	2/6/94
1.15	18	0.094	0.06	2/6/94
0.12	5	0.010	0.02	2/8/94
0.03	3	0.022	0.09	2/11/94
0.40	4	0.001	0.00	2/17/94
0.02	1	0.024	0.29	2/17/94
0.05	3	0.019	0.08	2/18/94
0.71	13	0.025	0.02	2/19/94
0.25	4	0.001	0.00	2/26/94
0.03	4	0.022	0.07	2/26/94
0.05	2	0.019	0.11	2/27/94
0.10	4	0.012	0.04	4/8/94
0.04	4	0.021	0.06	4/9/94
0.28	4	0.000	0.00	4/25/94
0.02	1	0.024	0.29	4/26/94
0.93	22	0.055	0.03	5/6/94
0.20	1	0.004	0.04	5/17/94
0.04	3	0.021	0.08	5/19/94
0.53	15	0.008	0.01	10/4/94
0.07	4	0.016	0.05	10/5/94
2.05	27	0.299	0.13	11/5/94
0.37	10	0.000	0.00	11/9/94
0.57	11	0.011	0.01	11/15/94
0.34	6	0.000	0.00	11/24/94
0.07	1	0.016	0.19	11/26/94
0.05	2	0.019	0.11	12/2/94
0.28	6	0.000	0.00	12/3/94
0.44	10	0.003	0.00	12/3/94
0.46	6	0.003	0.01	12/4/94
0.04	1	0.021	0.25	12/5/94
0.03	3	0.022	0.09	12/6/94
0.04	2	0.021	0.12	12/11/94

Table E-3. Storm Event and Storm Runoff Flow Records from the Davis 2 WSW Experimental Farm Station for 1994 and 1995

Total Storm Rainfall Rt (inches)	Storm Duration T (hours)	Storm Water Runoff Volume Vr (acre-ft)	Storm Water Runoff Flow Vr/T (cubic ft/second)	Date of Storm (M/D/Y)
0.49	16	0.005	0.00	12/11/94
0.54	14	0.008	0.01	12/14/94
0.09	2	0.013	0.08	12/24/94
1995 STORMS				
0.05	1	0.019	0.23	1/1/95
0.74	7	0.028	0.05	1/3/95
0.05	1	0.019	0.23	1/3/95
1.42	18	0.148	0.10	1/4/95
0.31	13	0.000	0.00	1/6/95
0.09	3	0.013	0.05	1/7/95
0.11	8	0.011	0.02	1/7/95
1.94	26	0.271	0.13	1/8/95
2.34	8	0.376	0.57	1/9/95
0.39	7	0.001	0.00	1/10/95
0.24	5	0.002	0.00	1/10/95
0.10	4	0.012	0.04	1/12/95
0.32	16	0.000	0.00	1/12/95
0.54	11	0.008	0.01	1/13/95
0.08	2	0.015	0.09	1/14/95
0.04	3	0.021	0.08	1/16/95
0.24	5	0.002	0.00	1/20/95
0.27	4	0.001	0.00	1/24/95
0.02	1	0.024	0.29	1/25/95
0.05	1	0.019	0.23	1/25/95
1.25	32	0.113	0.04	1/26/95
0.13	4	0.009	0.03	1/28/95
0.52	11	0.007	0.01	1/30/95
0.09	3	0.013	0.05	2/8/95
0.90	11	0.051	0.06	3/2/95
0.08	7	0.015	0.03	3/5/95
1.85	28	0.249	0.11	3/8/95
1.00	15	0.067	0.05	3/10/95
0.66	11	0.019	0.02	3/11/95
0.07	3	0.016	0.06	3/13/95
0.17	5	0.006	0.01	3/14/95
0.13	5	0.009	0.02	3/18/95
0.39	5	0.001	0.00	3/20/95

Table E-3. Storm Event and Storm Runoff Flow Records from the Davis 2 WSW Experimental Farm Station for 1994 and 1995

Total Storm Rainfall	Storm Duration	Storm Water Runoff Volume	Storm Water Runoff Flow	Date of Storm
Rt	T	Vr	Vr/T	
(inches)	(hours)	(acre-ft)	(cubic ft/second)	(M/D/Y)
0.09	10	0.013	0.02	3/21/95
2.00	20	0.287	0.17	3/22/95
0.07	5	0.016	0.04	3/23/95
0.28	5	0.000	0.00	3/23/95
0.14	5	0.008	0.02	4/7/95
0.05	12	0.019	0.02	4/8/95
0.10	4	0.012	0.04	4/13/95
0.17	13	0.006	0.01	4/15/95
0.05	1	0.019	0.23	4/20/95
0.06	1	0.017	0.21	4/28/95
0.04	1	0.021	0.25	4/28/95
0.05	4	0.019	0.06	4/29/95
0.04	1	0.021	0.25	4/29/95
0.21	6	0.003	0.01	4/30/95
0.02	3	0.024	0.10	5/4/95
0.60	4	0.013	0.04	5/5/95
0.04	2	0.021	0.12	5/9/95
0.41	9	0.001	0.00	5/13/95
0.18	5	0.005	0.01	6/14/95
0.11	2	0.011	0.07	6/15/95
0.35	9	0.000	0.00	6/16/95
0.02	1	0.024	0.29	11/1/95
0.10	1	0.012	0.15	12/7/95
5.24	34	1.246	0.44	12/11/95
0.06	3	0.017	0.07	12/13/95
0.28	3	0.000	0.00	12/13/95
0.34	3	0.000	0.00	12/15/95
0.02	2	0.024	0.14	12/19/95
0.04	1	0.021	0.25	12/22/95
0.03	2	0.022	0.13	12/23/95
0.30	9	0.000	0.00	12/29/95
0.02	1	0.024	0.29	12/30/95

Table E-4. Maximum, Minimum, and Average Dilution Factors for 1994, 1995, and the two year period 1994-1995

	Dilution Factors		
Time Period	Maximum	Minimum	Average
	(unitless)	(unitless)	(unitless)
1994 Data	95,060	36.5	137
1995 Data	156,650	46.9	277
1994-1995 Data	156,650	36.5	201

Table E-5. Possible Site Impact of Non-Radionuclides to Putah Creek Surface Water

Contaminant of Concern	OU1/OU2 Surface Soil Concentration		SWL-1/SWL-2 Storm Water Concentration		Dilution Factor		Putah Creek Conc. PCU/PCD Only		Putah Creek Conc. Contributed by DOE Areas		Putah Creek Conc. From DOE Areas Surface Soil Conc.	
	MAX	AVERAGE	MAX	AVERAGE	MIN	AVERAGE	MAX	AVERAGE	MAX	AVERAGE	MAX	AVERAGE
	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)	(unitless)	(unitless)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)/(mg/kg)	(mg/L)/(mg/kg)
Acetone	6.00E-03	4.30E-03	1.70E-02	1.10E-02	3.65E+01	1.37E+02	2.00E-02	9.30E-03	4.66E-04	8.05E-05	7.76E-02	1.87E-02
Alpha Chlordane	8.00E-01	1.48E-01	1.50E-05	1.50E-05	3.65E+01	1.37E+02	<1.00E-05	<1.00E-05	4.11E-07	1.10E-07	5.14E-07	7.42E-07
Bis(2-Ethylhexyl)phthalate	1.00E-01	6.60E-02	1.00E-03	8.00E-04	3.65E+01	1.37E+02	2.10E-02	6.30E-03	2.74E-05	5.86E-06	2.74E-04	8.87E-05
Chlordane	8.00E-01	1.48E-01	1.50E-05	1.50E-05	3.65E+01	1.37E+02	<1.00E-05	<1.00E-05	4.11E-07	1.10E-07	5.14E-07	7.42E-07
Chromium	2.30E+02	1.41E+02	7.20E-03	3.80E-03	3.65E+01	1.37E+02	8.00E-02	1.20E-02	1.97E-04	2.78E-05	8.58E-07	1.97E-07
Chromium, Hexavalent (+6)	2.20E-01	2.20E-01	1.00E-02	6.00E-03	3.65E+01	1.37E+02	4.30E-02	1.70E-02	2.74E-04	4.39E-05	1.25E-03	2.00E-04
Copper	2.40E+01	1.80E+01	9.80E-03	5.00E-03	3.65E+01	1.37E+02	5.00E-02	8.00E-03	2.69E-04	3.66E-05	1.12E-05	2.03E-06
Delta BHC	<1.70E-03	<1.70E-03	<1.00E-05	<1.00E-05	3.65E+01	1.37E+02	5.50E-05	2.80E-05	2.74E-07	7.32E-08	1.61E-04	4.31E-05
Di-n-Butylphthalate	<3.30E-01	<3.30E-01	<1.00E-02	<1.00E-02	3.65E+01	1.37E+02	1.30E-01	3.40E-02	2.74E-04	7.32E-05	8.30E-04	2.22E-04
Formaldehyde	1.60E+00	1.60E+00	<1.00E+00	<1.00E+00	3.65E+01	1.37E+02	<1.00E+00	<1.00E+00	2.74E-02	7.32E-03	1.71E-02	4.58E-03
Gamma Chlordane	7.40E-01	1.40E-01	1.30E-05	1.30E-05	3.65E+01	1.37E+02	<1.00E-05	<1.00E-05	3.56E-07	9.52E-08	4.81E-07	6.80E-07
Lead	2.10E+01	8.60E+00	3.84E-02	2.05E-02	3.65E+01	1.37E+02	1.00E-02	4.20E-03	1.05E-03	1.50E-04	5.01E-05	1.74E-05
Mercury	5.70E-01	3.10E-01	<2.00E-04	<2.00E-04	3.65E+01	1.37E+02	9.00E-04	5.00E-04	5.48E-06	1.46E-06	9.61E-06	4.72E-06
Manganese	8.80E+02	5.83E+02	1.92E-02	1.85E-02	3.65E+01	1.37E+02	1.32E-02	7.30E-03	5.26E-04	1.35E-04	5.98E-07	2.32E-07
Zinc	1.30E+02	6.89E+01	1.12E-01	8.43E-02	3.65E+01	1.37E+02	1.19E+00	3.90E-02	3.07E-03	6.17E-04	2.36E-05	8.96E-06

The following Contract Reporting Detection Limits were used because the particular analyte was reported as not detected in the samples:
Detection limit of 0.00001 mg/L used for Putah Creek Concentrations of chlordane, alpha chlordane, and gamma chlordane.
Detection limit of 0.0017 mg/kg used for surface soil concentration of delta BHC.
Detection limit of 0.00001 mg/L used for storm water concentration of delta BHC.
Detection limit of 0.33 mg/kg used for surface soil concentration of di-n-Butylphthalate.
Detection limit of 0.01 mg/L used for storm water concentration of di-n-Butylphthalate.
Detection limit of 1 mg/L used for formaldehyde storm water and Putah Creek concentrations.
Detection limit of 0.0002 mg/L used for storm water concentration of mercury.

Calculations:
Dilution Factor = creek flow/storm runoff flow
Putah Creek Concentration Contributed by Site = storm water concentration/dilution factor

Table E-6. Possible Site Impact of Radionuclides to Putah Creek Surface Water

	OU1/OU2 Surface Soil Concentration		SWL-1/SWL-2 Storm Water Concentration		Dilution Factor		Putah Creek Conc. PCU/PCD Only		Putah Creek Conc. Contributed by DOE Areas		Putah Creek Conc. From DOE Areas Surface Soil Conc.	
Contaminant of Concern	MAX	AVERAGE	MAX	AVERAGE	MIN	AVERAGE	MAX	AVERAGE	MAX	AVERAGE	MAX	AVERAGE
	(pCi/g)	(pCi/g)	(pCi/L)	(pCi/L)	(unitless)	(unitless)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)/(pCi/g)	(pCi/L)/(pCi/g)
Americium-241	2.40E-02	1.70E-02	3.30E-02	1.70E-02	3.65E+01	1.37E+02	5.10E-02	1.90E-02	9.04E-04	1.24E-04	3.77E-02	7.32E-03
Bismuth-212	4.70E-01	2.20E-01	3.30E+01	1.20E+01	3.65E+01	1.37E+02	1.40E+01	-1.33E+01	9.04E-01	8.78E-02	1.92E+00	3.99E-01
Bismuth-214	5.90E-01	3.90E-01	4.00E+00	-1.48E+00	3.65E+01	1.37E+02	3.30E+01	8.40E+00	1.10E-01	-1.08E-02	1.86E-01	-2.78E-02
Carbon-14	3.90E+00	-7.70E-01	3.20E+01	-7.75E+00	3.65E+01	1.37E+02	1.22E+02	9.30E+00	8.77E-01	-5.67E-02	2.25E-01	7.37E-02
Cesium-137	2.30E+01	1.60E+00	4.10E+00	-1.25E-01	3.65E+01	1.37E+02	2.80E+00	-1.60E-01	1.12E-01	-9.15E-04	4.88E-03	-5.72E-04
Cobalt-60	2.10E-02	1.00E-03	2.70E+00	-7.60E-01	3.65E+01	1.37E+02	7.00E+00	4.80E-03	7.40E-02	-5.56E-03	3.52E+00	-5.56E+00
Lead-210	5.40E+00	6.86E-01	1.00E+02	5.30E+01	3.65E+01	1.37E+02	1.90E+02	-2.92E+00	2.74E+00	3.88E-01	5.07E-01	5.66E-01
Plutonium-241	1.50E+00	2.60E-01	1.00E+00	-2.60E-01	3.65E+01	1.37E+02	7.20E+00	4.90E-01	2.74E-02	-1.90E-03	1.83E-02	-7.32E-03
Radium-223	4.70E-01	6.30E-02	NA	NA	3.65E+01	1.37E+02	3.30E+01	3.30E+00	NC	NC	NC	NC
Radium-226	1.73E+00	5.90E-01	9.00E+01	-7.80E+00	3.65E+01	1.37E+02	1.00E+01	-4.04E+01	2.47E+00	-5.71E-02	1.43E+00	-9.68E-02
Strontium-90	2.03E+01	2.73E+00	2.40E-01	-1.90E-02	3.65E+01	1.37E+02	6.90E+00	5.20E-01	6.58E-03	-1.39E-04	3.24E-04	-5.09E-05
Thorium-234	9.40E-01	5.10E-01	3.60E+01	6.20E+00	3.65E+01	1.37E+02	3.30E+02	-5.60E+00	9.86E-01	4.54E-02	1.05E+00	8.90E-02
Tritium	9.11E+01	4.42E+01	1.50E+02	0.00E+00	3.65E+01	1.37E+02	2.03E+03	1.92E+02	4.11E+00	0.00E+00	4.51E-02	0.00E+00
Uranium-235	1.20E-01	-4.90E-03	1.40E+01	-1.39E+00	3.65E+01	1.37E+02	4.00E+01	-1.50E+00	3.84E-01	-1.02E-02	3.20E+00	2.08E+00

NA = Not Analyzed
NC = Not Calculated
Calculations:
Dilution Factor = creek flow/storm runoff flow
Putah Creek Concentration Contributed by Site = storm water concentration/dilution factor

Table E-7. Mass Loading for Lead in Surface Water

Time	Putah Creek Average Flow	DOE Areas Storm Runoff Flow	Putah Creek Lead Concentration		DOE Areas Stormwater Lead Concentration		Mass Loading Putah Creek		Mass Loading DOE Areas Stormwater		Calculated DOE Areas Lead Contribution	
			MAX	AVE	MAX	AVE	MAX	AVE	MAX	AVE	MAX	AVE
	(ft^3/yr)	(ft^3/yr)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/yr)	(mg/yr)	(mg/yr)	(mg/yr)	(%)	(%)
1994 Average	1.965E+08	3.978E+04	1.00E-02	4.20E-03	3.84E-02	2.05E-02	5.56E+07	2.34E+07	4.33E+04	2.31E+04	0.078%	0.099%
1995 Average	8.373E+08	1.520E+05	1.00E-02	4.20E-03	3.84E-02	2.05E-02	2.37E+08	9.96E+07	1.65E+05	8.83E+04	0.070%	0.089%
1994-1995 Average	5.011E+08	9.591E+04	1.00E-02	4.20E-03	3.84E-02	2.05E-02	1.42E+08	5.96E+07	1.04E+05	5.57E+04	0.073%	0.093%

LOCATION MAP
STORM WATER RUNOFF MONITORING POINTS
Revised Field Sampling Plan
LEHR/SCDS Environmental Restoration
Davis, California
FIGURE 16

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ATTACHMENT F

VADOSE ZONE AND GROUND WATER MODELING

VADOSE ZONE AND GROUND WATER MODELING

In order to relate concentrations of COCs in groundwater to their concentrations in DOE OU soils, one-dimensional vadose zone modeling was conducted for chemical and radiological constituents using the USNT module of the Nonisothermal Unsaturated-Saturated Flow and Transport (NUFT) model (Nitao, 1996) and RESRAD Version 5.62, respectively. To relate offsite concentrations of COCs in ground water at the Scenario 2 location to the COC concentrations in onsite DOE OU soil, two-dimensional saturated zone solute transport modeling has been conducted using the model Solute 3.01 (Colorado School of Mines, 1995). The ground water modeling for this investigation is summarized below.

F.1 Chemical-Specific Input Parameter Determination

All modeling parameters that are not compound-specific were based on previous NUFT vadose zone modeling for the Site (Weiss Associates, 1997). Based on a statistical analysis and comparison of Site soil concentrations with background and RME values, 16 radiological compounds and 70 non-radiological compounds were determined to be COCs at the Site.

F.1.1 Chemical constituents

The soil/water partitioning coefficient, K_d, was calculated or estimated for each of the chemical compounds (Tables F-1 and F-2). The method of determining K_d varied depending on the type of constituent. For metals, a conservative estimate (lower value) of K_d was chosen from values presented in Thibault *et al.* (1990). Values for metals not addressed in this reference were conservatively estimated from values presented in Baes *et al.* (1984). K_d values for radiological compounds were default values from the program RESRAD version 5.62. K_d values for organic compounds were calculated from the product of the organic carbon partitioning coefficient, K_{oc}, and the fraction of organic carbon, f_{oc}. The value chosen for f_{oc} was 0.02 (State of California EPA, 1994). K_{oc} values, when not available from literature, were calculated using the method of Strenge *et al.* (1989). This method is consistent with previous NUFT vadose zone modeling at the Site (Weiss Associates, 1997) and is based on the equation

$$\text{Log } K_{oc} = 1.0 \text{ Log } K_{ow} - 0.21$$

where K_{ow} is the octanol/water partitioning coefficient. The most conservative (lowest) K_{ow} value was selected for each chemical compound from published values (Baes *et al.*, 1984; Fetter, 1993;

decrease with shorter arrival times. Therefore, the lithology of the Southwest Trenches Area was chosen for the conservative basecase scenarios.

In all model simulations, the initial concentration in soil was applied at 100 mg/kg for chemical compound. Model runs were completed using using a 10 cm/yr infiltration rate. The Vadose zone modeling report (WA 1997) analysis indicated that a 3 cm infiltration rate is likely a better site specific value, however the 10 cm value was selected for use here as conservative.

Model simulations for the risk evaluation have been run with the initial concentration applied uniformly from 0 to 15 ft bgs. In general, the vertical contaminant distribution at the Site is limited to the upper 6 ft of soil, however, there are a small number of exceptions where contaminants are reported to be as deep as 15 ft bgs (Weiss Associates, 1997). Therefore, model results used to calculate the soil/water concentration ratios are very conservatively relative to actual Site conditions.

For organic compounds, volatilization of organics was taken into consideration with the use of the Henry's constant for each compound.

The results of this analysis were used to estimate the ratio between onsite ground water concentrations to onsite DOE OU soil concentrations, and are shown in Tables F-1 and F-3. The vadose zone model estimates the maximum concentration in ground water beneath the site, which typically coincides with the arrival time. The arrival time for many compounds is on the order of many thousands of years. To help assess the uncertainties associated with conservatively assuming a worst case concentration is present over the near term exposure period evaluated in this analysis, the tables also show the results at 1000 years.

F.2.2 Radionuclides

The vadose zone fate and transport analysis is built into the RESRAD model. Details of the modeling approach are included in the RESRAD Guidance manual (ANL, 1993) and will not be repeated here. As described above, RESRAD defaults were used for radionuclide specific half-lives and K_d values. Site-specific input values for infiltration, contamination zone thickness, etc. were matched to those used in the chemical constituent modeling. Attachment J includes a complete listing of these input parameters.

Table F-2 provides the results of the RESRAD vadose zone modeling, in a format similar to that for the chemical constituents (the ratio of the onsite ground water concentration to the onsite DOE OU soil concentration). For Scenario 2, RESRAD assumed that the ground water pathway was complete for all of the radionuclide COCs. For those COCs that have no results shown in Table F-2, RESRAD vadose zone modeling predicted that no breakthrough of the contaminants to the ground water table would occur within the 1000 year modeling horizon; in other words, the maximum ground water concentration predicted for the other radionuclides was zero. Physically, this result likely indicates that the compounds remain sorbed in the vadose zone, or move slowly enough through it based on their Kds, that they degrade based on their half-lives before they impact ground

F.3 Saturated Zone Solute Transport Modeling

The solute transport model, Solute 3.01, was used to approximate the amount of dilution and degradation that will occur as Site COCs travel with ground water to the location of an offsite receptor. By coupling the results of the ground water transport to the vadose zone transport, the ratio between the offsite (Scenario 2) ground water concentration and the onsite soil concentration can be estimated for use in the action standard calculations. The results of the ground water modeling along are used in the analysis to adjust the RESRAD-generated Scenario 2 results for onsite to offsite transport, as described in Attachment J.

Based on estimated aquifer properties of HSU-1 beneath the Site, the following input parameters were developed for the saturated zone solute transport modeling. The porosity was estimated to be 0.30, and the longitudinal and lateral dispersivity values were estimated to be 10 meters and 1 meter, respectively.

Solute determined a maximum initial concentration of 54,400 mg/L based on a source strength of 1 kg/day for 30,000,000 days. A single, continuous point source has been defined and the retardation factor has been assigned a value of 50, regardless of the compound considered. By running the Solute simulation, a ground water concentration of 10,400 mg/L was determined to exist in ground water 370 meters from the Site in the direction of ground water flow (to the northeast). This is the Scenario 2 receptor location By dividing the offsite ground water concentration by the initial ground water concentration, a unitless factor of 0.19 was determined. This factor was applied to the ground water/soil concentration ratios determined in the unsaturated zone flow and transport modeling to calculate the offsite ground water/Site soil concentration ratio.

F.4 Water/Soil Concentration Ratio

For all modeled compounds, a maximum concentration of the constituent in ground water (at 30 ft bgs) and the time (in years) for which the maximum concentration will occur was estimated (Table F-1 through F-3) using the NUFT model or the RESRAD model (for radionuclides). The initial concentration of the constituent in ground water (in pCi/L for radionuclides and ug/L for non-radionuclides) was divided by the concentration of the constituent in soil (in pCi/g for radionuclides and mg/kg for non-radionuclides) to determine the water/soil concentration ratio beneath the Site. These values were multiplied by the saturated zone dilution coefficient of 0.19 to calculate the offsite ground water/Site soil concentration ratio for a receptor located 370 meters offsite. For metals and radionuclides, the calculated ratios were then applied to all constituents within the same range of K_d values (Tables F-1 and F-2). The Site and offsite water soil concentration ratios, as well as arrival times for each organic compound are presented in Table F-3.

If the peak ground water concentration at the water table was found to occur after 1,000 years, the concentration of each compound in ground water at 1,000 years was determined for comparison purposes. The Site water/soil concentration ratio was then calculated from the concentration data. These values were multiplied by the saturated zone dilution coefficient of 0.19 to calculate the offsite ground water/Site soil concentration ratio for a receptor located 370 meters

If the peak ground water concentration at the water table was found to occur after 1,000 years, the concentration of each compound in ground water at 1,000 years was determined for comparison purposes. The Site water/soil concentration ratio was then calculated from the concentration data. These values were multiplied by the saturated zone dilution coefficient of 0.19 to calculate the offsite ground water/Site soil concentration ratio for a receptor located 370 meters offsite (Tables F-1 through F-3). These ratios, based on the 1000 yr ground water concentrations, are significantly less than the calculated ratios associated with the peak ground water concentrations.

F.5 References

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Table F-1. Vadose Zone Modeling Results for Metals.

Chemical of Concern	Partitioning Coefficient[a] K_d (ml/g)	Partitioning Coefficient Used in Model (ml/g)	Water/Soil Concentration Ratio[b] Initial Concentration 0-15 ft: Beneath LEHR (ug/L)/(mg/kg)	Water/Soil Concentration Ratio[b] Initial Concentration 0-15 ft: 370 meters Offsite (ug/L)/(mg/kg)	Arrival Time when the Initial Concentration Applied from 0 to 15 ft (y)	Water/Soil Concentration Ratio[b] after 1,000 years Initial Concentration 0-15 ft: Beneath LEHR (ug/L)/(mg/kg)	Water/Soil Concentration Ratio[b] after 1,000 years Initial Concentration 0-15 ft: 370 meters Offsite (ug/L)/(mg/kg)
Chromium, Hexavalent (Cr+6)	1.00E+01	1.00E+01	7.56E+01	1.44E+01	1,270	6.57E+01	1.25E+01
Mercury (Hg)	1.00E+01	1.00E+01	7.56E+01	1.44E+01	1,270	6.57E+01	1.25E+01
Molybdenum (Mo)	1.00E+01	1.00E+01	7.56E+01	1.44E+01	1,270	6.57E+01	1.25E+01
Chromium (Cr)	3.00E+01	1.00E+01	7.56E+01	1.44E+01	1,270	6.57E+01	1.25E+01
Copper (Cu)	3.50E+01	1.00E+01	7.56E+01	1.44E+01	1,270	6.57E+01	1.25E+01
Cadmium (Cd)	4.00E+01	1.00E+01	7.56E+01	1.44E+01	1,270	6.57E+01	1.25E+01
Antimony (Sb)	4.50E+01	1.00E+01	7.56E+01	1.44E+01	1,270	6.57E+01	1.25E+01
Manganese (Mn)	5.00E+01	1.00E+01	7.56E+01	1.44E+01	1,270	6.57E+01	1.25E+01
Barium (Ba)	6.00E+01	1.00E+01	7.56E+01	1.44E+01	1,270	6.57E+01	1.25E+01
Cobalt (Co)	6.00E+01	1.00E+01	7.56E+01	1.44E+01	1,270	6.57E+01	1.25E+01
Silver (Ag)	9.00E+01	1.00E+01	7.56E+01	1.44E+01	1,270	6.57E+01	1.25E+01
Selenium (Se)	1.50E+02	1.50E+02	4.96E+00	9.42E-01	18,700	1.03E-06	1.96E-07
Iron (Fe)	1.65E+02	1.50E+02	4.96E+00	9.42E-01	18,700	1.03E-06	1.96E-07
Arsenic (As)	2.00E+02	1.50E+02	4.96E+00	9.42E-01	18,700	1.03E-06	1.96E-07
Zinc (Zn)	2.00E+02	1.50E+02	4.96E+00	9.42E-01	18,700	1.03E-06	1.96E-07
Beryllium (Be)	2.50E+02	1.50E+02	4.96E+00	9.42E-01	18,700	1.03E-06	1.96E-07
Lead (Pb)	2.70E+02	1.50E+02	4.96E+00	9.42E-01	18,700	1.03E-06	1.96E-07
Nickel (Ni)	3.00E+02	1.50E+02	4.96E+00	9.42E-01	18,700	1.03E-06	1.96E-07
Vanadium (V)	1.00E+03	1.00E+03	7.54E-01	1.43E-01	124,000	1.84E-16	3.50E-17
Thallium (Tl)	1.50E+03	1.00E+03	7.54E-01	1.43E-01	124,000	1.84E-16	3.50E-17

Modeling methodology follows that in the Draft Final One-Dimensional Vadose Zone Modeling Study (Weiss Associates, 1997).

[a]Sources of Kd values include Baes *et al.*, 1984; Thibault *et al.*, 1990; Weiss Associates, 1997.

[b]Assumes homogeneous contamination at a hypothetical soil concentration of 100 mg/kg from 0 to a depth of 15 ft with an infiltration rate of 10 cm/yr.

Table F-2. Vadose Zone Modeling Results for Radionuclides

Radionuclide of Concern	Half-Life[a]	Partitioning Coefficient[b]	Water/Soil Concentration Ratio[c] Initial Concentration 0-15 ft		Arrival Time when the Initial Concentration Applied from 0 to 15 ft
		K_d	Beneath LEHR	370 meters Offsite	
	(y)	(L/kg)	(pCi/L)/(pCi/g)	(pCi/L)/(pCi/g)	(y)
Tritium	1.23E+01	RESRAD Defaults	6.23E+00	1.18E+00	17
Uranium-235	7.04E+08	RESRAD Defaults	5.42E+02	1.03E+02	75
Thorium-234	6.60E-02	RESRAD Defaults	1.01E+01	1.92E+00	1,000
Plutonium-241	1.44E+01	RESRAD Defaults	2.25E+01	4.28E+00	730
Americium-241	4.33E+02	RESRAD Defaults	7.88E+02	1.50E+02	670

[a]Half-Life values from Walker *et al.* (1989).

[b]Partitioning coefficient values from Thibault *et al.* (1990).

[c]Assumes homogeneous contamination at a hypothetical soil concentration of 100 mg/kg from 0 to a depth of 15 ft with an infiltration rate = 10 cm/yr

Table F-3. Vadose Zone Modeling Results for Organics.

Chemical of Concern	Henry's Constant[a] H	Partitioning Coefficient[b] K_d	Water/Soil Concentration Ratio[c] Initial Concentration 0-15 ft		Arrival Time when the Initial Concentration Applied from 0 to 15 ft	Water/Soil Concentration Ratio[c] after 1,000 years Initial Concentration 0-15 ft	
			Beneath Site	370 meters Offsite		Beneath LEHR	370 meters Offsite
	(atm-m^3/mol)	(ml/g)	(ug/L)/(mg/kg)	(ug/L)/(mg/kg)	(y)	(ug/L)/(mg/kg)	(ug/L)/(mg/kg)
Acetone	2.1E-05	7.19E-03	3.3E+03	6.3E+02	25	N/A	N/A
2-Butanone (MEK)	2.7E-05	2.42E-02	2.9E+03	5.5E+02	27	N/A	N/A
Formaldehyde	1.7E-07	2.78E-02	5.0E+03	9.5E+02	29	N/A	N/A
Methylene Chloride	2.6E-03	5.30E-02	3.5E+02	6.7E+01	25	N/A	N/A
2-Hexanone	1.1E-05	2.98E-01	1.6E+03	3.1E+02	60	N/A	N/A
Benzene	5.5E-03	3.90E-01	1.7E+02	3.2E+01	51	N/A	N/A
Carbon Tetrachloride	2.4E-02	6.60E-01	4.5E+01	8.6E+00	63	N/A	N/A
Ethyl Benzene	7.9E-03	1.30E+00	9.8E+01	1.9E+01	124	N/A	N/A
Xylenes (Total)	5.3E-03	1.40E+00	1.2E+02	2.3E+01	140	N/A	N/A
Toluene	6.6E-03	1.50E+00	1.0E+02	1.9E+01	140	N/A	N/A
Styrene	2.3E-03	2.20E+00	1.2E+02	2.3E+01	210	N/A	N/A
Diethyl Phthalate	2.0E-08	3.66E+00	2.0E+02	3.9E+01	500	N/A	N/A
Heptachlor Epoxide	4.4E-04	6.32E+00	6.8E+01	1.3E+01	620	N/A	N/A
Naphthalene	1.3E-03	7.70E+00	4.5E+01	8.5E+00	710	N/A	N/A
Acenaphthene	1.2E-03	2.80E+01	7.9E+00	1.5E+00	2,602	1.4E+00	2.7E-01
Carbazole	2.8E-04	4.01E+01	6.5E+00	1.2E+00	4,003	1.6E-01	3.0E-02
Endosulfan I	1.0E-05	4.46E+01	1.2E+01	2.2E+00	5,003	9.7E-02	1.8E-02
Endosulfan Sulfate	1.0E-05	4.46E+01	1.3E+01	2.5E+00	5,384	8.0E-02	1.5E-02
Fluorene	7.7E-05	4.70E+01	7.4E+00	1.4E+00	4,803	9.0E-02	1.7E-02
Dibenzofuran	1.3E-05	4.70E+01	1.2E+01	2.3E+00	5,504	5.8E-02	1.1E-02
Gamma-BHC	7.8E-06	6.45E+01	8.5E+00	1.6E+00	8,005	1.2E-02	2.2E-03
Anthracene	3.4E-05	7.60E+01	6.0E+00	1.1E+00	8,606	3.1E-03	6.0E-04
2-Methylnaphthalene	2.9E-04	8.93E+01	3.0E+00	5.7E-01	8,906	7.9E-04	1.5E-04
Alpha-BHC	2.1E-07	9.80E+01	7.0E+00	1.3E+00	12,008	4.4E-04	8.3E-05
Delta-BHC	2.1E-07	1.61E+02	3.8E+00	7.3E-01	22,015	3.2E-06	6.0E-07
Di-n-Butylphthalate	2.8E-07	1.67E+02	4.1E+00	7.7E-01	21,860	1.2E-06	2.2E-07
Heptachlor	2.9E-03	2.31E+02	4.4E-01	8.4E-02	19,013	1.0E-07	2.0E-08
Methoxychlor	2.5E-08	2.48E+02	2.7E+00	5.1E-01	32,022	4.8E-08	9.1E-09

Table F-3. Vadose Zone Modeling Results for Organics.

Chemical of Concern	Henry's Constant[a] H	Partitioning Coefficient[b] K_d	Water/Soil Concentration Ratio[c] Initial Concentration 0-15 ft		Arrival Time when the Initial Concentration Applied from 0 to 15 ft	Water/Soil Concentration Ratio[c] after 1,000 years Initial Concentration 0-15 ft	
			Beneath Site	370 meters Offsite		Beneath LEHR	370 meters Offsite
	(atm-m^3/mol)	(ml/g)	(ug/L)/(mg/kg)	(ug/L)/(mg/kg)	(y)	(ug/L)/(mg/kg)	(ug/L)/(mg/kg)
Dieldrin	4.6E-07	4.46E+02	1.4E+00	2.6E-01	61,042	9.9E-13	1.9E-13
Phenanthrene	1.6E-04	4.59E+02	6.2E-01	1.2E-01	49,034	4.5E-11	8.5E-12
Pyrene	1.0E-05	7.40E+02	8.3E-01	1.6E-01	87,060	3.3E-15	6.3E-16
Fluoranthene	1.0E-05	1.10E+03	4.7E-01	8.9E-02	145,099	5.6E-16	1.1E-16
Chrysene	1.1E-06	1.20E+03	5.7E-01	1.1E-01	150,103	1.6E-16	3.0E-17
Bis(2-Ethylhexyl)phthalate	4.4E-07	1.60E+03	3.3E-01	6.3E-02	246,169	4.6E-18	8.8E-19
Alpha-Chlordane	1.9E-03	3.72E+03	2.5E-01	4.7E-02	50,000	2.0E-16	3.7E-17
Chlordane	1.9E-03	3.72E+03	2.5E-01	4.7E-02	50,000	2.0E-16	3.7E-17
Gamma-Chlordane	1.9E-03	3.72E+03	2.5E-01	4.7E-02	50,000	2.0E-16	3.7E-17
Benzo(a)anthracene	1.2E-06	5.67E+03	9.7E-02	1.8E-02	900,616	9.9E-27	1.9E-27
4,4'-DDE	6.8E-05	6.07E+03	6.0E-02	1.1E-02	600,411	1.4E-26	2.7E-27
4,4'-DDD	8.0E-06	7.81E+03	7.4E-02	1.4E-02	900,616	2.0E-27	3.9E-28
Pentachlorophenol	2.8E-06	8.93E+03	6.2E-02	1.2E-02	1,240,849	9.8E-30	1.9E-30
Benzo(k)fluoranthene	3.9E-05	1.49E+04	3.3E-02	6.2E-03	1,501,027	2.3E-31	4.4E-32
Benzo(g,h,i)perylene	1.2E-05	1.49E+04	3.8E-02	7.3E-03	1,781,219	2.9E-31	5.5E-32
Benzo(a)pyrene	1.5E-06	1.56E+04	3.6E-02	6.8E-03	2,001,370	3.5E-33	6.6E-34
Benzo(b)fluoranthene	1.2E-05	1.61E+04	2.5E-02	4.8E-03	2,001,370	1.2E-32	2.2E-33
4,4'-DDT	5.1E-04	1.92E+04	1.3E-02	2.5E-03	1,701,164	5.1E-34	9.7E-35
Indeno(1,2,3-cd)pyrene	6.9E-08	4.71E+04	1.2E-02	2.2E-03	6,004,110	4.1E-40	7.8E-41
Dibenzo(a,h)anthracene	2.6E-09	8.56E+04	7.8E-03	1.5E-03	11,007,534	7.1E-44	1.3E-44
Arochlor-1260	1.7E-04	1.74E+05	1.7E-03	3.2E-04	18,312,535	8.0E-46	1.5E-46
Di-n-Octylphthalate	5.5E-06	9.18E+07	6.6E-06	1.3E-06	11,007,534,247	2.8E-86	5.4E-87

Modeling methodology follows that in the Draft Final One-Dimensional Vadose Zone Modeling Study (Weiss Associates, 1997).
[a]Sources of H values include EPA (1996), US DOE (1996), and Windholz (1983).
[b]Sources of Kd values include Baes *et al.*, 1984; Thibault *et al.*, 1990; Weiss Associates, 1997.
[c]Assumes homogeneous contamination at a hypothetical soil concentration of 100 mg/kg from 0 to a depth of 15 ft with an infiltration rate of 10 cm/yr.
Volitalization based on Henry's Constant.

ATTACHMENT G

BIOLOGICAL MEDIA UPTAKE SUPPORT CALCULATIONS

BIOLOGICAL MEDIA UPTAKE SUPPORT CALCULATIONS

1.1 Approach

Biological transfer calculations were used in this assessment to estimate the concentration of COCs that may transport from impacted LEHR site soil to food. The four food groups evaluated were: 1) fruits and vegetables, 2) meat, 3) milk and 4) fish. These food media were evaluated in residential farming scenarios 2 and 3. The equations used to calculate concentrations in each of these media were taken from CalTOX, A Multimedia Total Exposure Model for Hazardous Waste Sites (CalEPA, 1993). COCs were assumed to transport offsite to the scenario 2 and 3 locations by wind blown fugitive dust re-suspension and deposition. The calculation of wind blown particle transport is discussed in Attachment D. Offsite vegetation is assumed to uptake COCs from soil that has been impaccted by contaminated particles and air that contains contaminated particles. Offsite beef (meat producing) and dairy (milk producing) cattle are assumed to uptake COCs from offsite soil, air and vegetation that has been impacted by contaminated particles. COCs are assumed to transport to fish from impacted LEHR site soil to surface water run-off that flows to Putah Creek. The calculation of COC concentrations in Putah Creek contributed by LEHR site soil is discussed in Attachment E.

The concentration of organic COCs in fruit and vegetable media, C_{veg}, was calculated using the expression:

$$C_{veg} = C_{ap} * K_{pa}^{pt} + C_{ss} * K_{ps}$$

Where C_{ap} is the COC concentration in outdoor air, $K^{pt}/_{pa}$ is the plant-air partition coefficient for particle bound contamination, C_{ss} is the COC concentration in surface soil at the exposure location and K_{ps} is the plant-soil partition coefficient. The value used for $K^{pt}/_{pa}$ was 3300 m^3/kg(fresh mass) (McKone and Ryan, 1989) and the value used for K_{ps} was calculated from the expression K_{ps} (kg/kg fresh mass) = $7.7K_{ow}^{-0.58}$, (Travis and Arms, 1988). The sources of octanol/water partition coefficients are from Baes et al., 1984; Thibault et al., 1990; Weiss Associates, 1997.

The concentration of inorganic COCs in fruit and vegetable media was calculated using the expression:

$$C_{veg} = C_{ap} * K_{pa}^{pt} + C_{ss} * K_{ps} * bio_{\dim}$$

This expression is identical to the expression for organic chemicals in fruit and vegetables except bio_{dim}, the ratio of plant dry mass to fresh mass, is used to convert K_{ps} to a fresh mass basis.

The values of K_{ps} for inorganic chemicals were obtained from Baes et al., (1984) and bio_{dim} (0.2 kg dry mass/kg fresh mass) was obtained from CalEPA (1993).

Beef cattle were selected as the agricultural animal for calculating chemical concentrations in meat. The expression used for the beef media calculation was:

$$C_{beef} = C_{ap} * \left(Inh_c + K_{pa}^{pt} * Ivbc\right) * Bt + C_{ss} * \left(Isc + K_{ps} * bio_{dim} * Ivbc\right) * Bt$$

Where Inh_c is the daily inhalation rate for beef cattle, Ivbc is the ingestion rate of fresh pasture by beef cattle, Bt is the biotransfer factor for beef cattle and Isc is the ingestion rate of surface soil by beef cattle. Values for Inhc, Ivbc and Isc were obtained from McCone and Ryan (1989). Bt values for organic compounds were calculated from the expression Bt (d/kg) = $Kow*10^{-7.6}$ (Travis and Arms, 1988) and Bt values for inorganic compounds were obtained from Ng et al. (1982) and Baes et al, (1984). Values for C_{ap}, K_{pa}^{pt}, C_{ss}, K_{ps} and bio_{dim} were the same as those used to calculate chemical concentrations in fruit and vegetables.

The expression used to calculate chemical concentrations in milk was:

$$C_{milk} = C_{ap} * \left(Inh_c + K_{pa}^{pt} * Ivdc\right) * Bk + C_{ss} * \left(Isc + K_{ps} * bio_{dim} * Ivdc\right) * Bk$$

Where Ivdc and Bk are the ingestion rate of pasture by dairy cattle and the biotransfer factor for dairy cattle, respectively. All other parameters are the same as those used in the beef media calculation. Bk values for organic compounds were calculated from the expression Bk (d/kg) = $Kow*10^{-8.1}$ (Travis and Arms, 1988) and Bt values for inorganic compounds were obtained from Baes et al., (1984). The value for Ivdc (85 Kg fresh mass/day) was obtained from McCone and Ryan (1989).

The chemical concentration in fish was calculated from the expression:

$$C_{fish} = C_{sw} * Bcf$$

Where C_{sw} is the concentration of COCs in surface water and Bcf is the bioconcentration factor for fish. Bcf values for organic chemicals were calculated from the expression reported in Veith et al. 1980:

$$Bcf = K_{ow}^{0.76} * 10^{-0.23}$$

Bcf values for inorganic chemicals were obtained from the Aquatic Toxicity Information Retrieval Database.

Calculations of COC concentration and biological media/onsite soil concentration ratios for fruit/vegetable, meat, milk and fish are presented in spreadsheet form for scenarios 2 and 3 in the calculations section of this attachment.

1.2 References

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Table G-1. Scenario 2. Vegetable and Fruit Media Calculation.

Organic Chemical	Kow (organics) a	Log Kow (organics)	Csoil mg/kg	Cap mg/m3	Css mg/kg	Kpapt m3/kg(fm) b	Kps kg/kg(fm) c	Cveg mg/kg(fm) d	Cveg/Csoil [mg/kg(fm)]/[mg/kg(soil)]
Carcinogens									
4,4'-DDD	6.30E+05	5.80	100	5.800E-11	7.88E-06	3300	3.33E-03	2.18E-07	2.18E-09
4,4'-DDE	4.90E+05	5.69	100	5.800E-11	7.88E-06	3300	3.86E-03	2.22E-07	2.22E-09
4,4'-DDT	1.55E+06	6.19	100	5.800E-11	7.88E-06	3300	1.98E-03	2.07E-07	2.07E-09
Alpha-BHC	7.90E+03	3.90	100	5.800E-11	7.88E-06	3300	4.23E-02	5.24E-07	5.24E-09
Alpha-Chlordane	3.00E+05	5.48	100	5.800E-11	7.88E-06	3300	5.13E-03	2.32E-07	2.32E-09
Arochlor-1260	1.40E+07	7.15	100	5.800E-11	7.88E-06	3300	5.52E-04	1.96E-07	1.96E-09
Benzene	1.30E+02	2.11	100	0.000E+00	0.00E+00	3300	4.58E-01	0.00E+00	0.00E+00
Benzo(a)anthracene	4.57E+05	5.66	100	5.800E-11	7.88E-06	3300	4.02E-03	2.23E-07	2.23E-09
Benzo(a)pyrene	1.26E+06	6.10	100	5.800E-11	7.88E-06	3300	2.23E-03	2.09E-07	2.09E-09
Benzo(b)fluoranthene	1.30E+06	6.11	100	5.800E-11	7.88E-06	3300	2.19E-03	2.09E-07	2.09E-09
Benzo(k)fluoranthene	1.20E+06	6.08	100	5.800E-11	7.88E-06	3300	2.29E-03	2.09E-07	2.09E-09
Bis(2-Ethylhexyl)phthalate	1.29E+05	5.11	100	5.800E-11	7.88E-06	3300	8.37E-03	2.57E-07	2.57E-09
Carbazole	3.24E+03	3.51	100	5.800E-11	7.88E-06	3300	7.09E-02	7.50E-07	7.50E-09
Carbon Tetrachloride	6.76E+02	2.83	100	0.000E+00	0.00E+00	3300	1.76E-01	0.00E+00	0.00E+00
Chlordane	3.00E+05	5.48	100	5.800E-11	7.88E-06	3300	5.13E-03	2.32E-07	2.32E-09
Chrysene	4.57E+05	5.66	100	5.800E-11	7.88E-06	3300	4.02E-03	2.23E-07	2.23E-09
Delta-BHC	1.30E+04	4.11	100	5.800E-11	7.88E-06	3300	3.17E-02	4.41E-07	4.41E-09
Dibenzo(a,h)anthracene	6.90E+06	6.84	100	5.800E-11	7.88E-06	3300	8.32E-04	1.98E-07	1.98E-09
Dieldrin	3.60E+04	4.56	100	5.800E-11	7.88E-06	3300	1.75E-02	3.30E-07	3.30E-09
Formaldehyde	2.24E+00	0.35	100	0.000E+00	0.00E+00	3300	4.82E+00	0.00E+00	0.00E+00
Gamma-BHC	5.20E+03	3.72	100	5.800E-11	7.88E-06	3300	5.39E-02	6.16E-07	6.16E-09
Gamma-Chlordane	3.00E+05	5.48	100	5.800E-11	7.88E-06	3300	5.13E-03	2.32E-07	2.32E-09
Heptachlor	1.86E+04	4.27	100	5.800E-11	7.88E-06	3300	2.57E-02	3.94E-07	3.94E-09
Heptachlor Epoxide	5.10E+02	2.71	100	5.800E-11	7.88E-06	3300	2.07E-01	1.82E-06	1.82E-08
Indeno(1,2,3-cd)pyrene	3.80E+06	6.58	100	5.800E-11	7.88E-06	3300	1.18E-03	2.01E-07	2.01E-09
Methylene Chloride	1.78E+01	1.25	100	0.000E+00	0.00E+00	3300	1.45E+00	0.00E+00	0.00E+00
Pentachlorophenol	7.20E+05	5.86	100	5.800E-11	7.88E-06	3300	3.08E-03	2.16E-07	2.16E-09

Table G-1. Scenario 2. Vegetable and Fruit Media Calculation.

Organic Chemical	Kow (organics) a	Log Kow (organics)	Csoil mg/kg	Cap mg/m3	Css mg/Kg	Kpapt m3/Kg(fm) b	Kps Kg/Kg(fm) c	Cveg mg/Kg(fm) d	Cveg/Csoil [mg/kg(fm)]/[mg/kg(soil)]
Non-Carcinogens									
2-Butanone (MEK)	1.95E+00	0.29	100	0.000E+00	0.00E+00	3300	5.23E+00	0.00E+00	0.00E+00
Acenaphthene	1.00E+04	4.00	100	5.800E-11	7.88E-06	3300	3.69E-02	4.82E-07	4.82E-09
Acetone	5.80E-01	-0.24	100	0.000E+00	0.00E+00	3300	1.06E+01	0.00E+00	0.00E+00
Anthracene	2.80E+04	4.45	100	5.800E-11	7.88E-06	3300	2.03E-02	3.51E-07	3.51E-09
Benzo(g,h,i)perylene	1.20E+06	6.08	100	5.8E-11	7.88E-06	3300	2.29E-03	2.09E-07	2.09E-09
Dibenzofuran	3.79E+03	3.58	100	5.800E-11	7.88E-06	3300	6.47E-02	7.01E-07	7.01E-09
Diethyl Phthalate	2.95E+02	2.47	100	5.800E-11	7.88E-06	3300	2.84E-01	2.43E-06	2.43E-08
Di-n-Butylphthalate	1.35E+04	4.13	100	5.800E-11	7.88E-06	3300	3.10E-02	4.36E-07	4.36E-09
Di-n-Octylphthalate	7.40E+09	9.87	100	5.800E-11	7.88E-06	3300	1.45E-05	1.92E-07	1.92E-09
Endosulfan I	3.60E+03	3.56	100	5.800E-11	7.88E-06	3300	6.67E-02	7.17E-07	7.17E-09
Endosulfan Sulfate	3.60E+03	3.56	100	5.800E-11	7.88E-06	3300	6.67E-02	7.17E-07	7.17E-09
Ethyl Benzene	1.35E+03	3.13	100	0.000E+00	0.00E+00	3300	1.18E-01	0.00E+00	0.00E+00
Fluoranthene	8.90E+04	4.95	100	5.800E-11	7.88E-06	3300	1.04E-02	2.73E-07	2.73E-09
Fluorene	1.60E+04	4.20	100	5.800E-11	7.88E-06	3300	2.81E-02	4.13E-07	4.13E-09
Formaldehyde	2.24E+00	0.35	100	0.000E+00	0.00E+00	3300	4.82E+00	0.00E+00	0.00E+00
Methoxychlor	2.00E+04	4.30	100	5.800E-11	7.88E-06	3300	2.47E-02	3.86E-07	3.86E-09
Naphthalene	2.00E+03	3.30	100	5.800E-11	7.88E-06	3300	9.39E-02	9.31E-07	9.31E-09
Phenanthrene	3.70E+04	4.57	100	5.8E-11	7.88E-06	3300	1.73E-02	3.27E-07	3.27E-09
Pyrene	2.09E+05	5.32	100	5.800E-11	7.88E-06	3300	6.32E-03	2.41E-07	2.41E-09
Styrene	8.90E+02	2.95	100	0.000E+00	0.00E+00	3300	1.50E-01	0.00E+00	0.00E+00
Toluene	4.47E+02	2.65	100	0.000E+00	0.00E+00	3300	2.24E-01	0.00E+00	0.00E+00
Xylenes (Total)	1.80E+03	3.26	100	0.000E+00	0.00E+00	3300	9.96E-02	0.00E+00	0.00E+00
Compounds With no Toxicity Parameters									
2-Hexanone	2.40E+01	1.38	100	0	0.00E+00	3300	1.22E+00	0.00E+00	0.00E+00
2-Methylnaphthalene	7.20E+03	3.86	100	5.8E-11	7.88E-06	3300	4.46E-02	5.43E-07	5.43E-09

Table G-1. Scenario 2. Vegetable and Fruit Media Calculation.

Inorganic Chemical	Csoil mg/kg	Cap mg/m3	Css mg/Kg	Kpapt m3/Kg(fm)	Kps Kg/Kg(dm) e	biodim Kg(dm)/Kg(fm) f	Cveg mg/Kg(fm) g	Cveg/Csoil [mg/kg(fm)]/ [mg/kg(soil)]
Carcinogens								
Cadmium (Cd)	100	5.8E-11	7.88E-06	3300	0.55	0.2	8.67E-07	8.67E-09
Chromium	100	5.8E-11	7.88E-06	3300	0.0075	0.2	1.20E-08	1.20E-10
Chromium, Hexavalent (+6)	100	5.8E-11	7.88E-06	3300	0.0075	0.2	1.20E-08	1.20E-10
Lead	100	5.8E-11	0.00000788	3300	0.045	0.2	7.11E-08	7.11E-10
Mercury (Hg)	100	5.8E-11	7.88E-06	3300	0.9	0.2	1.42E-06	1.42E-08
Non-Carcinogens								
Antimony (Sb)	100	5.8E-11	0.00000788	3300	0.2	0.2	3.15E-07	3.15E-09
Barium (Ba)	100	5.8E-11	0.00000788	3300	0.15	0.2	2.37E-07	2.37E-09
Cadmium (Cd)	100	5.8E-11	0.00000788	3300	0.55	0.2	8.67E-07	8.67E-09
Chromium (Cr)	100	5.8E-11	0.00000788	3300	0.0075	0.2	1.20E-08	1.20E-10
Chromium, Hexavalent (Cr+6)	100	5.8E-11	0.00000788	3300	0.0075	0.2	1.20E-08	1.20E-10
Copper	100	5.8E-11	0.00000788	3300	0.4	0.2	6.31E-07	6.31E-09
Manganese	100	5.8E-11	0.00000788	3300	0.25	0.2	3.94E-07	3.94E-09
Mercury (Hg)	100	5.8E-11	0.00000788	3300	0.9	0.2	1.42E-06	1.42E-08
Selenium (Se)	100	5.8E-11	0.00000788	3300	0.025	0.2	3.96E-08	3.96E-10
Silver (Ag)	100	5.8E-11	0.00000788	3300	0.4	0.2	6.31E-07	6.31E-09
Zinc (Zn)	100	5.8E-11	0.00000788	3300	1.5	0.2	2.36E-06	2.36E-08

notes:

Kow = Octanol/Water partition coefficient.
Cap = COC concentration in particulate phase of ambient outdoor air at exposure location from chemical deposition calculation (ug/m3) or (pCi/m3).
Css = COC concentration in surface soil at exposure location from chemical deposition calculation (mg/kg) or (pCi/kg).
Kpapt = Plant-air partition coefficient for particle bound contamination (m3-air / kg-plant fresh mass).
Kps = Plant-soil partition coefficient ((mg/kg-plant fresh mass)/(mg/kg-soil)) = (kg-soil/kg-plant fresh mass).
biodim = Ratio of vegetable/fruit dry mass to fresh mass (kg-dry mass)/(kg-fresh mass).
Cveg = COC concentration in vegetable/fruit media (mg/kg-fresh mass) or (pCi/kg-fresh mass).

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.
b = Value from McKone and Ryan, 1989.
c = Organic compounds: Kps (Kg/Kgfm) = 7.7 Kow-0.58 Travis and Arms, 1988.
d = Calculation for organic compounds: Cveg = Cap x Kpapt + Css x Kps. Cal EPA, 1993.
e = Values from Baes et al., 1984.
f = Value from Cal EPA, 1993.
g = Calculation for inorganic compounds and radionuclides: Cveg = Cap x Kpapt + Css x Kps x biodim. Cal EPA, 1993.

Table G-2. Scenario 2. Beef Calculation.

Organic Chemical	Kow a	Log Kow	Bt (organics) d/kg b	Cap mg/m3	Css mg/kg	Inhc m3/d c	Kpapt m3/kg c	Ivbc kg(fm)/d c	Isc kg/d c	Kps kg/kg d	Cbeef mg/kg e	Csoil,onsite mg/kg	Cbeef/Csoil,onsite (mg/kg)/(mg/kg)
Carcinogens													
4,4'-DDD	6.30E+05	5.80E+00	1.58E-02	5.8E-11	7.88E-06	122	3300	60	0.4	0.00333329	2.55E-07	100	2.55E-09
4,4'-DDE	4.90E+05	5.69E+00	1.22E-02	5.8E-11	7.88E-06	122	3300	60	0.4	0.00385736	2.02E-07	100	2.02E-09
4,4'-DDT	1.55E+06	6.19E+00	3.87E-02	5.8E-11	7.88E-06	122	3300	60	0.4	0.00197829	6.03E-07	100	6.03E-09
Alpha-BHC	7.90E+03	3.90E+00	1.98E-04	5.8E-11	7.88E-06	122	3300	60	0.4	0.04225392	6.84E-09	100	6.84E-11
Alpha-Chlordane	3.00E+05	5.48E+00	7.50E-03	5.8E-11	7.88E-06	122	3300	60	0.4	0.00512579	1.28E-07	100	1.28E-09
Arochlor-1260	1.40E+07	7.15E+00	3.50E-01	5.8E-11	7.88E-06	122	3300	60	0.4	0.00055174	5.22E-06	100	5.22E-08
Benzene	1.30E+02	2.11E+00	3.25E-06	0	0	122	3300	60	0.4	0.45751315	0.00E+00	100	0.00E+00
Benzo(a)anthracene	4.57E+05	5.66E+00	1.14E-02	5.8E-11	7.88E-06	122	3300	60	0.4	0.00401505	1.89E-07	100	1.89E-09
Benzo(a)pyrene	1.26E+06	6.10E+00	3.15E-02	5.8E-11	7.88E-06	122	3300	60	0.4	0.00223095	4.94E-07	100	4.94E-09
Benzo(b)fluoranthene	1.30E+06	6.11E+00	3.25E-02	5.8E-11	7.88E-06	122	3300	60	0.4	0.0021898	5.10E-07	100	5.10E-09
Benzo(k)fluoranthene	1.20E+06	6.08E+00	3.00E-02	5.8E-11	7.88E-06	122	3300	60	0.4	0.00229385	4.72E-07	100	4.72E-09
Bis(2-Ethylhexyl)phthalate	1.29E+05	5.11E+00	3.22E-03	5.8E-11	7.88E-06	122	3300	60	0.4	0.00836933	5.99E-08	100	5.99E-10
Carbazole	3.24E+03	3.51E+00	8.09E-05	5.8E-11	7.88E-06	122	3300	60	0.4	0.07090726	3.90E-09	100	3.90E-11
Carbon Tetrachloride	6.76E+02	2.83E+00	1.69E-05	0	0	122	3300	60	0.4	0.17582909	0.00E+00	100	0.00E+00
Chlordane	3.00E+05	5.48E+00	7.50E-03	5.8E-11	7.88E-06	122	3300	60	0.4	0.00512579	1.28E-07	100	1.28E-09
Chrysene	4.57E+05	5.66E+00	1.14E-02	5.8E-11	7.88E-06	122	3300	60	0.4	0.00401505	1.89E-07	100	1.89E-09
Delta-BHC	1.30E+04	4.11E+00	3.25E-04	5.8E-11	7.88E-06	122	3300	60	0.4	0.03165218	9.62E-09	100	9.62E-11
Dibenzo(a,h)anthracene	6.90E+06	6.84E+00	1.73E-01	5.8E-11	7.88E-06	122	3300	60	0.4	0.00083168	2.59E-06	100	2.59E-08
Dieldrin	3.60E+04	4.56E+00	9.00E-04	5.8E-11	7.88E-06	122	3300	60	0.4	0.01753215	2.06E-08	100	2.06E-10
Formaldehyde	2.24E+00	3.50E-01	5.60E-08	0	0	122	3300	60	0.4	4.82492676	0.00E+00	100	0.00E+00
Gamma-BHC	5.20E+03	3.72E+00	1.30E-04	5.8E-11	7.88E-06	122	3300	60	0.4	0.05385286	5.21E-09	100	5.21E-11
Gamma-Chlordane	3.00E+05	5.48E+00	7.50E-03	5.8E-11	7.88E-06	122	3300	60	0.4	0.00512579	1.28E-07	100	1.28E-09
Heptachlor	1.86E+04	4.27E+00	4.66E-04	5.8E-11	7.88E-06	122	3300	60	0.4	0.02569749	1.25E-08	100	1.25E-10
Heptachlor Epoxide	5.10E+02	2.71E+00	1.28E-05	5.8E-11	7.88E-06	122	3300	60	0.4	0.20706182	1.43E-09	100	1.43E-11
Indeno(1,2,3-cd)pyrene	3.80E+06	6.58E+00	9.50E-02	5.8E-11	7.88E-06	122	3300	60	0.4	0.00117548	1.44E-06	100	1.44E-08
Methylene Chloride	1.78E+01	1.25E+00	4.45E-07	0	0	122	3300	60	0.4	1.4504098	0.00E+00	100	0.00E+00
Pentachlorophenol	7.20E+05	5.86E+00	1.80E-02	5.8E-11	7.88E-06	122	3300	60	0.4	0.00308488	2.90E-07	100	2.90E-09

Table G-2. Scenario 2. Beef Calculation.

Organic Chemical	Kow a	Log Kow	Bt (organics) d/kg b	Cap mg/m3	Css mg/kg	Inhc m3/d c	Kpapt m3/kg c	Ivbc kg(fm)/d c	Isc kg/d c	Kps kg/kg d	Cbeef mg/kg e	Csoil,onsite mg/kg	Cbeef/Csoil,onsite (mg/kg)/(mg/kg)
Non-Carcinogens													
2-Butanone (MEK)	1.95E+00	2.90E-01	4.87E-08	0	0	122	3300	60	0.4	5.22746008	0.00E+00	100	0.00E+00
Acenaphthene	1.00E+04	4.00E+00	2.50E-04	5.8E-11	7.88E-06	122	3300	60	0.4	0.03685452	8.02E-09	100	8.02E-11
Acetone	5.80E-01	-2.37E-01	1.45E-08	0	0	122	3300	60	0.4	10.5609379	0.00E+00	100	0.00E+00
Anthracene	2.80E+04	4.45E+00	7.00E-04	5.8E-11	7.88E-06	122	3300	60	0.4	0.02028332	1.70E-08	100	1.70E-10
Benzo(g,h,i)perylene	1.20E+06	6.08E+00	3.00E-02	5.8E-11	7.88E-06	122	3300	60	0.4	0.00229385	4.72E-07	100	4.72E-09
Dibenzofuran	3.79E+03	3.58E+00	9.48E-05	5.8E-11	7.88E-06	122	3300	60	0.4	0.06469638	4.29E-09	100	4.29E-11
Diethyl Phthalate	2.95E+02	2.47E+00	7.38E-06	5.8E-11	7.88E-06	122	3300	60	0.4	0.28437455	1.10E-09	100	1.10E-11
Di-n-Butylphthalate	1.35E+04	4.13E+00	3.37E-04	5.8E-11	7.88E-06	122	3300	60	0.4	0.03098066	9.88E-09	100	9.88E-11
Di-n-Octylphthalate	7.40E+09	9.87E+00	1.85E+02	5.8E-11	7.88E-06	122	3300	60	0.4	1.4532E-05	2.71E-03	100	2.71E-05
Endosulfan I	3.60E+03	3.56E+00	9.00E-05	5.8E-11	7.88E-06	122	3300	60	0.4	0.06665539	4.15E-09	100	4.15E-11
Endosulfan Sulfate	3.60E+03	3.56E+00	9.00E-05	5.8E-11	7.88E-06	122	3300	60	0.4	0.06665539	4.15E-09	100	4.15E-11
Ethyl Benzene	1.35E+03	3.13E+00	3.37E-05	0	0	122	3300	60	0.4	0.1177852	0.00E+00	100	0.00E+00
Fluoranthene	8.90E+04	4.95E+00	2.23E-03	5.8E-11	7.88E-06	122	3300	60	0.4	0.01037157	4.35E-08	100	4.35E-10
Fluorene	1.60E+04	4.20E+00	4.00E-04	5.8E-11	7.88E-06	122	3300	60	0.4	0.02806087	1.12E-08	100	1.12E-10
Formaldehyde	2.24E+00	3.50E-01	5.60E-08	0	0	122	3300	60	0.4	4.82492676	0.00E+00	100	0.00E+00
Methoxychlor	2.00E+04	4.30E+00	5.00E-04	5.8E-11	7.88E-06	122	3300	60	0.4	0.02465434	1.31E-08	100	1.31E-10
Naphthalene	2.00E+03	3.30E+00	4.99E-05	5.8E-11	7.88E-06	122	3300	60	0.4	0.0938622	2.94E-09	100	2.94E-11
Phenanthrene	3.70E+04	4.57E+00	9.25E-04	5.8E-11	7.88E-06	122	3300	60	0.4	0.01725575	2.11E-08	100	2.11E-10
Pyrene	2.09E+05	5.32E+00	5.23E-03	5.8E-11	7.88E-06	122	3300	60	0.4	0.00632129	9.21E-08	100	9.21E-10
Styrene	8.90E+02	2.95E+00	2.23E-05	0	0	122	3300	60	0.4	0.1499148	0.00E+00	100	0.00E+00
Toluene	4.47E+02	2.65E+00	1.12E-05	0	0	122	3300	60	0.4	0.22360974	0.00E+00	100	0.00E+00
Xylenes (Total)	1.80E+03	3.26E+00	4.50E-05	0	0	122	3300	60	0.4	0.09963976	0.00E+00	100	0.00E+00
Compounds With no Toxicity Parameters													
2-Hexanone	2.40E+01	1.38E+00	6.00E-07	5.8E-11	7.88E-06	122	3300	60	0.4	1.21890036	3.55E-10	100	3.55E-12
2-Methylnaphthalene	7.20E+03	3.86E+00	1.80E-04	5.8E-11	7.88E-06	122	3300	60	0.4	0.04459004	6.43E-09	100	6.43E-11

Table G-2. Scenario 2. Beef Calculation.

Inorganic Chemical	Bt (inorganics) d/kg f	Cap mg/m3	Css mg/kg	Inhc m3/d	Kpapt m3/kg	Ivbc kg(fm)/d	Isc kg/d	Kps kg/kg[dm] g	biodim kg(dm)/kg(fm) h	Cbeef mg/kg	Csoil,onsite mg/kg	Cbeef/Csoil,onsite (mg/kg)/(mg/kg)
Carcinogens												
Cadmium (Cd)	0.00035	5.8E-11	0.00000788	122	3300	60	0.4	0.55	0.2	2.3328E-08	100	2.33E-10
Chromium	0.0092	5.8E-11	0.00000788	122	3300	60	0.4	0.0075	0.2	1.4124E-07	100	1.41E-09
Chromium, Hexavalent (+6)	0.0092	5.8E-11	0.00000788	122	3300	60	0.4	0.0075	0.2	1.4124E-07	100	1.41E-09
Lead	0.0007	5.8E-11	0.00000788	122	3300	60	0.4	0.045	0.2	1.3229E-08	100	1.32E-10
Mercury (Hg)	0.027	5.8E-11	0.00000788	122	3300	60	0.4	0.9	0.2	2.6932E-06	100	2.69E-08
Non-Carcinogens												
Antimony (Sb)	0.001	5.8E-11	0.00000788	122	3300	60	0.4	0.2	0.2	3.3555E-08	100	3.36E-10
Barium (Ba)	0.000097	5.8E-11	0.00000788	122	3300	60	0.4	0.15	0.2	2.7962E-09	100	2.80E-11
Cadmium (Cd)	0.00035	5.8E-11	0.00000788	122	3300	60	0.4	0.55	0.2	2.3328E-08	100	2.33E-10
Chromium (Cr)	0.0092	5.8E-11	0.00000788	122	3300	60	0.4	0.0075	0.2	1.4124E-07	100	1.41E-09
Chromium, Hexavalent (Cr+6)	0.0092	5.8E-11	0.00000788	122	3300	60	0.4	0.0075	0.2	1.4124E-07	100	1.41E-09
Copper	0.013	5.8E-11	0.00000788	122	3300	60	0.4	0.4	0.2	6.8207E-07	100	6.82E-09
Manganese	0.0007	5.8E-11	0.00000788	122	3300	60	0.4	0.25	0.2	2.6798E-08	100	2.68E-10
Mercury (Hg)	0.027	5.8E-11	0.00000788	122	3300	60	0.4	0.9	0.2	2.6932E-06	100	2.69E-08
Selenium (Se)	0.015	5.8E-11	0.00000788	122	3300	60	0.4	0.025	0.2	2.5511E-07	100	2.55E-09
Silver (Ag)	0.003	5.8E-11	0.00000788	122	3300	60	0.4	0.4	0.2	1.574E-07	100	1.57E-09
Zinc (Zn)	0.2	5.8E-11	0.00000788	122	3300	60	0.4	1.5	0.2	3.1297E-05	100	3.13E-07

notes:

Kow = Octanol/water partition coefficient.
Bt = Biotransfer factor for beef cattle (d/kg).
Cap = COC concentration in particulate phase of ambient outdoor air at exposure location from chemical deposition calculation (ug/m3).
Css = COC concentration in surface soil at exposure location from chemical deposition calculation (mg/kg).
Inhc = Daily inhalation rate of cattle (m3/d)
Kpapt = Plant-air partition coefficient for particle-bound contamination (m3-air / kg-plant fresh mass).
Ivbc = Ingestion of pasture by beef cattle (kg-fresh mass/day).
Isc = Ingestion of soil by cattle (kg/day)
Kps = Plant-soil partition coefficient ((mg/kg-plant dry mass)/(mg/kg-soil)) = (kg-soil/kg-plant dry mass).
biodim = Ratio of vegetable/fruit dry mass to fresh mass (kg-dry mass)/(kg-fresh mass).
Cbeef = COC concentration in beef media (mg/kg)

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.
b = Log(Bt) = Log(Kow) - 7.6, Travis and Arms, 1988.
c = Value from McKone and Ryan, 1989.
d = Organic compounds: Kps = 7.7 Kow-0.58 (Travis and Arms, 1988).
e = Calculation: Cbeef = Cap x (Inhc + Kpapt x Ivbc) x Bt + Css x (Isc + Kps x biodim x Ivbc) x Bt. (Cal EPA, 1993).
f = Values from Ng et al., 1982. Except arsenic, beryllium, antimony, selenium, thallium and vanadium from Baes et al., 1984.
g = Values from Baes et al., 1984.
h = Value from Cal EPA, 1993.

Table G-3. Scenario 2. Milk Media Calculation.

Organic Chemical	Kow a	Log Kow	Bk d/kg b	Cap mg/m3	Css mg/kg	Inhc m3/d c	Kpapt m3/kg(fm) c	Ivdc kg(fm)/d c	Isc kg/d c	Kps kg/kg(fm) d	Cmilk mg/kg e	Csoil,onsite mg/kg	Cmilk/Csoil,onsite (mg/kg)/(mg/kg)
Carcinogens													
4,4'-DDD	6.30E+05	5.80E+00	5.00E-03	5.8E-11	7.88E-06	122	3300	85	0.4	3.33E-03	1.08E-07	100	1.08E-09
4,4'-DDE	4.90E+05	5.69E+00	3.89E-03	5.8E-11	7.88E-06	122	3300	85	0.4	3.86E-03	8.56E-08	100	8.56E-10
4,4'-DDT	1.55E+06	6.19E+00	1.23E-02	5.8E-11	7.88E-06	122	3300	85	0.4	1.98E-03	2.55E-07	100	2.55E-09
Alpha-BHC	7.90E+03	3.90E+00	6.28E-05	5.8E-11	7.88E-06	122	3300	85	0.4	4.23E-02	3.00E-09	100	3.00E-11
Alpha-Chlordane	3.00E+05	5.48E+00	2.38E-03	5.8E-11	7.88E-06	122	3300	85	0.4	5.13E-03	5.45E-08	100	5.45E-10
Arochlor-1260	1.40E+07	7.15E+00	1.11E-01	5.8E-11	7.88E-06	122	3300	85	0.4	5.52E-04	2.20E-06	100	2.20E-08
Benzene	1.30E+02	2.11E+00	1.03E-06	0	0	122	3300	85	0.4	4.58E-01	0.00E+00	100	0.00E+00
Benzo(a)anthracene	4.57E+05	5.66E+00	3.63E-03	5.8E-11	7.88E-06	122	3300	85	0.4	4.02E-03	8.03E-08	100	8.03E-10
Benzo(a)pyrene	1.26E+06	6.10E+00	1.00E-02	5.8E-11	7.88E-06	122	3300	85	0.4	2.23E-03	2.09E-07	100	2.09E-09
Benzo(b)fluoranthene	1.30E+06	6.11E+00	1.03E-02	5.8E-11	7.88E-06	122	3300	85	0.4	2.19E-03	2.16E-07	100	2.16E-09
Benzo(k)fluoranthene	1.20E+06	6.08E+00	9.53E-03	5.8E-11	7.88E-06	122	3300	85	0.4	2.29E-03	2.00E-07	100	2.00E-09
Bis(2-Ethylhexyl)phthalate	1.29E+05	5.11E+00	1.02E-03	5.8E-11	7.88E-06	122	3300	85	0.4	8.37E-03	2.56E-08	100	2.56E-10
Carbazole	3.24E+03	3.51E+00	2.57E-05	5.8E-11	7.88E-06	122	3300	85	0.4	7.09E-02	1.72E-09	100	1.72E-11
Carbon Tetrachloride	6.76E+02	2.83E+00	5.37E-06	0	0	122	3300	85	0.4	1.76E-01	0.00E+00	100	0.00E+00
Chlordane	3.00E+05	5.48E+00	2.38E-03	5.8E-11	7.88E-06	122	3300	85	0.4	5.13E-03	5.45E-08	100	5.45E-10
Chrysene	4.57E+05	5.66E+00	3.63E-03	5.8E-11	7.88E-06	122	3300	85	0.4	4.02E-03	8.03E-08	100	8.03E-10
Delta-BHC	1.30E+04	4.11E+00	1.03E-04	5.8E-11	7.88E-06	122	3300	85	0.4	3.17E-02	4.20E-09	100	4.20E-11
Dibenzo(a,h)anthracene	6.90E+06	6.84E+00	5.48E-02	5.8E-11	7.88E-06	122	3300	85	0.4	8.32E-04	1.10E-06	100	1.10E-08
Dieldrin	3.60E+04	4.56E+00	2.86E-04	5.8E-11	7.88E-06	122	3300	85	0.4	1.75E-02	8.91E-09	100	8.91E-11
Formaldehyde	2.24E+00	3.50E-01	1.78E-08	0	0	122	3300	85	0.4	4.82E+00	0.00E+00	100	0.00E+00
Gamma-BHC	5.20E+03	3.72E+00	4.13E-05	5.8E-11	7.88E-06	122	3300	85	0.4	5.39E-02	2.29E-09	100	2.29E-11
Gamma-Chlordane	3.00E+05	5.48E+00	2.38E-03	5.8E-11	7.88E-06	122	3300	85	0.4	5.13E-03	5.45E-08	100	5.45E-10
Heptachlor	1.86E+04	4.27E+00	1.48E-04	5.8E-11	7.88E-06	122	3300	85	0.4	2.57E-02	5.42E-09	100	5.42E-11
Heptachlor Epoxide	5.10E+02	2.71E+00	4.05E-06	5.8E-11	7.88E-06	122	3300	85	0.4	2.07E-01	6.41E-10	100	6.41E-12
Indeno(1,2,3-cd)pyrene	3.80E+06	6.58E+00	3.02E-02	5.8E-11	7.88E-06	122	3300	85	0.4	1.18E-03	6.10E-07	100	6.10E-09
Methylene Chloride	1.78E+01	1.25E+00	1.41E-07	0	0	122	3300	85	0.4	1.45E+00	0.00E+00	100	0.00E+00
Pentachlorophenol	7.20E+05	5.86E+00	5.72E-03	5.8E-11	7.88E-06	122	3300	85	0.4	3.08E-03	1.23E-07	100	1.23E-09

Table G-3. Scenario 2. Milk Media Calculation.

Organic Chemical	Kow a	Log Kow	Bk (organics) d/kKg b	Cap mg/m3	Css mg/kg	Inhc m3/d c	Kpapt m3/kg(fm) c	Ivdc kg(fm)/d c	Isc kg/d c	Kps kg/kg(fm) d	Cmilk mg/kg e	Csoil,onsite mg/kg	Cmilk/Csoil,onsite (mg/kg)/(mg/kg)
Non-Carcinogens													
2-Butanone (MEK)	1.95E+00	2.90E-01	1.55E-08	0	0	122	3300	85	0.4	5.23E+00	0.00E+00	100	0.00E+00
Acenaphthene	1.00E+04	4.00E+00	7.94E-05	5.8E-11	7.88E-06	122	3300	85	0.4	3.69E-02	3.50E-09	100	3.50E-11
Acetone	5.80E-01	-2.37E-01	4.61E-09	0	0	122	3300	85	0.4	1.06E+01	0.00E+00	100	0.00E+00
Anthracene	2.80E+04	4.45E+00	2.22E-04	5.8E-11	7.88E-06	122	3300	85	0.4	2.03E-02	7.34E-09	100	7.34E-11
Benzo(g,h,i)perylene	1.20E+06	6.08E+00	9.53E-03	5.8E-11	7.88E-06	122	3300	85	0.4	2.29E-03	2.00E-07	100	2.00E-09
Dibenzofuran	3.79E+03	3.58E+00	3.01E-05	5.8E-11	7.88E-06	122	3300	85	0.4	6.47E-02	1.89E-09	100	1.89E-11
Diethyl Phthalate	2.95E+02	2.47E+00	2.34E-06	5.8E-11	7.88E-06	122	3300	85	0.4	2.84E-01	4.92E-10	100	4.92E-12
Di-n-Butylphthalate	1.35E+04	4.13E+00	1.07E-04	5.8E-11	7.88E-06	122	3300	85	0.4	3.10E-02	4.31E-09	100	4.31E-11
Di-n-Octylphthalate	7.40E+09	9.87E+00	5.88E+01	5.8E-11	7.88E-06	122	3300	85	0.4	1.45E-05	1.14E-03	100	1.14E-05
Endosulfan I	3.60E+03	3.56E+00	2.86E-05	5.8E-11	7.88E-06	122	3300	85	0.4	6.67E-02	1.83E-09	100	1.83E-11
Endosulfan Sulfate	3.60E+03	3.56E+00	2.86E-05	5.8E-11	7.88E-06	122	3300	85	0.4	6.67E-02	1.83E-09	100	1.83E-11
Ethyl Benzene	1.35E+03	3.13E+00	1.07E-05	0	0	122	3300	85	0.4	1.18E-01	0.00E+00	100	0.00E+00
Fluoranthene	8.90E+04	4.95E+00	7.07E-04	5.8E-11	7.88E-06	122	3300	85	0.4	1.04E-02	1.86E-08	100	1.86E-10
Fluorene	1.60E+04	4.20E+00	1.27E-04	5.8E-11	7.88E-06	122	3300	85	0.4	2.81E-02	4.86E-09	100	4.86E-11
Formaldehyde	2.24E+00	3.50E-01	1.78E-08	0	0	122	3300	85	0.4	4.82E+00	0.00E+00	100	0.00E+00
Methoxychlor	2.00E+04	4.30E+00	1.59E-04	5.8E-11	7.88E-06	122	3300	85	0.4	2.47E-02	5.71E-09	100	5.71E-11
Naphthalene	2.00E+03	3.30E+00	1.58E-05	5.8E-11	7.88E-06	122	3300	85	0.4	9.39E-02	1.30E-09	100	1.30E-11
Phenanthrene	3.70E+04	4.57E+00	2.94E-04	5.8E-11	7.88E-06	122	3300	85	0.4	1.73E-02	9.11E-09	100	9.11E-11
Pyrene	2.09E+05	5.32E+00	1.66E-03	5.8E-11	7.88E-06	122	3300	85	0.4	6.32E-03	3.93E-08	100	3.93E-10
Styrene	8.90E+02	2.95E+00	7.07E-06	0	0	122	3300	85	0.4	1.50E-01	0.00E+00	100	0.00E+00
Toluene	4.47E+02	2.65E+00	3.55E-06	0	0	122	3300	85	0.4	2.24E-01	0.00E+00	100	0.00E+00
Xylenes (Total)	1.80E+03	3.26E+00	1.43E-05	0	0	122	3300	85	0.4	9.96E-02	0.00E+00	100	0.00E+00
Compounds With no Toxicity Parameters													
2-Hexanone	2.40E+01	1.38E+00	1.91E-07	0	0	122	3300	85	0.4	1.22E+00	0.00E+00	100	0.00E+00
2-Methylnaphthalene	7.20E+03	3.86E+00	5.72E-05	5.8E-11	7.88E-06	122	3300	85	0.4	4.46E-02	2.82E-09	100	2.82E-11

Table G-3. Scenario 2. Milk Media Calculation.

Inorganic Chemical	Bk d/Kg f	Cap mg/m3	Css mg/kg	Inhc m3/d	Kpapt m3/kg(fm)	Ivdc kg(fm)/d	Isc kg/d	Kps kg/kg(dm) g	biodim kg(dm)/kg(fm) h	Cmilk mg/kg I	Csoil,onsite mg/kg	Cmilk/Csoil,onsite (mg/kg)/(mg/kg)
Carcinogens												
Cadmium (Cd)	0.001	5.8E-11	7.88E-06	122	3300	85	0.4	0.55	0.2	9.31E-08	100	9.31E-10
Chromium	0.0015	5.8E-11	7.88E-06	122	3300	85	0.4	0.0075	0.2	3.06E-08	100	3.06E-10
Chromium, Hexavalent (+6)	0.0015	5.8E-11	7.88E-06	122	3300	85	0.4	0.0075	0.2	3.06E-08	100	3.06E-10
Lead	0.00025	5.8E-11	7.88E-06	122	3300	85	0.4	0.045	0.2	6.36E-09	100	6.36E-11
Mercury (Hg)	0.00045	5.8E-11	7.88E-06	122	3300	85	0.4	0.9	0.2	6.30E-08	100	6.30E-10
Non-Carcinogens												
Antimony (Sb)	0.0001	5.8E-11	7.88E-06	122	3300	85	0.4	0.2	0.2	4.62E-09	100	4.62E-11
Barium (Ba)	0.00035	5.8E-11	7.88E-06	122	3300	85	0.4	0.15	0.2	1.38E-08	100	1.38E-10
Cadmium (Cd)	0.001	5.8E-11	7.88E-06	122	3300	85	0.4	0.55	0.2	9.31E-08	100	9.31E-10
Chromium (Cr)	0.0015	5.8E-11	7.88E-06	122	3300	85	0.4	0.0075	0.2	3.06E-08	100	3.06E-10
Chromium, Hexavalent (Cr+6)	0.0015	5.8E-11	7.88E-06	122	3300	85	0.4	0.0075	0.2	3.06E-08	100	3.06E-10
Copper	0.0015	5.8E-11	7.88E-06	122	3300	85	0.4	0.4	0.2	1.10E-07	100	1.10E-09
Manganese	0.00035	5.8E-11	7.88E-06	122	3300	85	0.4	0.25	0.2	1.85E-08	100	1.85E-10
Mercury (Hg)	0.00045	5.8E-11	7.88E-06	122	3300	85	0.4	0.9	0.2	6.30E-08	100	6.30E-10
Selenium (Se)	0.004	5.8E-11	7.88E-06	122	3300	85	0.4	0.025	0.2	9.11E-08	100	9.11E-10
Silver (Ag)	0.02	5.8E-11	7.88E-06	122	3300	85	0.4	0.4	0.2	1.46E-06	100	1.46E-08
Zinc (Zn)	0.01	5.8E-11	7.88E-06	122	3300	85	0.4	1.5	0.2	2.20E-06	100	2.20E-08

notes:

Kow = Octanol/water partition coefficient.

Bk = Biotransfer factor for dairy cattle (d/kg).

Cap = COC concentration in particulate phase of ambient outdoor air at exposure location from chemical deposition calculation (ug/m3) or (pCi/m3).

Css = COC concentration in surface soil at exposure location from chemical deposition calculation (mg/kg) or (pCi/kg).

Inhc = Daily inhalation rate for cattle (m3/d)

Kpapt = Plant-air partition coefficient for particle-bound contamination (m3-air / kg-plant fresh mass).

Ivdc = Ingestion of pasture by dairy cattle (kg-fresh mass/day).

Isc = Ingestion of soil by cattle (kg/day)

Kps = Plant-soil partition coefficient ((mg/kg-plant fresh mass)/(mg/kg-soil)) = (kg-soil/kg-plant fresh mass).

biodim = Ratio of pasture dry mass to fresh mass (kg-dry mass)/(kg-fresh mass).

Cmilk = COC concentration in dairy milk media (mg/kg) or (pCi/kg).

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.

b = Log(Bk) = Log(Kow) - 8.1, Travis and Arms 1988.

c = Value from McKone and Ryan 1989.

d = Organic compounds: Kps (Kg/Kgfm) = 7.7 Kow-0.58 Travis and Arms, 1988.

e = Calculation for organic compounds: Cmilk = Cap x (Inhc + Kpapt x Ivdc) x Bk + Css x (Isc + Kps x Ivdc) x Bk. Cal EPA, 199

f = Values from Baes et al., 1984.

g = Values from Baes et al., 1984.

h = Value from Cal EPA, 1993.

i = Calculation for inorganic compounds and radionuclides: Cmilk = Cap x (Inhc + Kpapt x Ivdc) x Bk + Css x (Isc + Kps x Ivdc x biodim) x Bk. Cal EPA 1993.

Table G-4. Scenario 2. Fish Calculation.

Organic Chemical	Kow a	Log Kow	Csw mg/L	Bcf L/kg b	Cfish mg/kg c	Csoil mg/kg	Cfish/Csoil,onsite [mg/kg(fish)]/[mg/kg(soil)]
Carcinogens							
4,4'-DDD	6.30E+05	5.80E+00	0	1.50E+04	0.00E+00	100	0.00E+00
4,4'-DDE	4.90E+05	5.69E+00	0	1.24E+04	0.00E+00	100	0.00E+00
4,4'-DDT	1.55E+06	6.19E+00	0	2.98E+04	0.00E+00	100	0.00E+00
Alpha-BHC	7.90E+03	3.90E+00	0	5.40E+02	0.00E+00	100	0.00E+00
Alpha-Chlordane	3.00E+05	5.48E+00	7.41892E-05	8.56E+03	6.35E-01	100	6.35E-03
Arochlor-1260	1.40E+07	7.15E+00	0	1.59E+05	0.00E+00	100	0.00E+00
Benzene	1.30E+02	2.11E+00	0	2.38E+01	0.00E+00	100	0.00E+00
Benzo(a)anthracene	4.57E+05	5.66E+00	0	1.18E+04	0.00E+00	100	0.00E+00
Benzo(a)pyrene	1.26E+06	6.10E+00	0	2.55E+04	0.00E+00	100	0.00E+00
Benzo(b)fluoranthene	1.30E+06	6.11E+00	0	2.61E+04	0.00E+00	100	0.00E+00
Benzo(k)fluoranthene	1.20E+06	6.08E+00	0	2.46E+04	0.00E+00	100	0.00E+00
Bis(2-Ethylhexyl)phthalate	1.29E+05	5.11E+00	0.008872727	4.50E+03	4.00E+01	100	4.00E-01
Carbazole	3.24E+03	3.51E+00	0	2.74E+02	0.00E+00	100	0.00E+00
Carbon Tetrachloride	6.76E+02	2.83E+00	0	8.33E+01	0.00E+00	100	0.00E+00
Chlordane	3.00E+05	5.48E+00	7.41892E-05	8.56E+03	6.35E-01	100	6.35E-03
Chrysene	4.57E+05	5.66E+00	0	1.18E+04	0.00E+00	100	0.00E+00
Delta-BHC	1.30E+04	4.11E+00	0.004305882	7.88E+02	3.39E+00	100	3.39E-02
Dibenzo(a,h)anthracene	6.90E+06	6.84E+00	0	9.28E+04	0.00E+00	100	0.00E+00
Dieldrin	3.60E+04	4.56E+00	0	1.71E+03	0.00E+00	100	0.00E+00
Formaldehyde	2.24E+00	3.50E-01	0.4575	1.09E+00	4.97E-01	100	4.97E-03
Gamma-BHC	5.20E+03	3.72E+00	0	3.93E+02	0.00E+00	100	0.00E+00
Gamma-Chlordane	3.00E+05	5.48E+00	6.79714E-05	8.56E+03	5.82E-01	100	5.82E-03
Heptachlor	1.86E+04	4.27E+00	0	1.04E+03	0.00E+00	100	0.00E+00
Heptachlor Epoxide	5.10E+02	2.71E+00	0	6.73E+01	0.00E+00	100	0.00E+00
Indeno(1,2,3-cd)pyrene	3.80E+06	6.58E+00	0	5.90E+04	0.00E+00	100	0.00E+00
Methylene Chloride	1.78E+01	1.25E+00	0	5.25E+00	0.00E+00	100	0.00E+00
Pentachlorophenol	7.20E+05	5.86E+00	0	1.67E+04	0.00E+00	100	0.00E+00

Table G-4. Scenario 2. Fish Calculation.

Inorganic Chemical	Csw mg/L	Bcf L/kg d	Cfish mg/kg	Csoil mg/kg	Cfish/Csoil,onsite [mg/kg(fish)]/[mg/kg(soil)]
Carcinogens					
Cadmium (Cd)	0.0E+00	3900	0.00E+00	100	0.00E+00
Chromium	2.0E-05	200	3.95E-03	100	3.95E-05
Chromium, Hexavalent (+6)	2.0E-02	200	3.99E+00	100	3.99E-02
Lead	1.7E-03	75	1.31E-01	100	1.31E-03
Mercury (Hg)	4.7E-04	64000	3.02E+01	100	3.02E-01
Non-Carcinogens					
Antimony (Sb)	0.0E+00	0.28	0.00E+00	100	0.00E+00
Barium (Ba)	0.0E+00	200	0.00E+00	100	0.00E+00
Cadmium (Cd)	0.0E+00	3900	0.00E+00	100	0.00E+00
Chromium (Cr)	2.0E-05	200	3.95E-03	100	3.95E-05
Chromium, Hexavalent (Cr+6)	2.0E-02	200	3.99E+00	100	3.99E-02
Copper	2.0E-04	170	3.46E-02	100	3.46E-04
Manganese	2.3E-05	1000	2.32E-02	100	2.32E-04
Mercury (Hg)	4.7E-04	64000	3.02E+01	100	3.02E-01
Selenium (Se)	0.0E+00	6.9	0.00E+00	100	0.00E+00
Silver (Ag)	0.0E+00	160	0.00E+00	100	0.00E+00
Zinc (Zn)	9.0E-04	1400	1.25E+00	100	1.25E-02

notes:

Kow = Octanol/water partition coefficient.
Bcf = Bioconcentration factor for fish (L/kg)
Csw = Chemical concentration in surface water contributed by the LEHR site (mg/L)
CFish = COC concentration in fish (mg/kg).

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPa, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.
b = Log(Bcf) = 0.76 Log(Kow) - 1.23, Veith et al., 1980.
c = Cfish = Csw x Bcf, CalEPA, 1993.
d = Values from Aquire database, USEPA, 1996. Chromium, barium, molybdenum, thallium and vanadium from PNNL, 1996.

Table G-5. Scenario 3. Vegetable and Fruit Calculation.

Organic Chemical	Kow (organics) a	Log Kow (organics)	Cap mg/m3	Css mg/kg	Kpapt m3/kg(fm) b	Kps kg/kg(fm) c	Cveg mg/kg(fm) d	Csoil mg/kg	Cveg/Csoil [mg/kg(fm)]/[mg/kg(soil)]
Non-Carcinogens									
2-Butanone (MEK)	1.95E+00	0.29	0.000E+00	0.00E+00	3300	5.23E+00	0.00E+00	100	0.00E+00
Acenaphthene	1.00E+04	4.00	3.100E-10	6.67E-05	3300	3.69E-02	3.48E-06	100	3.48E-08
Acetone	5.80E-01	-0.24	0.000E+00	0.00E+00	3300	1.06E+01	0.00E+00	100	0.00E+00
Anthracene	2.80E+04	4.45	3.100E-10	6.67E-05	3300	2.03E-02	2.38E-06	100	2.38E-08
Benzo(g,h,i)perylene	1.20E+06	6.08	3.100E-10	6.67E-05	3300	2.29E-03	1.18E-06	100	1.18E-08
Dibenzofuran	3.79E+03	3.58	3.100E-10	6.67E-05	3300	6.47E-02	5.34E-06	100	5.34E-08
Diethyl Phthalate	2.95E+02	2.47	3.100E-10	6.67E-05	3300	2.84E-01	2.00E-05	100	2.00E-07
Di-n-Butylphthalate	1.35E+04	4.13	3.100E-10	6.67E-05	3300	3.10E-02	3.09E-06	100	3.09E-08
Di-n-Octylphthalate	7.40E+09	9.87	3.100E-10	6.67E-05	3300	1.45E-05	1.02E-06	100	1.02E-08
Endosulfan I	3.60E+03	3.56	3.100E-10	6.67E-05	3300	6.67E-02	5.47E-06	100	5.47E-08
Endosulfan Sulfate	3.60E+03	3.56	3.100E-10	6.67E-05	3300	6.67E-02	5.47E-06	100	5.47E-08
Ethyl Benzene	1.35E+03	3.13	0.000E+00	0.00E+00	3300	1.18E-01	0.00E+00	100	0.00E+00
Fluoranthene	8.90E+04	4.95	3.100E-10	6.67E-05	3300	1.04E-02	1.71E-06	100	1.71E-08
Fluorene	1.60E+04	4.20	3.100E-10	6.67E-05	3300	2.81E-02	2.89E-06	100	2.89E-08
Formaldehyde	2.24E+00	0.35	0.000E+00	0.00E+00	3300	4.82E+00	0.00E+00	100	0.00E+00
Methoxychlor	2.00E+04	4.30	3.100E-10	6.67E-05	3300	2.47E-02	2.67E-06	100	2.67E-08
Naphthalene	2.00E+03	3.30	3.100E-10	6.67E-05	3300	9.39E-02	7.28E-06	100	7.28E-08
Phenanthrene	3.70E+04	4.57	3.100E-10	6.67E-05	3300	1.73E-02	2.17E-06	100	2.17E-08
Pyrene	2.09E+05	5.32	3.100E-10	6.67E-05	3300	6.32E-03	1.44E-06	100	1.44E-08
Styrene	8.90E+02	2.95	0.000E+00	0.00E+00	3300	1.50E-01	0.00E+00	100	0.00E+00
Toluene	4.47E+02	2.65	0.000E+00	0.00E+00	3300	2.24E-01	0.00E+00	100	0.00E+00
Xylenes (Total)	1.80E+03	3.26	0.000E+00	0.00E+00	3300	9.96E-02	0.00E+00	100	0.00E+00
Compounds With no Toxicity Parameters									
2-Hexanone	2.40E+01	1.38	0.000E+00	0.00E+00	3300	1.22E+00	0.00E+00	100	0.00E+00
2-Methylnaphthalene	7.20E+03	3.86	3.100E-10	6.67E-05	3300	4.46E-02	4.00E-06	100	4.00E-08

Table G-5. Scenario 3. Vegetable and Fruit Calculation.

Inorganic Chemical	Cap mg/m3	Css mg/kg	Kpapt m3/kg(fm)	Kps kg/kg(dm) e	biodim kg(dm)/kg(fm) f	Cveg mg/kg(fm) g	Csoil,onsite mg/kg	Cveg/Csoil,onsite [mg/kg(fm)]/ [mg/kg(soil)]
Carcinogens								
Cadmium (Cd)	3.100E-10	6.67E-05	3300	0.55	0.2	7.34E-06	100	7.34E-08
Chromium	3.100E-10	6.67E-05	3300	0.0075	0.2	1.01E-07	100	1.01E-09
Chromium, Hexavalent (+6)	3.100E-10	6.67E-05	3300	0.0075	0.2	1.01E-07	100	1.01E-09
Lead	3.100E-10	6.67E-05	3300	0.045	0.2	6.01E-07	100	6.01E-09
Mercury (Hg)	3.100E-10	6.67E-05	3300	0.9	0.2	1.20E-05	100	1.20E-07
Non-Carcinogens								
Antimony (Sb)	3.100E-10	6.67E-05	3300	0.2	0.2	2.67E-06	100	2.67E-08
Barium (Ba)	3.100E-10	6.67E-05	3300	0.15	0.2	2.00E-06	100	2.00E-08
Cadmium (Cd)	3.100E-10	6.67E-05	3300	0.55	0.2	7.34E-06	100	7.34E-08
Chromium (Cr)	3.100E-10	6.67E-05	3300	0.0075	0.2	1.01E-07	100	1.01E-09
Chromium, Hexavalent (Cr+6)	3.100E-10	6.67E-05	3300	0.0075	0.2	1.01E-07	100	1.01E-09
Copper	3.100E-10	6.67E-05	3300	0.4	0.2	5.34E-06	100	5.34E-08
Manganese	3.100E-10	6.67E-05	3300	0.25	0.2	3.34E-06	100	3.34E-08
Mercury (Hg)	3.100E-10	6.67E-05	3300	0.9	0.2	1.20E-05	100	1.20E-07
Selenium (Se)	3.100E-10	6.67E-05	3300	0.025	0.2	3.35E-07	100	3.35E-09
Silver (Ag)	3.100E-10	6.67E-05	3300	0.4	0.2	5.34E-06	100	5.34E-08
Zinc (Zn)	3.100E-10	6.67E-05	3300	1.5	0.2	2.00E-05	100	2.00E-07

notes:

Kow = Octanol/water partition coefficient.
Cap = COC concentration in particulate phase of ambient outdoor air at exposure location from chemical deposition calculation (ug/m3) or (pCi/m3).
Css = COCn concentration in surface soil at exposure location from chemical deposition calculation (mg/kg) or (pCi/kg).
Kpapt = Plant-air partition coefficient for particle-bound contamination (m3-air / kg-plant fresh mass).
Kps = Plant-soil partition coefficient ((mg/kg-plant fresh mass)/(mg/kg-soil)) = (kg-soil/kg-plant fresh mass).
biodim = Ratio of vegetable/fruit dry mass to fresh mass (kg-dry mass)/(kg-fresh mass).
Cveg = COC concentration in vegetable/fruit media (mg/kg-fresh mass) or (pCi/kg-fresh mass).

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.
b = Value from McKone and Ryan, 1989.
c = Organic compounds: Kps (Kg/Kgfm) = 7.7 Kow-0.58 Travis and Arms 1988.
d = Calculation for organic compounds: Cveg = Cap x Kpapt + Css x Kps. Cal EPA 1993.
e = Values from Baes et al., 1984.
f = Value from Cal EPA, 1993.
g = Calculation for inorganic compounds and radionuclides: Cveg = Cap x Kpapt + Css x Kps x biodim. Cal EPA, 1993.

Table G-6. Scenario 3. Beef Calculation.

Organic Chemical	Kow a	Log Kow	Bt (organics) d/kg b	Cap mg/m3	Css mg/kg	Inhc m3/d c	Kpapt m3/kg c	Ivbc kg(fm)/d c	Isc kg/d c	Kps kg/kg d	Cbeef mg/kg e	Csoil,onsite mg/kg	Cbeef/Csoil,onsite (mg/kg)/(mg/kg)
Carcinogens													
4,4'-DDD	6.30E+05	5.80E+00	1.58E-02	3.1E-10	6.67E-05	122	3300	60	0.4	0.00333329	1.60E-06	100	1.60E-08
4,4'-DDE	4.90E+05	5.69E+00	1.22E-02	3.1E-10	6.67E-05	122	3300	60	0.4	0.00385736	1.27E-06	100	1.27E-08
4,4'-DDT	1.55E+06	6.19E+00	3.87E-02	3.1E-10	6.67E-05	122	3300	60	0.4	0.00197829	3.72E-06	100	3.72E-08
Alpha-BHC	7.90E+03	3.90E+00	1.98E-04	3.1E-10	6.67E-05	122	3300	60	0.4	0.04225392	5.08E-08	100	5.08E-10
Alpha-Chlordane	3.00E+05	5.48E+00	7.50E-03	3.1E-10	6.67E-05	122	3300	60	0.4	0.00512579	8.15E-07	100	8.15E-09
Arochlor-1260	1.40E+07	7.15E+00	3.50E-01	3.1E-10	6.67E-05	122	3300	60	0.4	0.00055174	3.16E-05	100	3.16E-07
Benzene	1.30E+02	2.11E+00	3.25E-06	0	0	122	3300	60	0.4	0.45751315	0.00E+00	100	0.00E+00
Benzo(a)anthracene	4.57E+05	5.66E+00	1.14E-02	3.1E-10	6.67E-05	122	3300	60	0.4	0.00401505	1.19E-06	100	1.19E-08
Benzo(a)pyrene	1.26E+06	6.10E+00	3.15E-02	3.1E-10	6.67E-05	122	3300	60	0.4	0.00223095	3.05E-06	100	3.05E-08
Benzo(b)fluoranthene	1.30E+06	6.11E+00	3.25E-02	3.1E-10	6.67E-05	122	3300	60	0.4	0.0021898	3.15E-06	100	3.15E-08
Benzo(k)fluoranthene	1.20E+06	6.08E+00	3.00E-02	3.1E-10	6.67E-05	122	3300	60	0.4	0.00229385	2.92E-06	100	2.92E-08
Bis(2-Ethylhexyl)phthalate	1.29E+05	5.11E+00	3.22E-03	3.1E-10	6.67E-05	122	3300	60	0.4	0.00836933	3.92E-07	100	3.92E-09
Carbazole	3.24E+03	3.51E+00	8.09E-05	3.1E-10	6.67E-05	122	3300	60	0.4	0.07090726	3.01E-08	100	3.01E-10
Carbon Tetrachloride	6.76E+02	2.83E+00	1.69E-05	0	0	122	3300	60	0.4	0.17582909	0.00E+00	100	0.00E+00
Chlordane	3.00E+05	5.48E+00	7.50E-03	3.1E-10	6.67E-05	122	3300	60	0.4	0.00512579	8.15E-07	100	8.15E-09
Chrysene	4.57E+05	5.66E+00	1.14E-02	3.1E-10	6.67E-05	122	3300	60	0.4	0.00401505	1.19E-06	100	1.19E-08
Delta-BHC	1.30E+04	4.11E+00	3.25E-04	3.1E-10	6.67E-05	122	3300	60	0.4	0.03165218	6.98E-08	100	6.98E-10
Dibenzo(a,h)anthracene	6.90E+06	6.84E+00	1.73E-01	3.1E-10	6.67E-05	122	3300	60	0.4	0.00083168	1.58E-05	100	1.58E-07
Dieldrin	3.60E+04	4.56E+00	9.00E-04	3.1E-10	6.67E-05	122	3300	60	0.4	0.01753215	1.42E-07	100	1.42E-09
Formaldehyde	2.24E+00	3.50E-01	5.60E-08	0	0	122	3300	60	0.4	4.82492676	0.00E+00	100	0.00E+00
Gamma-BHC	5.20E+03	3.72E+00	1.30E-04	3.1E-10	6.67E-05	122	3300	60	0.4	0.05385286	3.95E-08	100	3.95E-10
Gamma-Chlordane	3.00E+05	5.48E+00	7.50E-03	3.1E-10	6.67E-05	122	3300	60	0.4	0.00512579	8.15E-07	100	8.15E-09
Heptachlor	1.86E+04	4.27E+00	4.66E-04	3.1E-10	6.67E-05	122	3300	60	0.4	0.02569749	8.89E-08	100	8.89E-10
Heptachlor Epoxide	5.10E+02	2.71E+00	1.28E-05	3.1E-10	6.67E-05	122	3300	60	0.4	0.20706182	1.17E-08	100	1.17E-10
Indeno(1,2,3-cd)pyrene	3.80E+06	6.58E+00	9.50E-02	3.1E-10	6.67E-05	122	3300	60	0.4	0.00117548	8.82E-06	100	8.82E-08
Methylene Chloride	1.78E+01	1.25E+00	4.45E-07	0	0	122	3300	60	0.4	1.4504098	0.00E+00	100	0.00E+00
Pentachlorophenol	7.20E+05	5.86E+00	1.80E-02	3.1E-10	6.67E-05	122	3300	60	0.4	0.00308488	1.81E-06	100	1.81E-08

Table G-6. Scenario 3. Beef Calculation.

Organic Chemical	Kow a	Log Kow	Bt (organics) d/kg b	Cap mg/m3	Css mg/kg	Inhc m3/d c	Kpapt m3/kg c	Ivbc kg(fm)/d c	Isc kg/d c	Kps kg/kg d	Cbeef mg/kg e	Csoil,onsite mg/kg	Cbeef/Csoil,onsite (mg/kg)/(mg/kg)
Non-Carcinogens													
2-Butanone (MEK)	1.95E+00	2.90E-01	4.87E-08	0	0	122	3300	60	0.4	5.22746008	0.00E+00	100	0.00E+00
Acenaphthene	1.00E+04	4.00E+00	2.50E-04	3.1E-10	6.67E-05	122	3300	60	0.4	0.03685452	5.89E-08	100	5.89E-10
Acetone	5.80E-01	-2.37E-01	1.45E-08	0	0	122	3300	60	0.4	10.5609379	0.00E+00	100	0.00E+00
Anthracene	2.80E+04	4.45E+00	7.00E-04	3.1E-10	6.67E-05	122	3300	60	0.4	0.02028332	1.18E-07	100	1.18E-09
Benzo(g,h,i)perylene	1.20E+06	6.08E+00	3.00E-02	3.1E-10	6.67E-05	122	3300	60	0.4	0.00229385	2.92E-06	100	2.92E-08
Dibenzofuran	3.79E+03	3.58E+00	9.48E-05	3.1E-10	6.67E-05	122	3300	60	0.4	0.06469638	3.29E-08	100	3.29E-10
Diethyl Phthalate	2.95E+02	2.47E+00	7.38E-06	3.1E-10	6.67E-05	122	3300	60	0.4	0.28437455	9.05E-09	100	9.05E-11
Di-n-Butylphthalate	1.35E+04	4.13E+00	3.37E-04	3.1E-10	6.67E-05	122	3300	60	0.4	0.03098066	7.15E-08	100	7.15E-10
Di-n-Octylphthalate	7.40E+09	9.87E+00	1.85E+02	3.1E-10	6.67E-05	122	3300	60	0.4	1.4532E-05	1.63E-02	100	1.63E-04
Endosulfan I	3.60E+03	3.56E+00	9.00E-05	3.1E-10	6.67E-05	122	3300	60	0.4	0.06665539	3.19E-08	100	3.19E-10
Endosulfan Sulfate	3.60E+03	3.56E+00	9.00E-05	3.1E-10	6.67E-05	122	3300	60	0.4	0.06665539	3.19E-08	100	3.19E-10
Ethyl Benzene	1.35E+03	3.13E+00	3.37E-05	0	0	122	3300	60	0.4	0.1177852	0.00E+00	100	0.00E+00
Fluoranthene	8.90E+04	4.95E+00	2.23E-03	3.1E-10	6.67E-05	122	3300	60	0.4	0.01037157	2.88E-07	100	2.88E-09
Fluorene	1.60E+04	4.20E+00	4.00E-04	3.1E-10	6.67E-05	122	3300	60	0.4	0.02806087	8.02E-08	100	8.02E-10
Formaldehyde	2.24E+00	3.50E-01	5.60E-08	0	0	122	3300	60	0.4	4.82492676	0.00E+00	100	0.00E+00
Methoxychlor	2.00E+04	4.30E+00	5.00E-04	3.1E-10	6.67E-05	122	3300	60	0.4	0.02465434	9.34E-08	100	9.34E-10
Naphthalene	2.00E+03	3.30E+00	4.99E-05	3.1E-10	6.67E-05	122	3300	60	0.4	0.0938622	2.31E-08	100	2.31E-10
Phenanthrene	3.70E+04	4.57E+00	9.25E-04	3.1E-10	6.67E-05	122	3300	60	0.4	0.01725575	1.45E-07	100	1.45E-09
Pyrene	2.09E+05	5.32E+00	5.23E-03	3.1E-10	6.67E-05	122	3300	60	0.4	0.00632129	5.92E-07	100	5.92E-09
Styrene	8.90E+02	2.95E+00	2.23E-05	0	0	122	3300	60	0.4	0.1499148	0.00E+00	100	0.00E+00
Toluene	4.47E+02	2.65E+00	1.12E-05	0	0	122	3300	60	0.4	0.22360974	0.00E+00	100	0.00E+00
Xylenes (Total)	1.80E+03	3.26E+00	4.50E-05	0	0	122	3300	60	0.4	0.09963976	0.00E+00	100	0.00E+00
Compounds With no Toxicity Parameters													
2-Hexanone	2.40E+01	1.38E+00	6.00E-07	0	0	122	3300	60	0.4	1.21890036	0.00E+00	100	0.00E+00
2-Methylnaphthalene	7.20E+03	3.86E+00	1.80E-04	3.1E-10	6.67E-05	122	3300	60	0.4	0.04459004	4.80E-08	100	4.80E-10

Table G-6. Scenario 3. Beef Calculation.

Inorganic Chemical	Bt (inorganics) d/kg f	Cap mg/m3	Css mg/kg	Inhc m3/d	Kpapt m3/kg	Ivbc kg(fm)/d	Isc kg/d	Kps kg/kg[dm] g	biodim kg(dm)/kg(fm) h	Cbeef mg/Kg	Csoil,onsite mg/kg	Cbeef/Csoil,onsite (mg/kg)/(mg/kg)
Carcinogens												
Cadmium (Cd)	0.00035	3.1E-10	6.67E-05	122	3300	60	0.4	0.55	0.2	1.8491E-07	100	1.85E-09
Chromium	0.0092	3.1E-10	6.67E-05	122	3300	60	0.4	0.0075	0.2	8.6573E-07	100	8.66E-09
Chromium, Hexavalent (+6)	0.0092	3.1E-10	6.67E-05	122	3300	60	0.4	0.0075	0.2	8.6573E-07	100	8.66E-09
Lead	0.0007	3.1E-10	6.67E-05	122	3300	60	0.4	0.045	0.2	8.6881E-08	100	8.69E-10
Mercury (Hg)	0.027	3.1E-10	6.67E-05	122	3300	60	0.4	0.9	0.2	2.1828E-05	100	2.18E-07
Non-Carcinogens												
Antimony (Sb)	0.001	3.1E-10	6.67E-05	122	3300	60	0.4	0.2	0.2	2.4818E-07	100	2.48E-09
Barium (Ba)	0.000097	3.1E-10	6.67E-05	122	3300	60	0.4	0.15	0.2	2.0191E-08	100	2.02E-10
Cadmium (Cd)	0.00035	3.1E-10	6.67E-05	122	3300	60	0.4	0.55	0.2	1.8491E-07	100	1.85E-09
Chromium (Cr)	0.0092	3.1E-10	6.67E-05	122	3300	60	0.4	0.0075	0.2	8.6573E-07	100	8.66E-09
Chromium, Hexavalent (Cr+6)	0.0092	3.1E-10	6.67E-05	122	3300	60	0.4	0.0075	0.2	8.6573E-07	100	8.66E-09
Copper	0.013	3.1E-10	6.67E-05	122	3300	60	0.4	0.4	0.2	5.3074E-06	100	5.31E-08
Manganese	0.0007	3.1E-10	6.67E-05	122	3300	60	0.4	0.25	0.2	2.0174E-07	100	2.02E-09
Mercury (Hg)	0.027	3.1E-10	6.67E-05	122	3300	60	0.4	0.9	0.2	2.1828E-05	100	2.18E-07
Selenium (Se)	0.015	3.1E-10	6.67E-05	122	3300	60	0.4	0.025	0.2	1.6216E-06	100	1.62E-08
Silver (Ag)	0.003	3.1E-10	6.67E-05	122	3300	60	0.4	0.4	0.2	1.2248E-06	100	1.22E-08
Zinc (Zn)	0.2	3.1E-10	6.67E-05	122	3300	60	0.4	1.5	0.2	0.00025774	100	2.58E-06

notes:

Kow = Octanol/water partition coefficient.

Bt = Biotransfer factor for beef cattle (d/kg).

Cap = COC concentration in particulate phase of ambient outdoor air at exposure location from chemical deposition calculation (ug/m3).

Css = COC concentration in surface soil at exposure location from chemical deposition calculation (mg/kg).

Inhc = Daily inhalation rate of cattle (m3/d)

Kpapt = Plant-air partition coefficient for particle bound contamination (m3-air / kg-plant fresh mass).

Ivbc = Ingestion of pasture by beef cattle (kg-fresh mass/day).

Isc = Ingestion of soil by cattle (kg/day)

Kps = Plant-soil partition coefficient ((mg/kg-plant dry mass)/(mg/kg-soil)) = (kg-soil/kg-plant dry mass).

biodim = Ratio of vegetable/fruit dry mass to fresh mass (kg-dry mass)/(kg-fresh mass).

Cbeef = COC concentration in beef media (mg/kg)

N/A = Not applicable. Uptake of inorganic compounds is not based on octanol/water partion coefficients.

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.

b = Log(Bt) = Log(Kow) - 7.6, Travis and Arms, 1988.

c = Value from McKone and Ryan 1989.

d = Organic compounds: Kps = 7.7 Kow-0.58 Travis and Arms, 1988.

e = Calculation: Cbeef = Cap x (Inhc + Kpapt x Ivbc) x Bt + Css x (Isc + Kps x biodim x Ivbc) x Bt. Cal EPA, 1993.

f = Values from Ng et al., 1982. Except arsenic, beryllium, antimony, selenium, thallium and vanadium from Baes et al., 1984.

g = Values from Baes et al., 1984.

h = Value from Cal EPA, 1993.

Table G-7. Scenario 3. Milk Calculation.

Organic Chemical	Kow a	Log Kow	Bk d/kg b	Cap mg/m3	Css mg/kg	Inhc m3/d c	Kpapt m3/kg(fm) c	Ivdc kg(fm)/d c	Isc kg/d c	Kps kg/kg(fm) d	Cmilk mg/kg e	Csoil,onsite mg/kg	Cmilk/Csoil,onsite (mg/kg)/(mg/kg)
Carcinogens													
4,4'-DDD	6.30E+05	5.80E+00	5.00E-03	3.1E-10	0.0000667	122	3300	85	0.4	3.33E-03	6.63E-07	100	6.63E-09
4,4'-DDE	4.90E+05	5.69E+00	3.89E-03	3.1E-10	0.0000667	122	3300	85	0.4	3.86E-03	5.27E-07	100	5.27E-09
4,4'-DDT	1.55E+06	6.19E+00	1.23E-02	3.1E-10	0.0000667	122	3300	85	0.4	1.98E-03	1.54E-06	100	1.54E-08
Alpha-BHC	7.90E+03	3.90E+00	6.28E-05	3.1E-10	0.0000667	122	3300	85	0.4	4.23E-02	2.22E-08	100	2.22E-10
Alpha-Chlordane	3.00E+05	5.48E+00	2.38E-03	3.1E-10	0.0000667	122	3300	85	0.4	5.13E-03	3.40E-07	100	3.40E-09
Arochlor-1260	1.40E+07	7.15E+00	1.11E-01	3.1E-10	0.0000667	122	3300	85	0.4	5.52E-04	1.30E-05	100	1.30E-07
Benzene	1.30E+02	2.11E+00	1.03E-06	0	0	122	3300	85	0.4	4.58E-01	0.00E+00	100	0.00E+00
Benzo(a)anthracene	4.57E+05	5.66E+00	3.63E-03	3.1E-10	0.0000667	122	3300	85	0.4	4.02E-03	4.95E-07	100	4.95E-09
Benzo(a)pyrene	1.26E+06	6.10E+00	1.00E-02	3.1E-10	0.0000667	122	3300	85	0.4	2.23E-03	1.26E-06	100	1.26E-08
Benzo(b)fluoranthene	1.30E+06	6.11E+00	1.03E-02	3.1E-10	0.0000667	122	3300	85	0.4	2.19E-03	1.30E-06	100	1.30E-08
Benzo(k)fluoranthene	1.20E+06	6.08E+00	9.53E-03	3.1E-10	0.0000667	122	3300	85	0.4	2.29E-03	1.21E-06	100	1.21E-08
Bis(2-Ethylhexyl)phthalate	1.29E+05	5.11E+00	1.02E-03	3.1E-10	0.0000667	122	3300	85	0.4	8.37E-03	1.65E-07	100	1.65E-09
Carbazole	3.24E+03	3.51E+00	2.57E-05	3.1E-10	0.0000667	122	3300	85	0.4	7.09E-02	1.33E-08	100	1.33E-10
Carbon Tetrachloride	6.76E+02	2.83E+00	5.37E-06	0	0	122	3300	85	0.4	1.76E-01	0.00E+00	100	0.00E+00
Chlordane	3.00E+05	5.48E+00	2.38E-03	3.1E-10	0.0000667	122	3300	85	0.4	5.13E-03	3.40E-07	100	3.40E-09
Chrysene	4.57E+05	5.66E+00	3.63E-03	3.1E-10	0.0000667	122	3300	85	0.4	4.02E-03	4.95E-07	100	4.95E-09
Delta-BHC	1.30E+04	4.11E+00	1.03E-04	3.1E-10	0.0000667	122	3300	85	0.4	3.17E-02	3.03E-08	100	3.03E-10
Dibenzo(a,h)anthracene	6.90E+06	6.84E+00	5.48E-02	3.1E-10	0.0000667	122	3300	85	0.4	8.32E-04	6.49E-06	100	6.49E-08
Dieldrin	3.60E+04	4.56E+00	2.86E-04	3.1E-10	0.0000667	122	3300	85	0.4	1.75E-02	6.09E-08	100	6.09E-10
Formaldehyde	2.24E+00	3.50E-01	1.78E-08	0	0	122	3300	85	0.4	4.82E+00	0.00E+00	100	0.00E+00
Gamma-BHC	5.20E+03	3.72E+00	4.13E-05	3.1E-10	0.0000667	122	3300	85	0.4	5.39E-02	1.73E-08	100	1.73E-10
Gamma-Chlordane	3.00E+05	5.48E+00	2.38E-03	3.1E-10	0.0000667	122	3300	85	0.4	5.13E-03	3.40E-07	100	3.40E-09
Heptachlor	1.86E+04	4.27E+00	1.48E-04	3.1E-10	0.0000667	122	3300	85	0.4	2.57E-02	3.84E-08	100	3.84E-10
Heptachlor Epoxide	5.10E+02	2.71E+00	4.05E-06	3.1E-10	0.0000667	122	3300	85	0.4	2.07E-01	5.22E-09	100	5.22E-11
Indeno(1,2,3-cd)pyrene	3.80E+06	6.58E+00	3.02E-02	3.1E-10	0.0000667	122	3300	85	0.4	1.18E-03	3.63E-06	100	3.63E-08
Methylene Chloride	1.78E+01	1.25E+00	1.41E-07	0	0	122	3300	85	0.4	1.45E+00	0.00E+00	100	0.00E+00
Pentachlorophenol	7.20E+05	5.86E+00	5.72E-03	3.1E-10	0.0000667	122	3300	85	0.4	3.08E-03	7.50E-07	100	7.50E-09

Table G-7. Scenario 3. Milk Calculation.

Organic Chemical	Kow a	Log Kow	Bk d/kg b	Cap mg/m3	Css mg/kg	Inhc m3/d c	Kpapt m3/kg(fm) c	Ivdc kg(fm)/d c	Isc kg/d c	Kps kg/kg(fm) d	Cmilk mg/kg e	Csoil,onsite mg/kg	Cmilk/Csoil,onsite (mg/kg)/(mg/kg)
Non-Carcinogens													
2-Butanone (MEK)	1.95E+00	2.90E-01	1.55E-08	0	0	122	3300	85	0.4	5.23E+00	0.00E+00	100	0.00E+00
Acenaphthene	1.00E+04	4.00E+00	7.94E-05	3.1E-10	0.0000667	122	3300	85	0.4	3.69E-02	2.56E-08	100	2.56E-10
Acetone	5.80E-01	-2.37E-01	4.61E-09	0	0	122	3300	85	0.4	1.06E+01	0.00E+00	100	0.00E+00
Anthracene	2.80E+04	4.45E+00	2.22E-04	3.1E-10	0.0000667	122	3300	85	0.4	2.03E-02	5.09E-08	100	5.09E-10
Benzo(g,h,i)perylene	1.20E+06	6.08E+00	9.53E-03	3.1E-10	0.0000667	122	3300	85	0.4	2.29E-03	1.21E-06	100	1.21E-08
Dibenzofuran	3.79E+03	3.58E+00	3.01E-05	3.1E-10	0.0000667	122	3300	85	0.4	6.47E-02	1.45E-08	100	1.45E-10
Diethyl Phthalate	2.95E+02	2.47E+00	2.34E-06	3.1E-10	0.0000667	122	3300	85	0.4	2.84E-01	4.05E-09	100	4.05E-11
Di-n-Butylphthalate	1.35E+04	4.13E+00	1.07E-04	3.1E-10	0.0000667	122	3300	85	0.4	3.10E-02	3.10E-08	100	3.10E-10
Di-n-Octylphthalate	7.40E+09	9.87E+00	5.88E+01	3.1E-10	0.0000667	122	3300	85	0.4	1.45E-05	6.69E-03	100	6.69E-05
Endosulfan I	3.60E+03	3.56E+00	2.86E-05	3.1E-10	0.0000667	122	3300	85	0.4	6.67E-02	1.41E-08	100	1.41E-10
Endosulfan Sulfate	3.60E+03	3.56E+00	2.86E-05	3.1E-10	0.0000667	122	3300	85	0.4	6.67E-02	1.41E-08	100	1.41E-10
Ethyl Benzene	1.35E+03	3.13E+00	1.07E-05	0	0	122	3300	85	0.4	1.18E-01	0.00E+00	100	0.00E+00
Fluoranthene	8.90E+04	4.95E+00	7.07E-04	3.1E-10	0.0000667	122	3300	85	0.4	1.04E-02	1.22E-07	100	1.22E-09
Fluorene	1.60E+04	4.20E+00	1.27E-04	3.1E-10	0.0000667	122	3300	85	0.4	2.81E-02	3.47E-08	100	3.47E-10
Formaldehyde	2.24E+00	3.50E-01	1.78E-08	0	0	122	3300	85	0.4	4.82E+00	0.00E+00	100	0.00E+00
Methoxychlor	2.00E+04	4.30E+00	1.59E-04	3.1E-10	0.0000667	122	3300	85	0.4	2.47E-02	4.03E-08	100	4.03E-10
Naphthalene	2.00E+03	3.30E+00	1.58E-05	3.1E-10	0.0000667	122	3300	85	0.4	9.39E-02	1.02E-08	100	1.02E-10
Phenanthrene	3.70E+04	4.57E+00	2.94E-04	3.1E-10	0.0000667	122	3300	85	0.4	1.73E-02	6.22E-08	100	6.22E-10
Pyrene	2.09E+05	5.32E+00	1.66E-03	3.1E-10	0.0000667	122	3300	85	0.4	6.32E-03	2.48E-07	100	2.48E-09
Styrene	8.90E+02	2.95E+00	7.07E-06	0	0	122	3300	85	0.4	1.50E-01	0.00E+00	100	0.00E+00
Toluene	4.47E+02	2.65E+00	3.55E-06	0	0	122	3300	85	0.4	2.24E-01	0.00E+00	100	0.00E+00
Xylenes (Total)	1.80E+03	3.26E+00	1.43E-05	0	0	122	3300	85	0.4	9.96E-02	0.00E+00	100	0.00E+00
Compounds With no Toxicity Parameters													
2-Hexanone	2.40E+01	1.38E+00	1.91E-07	0	0	122	3300	85	0.4	1.22E+00	0.00E+00	100	0.00E+00
2-Methylnaphthalene	7.20E+03	3.86E+00	5.72E-05	3.1E-10	0.0000667	122	3300	85	0.4	4.46E-02	2.10E-08	100	2.10E-10

Table G-7. Scenario 3. Milk Calculation.

Inorganic Chemical	Bk d/kg f	C_{ap} mg/m3	C_{ss} mg/kKg	Inhc m3/d	K_{papt} m3/kg(fm)	Ivdc kg(fm)/d	Isc kg/d	Kps kg/kg(dm) g	bio_{dim} kg(dm)/kg(fm) h	C_{milk} mg/kg I	$C_{soil,onsite}$ mg/kg	Cmilk/$Csoil_{onsite}$ (mg/kg)/(mg/kg)
Carcinogens												
Cadmium (Cd)	0.001	3.1E-10	0.0000667	122	3300	85	0.4	0.55	0.2	7.37E-07	100	7.37E-09
Chromium	0.0015	3.1E-10	0.0000667	122	3300	85	0.4	0.0075	0.2	1.83E-07	100	1.83E-09
Chromium, Hexavalent (+6)	0.0015	3.1E-10	0.0000667	122	3300	85	0.4	0.0075	0.2	1.83E-07	100	1.83E-09
Lead	0.00025	3.1E-10	0.0000667	122	3300	85	0.4	0.045	0.2	4.12E-08	100	4.12E-10
Mercury (Hg)	0.00045	3.1E-10	0.0000667	122	3300	85	0.4	0.9	0.2	5.10E-07	100	5.10E-09
Non-Carcinogens												
Antimony (Sb)	0.0001	3.1E-10	0.0000667	122	3300	85	0.4	0.2	0.2	3.40E-08	100	3.40E-10
Barium (Ba)	0.00035	3.1E-10	0.0000667	122	3300	85	0.4	0.15	0.2	9.93E-08	100	9.93E-10
Cadmium (Cd)	0.001	3.1E-10	0.0000667	122	3300	85	0.4	0.55	0.2	7.37E-07	100	7.37E-09
Chromium (Cr)	0.0015	3.1E-10	0.0000667	122	3300	85	0.4	0.0075	0.2	1.83E-07	100	1.83E-09
Chromium, Hexavalent (Cr+6)	0.0015	3.1E-10	0.0000667	122	3300	85	0.4	0.0075	0.2	1.83E-07	100	1.83E-09
Copper	0.0015	3.1E-10	0.0000667	122	3300	85	0.4	0.4	0.2	8.51E-07	100	8.51E-09
Manganese	0.00035	3.1E-10	0.0000667	122	3300	85	0.4	0.25	0.2	1.39E-07	100	1.39E-09
Mercury (Hg)	0.00045	3.1E-10	0.0000667	122	3300	85	0.4	0.9	0.2	5.10E-07	100	5.10E-09
Selenium (Se)	0.004	3.1E-10	0.0000667	122	3300	85	0.4	0.025	0.2	5.68E-07	100	5.68E-09
Silver (Ag)	0.02	3.1E-10	0.0000667	122	3300	85	0.4	0.4	0.2	1.13E-05	100	1.13E-07
Zinc (Zn)	0.01	3.1E-10	0.0000667	122	3300	85	0.4	1.5	0.2	1.81E-05	100	1.81E-07

notes:

Kow = Octanol/wWater partition coefficient.

Bk = Biotransfer factor for dairy cattle (d/kg).

Cap = COC concentration in particulate phase of ambient outdoor air at exposure location from chemical deposition calculation (ug/m3) or (pCi/m3).

Css = COC concentration in surface soil at exposure location from chemical deposition calculation (mg/kg) or (pCi/kg).

Inhc = Daily inhalation rate for cattle (m3/d)

Kpapt = Plant-air partition coefficient for particle bound contamination (m3-air / kg-plant fresh mass).

Ivdc = Ingestion of pasture by dairy cattle (kg-fresh mass/day).

Isc = Ingestion of soil by cattle (kg/day)

Kps = Plant-soil partition coefficient ((mg/kg-plant fresh mass)/(mg/kg-soil)) = (kg-soil/kg-plant fresh mass).

biodim = Ratio of pasture dry mass to fresh mass (kg-dry mass)/(kg-fresh mass).

Cmilk = COC concentration in dairy milk media (mg/kg) or (pCi/kg).

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.

b = Log(Bk) = Log(Kow) - 8.1, Travis and Arms 1988.

c = Value from McKone and Ryan 1989.

d = Organic compounds: Kps (Kg/Kgfm) = 7.7 Kow-0.58 Travis and Arms, 1988.

e = Calculation for organic compounds: Cmilk = Cap x (Inhc + Kpapt x Ivdc) x Bk + Css x (Isc + Kps x Ivdc) x Bk. Cal EPA 1993.

f = Values from Baes et al., 1984.

g = Values from Baes et al., 1984.

h = Value from Cal EPA, 1993.

i = Calculation for inorganic compounds and radionuclides: Cmilk = Cap x (Inhc + Kpapt x Ivdc) x Bk + Css x (Isc + Kps x Ivdc x biodim) x

Table G-8. Scenario 3. Fish Calculation.

Organic Chemical	Kow a	Log Kow	Csw mg/L	Bcf L/kg b	Cfish mg/kg c	Csoil mg/kg	Cfish/Csoil,onsite [mg/kg(fish)]/[mg/kg(soil)]
Carcinogens							
4,4'-DDD	6.30E+05	5.80E+00	0	1.50E+04	0.00E+00	100	0.00E+00
4,4'-DDE	4.90E+05	5.69E+00	0	1.24E+04	0.00E+00	100	0.00E+00
4,4'-DDT	1.55E+06	6.19E+00	0	2.98E+04	0.00E+00	100	0.00E+00
Alpha-BHC	7.90E+03	3.90E+00	0	5.40E+02	0.00E+00	100	0.00E+00
Alpha-Chlordane	3.00E+05	5.48E+00	7.41892E-05	8.56E+03	6.35E-01	100	6.35E-03
Arochlor-1260	1.40E+07	7.15E+00	0	1.59E+05	0.00E+00	100	0.00E+00
Benzene	1.30E+02	2.11E+00	0	2.38E+01	0.00E+00	100	0.00E+00
Benzo(a)anthracene	4.57E+05	5.66E+00	0	1.18E+04	0.00E+00	100	0.00E+00
Benzo(a)pyrene	1.26E+06	6.10E+00	0	2.55E+04	0.00E+00	100	0.00E+00
Benzo(b)fluoranthene	1.30E+06	6.11E+00	0	2.61E+04	0.00E+00	100	0.00E+00
Benzo(k)fluoranthene	1.20E+06	6.08E+00	0	2.46E+04	0.00E+00	100	0.00E+00
Bis(2-Ethylhexyl)phthalate	1.29E+05	5.11E+00	0.008872727	4.50E+03	4.00E+01	100	4.00E-01
Carbazole	3.24E+03	3.51E+00	0	2.74E+02	0.00E+00	100	0.00E+00
Carbon Tetrachloride	6.76E+02	2.83E+00	0	8.33E+01	0.00E+00	100	0.00E+00
Chlordane	3.00E+05	5.48E+00	7.41892E-05	8.56E+03	6.35E-01	100	6.35E-03
Chrysene	4.57E+05	5.66E+00	0	1.18E+04	0.00E+00	100	0.00E+00
Delta-BHC	1.30E+04	4.11E+00	0.004305882	7.88E+02	3.39E+00	100	3.39E-02
Dibenzo(a,h)anthracene	6.90E+06	6.84E+00	0	9.28E+04	0.00E+00	100	0.00E+00
Dieldrin	3.60E+04	4.56E+00	0	1.71E+03	0.00E+00	100	0.00E+00
Formaldehyde	2.24E+00	3.50E-01	0.4575	1.09E+00	4.97E-01	100	4.97E-03
Gamma-BHC	5.20E+03	3.72E+00	0	3.93E+02	0.00E+00	100	0.00E+00
Gamma-Chlordane	3.00E+05	5.48E+00	6.79714E-05	8.56E+03	5.82E-01	100	5.82E-03
Heptachlor	1.86E+04	4.27E+00	0	1.04E+03	0.00E+00	100	0.00E+00
Heptachlor Epoxide	5.10E+02	2.71E+00	0	6.73E+01	0.00E+00	100	0.00E+00
Indeno(1,2,3-cd)pyrene	3.80E+06	6.58E+00	0	5.90E+04	0.00E+00	100	0.00E+00
Methylene Chloride	1.78E+01	1.25E+00	0	5.25E+00	0.00E+00	100	0.00E+00
Pentachlorophenol	7.20E+05	5.86E+00	0	1.67E+04	0.00E+00	100	0.00E+00

Table G-8. Scenario 3. Fish Calculation.

Organic Chemical	Kow a	Log Kow	Csw mg/L	Bcf L/kg b	Cfish mg/kg c	Csoil mg/kg	Cfish/Csoil,onsite [mg/kg(fish)]/[mg/kg(soil)]
Non-Carcinogens							
2-Butanone (MEK)	1.95E+00	2.90E-01	0	9.78E-01	0.00E+00	100	0.00E+00
Acenaphthene	1.00E+04	4.00E+00	0	6.46E+02	0.00E+00	100	0.00E+00
Acetone	5.80E-01	-2.37E-01	1.87255814	3.89E-01	7.29E-01	100	7.29E-03
Anthracene	2.80E+04	4.45E+00	0	1.41E+03	0.00E+00	100	0.00E+00
Benzo(g,h,i)perylene	1.20E+06	6.08E+00	0	2.46E+04	0.00E+00	100	0.00E+00
Dibenzofuran	3.79E+03	3.58E+00	0	3.09E+02	0.00E+00	100	0.00E+00
Diethyl Phthalate	2.95E+02	2.47E+00	0	4.44E+01	0.00E+00	100	0.00E+00
Di-n-Butylphthalate	1.35E+04	4.13E+00	0.022181818	8.11E+02	1.80E+01	100	1.80E-01
Di-n-Octylphthalate	7.40E+09	9.87E+00	0	1.86E+07	0.00E+00	100	0.00E+00
Endosulfan I	3.60E+03	3.56E+00	0	2.97E+02	0.00E+00	100	0.00E+00
Endosulfan Sulfate	3.60E+03	3.56E+00	0	2.97E+02	0.00E+00	100	0.00E+00
Ethyl Benzene	1.35E+03	3.13E+00	0	1.41E+02	0.00E+00	100	0.00E+00
Fluoranthene	8.90E+04	4.95E+00	0	3.40E+03	0.00E+00	100	0.00E+00
Fluorene	1.60E+04	4.20E+00	0	9.23E+02	0.00E+00	100	0.00E+00
Formaldehyde	2.24E+00	3.50E-01	0.4575	1.09E+00	4.97E-01	100	4.97E-03
Methoxychlor	2.00E+04	4.30E+00	0	1.09E+03	0.00E+00	100	0.00E+00
Naphthalene	2.00E+03	3.30E+00	0	1.90E+02	0.00E+00	100	0.00E+00
Phenanthrene	3.70E+04	4.57E+00	0	1.75E+03	0.00E+00	100	0.00E+00
Pyrene	2.09E+05	5.32E+00	0	6.51E+03	0.00E+00	100	0.00E+00
Styrene	8.90E+02	2.95E+00	0	1.03E+02	0.00E+00	100	0.00E+00
Toluene	4.47E+02	2.65E+00	0	6.08E+01	0.00E+00	100	0.00E+00
Xylenes (Total)	1.80E+03	3.26E+00	0	1.75E+02	0.00E+00	100	0.00E+00
Compounds With no Toxicity Parameters							
2-Hexanone	2.40E+01	1.38E+00	0	6.59E+00	0.00E+00	100	0.00E+00
2-Methylnaphthalene	7.20E+03	3.86E+00	0	5.03E+02	0.00E+00	100	0.00E+00

Table G-8. Scenario 3. Fish Calculation.

Inorganic Chemical	Csw mg/L	Bcf L/kg d	Cfish mg/kg	Csoil mg/kg	Cfish/Csoil,onsite [mg/kg(fish)]/[mg/kg(soil)]
Carcinogens					
Cadmium (Cd)	0	3900	0.00E+00	100	0
Chromium	1.97E-05	200	3.95E-03	100	3.94553E-05
Chromium, Hexavalent (+6)	2.00E-02	200	3.99E+00	100	0.039927273
Lead	1.74E-03	75	1.31E-01	100	0.001308663
Mercury (Hg)	4.72E-04	64000	3.02E+01	100	0.302245161
Non-Carcinogens					
Antimony (Sb)	0	0.28	0.00E+00	100	0
Barium (Ba)	0	200	0.00E+00	100	0
Cadmium (Cd)	0	3900	0.00E+00	100	0
Chromium (Cr)	1.97277E-05	200	3.95E-03	100	3.94553E-05
Chromium, Hexavalent (Cr+6)	0.019963636	200	3.99E+00	100	0.039927273
Copper	0.000203333	170	3.46E-02	100	0.000345667
Manganese	2.32281E-05	1000	2.32E-02	100	0.000232281
Mercury (Hg)	0.000472258	64000	3.02E+01	100	0.302245161
Selenium (Se)	0	6.9	0.00E+00	100	0
Silver (Ag)	0	160	0.00E+00	100	0
Zinc (Zn)	0.000895611	1400	1.25E+00	100	0.012538554

notes:

Kow = Octanol/water partition coefficient.

Bcf = Bioconcentration factor for fish media (L/kg)

Csw = Chemical concentration in surface water contributed by the Site (mg/L)

CFish = COC concentration in fish media (mg/kg).

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.

b = Log(Bcf) = 0.76 Log(Kow) - 1.23, Veith et al., 1980.

c = Cfish = Csw x Bcf, CalEPA, 1993.

d = Values from Aquire database, USEPA 1996. Chromium, barium, molybdenum, thallium and vanadium from PNNL, 1996.

ATTACHMENT H

SURFACE WATER PATHWAY RISK CONTRIBUTIONS FOR RADIONUCLIDES

SURFACE WATER PATHWAY RISK CONTRIBUTIONS FOR RADIONUCLIDES

Most of the calculations relating radionuclide action standards in LEHR site soil to target risk from exposure pathways identified in this evaluation (Section 4.3 of this document) were performed using the RESRAD (v5.62) model. However, RESRAD did not have the capabilities necessary to model the surface water transport mechanisms at the Site, as the RESRAD approach does not match the Site conceptual model. Therefore, the surface water pathway in the RESRAD program was turned off and the surface water pathway risk contributions were calculated as described below.

The soil action standards produced by RESRAD were used as the starting point to calculate surface water pathway risk. The action standards were converted to surface water exposure media concentrations using the surface water transport modeling results described in Attachment E. The exposure media concentrations were then used in the RAGS Part A (USEPA, 1989) intake/dose equations with the exposure parameters listed in Table I-1 and the radionuclide toxicity values in the RESRAD database to determine carcinogenic risk.

The surface water pathways used in these calculations are:

- ingestion of surface water while swimming,
- dermal contact with surface water while swimming, and;
- ingestion of fish.

The risk calculated for each of these surface water exposure pathways was summed together to yield a total surface water pathway risk for input into further calculations in Attachment J. A three-step approach was used to calculate the risk. The three steps involved running forward risk calculations for each radionuclide in Scenarios 2 and 3 as follows:

1. The surface water/DOE Area soil concentration ratios (*X*/Q ratios) from the surface water modeling calculations in Attachment E were summarized into *X*/Q spreadsheets. The action standards from the RESRAD calculations for Scenarios 2 and 3 were multiplied by the surface water *X*/Q values to determine the concentration in surface water. The surface water concentrations were then entered into fish media calculation spreadsheets to determine the radionuclide concentration in fish.

2. The concentrations in surface water and fish in Scenarios 2 and 3 determined in Step 1 were entered into spreadsheets containing the RAGS Part A equations to calculate chemical intakes/doses that may result from the action standards. The exposure factors used in the spreadsheet calculations and the references for these values are summarized in

Table I-1 of this document. A dermal permeability constant of 0.001 cm/hr (USEPA, 1992) was used for dermal exposure to radionuclides in surface water while swimming. The intakes/doses were multiplied by the cancer slope factors to determine the carcinogenic risk value. The radionuclide-specific cancer slope factors (Sfo) were taken from the RESRAD database and are summarized in the cancer slope factor column of the spreadsheets.

3. Risk values were summed across all three surface water exposure pathways for each radionuclide in Scenarios 2 and 3. For example, the calculated risk across pathways resulting from 0.0175 pCi/g of Americium-241 in LEHR site soil in Scenario 2 is 8.0 x 10^{-13}. The risk from each contributing pathway was 2.8 x 10^{-13} due to ingestion while swimming, 2.5 x 10^{-14} due to dermal adsorption while swimming and 5.0 x 10^{-13} due to ingestion of fish. The sum of these risks is = 8.0 x 10^{-13}).

The calculations are presented in spreadsheet form in the Calculations section of this attachment. The calculations are divided into sections by scenario. Within each scenario section is a page summarizing the action standards, the calculated risk from each exposure pathway and the risk across surface water pathways. The summary page is followed by the RAGS Part A intake/dose spreadsheets for each exposure pathway. These spreadsheets also contain the radionuclide specific slope factors and the calculated risk. Each intake/uptake spreadsheet contains notes defining each exposure parameter and the formulas for calculating intake/dose and risk. Finally, the X/Q spreadsheets for surface water and the fish media calculation spreadsheets are attached at the end of each subsection.

The results of these calculations were used in the radionuclide action standard calculations presented in Attachment J.

1.1 References

CalEPA DTSC 1993, CalTOX, A Multimedia Total Exposure Model for Hazardous Waste Sites.

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U.S. EPA, 1989, Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual (Part A), Interim Final, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. (EPA/540/1-89/002).

U.S. EPA, 1992, Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B: Office of Health and Environmental Assessment, Washington, DC.

ATTACHMENT H

CALCULATIONS
SECTION 1, SCENARIO 2

Table H-1-a. Scenario 2. Forward Calculation of Activity Ratio Activity in Putah Creek/Activity in Onsite Soil

Isotope	Csoil pCi/g	Csw/Csoil,onsite [pCi/L(sw)]/[pCi/g(soil)]	Csw pCi/L
Americium-241	1.75E-02	3.77E-02	6.60E-04
Carbon-14	1.60E-02	2.25E-01	3.60E-03
Cesium-137+D	1.66E-02	4.88E-03	8.13E-05
Cobalt-60	4.19E-03	3.52E+00	1.48E-02
Lead-210+D	7.72E-02	5.07E-01	3.91E-02
Plutonium-241+D	6.13E-01	1.83E-02	1.12E-02
Radium-226+D	8.24E-04	1.43E+00	1.17E-03
Strontium-90+D	2.26E-02	3.24E-04	7.32E-06
Thorium-228+D	6.33E-03	1.05E+00	6.65E-03
Thorium-232	4.03E-03	1.05E+00	4.23E-03
Thorium-234 (U-328+D)	5.43E-01	1.05E+00	5.69E-01
Tritium	8.58E-01	4.51E-02	3.87E-02
Uranium-235+D	2.90E-02	3.20E+00	9.26E-02

Thorium-228+D and Thorium-232 activity ratios based on Thorium-234 (U-328+D) activity ratio.
Initial C_{soil} from RESRAD results, see Attachment J, Table J-1.

Table H-1-b. Scenario 2. Fish Media Calculation

Isotope	Csw pCi/L	Bcf L/kg a	Cfish pCi/Kg
Americium-241	6.60E-04	30	1.98E-02
Carbon-14	3.60E-03	50000	1.80E+02
Cesium-137+D	8.13E-05	2000	1.63E-01
Cobalt-60	1.48E-02	300	4.43E+00
Lead-210+D	3.91E-02	300	1.17E+01
Plutonium-241+D	1.12E-02	30	3.36E-01
Radium-226+D	1.17E-03	50	5.87E-02
Strontium-90+D	7.32E-06	60	4.39E-04
Thorium-228+D	6.65E-03	100	6.65E-01
Thorium-232	4.23E-03	100	4.23E-01
Thorium-234 (U-328+D)	5.69E-01	10	5.69E+00
Tritium	3.87E-02	1	3.87E-02
Uranium-235+D	9.26E-02	10	9.26E-01

Notes:

Bcf = Bioconcentration factor for fish media (L/kg)
Csw = Chemical concentration in surface water contributed by the LEHR site (mg/L)
CFish = Contaminant of concern concentration in fish media (mg/kg).

a = Values from Resrad database, version 5.62.
b = Cfish = Csw x Bcf, CalEPA 1993.

Table H-1-c. Scenario 2. Forward Risk Calculation for Radionuclides

Ingestion of Radionuclides in Surface Water While Swimming

Chemical	CW (pCi/L)	CR (L/d)	EF (d/yr)	Child ED (yr)	Adult ED (yr)	DCF (mrem/pCi)	I (mrem)	SFo (1/mrem)	Risk (unitless)
Americium-241	6.60E-04	0.13	90	6	24	3.64E-03	8.43E-04	3.30E-10	2.781E-13
Carbon-14	3.60E-03	0.13	90	6	24	2.09E-06	2.64E-06	1.00E-12	2.639E-18
Cesium-137+D	8.13E-05	0.13	90	6	24	5.00E-05	1.43E-06	3.20E-11	4.564E-17
Cobalt-60	1.48E-02	0.13	90	6	24	2.69E-05	1.39E-04	1.90E-11	2.647E-15
Lead-210+D	3.91E-02	0.13	90	6	24	7.27E-03	9.99E-02	1.00E-09	9.989E-11
Plutonium-241+D	1.12E-02	0.13	90	6	24	6.85E-05	2.69E-04	5.20E-12	1.399E-15
Radium-226+D	1.17E-03	0.13	90	6	24	1.33E-03	5.48E-04	3.00E-10	1.645E-13
Strontium-90+D	7.32E-06	0.13	90	6	24	1.53E-04	3.93E-07	5.60E-11	2.203E-17
Thorium-228+D	6.65E-03	0.13	90	6	24	8.08E-04	1.88E-03	2.30E-10	4.335E-13
Thorium-232	4.23E-03	0.13	90	6	24	2.73E-03	4.06E-03	3.30E-11	1.338E-13
Thorium-234 (U-328+D)	5.69E-01	0.13	90	6	24	2.69E-04	5.38E-02	6.20E-11	3.333E-12
Tritium	3.87E-02	0.13	90	6	24	6.40E-08	8.69E-07	7.20E-14	6.258E-20
Uranium-235+D	9.26E-02	0.13	90	6	24	2.67E-04	8.68E-03	4.70E-11	4.078E-13

CW = Isotope Activity in Water (mg/L)

CR = Contact Rate (L/d)

EF = Exposure Frequency (d/yr)

ED = Exposure Duration (yr)

DCF = Dose conversion factor (mrem/pCi) from Resrad database, Version 5.62.

I = Intake (mrem) = CW x CRchild x EF x EDchild x DCF + CW x CRadult x EF x EDadult x DCF

Sfo = Cancer Slope Factor (1/mrem)

Risk = Calculated Risk (positives/population) = I x SFo

Table H-1-d. Scenario 2. Forward Risk Calculation for Radionuclides

Dermal Contact With Radionuclides in Surface Water While Swimming

Chemical	CW (pCi/L)	SA (cm2)	PC (cm/hr)	ET (hr/d)	EF (d/yr)	Child ED (yr)	Adult ED (yr)	CF (1L/1000cm3)	DCF (mrem/pCi)	AD (mrem)	SFo (1/mrem)	Risk (unitless)
Americium-241	6.60E-04	23,000	0.001	0.5	90	6	24	0.001	3.64E-03	7.46E-05	3.30E-10	2.46E-14
Carbon-14	3.60E-03	23,000	0.001	0.5	90	6	24	0.001	2.09E-06	2.33E-07	1.00E-12	2.33E-19
Cesium-137+D	8.13E-05	23,000	0.001	0.5	90	6	24	0.001	5.00E-05	1.26E-07	3.20E-11	4.04E-18
Cobalt-60	1.48E-02	23,000	0.001	0.5	90	6	24	0.001	2.69E-05	1.23E-05	1.90E-11	2.34E-16
Lead-210+D	3.91E-02	23,000	0.001	0.5	90	6	24	0.001	7.27E-03	8.84E-03	1.00E-09	8.84E-12
Plutonium-241+D	1.12E-02	23,000	0.001	0.5	90	6	24	0.001	6.85E-05	2.38E-05	5.20E-12	1.24E-16
Radium-226+D	1.17E-03	23,000	0.001	0.5	90	6	24	0.001	1.33E-03	4.85E-05	3.00E-10	1.45E-14
Strontium-90+D	7.32E-06	23,000	0.001	0.5	90	6	24	0.001	1.53E-04	3.48E-08	5.60E-11	1.95E-18
Thorium-228+D	6.65E-03	23,000	0.001	0.5	90	6	24	0.001	8.08E-04	1.67E-04	2.30E-10	3.83E-14
Thorium-232	4.23E-03	23,000	0.001	0.5	90	6	24	0.001	2.73E-03	3.59E-04	3.30E-11	1.18E-14
Thorium-234 (U-328+D)	5.69E-01	23,000	0.001	0.5	90	6	24	0.001	2.69E-04	4.76E-03	6.20E-11	2.95E-13
Tritium	3.87E-02	23,000	0.001	0.5	90	6	24	0.001	6.40E-08	7.69E-08	7.20E-14	5.54E-21
Uranium-235+D	9.26E-02	23,000	0.001	0.5	90	6	24	0.001	2.67E-04	7.67E-04	4.70E-11	3.61E-14

CW = Isotope Activity in Water (mg/L)
SA = Skin Surface Area Available for Contact (cm2)
PC = Dermal Permeability Constant (cm/hr) - USEPA 1992
ET = Exposure Time (hr/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
CF = Volumetric Conversion Factor for Water (1L/1000cm3)
DCF = Dose conversion factor (mrem/pCi) from Resrad database, Version 5.62.
AD = Absorbed Dose (mrem) = CW x SA x PC x ET x EF x EDchild x CF x DCF + CW x SA x PC x ET x EF x EDadult x CF x DCF
Sfo = Cancer Slope Factor (1/mrem)
Risk = Calculated Risk (positives/population) = AD x SFo

Table H-1-e. Scenario 2, Forward Risk Calculation for Radionuclides

Ingestion of Radionuclides in Fish

Chemical	CF (pCi/kg)	IR (kg/day)	FI (unitless)	EF (days/yr)	Child ED (yr)	Adult ED (yr)	DCF (mrem/pCi)	I (mrem)	SFo (1/mrem)	Risk (unitless)
Americium-241	1.98E-02	0.054	0.5	26	6	24	3.64E-03	1.52E-03	3.30E-10	5.007E-13
Carbon-14	1.80E+02	0.054	0.5	26	6	24	2.09E-06	7.92E-03	1.00E-12	7.916E-15
Cesium-137+D	1.63E-01	0.054	0.5	26	6	24	5.00E-05	1.71E-04	3.20E-11	5.477E-15
Cobalt-60	4.43E+00	0.054	0.5	26	6	24	2.69E-05	2.51E-03	1.90E-11	4.765E-14
Lead-210+D	1.17E+01	0.054	0.5	26	6	24	7.27E-03	1.80E+00	1.00E-09	1.798E-09
Plutonium-241+D	3.36E-01	0.054	0.5	26	6	24	6.85E-05	4.84E-04	5.20E-12	2.519E-15
Radium-226+D	5.87E-02	0.054	0.5	26	6	24	1.33E-03	1.64E-03	3.00E-10	4.934E-13
Strontium-90+D	4.39E-04	0.054	0.5	26	6	24	1.53E-04	1.42E-06	5.60E-11	7.93E-17
Thorium-228+D	6.65E-01	0.054	0.5	26	6	24	8.08E-04	1.13E-02	2.30E-10	2.601E-12
Thorium-232	4.23E-01	0.054	0.5	26	6	24	2.73E-03	2.43E-02	3.30E-11	8.029E-13
Thorium-234 (U-328+D)	5.69E+00	0.054	0.5	26	6	24	2.69E-04	3.23E-02	6.20E-11	2E-12
Tritium	3.87E-02	0.054	0.5	26	6	24	6.40E-08	5.21E-08	7.20E-14	3.755E-21
Uranium-235+D	9.26E-01	0.054	0.5	26	6	24	2.67E-04	5.21E-03	4.70E-11	2.447E-13

CF = Activity in Fish (pCi/kg)

IR = Ingestion Rate (kg/meal)

FI = Fraction Ingested From Contaminated Source (unitless)

EF = Exposure Frequency (meals/yr)

ED = Exposure Duration (yr)

DCF = Dose conversion factor (mrem/pCi) from Resrad database, Version 5.62.

I = Intake (mrem) = CF x IR x FI x EF x Edchild x DCF + CF x IR x FI x EF x Edadult x DCF

Sfo = Cancer Slope Factor (1/mrem)

Risk = Calculated Risk (positives/population) = I x SFo

Table H-1-f. Scenario 2. Summary of Surface Water Risk for Radionuclides

Chemical	Action Standard (pCi/g)	Swimming Ingestion	Dermal Swimming	Fish Ingestion	Total Across Pathways
Americium-241	1.75E-02	2.8E-13	2.5E-14	5.0E-13	8.0E-13
Carbon-14	1.60E-02	2.6E-18	2.3E-19	7.9E-15	7.9E-15
Cesium-137+D	1.66E-02	4.6E-17	4.0E-18	5.5E-15	5.5E-15
Cobalt-60	4.19E-03	2.6E-15	2.3E-16	4.8E-14	5.1E-14
Lead-210+D	7.72E-02	1.0E-10	8.8E-12	1.8E-09	1.9E-09
Plutonium-241+D	6.13E-01	1.4E-15	1.2E-16	2.5E-15	4.0E-15
Radium-226+D	8.24E-04	1.6E-13	1.5E-14	4.9E-13	6.7E-13
Strontium-90+D	2.26E-02	2.2E-17	1.9E-18	7.9E-17	1.0E-16
Thorium-228+D	6.33E-03	4.3E-13	3.8E-14	2.6E-12	3.1E-12
Thorium-232	4.03E-03	1.3E-13	1.2E-14	8.0E-13	9.5E-13
Thorium-234 (U-328+D)	5.43E-01	3.3E-12	2.9E-13	2.0E-12	5.6E-12
Tritium	8.58E-01	6.3E-20	5.5E-21	3.8E-21	7.2E-20
Uranium-235+D	2.90E-02	4.1E-13	3.6E-14	2.4E-13	6.9E-13

Table H-2a. Scenario 3. Forward Calculation of Activity Ratio Activity in Putah Creek/Activity in Onsite Soil

Isotope	Csoil pCi/g	Csw/Csoil,onsite [pCi/L(sw)]/[pCi/g(soil)]	Csw pCi/L
Americium-241	1.29E+00	3.77E-02	4.87E-02
Carbon-14	1.60E-02	2.25E-01	3.60E-03
Cesium-137+D	1.66E-02	4.88E-03	8.13E-05
Cobalt-60	4.19E-03	3.52E+00	1.48E-02
Lead-210+D	7.71E-02	5.07E-01	3.91E-02
Plutonium-241+D	4.40E+01	1.83E-02	8.04E-01
Radium-226+D	8.26E-04	1.43E+00	1.18E-03
Strontium-90+D	2.26E-02	3.24E-04	7.32E-06
Thorium-228+D	6.33E-03	1.05E+00	6.64E-03
Thorium-232	4.03E-03	1.05E+00	4.23E-03
Thorium-234 (U-328+D)	5.59E-01	1.05E+00	5.87E-01
Tritium	1.68E+00	4.51E-02	7.58E-02
Uranium-235+D	1.91E-01	3.20E+00	6.11E-01

Thorium-228+D and Thorium-232 activity ratios based on Thorium-234 (U-328+D) activity ratio.
Initial C_{soil} from RESRAD results; see Attachment J, Table J-4.

Table H-2b. Scenario 3. Fish Media Calculation.

Isotope	Csw pCi/L	Bcf L/kg a	Cfish pCi/kg
Americium-241	4.87E-02	30	1.46E+00
Carbon-14	3.60E-03	50000	1.80E+02
Cesium-137+D	8.13E-05	2000	1.63E-01
Cobalt-60	1.48E-02	300	4.43E+00
Lead-210+D	3.91E-02	300	1.17E+01
Plutonium-241+D	8.04E-01	30	2.41E+01
Radium-226+D	1.18E-03	50	5.89E-02
Strontium-90+D	7.32E-06	60	4.39E-04
Thorium-228+D	6.64E-03	100	6.64E-01
Thorium-232	4.23E-03	100	4.23E-01
Thorium-234 (U-328+D)	5.87E-01	10	5.87E+00
Tritium	7.58E-02	1	7.58E-02
Uranium-235+D	6.11E-01	10	6.11E+00

notes:

Bcf = Bioconcentration factor for fish media (L/kg).
Csw = Chemical concentration in surface water contributed by the LEHR site (mg/L).
CFish = Contaminant of concern concentration in fish media (mg/kg).

a = Values from Resrad database, version 5.62.
b = Cfish = Csw x Bcf, CalEPA 1993.

Table H-2c. Scenario 3, Forward Risk Calculation for Radionuclides.

Ingestion of Radionuclides in Surface Water While Swimming

Chemical	CW (pCi/L)	CR (L/d)	EF (d/yr)	Child ED (yr)	Adult ED (yr)	DCF (mrem/pCi)	I (mrem)	SFo (1/mrem)	Risk (unitless)
Americium-241	4.87E-02	0.13	90	6	24	3.64E-03	6.22E-02	3.30E-10	2.05388E-11
Carbon-14	3.60E-03	0.13	90	6	24	2.09E-06	2.64E-06	1.00E-12	2.63882E-18
Cesium-137+D	8.13E-05	0.13	90	6	24	5.00E-05	1.43E-06	3.20E-11	4.56443E-17
Cobalt-60	1.48E-02	0.13	90	6	24	2.69E-05	1.39E-04	1.90E-11	2.64739E-15
Lead-210+D	3.91E-02	0.13	90	6	24	7.27E-03	9.99E-02	1.00E-09	9.98799E-11
Plutonium-241+D	8.04E-01	0.13	90	6	24	6.85E-05	1.93E-02	5.20E-12	1.00465E-13
Radium-226+D	1.18E-03	0.13	90	6	24	1.33E-03	5.50E-04	3.00E-10	1.64975E-13
Strontium-90	7.32E-06	0.13	90	6	24	1.53E-04	3.93E-07	5.60E-11	2.20269E-17
Thorium-228+D	6.64E-03	0.13	90	6	24	8.08E-04	1.88E-03	2.30E-10	4.33287E-13
Thorium-232	4.23E-03	0.13	90	6	24	2.73E-03	4.06E-03	3.30E-11	1.33825E-13
Thorium-234 (U-328+D)	5.87E-01	0.13	90	6	24	2.69E-04	5.54E-02	6.20E-11	3.4339E-12
Tritium	7.58E-02	0.13	90	6	24	6.40E-08	1.70E-06	7.20E-14	1.22662E-19
Uranium-235	6.11E-01	0.13	90	6	24	2.67E-04	5.73E-02	4.70E-11	2.69216E-12

CW = Isotope Activity in Water (mg/L)
CR = Contact Rate (L/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)

DCF = Dose conversion factor (mrem/pCi) from Resrad database, Version 5.62.
I = Intake (mrem) = CW x CRchild x EF x EDchild x DCF + CW x CRadult x EF x EDadult x DCF
Sfo = Cancer Slope Factor (1/mrem)
Risk = Calculated Risk (positives/population) = I x SFo

Table H-2d. Scenario 3, Forward Risk Calculation for Radionuclides.

Dermal Contact With Radionuclides in Surface Water While Swimming

Chemical	CW (pCi/L)	SA (cm2)	PC (cm/hr)	ET (hr/d)	EF (d/yr)	Child ED (yr)	Adult ED (yr)	CF (1L/1000cm3)	DCF (mrem/pCi)	AD (mrem)	SFo (1/mrem)	Risk (unitless)
Americium-241	4.87E-02	23,000	0.001	0.5	90	6	24	0.001	3.64E-03	5.51E-03	3.30E-10	1.82E-12
Carbon-14	3.60E-03	23,000	0.001	0.5	90	6	24	0.001	2.09E-06	2.33E-07	1.00E-12	2.33E-19
Cesium-137+D	8.13E-05	23,000	0.001	0.5	90	6	24	0.001	5.00E-05	1.26E-07	3.20E-11	4.04E-18
Cobalt-60	1.48E-02	23,000	0.001	0.5	90	6	24	0.001	2.69E-05	1.23E-05	1.90E-11	2.34E-16
Lead-210+D	3.91E-02	23,000	0.001	0.5	90	6	24	0.001	7.27E-03	8.84E-03	1.00E-09	8.84E-12
Plutonium-241+D	8.04E-01	23,000	0.001	0.5	90	6	24	0.001	6.85E-05	1.71E-03	5.20E-12	8.89E-15
Radium-226+D	1.18E-03	23,000	0.001	0.5	90	6	24	0.001	1.33E-03	4.86E-05	3.00E-10	1.46E-14
Strontium-9	7.32E-06	23,000	0.001	0.5	90	6	24	0.001	1.53E-04	3.48E-08	5.60E-11	1.95E-18
Thorium-228+D	6.64E-03	23,000	0.001	0.5	90	6	24	0.001	8.08E-04	1.67E-04	2.30E-10	3.83E-14
Thorium-232	4.23E-03	23,000	0.001	0.5	90	6	24	0.001	2.73E-03	3.59E-04	3.30E-11	1.18E-14
Thorium-234 (U-328+D)	5.87E-01	23,000	0.001	0.5	90	6	24	0.001	2.69E-04	4.90E-03	6.20E-11	3.04E-13
Tritium	7.58E-02	23,000	0.001	0.5	90	6	24	0.001	6.40E-08	1.51E-07	7.20E-14	1.09E-20
Uranium-23	6.11E-01	23,000	0.001	0.5	90	6	24	0.001	2.67E-04	5.07E-03	4.70E-11	2.38E-13

CW = Isotope Activity in Water (mg/L)
SA = Skin Surface Area Available for Contact (cm2)
PC = Dermal Permeability Constant (cm/hr) - USEPA 1992
ET = Exposure Time (hr/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
CF = Volumetric Conversion Factor for Water (1L/1000cm3)

DCF = Dose conversion factor (mrem/pCi) from Resrad database, Version 5.62.
AD = Absorbed Dose (mrem) = CW x SA x PC x ET x EF x EDchild x CF x DCF + CW x SA x PC x ET x EF x EDadult x CF x DCF
Sfo = Cancer Slope Factor (1/mrem)
Risk = Calculated Risk (positives/population) = AD x SFo

Table H-2e. Scenario 3, Forward Risk Calculation for Radionuclides.

Ingestion of Radionuclides in Fish

Chemical	CF (pCi/kg)	IR (kg/day)	FI (unitless)	EF (days/yr)	Child ED (yr)	Adult ED (yr)	DCF (mrem/pCi)	I (mrem)	SFo (1/mrem)	Risk (unitless)
Americium-241	1.46E+00	0.054	0.5	26	6	24	3.64E-03	1.12E-01	3.30E-10	3.7E-11
Carbon-14	1.80E+02	0.054	0.5	26	6	24	2.09E-06	7.92E-03	1.00E-12	7.9E-15
Cesium-137+D	1.63E-01	0.054	0.5	26	6	24	5.00E-05	1.71E-04	3.20E-11	5.5E-15
Cobalt-60	4.43E+00	0.054	0.5	26	6	24	2.69E-05	2.51E-03	1.90E-11	4.8E-14
Lead-210+D	1.17E+01	0.054	0.5	26	6	24	7.27E-03	1.80E+00	1.00E-09	1.8E-09
Plutonium-241+D	2.41E+01	0.054	0.5	26	6	24	6.85E-05	3.48E-02	5.20E-12	1.8E-13
Radium-226+D	5.89E-02	0.054	0.5	26	6	24	1.33E-03	1.65E-03	3.00E-10	4.9E-13
Strontium-90+D	4.39E-04	0.054	0.5	26	6	24	1.53E-04	1.42E-06	5.60E-11	7.9E-17
Thorium-228+D	6.64E-01	0.054	0.5	26	6	24	8.08E-04	1.13E-02	2.30E-10	2.6E-12
Thorium-232	4.23E-01	0.054	0.5	26	6	24	2.73E-03	2.43E-02	3.30E-11	8.0E-13
Thorium-234 (U-328+D)	5.87E+00	0.054	0.5	26	6	24	2.69E-04	3.32E-02	6.20E-11	2.1E-12
Tritium	7.58E-02	0.054	0.5	26	6	24	6.40E-08	1.02E-07	7.20E-14	7.4E-21
Uranium-235+D	6.11E+00	0.054	0.5	26	6	24	2.67E-04	3.44E-02	4.70E-11	1.6E-12

CF = Activity in Fish (pCi/kg)
IR = Ingestion Rate (kg/meal)
FI = Fraction Ingested From Contaminated Source (unitless)
EF = Exposure Frequency (meals/yr)
ED = Exposure Duration (yr)
DCF = Dose conversion factor (mrem/pCi) from Resrad database, Version 5.62.
I = Intake (mrem) = CF x IR x FI x EF x Edchild x DCF + CF x IR x FI x EF x Edadult x DCF
Sfo = Cancer Slope Factor (1/mrem)
Risk = Calculated Risk (positives/population) = I x SFo

Table H-2f. Scenario 3, Summary of Surface Water Risk for Radionuclides

Forward Calculation

Chemical	RESRAD Action Standard (pCi/g)	Swimming Ingestion Risk	Dermal Swimming Risk	Fish Ingestion Risk	Total Risk Across Pathways
Americium-241	1.3E+00	2.1E-11	1.8E-12	3.7E-11	5.9E-11
Carbon-14	1.6E-02	2.6E-18	2.3E-19	7.9E-15	7.9E-15
Cesium-137+D	1.7E-02	4.6E-17	4.0E-18	5.5E-15	5.5E-15
Cobalt-60	4.2E-03	2.6E-15	2.3E-16	4.8E-14	5.1E-14
Lead-210+D	7.7E-02	1.0E-10	8.8E-12	1.8E-09	1.9E-09
Plutonium-241+D	4.4E+01	1.0E-13	8.9E-15	1.8E-13	2.9E-13
Radium-226+D	8.3E-04	1.6E-13	1.5E-14	4.9E-13	6.7E-13
Strontium-90+D	2.3E-02	2.2E-17	1.9E-18	7.9E-17	1.0E-16
Thorium-228+D	6.3E-03	4.3E-13	3.8E-14	2.6E-12	3.1E-12
Thorium-232	4.0E-03	1.3E-13	1.2E-14	8.0E-13	9.5E-13
Thorium-234 (U-	5.6E-01	3.4E-12	3.0E-13	2.1E-12	5.8E-12
Tritium	1.7E+00	1.2E-19	1.1E-20	7.4E-21	1.4E-19
Uranium-235+D	1.9E-01	2.7E-12	2.4E-13	1.6E-12	4.5E-12

ATTACHMENT I

CHEMICAL ACTION STANDARD SUPPORT CALCULATIONS

CHEMICAL ACTION STANDARD SUPPORT CALCULATIONS

1.1 Chemical Action Standard Support Calculations

The calculations presented in this attachment were used to determine single-chemical action standards using the RAGS Part A intake/uptake and risk equations for each chemical in each scenario. The calculations were made using a seven-step approach. The first three steps involve running forward risk calculations for each chemical in each scenario using an arbitrarily assumed action standard. The last four steps involve estimating a new action standard for each chemical and verifying the action standard estimates with a second risk calculation. This seven-step approach consisted of:

1. All exposure media/LEHR soil concentration ratios (χ/Q ratios) from the modeling calculations were summarized into χ/Q spreadsheets. The objective of the modeling calculations was to determine χ/Q ratios that relate LEHR site soil concentrations to the concentrations in exposure media. For example, the concentration of a COC in fish was determined by multiplying the estimated action standard in LEHR site soil by the χ/Q value for fish. The calculation process for each COC in each scenario was started by assuming an arbitrarily initial action standard of 100 mg/kg in LEHR site soil. The 100 mg/kg action standard was multiplied by the χ/Q values in the spreadsheets to determine the exposure media concentration used in the forward risk calculation.
2. The concentrations for each exposure medium in each scenario determined in Step 1 were entered into spreadsheets containing the RAGS Part A equations to calculate chemical intakes/uptakes that may result from the initial LEHR 100 mg/kg soil action standard. The exposure factors used in the spreadsheet calculations and the references for these values are summarized in Table I-1 of this document. Standard default values were used for parameters not listed. A summary of chemical specific dermal permeability constants for exposure to chemicals in water and the references for these values are summarized in Table I-2. For carcinogenic compounds, the intakes/uptakes were multiplied by the cancer slope factors to determine the carcinogenic risk value. Intakes/uptakes for non-carcinogenic compounds were divided by the chemical-specific reference dose to determine the hazard quotient for each. The chemical-specific cancer slope factors and chronic reference doses and the references for these values are summarized in Table I-3.
3. Risk values were summed across all exposure pathways for each chemical in each scenario. The result was an estimated total risk across pathways from the arbitrary 100 mg/kg action standard for each chemical in LEHR site soil. For example, the calculated risk across pathways resulting from 100 mg/kg of DDT in LEHR site soil in Scenario 1 is 1.26×10^{-5}. The risk from each contributing pathway was 7.92×10^{-10} due to inhalation, 4.19×10^{-6} due to ingestion of soil and 8.39×10^{-6} due to adsorptive contact with soil (the sum of which is = 1.26×10^{-5}).

4. An estimated action standard for each chemical in each scenario was determined using the initial 100 mg/kg action standard, the risk across pathways calculated in step three and the target risk level. The equation used to calculate the estimated action standard is:

$$AS_{estimated} = AS_{initial} \times \frac{Risk_{target}}{Risk_{calculated}}$$

Where $AS_{estimated}$ is the estimated action standard, $AS_{initial}$ is the initial 100 mg/kg action standard, $Risk_{target}$ is the target risk level (i.e. 10^{-4}, 10^{-5}, 10^{-6} risk) and $Risk_{calculated}$ is the total risk across pathways determined in Step 3. Estimated action standards for non-carcinogenic chemicals are determined using the same equation except that the target hazard quotient and calculated hazard quotient are used in place of the target risk and calculated risk, respectively.

Steps 5, 6 and 7 are carried out to verify that the estimated action standard results in the target risk across pathways.

5. Step 5 is identical to Step 1. The estimated action standard from Step 4 is multiplied by the χ/Q ratio in the χ/Q spreadsheets to determine the exposure media concentration for each chemical in each scenario.
6. Similar to Step 2, in Step 6 the exposure media concentrations were applied to the RAGS Part A equation spreadsheets to determine the intakes/uptakes for each chemical in each scenario. The intakes/uptakes were then multiplied by the slope factor for carcinogens or divided by the reference dose for non-carcinogens to determine the risk or hazard quotient, respectively.
7. Risk values for each exposure medium were summed across pathways to verify whether the estimated action standard resulted in the target risk across pathways for each scenario. The estimated action standards did result in the target risk across pathways for all chemicals in all three scenarios. This was due to the linear mathematical relationships involved in the χ/Q ratios and RAGS Part A intake/uptake equations and the precision afforded by a spreadsheet system. An iterative solution would have been necessary if the mathematical relationships were not linear or if the number of digits[1] carried through the calculation resulted in significant additive error.

The results of these calculations are discussed in the Executive Summary, and Sections 5.1.1 and 6.0 of the main document. The results are summarized in Tables 5-1 through 5-8 and Tables 6-1, 6-2, 6-3 and 6-4. The exposure parameters used in these calculations are summarized in Table 4-1 in the main document.

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[1] The Excel spreadsheet system used in these calculations was capable of carrying 16 digits for each number. It was our experience that less than 4 digits carried through the calculation results in significant additive error (affecting the second significant digit) requiring several iterations to demonstrate achievement of the target risk level.

1.2 References

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Table I-1. Exposure Parameters.

Symbol	Definition (units)	Scenarios 2 and 3 Residential	Scenario 1 Worker	Reference
Chemical -specific values				
CSFo	Cancer slope factor oral (mg/kg-d)-1	chemical-specific	chemical-specific	IRIS, HEAST, or NCEA
CSFi	Cancer slope factor inhaled (mg/kg-d)-1	chemical-specific	chemical-specific	IRIS, HEAST, or NCEA
RfDo	Reference dose oral (mg/kg-d)	chemical-specific	chemical-specific	IRIS, HEAST, or NCEA
RfDi	Reference dose inhaled (mg/kg-d)	chemical-specific	chemical-specific	IRIS, HEAST, or NCEA
VFs	Volatilization factor for soil (m^3/kg)	chemical-specific	chemical-specific	Soil Screening Guidance (EPA 1996a,b)
sat	Soil saturation concentration (mg/kg)	chemical-specific	chemical-specific	Soil Screening Guidance (EPA 1996a,b)
CDF	Radionuclide dose conversion factors	chemical-specific	chemical-specific	EPA FGR no 11+12
Exposure parameters				
BWa	Body weight, adult (kg)	70	70	RAGS (Part A), EPA 1989 (EPA/540/1-89/002)
BWc	Body weight, child (kg)	15	15	Exposure Factors , EPA 1991 (OSWER No. 9285.6-03)
ATc	Averaging time - carcinogens (days)	25550	25550	RAGS(Part A), EPA 1989 (EPA/540/1-89/002)
ATn	Averaging time - noncarcinogens (days)	ED*365	ED*365	RAGS(Part A), EPA 1989 (EPA/540/1-89/002)
SAa	Surface area, adult (cm^2/day)	5000	5000	Dermal Assessment, EPA 1992 (EPA/600/8-91/011B)
SAc	Surface area, child (cm^2/day)	2000	2000	Dermal Assessment, EPA 1992 (EPA/ 600/8-9/011B)
AF	Adherence factor (mg/cm^2)	0.2	0.2	Dermal Assessment, EPA 1992 (EPA/ 600/8-9/011B)
ABS	Skin absorption (unitless):			
	-- organics	0.1	0.1	PEA, Cal-EPA (DTSC, 1994)
	--Inorganics	0.01	0.01	PEA, Cal-EPA (DTSC, 1994)
SAwc	skin surface area for water contact (cm**2)	23000	23000	PEA, Cal-EPA (DTSC, 1994)
IRAa	Inhalation rate - adult (m^3/day)	20	20	Exposure Factors , EPA 1991 (OSWER No. 9285.6-03)
IRAc	Inhalation rate - child (m^3/day)	10	10	RAGS (Part A), EPA 1989 (EPA/540/1-89/002)
IRWa	Drinking water ingestion - adult (L/day	2	Not used	RAGS(Part A), EPA 1989 (EPA/540/1-89/002)

Table I-1. Exposure Parameters (continued).

Symbol	Definition (units)	Scenarios 2 and 3 Residential	Scenario 1 Worker	Reference
IRWc	Drinking water ingestion - child (L/day)	1	Not used	PEA, Cal-EPA (DTSC, 1994)
IRsw	Incidental water intake during swimming (L/day)	0.13	not used	RESRAD default
IRfish	Aquatic food intake (g/day)	54	Not used	RAGS Part B, EPA 1991
IRSa	Soil ingestion - adult (mg/day)	100	50	Exposure Factors , EPA 1991 (OSWER No. 9285.6-03)
IRSc	Soil ingestion - child (mg/day),	200	not used	Exposure Factors , EPA 1991 (OSWER No. 9285.6-03)
IRv	Plant food intake (g/day)	80	not used	RAGS Part B, EPA 1991
IRmeat	Meat and poultry consumption (kg/day)	0.25	not used	RESRAD default
IRmild	Milk consumption (l/day)	0.17	not used	RESRAD default
EF	Exposure frequency (d/y)	350	250	Exposure Factors , EPA 1991 (OSWER No. 9285.6-03)
EFsw	Exposure Frequency swimming (d/yr)	90	not used	EPA default = 7; site-specific value assumed.
EFfi	Exposure frequency fish consumption (d/yr)	26	not used	Exposure Factors , EPA 1991 (OSWER No. 9285.6-03) assume 2/week for 90 days
ED_{RAD}	Exposure duration for radionuclides (yrs)	30	30	RAGS (Part B)
ED	Exposure duration - (years)	30	25	Exposure Factors , EPA 1991 (OSWER No. 9285.6-03)
EDc	Exposure duration - child (years)	6	6	Exposure Factors , EPA 1991 (OSWER No. 9285.6-03)
EDshower	duration for showering (hr/event)	0.25	not used	PEA, Cal-EPA (DTSC, 1994)
EDswin	duration for swimming (hr/event)	0.5	not used	
EDsoil	duration for soil contact (hr/event)	12	not used	
VFw	Volatilization factor for water (L/m^3)	0.5	not used	RAGS(Part B) , EPA 1991 (OSWER No. 9285.7-01B)
Contamination fractions:				
	ingested plant	0.5	not used	
	ingested meat	1	not used	
	ingested milk	1	not used	
	ingested aquatic food	0.5	not used	

Table I-1. Exposure Parameters (continued).

Symbol	Definition (units)	Scenarios 2 and 3 Residential	Scenario 1 Worker	Reference
	ingested drinking water	1	not used	
	ingested soil	1	not used	
	incidentally (swimming) ingested water	1	not used	
	dermal absorption from swimming	1	not used	
	dermal absorption from shower water	1	not used	
	dermal absorption from soil contact	1	not used	

Table I-2a. Dermal Permeability Constants Used in Risk Based Action Standard Calculations, Carcinogens.

Analyte	Dermal Permeability Constant Kp (cm/hr)		Molecular Weight (g/mol)	Kow (ml/g)
4,4'-DDD	0.28	a		
4,4'-DDE	0.24	a		
4,4'-DDT	0.43	a		
Alpha-BHC	0.019	c	290.83	7,900
Alpha-Chlordane	0.046	a		
Arochlor-1260	1.2	c	375.7	14,000,000
Benzene	0.11	b		
Benzo(a)anthracene	0.81	a		
Benzo(a)pyrene	1.2	a		
Benzo(b)fluoranthene	1.2	c	252.32	1,300,000
Benzo(k)fluoranthene	1.1	c	252.32	1,200,000
Bis(2-Ethylhexyl)phthalate	0.033	a		
Cadmium (Cd)	0.001	a		
Carbazole	0.057	c	167.21	3,236
Carbon Tetrachloride	0.022	a		
Chlordane	0.052	a		
Chromium (Cr)	0.001	a		
Chromium, Hexavalent (Cr+6)	0.001	a		
Chrysene	0.81	a		
Delta-BHC	0.027	c	290.83	13,000
Dibenzo(a,h)anthracene	2.7	a		
Dieldrin	0.016	a		
Formaldehyde	0.0022	a		
Gamma-BHC	0.014	c	290.83	5,200
Gamma-Chlordane	0.046	a		
Heptachlor	0.011	a		
Heptachlor Epoxide	0.00067	c	389.2	510
Indeno(1,2,3-cd)pyrene	1.9	a		
Lead (Pb)	0.001	a		
Mercury (Hg)	0.001	a		
Methylene Chloride	0.0045	a		
Pentachlorophenol	0.65	a		
Validation Calculation				
Benzo(a)anthracene	0.81		228.3	457,088

Notes:

a = Calculated value reported in EPA, 1992.

b = Measured value reported in EPA, 1992.

c = Calculated value using formula: log(Kp) = - 2.72 + 0.71*log(Kow) - 0.0061*MW. (EPA, 1992).

Kow = Octanol/water partition coefficient. Values from Fetter, 1993; Lyman et. Al, 1990; CalEPA, 1994; Stepehns, 1996; U.S. DOE, 1996; Weiss Associates, 1997.

Table I-2b. Dermal Permeability Constants Used in Risk-Based Action Standard Calculations

Non-Carcinogens.

Analyte	Dermal Permeability Constant Kp (cm/hr)		Molecular Weight (g/mol)	Kow (ml/g)
2-Butanone (MEK)	0.0011	a		
Acenaphthene	0.152	c	154	10,000
Acetone	0.001	c	58	0.58
Anthracene	0.225	c	178	28,000
Antimony (Sb)	0.001	a		
Barium (Ba)	0.001	a		
Benzo(g,h,i)perylene	0.81	b	276.34	1,200,000
Cadmium (Cd)	0.001	a		
Chromium (Cr)	0.001	a		
Chromium, Hexavalent (Cr+6)	0.001	a		
Copper (Cu)	0.001	a		
Dibenzofuran	0.062	c	168.2	3,790
Diethyl Phthalate	0.0048	a		
Di-n-Butylphthalate	0.033	a		
Di-n-Octylphthalate	80.304	c	390.56	7,400,000,000
Endosulfan I	0.002	c	406.9	3,600
Endosulfan Sulfate	0.002	c	406.9	3,600
Ethyl Benzene	1	b		
Fluoranthene	0.36	a		
Fluorene	0.179	c	166	16,000
Formaldehyde	0.0022	a		
Manganese (Mn)	0.001	a		
Mercury (Hg)	0.001	a		
Methoxychlor	0.017	c	345.65	20,000
Naphthalene	0.069	a		
Phenanthrene	0.27	a		
Pyrene	0.67	c	202.26	209,000
Selenium (Se)	0.001	a		
Silver (Ag)	0.001	a		
Styrene	0.055	a		
Toluene	1	b		
Xylenes (Total)	0.08	a		
Zinc (Zn)	0.001	a		

Notes:

a = Calculated value reported in EPA, 1992.

b = Measured value reported in EPA, 1992.

c = Calculated value using formula: log(Kp) = - 2.72 + 0.71*log(Kow) - 0.0061*MW. EPA 1992.

Kow = Octanol/water partition coefficient. Values from Fetter, 1993; Lyman et. Al, 1990;

CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.

Table I-2c. Dermal Permeability Constants Used in Risk-Based Action Standard Calculations, Compounds with Unknown Toxicity.

Analyte	Dermal Permeability Constant Kp (cm/hr)		Molecular Weight (g/mol)	Kow (ml/g)
2-Hexanone	0.0045	a	100.16	24
2-Methylnaphthalene	0.14	a	142.2	7,200

Notes:

a = Calculated value using formula: log(Kp) = - 2.72 + 0.71*log(Kow) - 0.0061*MW. EPA, 1992.

Kow = Octanol/water partition coefficient. Values from Fetter, 1993; Lyman et. Al, 1990; CalEPA, 1994; Stepehns, 1996; U.S. DOE, 1996; Weiss Associates, 1997.

Table I-3a. Slope Factors Used in Risk-Based Action Standard Calculations

Analyte	Cancer Sfi kg-d/mg	Cancer Sfo kg-d/mg		Ref
4,4'-DDD	0.24	0.24		96 PRGs
4,4'-DDE	0.34	0.34		96 PRGs
4,4'-DDT	0.34	0.34		96 PRGs
Alpha-BHC	6.3	6.3		96 PRGs
Alpha-Chlordane	1.3	1.3		96 PRGs
Arochlor-1260	7.7	7.7		96 PRGs
Benzene	0.1	0.1		96 PRGs
Benzo(a)anthracene	0.73	0.73		96 PRGs
Benzo(a)pyrene	7.3	7.3		96 PRGs
Benzo(b)fluoranthene	0.73	0.73		96 PRGs
Benzo(k)fluoranthene	0.073	0.073		96 PRGs
Bis(2-Ethylhexyl)phthalate	0.014	0.014		96 PRGs
Cadmium (Cd)	6.3	RfDo		96 PRGs
Carbazole	0.02	0.02		96 PRGs
Carbon Tetrachloride	0.053	0.13		96 PRGs
Chlordane	1.3	1.3		96 PRGs
Chromium (Cr)	42	RfDo		96 PRGs
Chromium, Hexavalent (Cr+6)	290	RfDo		96 PRGs
Chrysene	0.0073	0.0073		96 PRGs
Delta-BHC	6.3	6.3	a	96 PRGs
Dibenzo(a,h)anthracene	7.3	7.3		96 PRGs
Dieldrin	16	16		96 PRGs
Formaldehyde	0.046	RfDo		96 PRGs
Gamma-BHC	1.3	1.3		96 PRGs
Gamma-Chlordane	1.3	1.3		96 PRGs
Heptachlor	4.6	4.5		96 PRGs
Heptachlor Epoxide	9.1	9.1		96 PRGs
Indeno(1,2,3-cd)pyrene	0.73	0.73		96 PRGs
Lead (Pb)	1.61	1.61	b	Cal EPA ARB 1996
Mercury (Hg)	RfDi	0.0003		96 PRGs
Methylene Chloride	0.0016	0.0075		96 PRGs
Pentachlorophenol	0.12	0.12		96 PRGs

Notes:

a = Delta BHC toxicity values unavaliable in 96 PRGs or IRIS. Alpha BHC toxicity values used.

b = Cardiovascular Mortality Risk Value.

Table I-3b. Reference Dose Parameters Used in Risk-Based Action Standard Calculations

Analyte	RfDo mg/kg-day	RfDi mg/kg-day		Ref
2-Butanone (MEK)	0.6	0.29		96 PRGs
Acenaphthene	0.06	0.06		96 PRGs
Acetone	0.1	0.1		96 PRGs
Anthracene	0.3	0.3		96 PRGs
Antimony (Sb)	0.0004	0.0004	a	96 PRGs
Barium (Ba)	0.07	0.00014		96 PRGs
Benzo(g,h,i)perylene	0.03	0.03	c	96 PRGs
Cadmium (Cd)	0.0005	0.000057		96 PRGs
Chromium (Cr)	1	Sfi		IRIS
Chromium, Hexavalent (Cr+6)	0.005	Sfi		96 PRGs
Copper (Cu)	0.037	0.037	a	96 PRGs
Dibenzofuran	0.004	0.004		96 PRGs
Diethyl Phthalate	0.8	0.8		96 PRGs
Di-n-Butylphthalate	0.1	0.1		96 PRGs
Di-n-Octylphthalate	0.02	0.02		96 PRGs
Endosulfan I	0.006	0.006		96 PRGs
Endosulfan Sulfate	0.006	0.006	b	96 PRGs
Ethyl Benzene	0.1	0.29		96 PRGs
Fluoranthene	0.04	0.04		96 PRGs
Fluorene	0.04	0.04		96 PRGs
Formaldehyde	0.15	SFi		96 PRGs
Manganese (Mn)	0.047	0.000014		96 PRGs
Mercury (Hg)	0.0003	0.000086		96 PRGs
Methoxychlor	0.005	0.005		96 PRGs
Naphthalene	0.04	0.04		96 PRGs
Phenanthrene	0.03	0.03	c	96 PRGs
Pyrene	0.03	0.03		96 PRGs
Selenium (Se)	0.005	0.005	a	96 PRGs
Silver (Ag)	0.005	0.005	a	96 PRGs
Styrene	0.2	0.29		96 PRGs
Toluene	0.2	0.11		96 PRGs
Xylenes (Total)	2	0.2		96 PRGs
Zinc (Zn)	0.3	0.3	a	96 PRGs

Notes:

a = No RfDi value available in 96 PRGs or IRIS. RfDo value Used.

b = Endosulfan Sulfate not listed in 96 PRGs or IRIS. Endosulfan toxicity values used.

c = No toxicity parameters available. Pyrene RfDo and RfDi values used.

ATTACHMENT J

RESRAD MODEL INPUT PARAMETER SUMMARY, AND X/Q ADJUSTMENTS TO RESRAD RESULTS

RESRAD MODEL INPUT PARAMETER, SUMMARY, AND X/Q ADJUSTMENTS TO RESRAD RESULTS

1.1 RESRAD Model Action Standards Approach

Action standards for radionuclides in Scenarios 1, 2 and 3 were calculated using the results of the fate and transport models described in Attachments D, E, and F, Version 5.61 (USEPA, 1996) the surface water/aquatic foods calculations described in Attachment H and the RESRAD model. International Technologies Corporation of Martinez, California performed the RESRAD calculations and Weiss Associates performed the remainder of the calculations and fate and transport modeling.

The results of the particulate emission rate modeling (Attachment D) were entered into RESRAD to determine the inhalation risk contribution in Scenario 1. Risk contributions from ingestion and dermal contact with soil were calculated using RESRAD alone. The Scenario 1, 2 and 3 results for radionuclides are discussed in the executive summary and Sections 5.2.1 and 6.0 of the main document and are summarized in Tables 5-10, 6-1, 6-2 and 6-3.

The RESRAD model was compatible with the conceptual model for Scenario 1. The particulate emission rate modeling results were entered directly into the RESRAD program to calculate the risk contribution from the inhalation pathway. Fate and transport modeling was not necessary for the direct ingestion and external radiation pathways in Scenario 1 because these pathways were direct exposures to soil in the DOE OUs. Therefore, the action standards calculated by RESRAD were correct for Scenario 1. Several conceptual model compatibility issues arose when RESRAD was used for off-site Scenarios 2 and 3. The compatibility issues and the approaches to solving them are discussed for Scenarios 2 and 3 below.

The modeling capabilities of the RESRAD program were not compatible with the Scenario 2 and 3 conceptual models and the RESRAD simulations could not be modified or disabled to suit the needs of this analysis. By design, the action standards calculated by RESRAD assume the receptor is at the Site; RESRAD cannot adjust directly for an off-site receptor. The RESRAD results could not be used directly for the following exposure pathways:

- Radon inhalation, direct soil ingestion, external radiation, plant ingestion, meat ingestion and milk ingestion in Scenarios 2 and 3 due to the lack of particulate deposition modeling capabilities;
- Ground water ingestion in Scenario 2 due to the lack of saturated zone solute transport modeling capabilities, and;

- Surface water/aquatic foods in Scenarios 2 and 3 due to significant differences between the Site surface water conceptual model and the RESRAD surface water model.

Therefore, it was not possible to calculate action standards directly for Scenarios 2 and 3 using RESRAD. However, the RESRAD results were used as a step in calculating the action standards reported for Scenarios 2 and 3. The process for determining the Scenario 2 and 3 action standards is described in Section 1.3 below.

1.2 RESRAD Model Input Parameters

RESRAD model input parameters are presented in the Site-specific Parameter Summary section of each RESRAD dose calculation output file. Table J-4 summarizes the non-default values. Following Table J-4 are calculations from IT Corporation showing derivation of key input parameters, and example RESRAD output showing input parameters. Intake parameters were changed as necessary from the RESRAD default values to match the chemical intake calculations.

1.3 X/Q Adaptations

Fate and transport modeling was necessary to determine the action standards for Scenarios 2 and 3 and for the air pathways in Scenario 1. The fate and transport models were used to calculate the concentration in an exposure media from the concentration in soil in the DOE OUs. For example, the results of the particulate deposition modeling indicates that 100 mg/kg of chlordane in the DOE OUs will result in 0.0079 ug/kg of chlordane in soil at the Scenario 2 location. The modeling results are expressed as a ratio of exposure media concentration to the concentration in soil in the DOE OUs (χ/Q). The χ/Q value for soil at the Scenario 2 location is 7.88×10^{-8} (mg/kg)/(mg/kg). To determine the concentration of chlordane in soil at Scenario 2 we multiplied the concentration in soil from the DOE OUs by the χ/Q value (100 mg/kg x $7.88 \times 10^{-8} \times 10^{3}$ ug/mg = 0.0079 ug/kg).

1.3.1 Scenario 2 Adjustments to RESRAD-Calculated Action Standards and Risk for Soil-Related Pathways

The action standards calculated by RESRAD assume that the receptor is located directly at the source location; RESRAD is not designed for an off-site receptor location. Therefore, the action standards calculated by RESRAD needed to be adjusted to account for the difference between the concentration in soil at the Scenario 2 location and concentrations in DOE OU soil. This adjustment can be expressed as χ/Q, or the ratio between the off-site concentration, χ, and the on-site source concentration, Q. For soil-related pathways (inhalation, soil ingestion, external radiation, food-chain pathways), the Z concentration of a COC in surface soils at the Scenario 2 location is a function of wind erosion of on-site surface soils followed by off-site air transport and particulate deposition. Attachment D provided the χ/Q ratios for both Scenario 2 and 3.

It is possible to adjust the RESRAD results for χ/Q. Risk is the product of the assumed action standard, the χ/Q ratio, the exposure factors and the cancer slope factor. For example, the mathematical expression for calculating the risk from direct soil ingestion in Scenario 2 is:

$$Risk = AS \times \frac{\chi}{Q} \times IR \times FI \times EF \times ED \times Sf_o$$

Where AS is the action standard in soil in the DOE OUs, χ/Q is the modeling result for soil at the Scenario 2 location, IR is the soil ingestion rate, FI is the fraction of contaminated soil ingested, EF is the exposure frequency, ED is the exposure duration and Sfo is the radionuclide specific oral cancer slope factor. The expression used by RESRAD is:

$$Risk_{RESRAD} = AS_{RESRAD} \times IR \times FI \times EF \times ED \times Sf_o$$

Therefore, simply multiplying by χ/Q results in the correct risk value:

$$Risk_{corrected} = Risk_{RESRAD} \times \frac{\chi}{Q} = AS_{RESRAD} \times \frac{\chi}{Q} \times IR \times FI \times EF \times ED \times Sf_o$$

The risk values calculated by RESRAD for radon inhalation, external radiation, plant ingestion, meat ingestion and milk ingestion pathways were all adjusted by the soil χ/Q value in this manner. The adjusted values are presented in Table J-2.

For example, the action standard calculated by RESRAD for americium-241 was 0.0175 pCi/g in soil in the DOE OUs. RESRAD simply used 0.0175 pCi/g as the concentration in soil at the Scenario 2 location without adjusting the action standard by χ/Q to calculate risk. The necessary approach to obtain the action standard in on-site soil media for Scenario 2 is to multiply the action standard calculated by RESRAD at the Scenario 2 location by χ/Q (i.e. 0.0175 pCi/g x 7.88 x 10^{-8} = 1.38 x 10^{-9} pCi/g) prior to calculating the risk.

1.3.2 Scenario 2, χ/Q Adjustment to RESRAD Action Standards for Ground Water-Related Pathways

The ground water ingestion risk contributions were also adjusted. RESRAD has built in vadose zone modeling ability, and can therefore calculate a χ/Q value for vadose zone vertical transport from soil in the DOE OUs to the water table. However, it is not designed to address

horizontal saturated zone solute transport to the Scenario 2 location. The adjustment to the ground water ingestion risk values calculated by RESRAD was therefore made as:

$$Risk_{corrected} = Risk_{RESRAD} \times \frac{\chi_{saturated}}{Q} = AS_{RESRAD} \times \frac{\chi_{saturted}}{Q} \times \frac{\chi_{vadose}}{Q} \times IR \times EF \times ED \times Sf_o$$

Where $\chi_{saturated}/Q$ is the modeling result for horizontal saturated zone transport and χ_{vadose}/Q is the RESRAD modeling result for vadose zone vertical transport to the water table. The ground water fate and transport results in Attachment F showed that the ground water concentration for a given contaminant at the Scenario 2 receptor location has been conservatively estimated to be about 1/5 of the on-site concentration. This χ/Q correction is extremely conservative, since no degradation during the travel time was considered. The adjusted risk values for ground water ingestion are presented in Table J-2.

1.4 Scenario 2, Overall Adjustment to RESRAD Calculated Action Standards

As indicated in Table J-2, the total risk across pathways, based on the RESRAD action standards, was no longer equal to the target risk (10^{-6}). The risk becomes much lower for the pathways that received χ/Q adjustments. In addition, the risk from the surface water/aquatic foods pathway (calculated in Attachment H) was added. The risk from inhalation (excluding radon) remained the same because no χ/Q adjustment was necessary. The action standards calculated by RESRAD now needed adjustment to achieve the target risk.

The new action standards were estimated using the formula:

$$AS^{new}_{estimated} = AS_{RESRAD} \times \frac{Risk_{target}}{Risk_{sum}}$$

Where $AS^{new}_{estimated}$ is the new estimated action standard, $Risk_{target}$ is the target risk (10^{-6}), and $Risk_{sum}$ is the total risk summed across pathways after completing the χ/Q adjustments and adding the surface water/aquatic foods pathway. The risk values for each pathway were then adjusted based on the new action standard estimates. The equation for adjusting the risk values for each pathway is:

$$Risk^{new}_{corrected} = \frac{AS^{new}_{estimated}}{AS_{RESRAD}} Risk_{corrected}$$

Where $Risk^{new}_{corrected}$ is the exposure pathway risk based on the estimated action standard ($AS_{estimated}$), and $Risk_{corrected}$ is the risk calculated by RESRAD with the χ/Q adjustments. This risk

pathway adjustment is correct because the relationship between the risk and the action standard is linear. For example, the risk from the soil ingestion pathway was adjusted as follows:

$$Risk^{new}_{corrected} = Risk_{corrected} \times \frac{AS^{new}_{estimated}}{AS_{RESRAD}} = AS_{RESRAD} \times \frac{AS^{new}_{estimated}}{AS_{RESRAD}} \times \frac{\chi}{Q} IR \times FI \times EF \times ED \times Sf_o$$

The AS_{RESRAD} terms cancel giving the new risk including the χ/Q adjustment. All of the exposure pathway risks in Scenario 2 were adjusted using the $Risk^{new}_{corrected}$ formula and summed across pathways to verify that the target risk level (10^{-6}) was achieved. The final action standards for radionuclides, the risk contributions from each pathway and the total risk across pathways for Scenario 2 are summarized in Table J-3. The action standards calculated in this way represent the Site soil concentrations that will result in off-site media concentrations resulting in the target risk level.

1.5 Scenario 3, X/Q Adaptations

The χ/Q adaptations for Scenario 3 were identical to those for Scenario 2 except that the ground water exposure pathway is not complete in Scenario 3. The results of the RESRAD action standard calculations are presented in Table J-3. The RESRAD action standards, the χ/Q adjusted risk values and the results of the surface water/aquatic food pathway calculations (from Attachment H) are summarized in Table J-5. The final action standards for radionuclides, the risk contributions from each pathway and the total risk across pathways for Scenario 3 are summarized in Table J-6.

1.6 References

U.S. DOE, 1996, RESRAD, Version 5.62, Argonne National Laboratory, Environmental Assessment Division, Radiological Health Risk Section.

U. S. EPA, 1989b, Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual (Part A), Interim Final, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. (EPA/540/1-89/002).

Table J-1. RESRAD Risk-Based Soil Action Standards for Radionuclides for Scenario 2 - East Residential Farm Scenario for $1x10^{-6}$ Target Risk

Contaminant	RESRAD Action Standard at Scenario 2 (pCi/g)[1]	Annual Dose at Action Standard (mrem/yr)	Pathway-Specific Risk at Action Standard									Total Risk at Action Standard
			Inhalation (excluding Radon)	Radon Inhalation	Direct Soil Ingestion	External Radiation	Ground Water Ingestion	Plant Ingestion	Meat Ingestion	Milk Ingestion	Surface Water/Aquatic Foods[3]	
Americium-241	0.018	3.68E-01	1.08E-14	NC	1.35E-09	4.56E-10	9.96E-07	1.14E-09	4.13E-10	2.98E-11	1.40E-23	1.00E-06
Bismuth-212	Th-228 Daughter[2]											
Bismuth-214	Ra-226 Daughter[2]											
Carbon-14	0.016	6.97E-02	1.60E-12	NC	1.68E-11	3.99E-12	0.00E+00	2.15E-07	6.55E-07	1.30E-07	0.00E+00	1.00E-06
Cesium-137+D	0.017	5.38E-02	2.25E-17	NC	5.59E-10	8.20E-07	0.00E+00	1.87E-08	1.40E-07	2.13E-08	0.00E+00	1.00E-06
Cobalt-60	0.0042	5.48E-02	2.06E-17	NC	8.36E-11	9.68E-07	0.00E+00	5.56E-09	2.53E-08	1.43E-09	0.00E+00	1.00E-06
Lead-210+D	0.077	2.43E-01	2.14E-14	NC	8.10E-08	2.83E-10	0.00E+00	6.76E-07	1.98E-07	4.51E-08	0.00E+00	1.00E-06
Lead-214	Ra-226 Daughter[2]											
Pu-241+D	0.61	3.68E-01	1.16E-14	NC	1.45E-09	4.90E-10	9.97E-07	1.22E-09	4.21E-10	2.99E-11	1.40E-23	1.00E-06
Radium-223	U-235 Daughter[2]											
Radium-226+D	0.00082	6.57E-02	2.79E-16	8.36E-07	7.20E-10	1.28E-07	0.00E+00	1.24E-08	3.31E-09	1.49E-09	0.00E+00	1.00E-06
Strontium-90+D	0.023	9.06E-02	1.11E-16	NC	1.33E-09	1.07E-08	0.00E+00	3.33E-07	5.76E-07	7.98E-08	0.00E+00	1.00E-06
Thorium-228+D	0.0063	5.40E-02	4.37E-14	7.04E-08	1.53E-09	9.27E-07	0.00E+00	1.27E-09	2.20E-10	7.48E-12	0.00E+00	1.00E-06
Thorium-232	0.0040	6.37E-02	3.36E-14	4.48E-08	2.17E-09	9.03E-07	0.00E+00	3.64E-08	9.03E-09	5.01E-09	0.00E+00	1.00E-06
Thorium-234 (U-238+D)	0.54	8.08E-02	4.64E-13	0.00E+00	3.53E-08	8.46E-07	0.00E+00	7.37E-08	2.09E-08	2.39E-08	0.00E+00	1.00E-06
Tritium	0.86	2.96E-02	1.36E-18	NC	1.00E-11	0.00E+00	8.42E-07	2.90E-08	6.51E-08	6.39E-08	3.93E-25	1.00E-06
Uranium-235+D	0.029	8.05E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.96E-07	0.00E+00	2.83E-09	1.53E-09	6.41E-24	1.00E-06

Notes:
NC = Exposure pathway is not complete for this contaminant
(1) = These results are direct RESRAD results taken from RESRAD outputs.
(2) = These radionuclides are daughter products of others, no separate action level is calculated for daughter products.
(3) = Risk for the surface water related pathway calculated directly by RESRAD ~= 0.00.

Table J-2. **Scenario 2**, X/Q Adjustments to Risk and Summation of Risk Using RESRAD Action Standards

	RESRAD			Pathway-Specific Risk at Action Standard									
Contaminant	**Action Standard at Scenario 2 (pCi/g)**	**Soil X/Q**	**Ground Water X/Q**	**Inhalation (excluding Radon)**	**Adjusted Radon Inhalation**	**Adjusted Direct Soil Ingestion**	**Adjusted External Radiation**	**Adjusted Groundwater Ingestion**	**Adjusted Plant Ingestion**	**Adjusted Meat Ingestion**	**Adjusted Milk Ingestion**	**Surface Water/Aquatic Foods**	**Total Risk at Action Standard**
Americium-241	0.018	7.9E-08	1.9E-01	1.1E-14	NC	1.1E-16	3.6E-17	1.9E-07	9.0E-17	3.3E-17	2.3E-18	8.0E-13	1.9E-07
Bismuth-212	Th-228 Daughter[1]												
Bismuth-214	Ra-226 Daughter[1]												
Carbon-14	0.016	7.9E-08	1.9E-01	1.6E-12	NC	1.3E-18	3.1E-19	0.0E+00	1.7E-14	5.2E-14	1.0E-14	7.9E-15	1.7E-12
Cesium-137+D	0.017	7.9E-08	1.9E-01	2.3E-17	NC	4.4E-17	6.5E-14	0.0E+00	1.5E-15	1.1E-14	1.7E-15	5.5E-15	8.4E-14
Cobalt-60	0.0042	7.9E-08	1.9E-01	2.1E-17	NC	6.6E-18	7.6E-14	0.0E+00	4.4E-16	2.0E-15	1.1E-16	5.1E-14	1.3E-13
Lead-210+D	0.077	7.9E-08	1.9E-01	2.1E-14	NC	6.4E-15	2.2E-17	0.0E+00	5.3E-14	1.6E-14	3.6E-15	1.9E-09	1.9E-09
Lead-214	Ra-226 Daughter[1]												
Pu-241+D	0.61	7.9E-08	1.9E-01	1.2E-14	NC	1.1E-16	3.9E-17	1.9E-07	9.6E-17	3.3E-17	2.4E-18	4.0E-15	1.9E-07
Radium-223	U-235 Daughter[1]												
Radium-226+D	0.00082	7.9E-08	1.9E-01	2.8E-16	6.6E-14	5.7E-17	1.0E-14	0.0E+00	9.8E-16	2.6E-16	1.2E-16	6.7E-13	7.5E-13
Strontium-90+D	0.023	7.9E-08	1.9E-01	1.1E-16	NC	1.0E-16	8.4E-16	0.0E+00	2.6E-14	4.5E-14	6.3E-15	1.0E-16	7.9E-14
Thorium-228+D	0.0063	7.9E-08	1.9E-01	4.4E-14	5.5E-15	1.2E-16	7.3E-14	0.0E+00	1.0E-16	1.7E-17	5.9E-19	3.1E-12	3.2E-12
Thorium-232	0.0040	7.9E-08	1.9E-01	3.4E-14	3.5E-15	1.7E-16	7.1E-14	0.0E+00	2.9E-15	7.1E-16	3.9E-16	9.5E-13	1.1E-12
Thorium-234 (U-238+D)	0.54	7.9E-08	1.9E-01	4.6E-13	0.0E+00	2.8E-15	6.7E-14	0.0E+00	5.8E-15	1.6E-15	1.9E-15	5.6E-12	6.2E-12
Tritium	0.86	7.9E-08	1.9E-01	1.4E-18	NC	7.9E-19	0.0E+00	1.6E-07	2.3E-15	5.1E-15	5.0E-15	7.2E-20	1.6E-07
Uranium-235+D	0.029	7.9E-08	1.9E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.9E-07	0.0E+00	2.2E-16	1.2E-16	6.9E-13	1.9E-07

notes:

X/Q = Ratio of radionuclide concentration in soil or ground water at the receptor location to the concentration in soil in the DOE OUs.

[1] = Daughter products.

NC = Exposure pathway not complete for radionuclide.

These are interim calculation results showing risks, adjusted and including calculated risk from surface water pathways.

Table J-3. Scenario 2, Summary of Risk-Based Action Standards and Pathway Specific Risk Contributions at 10^{-6} Risk.

			Pathway-Specific Risk at LEHR Site Action Standard									
Contaminant	**Site Action Standard (pCi/g)**	**Annual Dose at Action Standard (mrem/yr)**	**Inhalation (excluding Radon)**	**Radon Inhalation**	**Direct Soil Ingestion**	**External Radiation**	**Groundwater Ingestion**	**Plant Ingestion**	**Meat Ingestion**	**Milk Ingestion**	**Surface Water/Aquatic Foods**	**Total Risk at Action Standard**
Americium-241	0.092	3.7E-01	5.7E-14	NC	5.6E-16	1.9E-16	1.0E-06	4.7E-16	1.7E-16	1.2E-17	4.2E-12	1.0E-06
Bismuth-212	Th-228 Daughter[1]											
Bismuth-214	Ra-226 Daughter[1]											
Carbon-14	9,486	7.0E-02	9.5E-07	NC	7.8E-13	1.9E-13	0.0E+00	1.0E-08	3.1E-08	6.1E-09	4.7E-09	1.0E-06
Cesium-137+D	197,247	5.4E-02	2.7E-10	NC	5.2E-10	7.7E-07	0.0E+00	1.7E-08	1.3E-07	2.0E-08	6.6E-08	1.0E-06
Cobalt-60	32,387	5.5E-02	1.6E-10	NC	5.1E-11	5.9E-07	0.0E+00	3.4E-09	1.5E-08	8.7E-10	3.9E-07	1.0E-06
Lead-210+D	40	2.4E-01	1.1E-11	NC	3.3E-12	1.2E-14	0.0E+00	2.8E-11	8.2E-12	1.9E-12	1.0E-06	1.0E-06
Lead-214	Ra-226 Daughter[1]											
Pu-241+D	3.2	3.7E-01	6.1E-14	NC	6.0E-16	2.0E-16	1.0E-06	5.1E-16	1.8E-16	1.2E-17	2.1E-14	1.0E-06
Radium-223	U-235 Daughter[1]											
Radium-226+D	1,098	6.6E-02	3.7E-10	8.8E-08	7.6E-11	1.3E-08	0.0E+00	1.3E-09	3.5E-10	1.6E-10	9.0E-07	1.0E-06
Strontium-90+D	286,159	9.1E-02	1.4E-09	NC	1.3E-09	1.1E-08	0.0E+00	3.3E-07	5.7E-07	8.0E-08	1.3E-09	1.0E-06
Thorium-228+D	1,982	5.4E-02	1.4E-08	1.7E-09	3.8E-11	2.3E-08	0.0E+00	3.1E-11	5.4E-12	1.8E-13	9.6E-07	1.0E-06
Thorium-232	3,801	6.4E-02	3.2E-08	3.3E-09	1.6E-10	6.7E-08	0.0E+00	2.7E-09	6.7E-10	3.7E-10	8.9E-07	1.0E-06
Thorium-234 (U-238+D)	87,937	8.1E-02	7.5E-08	0.0E+00	4.5E-10	1.1E-08	0.0E+00	9.4E-10	2.7E-10	3.1E-10	9.1E-07	1.0E-06
Tritium	5.4	3.0E-02	8.5E-18	NC	4.9E-18	0.0E+00	1.0E-06	1.4E-14	3.2E-14	3.1E-14	4.5E-19	1.0E-06
Uranium-235+D	0.15	8.0E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.0E-06	0.0E+00	1.2E-15	6.4E-16	3.6E-12	1.0E-06

D = Daughter products.

NC = Exposure pathway not complete for radionuclide.

(1) These radionuclides are daughter products of others; no separate action standard is calculated for daughter products.

Table J-4. RESRAD Risk-Based Soil Action Standards for Radionuclides for Scenario 3 - South Residential Farm Scenario for 10^{-6} Target Risk

Contaminant	RESRAD Action Standard at Scenario 3 (pCi/g)[1]	Annual Dose at Action Standard (mrem/yr)	Pathway-Specific Risk at Action Standard								Total Risk at Action Standard
			Inhalation (excluding Radon)	Radon Inhalation	Direct Soil Ingestion	External Radiation	Plant Ingestion	Meat Ingestion	Milk Ingestion	Surface Water/Aquatic Foods[3]	
Americium-241	1.3	3.6E-01	1.9E-11	NC	4.5E-07	1.4E-07	3.7E-07	3.3E-08	8.8E-10	0.0E+00	1.0E-06
Bismuth-212	Th-228 Daughter[2]										
Bismuth-214	Ra-226 Daughter[2]										
Carbon-14	**0.016**	**7.0E-02**	**1.6E-12**	**NC**	**1.7E-11**	**4.0E-12**	**2.1E-07**	**6.6E-07**	**1.3E-07**	**0.0E+00**	**1.0E-06**
Cesium-137+D	0.017	5.4E-02	1.2E-16	NC	5.6E-10	8.2E-07	1.9E-08	1.4E-07	2.1E-08	0.0E+00	1.0E-06
Cobalt-60	0.0042	5.5E-02	1.1E-16	NC	8.4E-11	9.7E-07	5.6E-09	2.5E-08	1.4E-09	0.0E+00	1.0E-06
Lead-210+D	0.077	2.4E-01	1.1E-13	NC	8.1E-08	2.8E-10	6.8E-07	2.0E-07	4.5E-08	0.0E+00	1.0E-06
Lead-214	Ra-226 Daughter[2]										
Pu-241+D	44	3.6E-01	1.9E-11	NC	4.5E-07	1.4E-07	3.8E-07	3.5E-08	8.7E-10	0.0E+00	1.0E-06
Radium-223	U-235 Daughter[2]										
Radium-226+D	0.00083	6.6E-02	1.4E-15	8.6E-07	6.9E-10	1.3E-07	1.2E-08	3.2E-09	1.5E-09	0.0E+00	1.0E-06
Strontium-90+D	0.023	9.1E-02	5.9E-16	NC	1.3E-09	1.1E-08	3.3E-07	5.8E-07	8.0E-08	0.0E+00	1.0E-06
Thorium-228+D	0.0063	5.4E-02	2.3E-13	7.0E-08	1.5E-09	9.3E-07	1.3E-09	2.2E-10	7.5E-12	0.0E+00	1.0E-06
Thorium-232	0.0040	6.4E-02	1.8E-13	4.5E-08	2.2E-09	9.0E-07	3.6E-08	9.0E-09	5.0E-09	0.0E+00	1.0E-06
Thorium-234 (U-238+D)	0.56	8.1E-02	2.5E-12	0.0E+00	3.6E-08	8.4E-07	7.6E-08	2.2E-08	2.5E-08	0.0E+00	1.0E-06
Tritium	1.7	3.0E-02	9.2E-17	NC	1.3E-10	0.0E+00	3.7E-07	4.5E-07	1.9E-07	0.0E+00	1.0E-06
Uranium-235+D	0.19	1.3E-01	8.1E-13	0.0E+00	9.7E-09	9.5E-07	2.4E-08	1.3E-08	4.5E-09	2.8E-19	1.0E-06

NC = Exposure pathway not complete for radionuclide.

[1] = These results taken directly from RESRAD output files.

[2] = These radionuclides are daughter products of others, no separate action level is calculated for daughter products.

[3] = Risk for surface water related pathway ~0.00 is RESRAD output.

Table J-5. **Scenario 3**, X/Q Adjustments and Summation of Risk Using RESRAD Action Standards

			Pathway-Specific Risk at Action Standard								
Contaminant	**RESRAD Action Standard at Scenario 3 (pCi/g)**	**Soil X/Q**	**Inhalation (excluding Radon)**	**Adjusted Radon Inhalation**	**Adjusted Direct Soil Ingestion**	**Adjusted External Radiation**	**Adjusted Plant Ingestion**	**Adjusted Meat Ingestion**	**Adjusted Milk Ingestion**	**Surface Water/ Aquatic Foods**	**Total Risk at Action Standards**
Americium-241	1.3	6.7E-07	1.9E-11	NC	3.0E-13	9.6E-14	2.5E-13	2.2E-14	5.9E-16	5.9E-11	7.9E-11
Bismuth-212	Th-228 Daughter1										
Bismuth-214	Ra-226 Daughter1										
Carbon-14	0.016	6.7E-07	1.6E-12	NC	1.1E-17	2.7E-18	1.4E-13	4.4E-13	8.7E-14	7.9E-15	2.3E-12
Cesium-137+D	0.017	6.7E-07	1.2E-16	NC	3.7E-16	5.5E-13	1.2E-14	9.3E-14	1.4E-14	5.5E-15	6.7E-13
Cobalt-60	0.0042	6.7E-07	1.1E-16	NC	5.6E-17	6.5E-13	3.7E-15	1.7E-14	9.5E-16	5.1E-14	7.2E-13
Lead-210+D	0.077	6.7E-07	1.1E-13	NC	5.4E-14	1.9E-16	4.5E-13	1.3E-13	3.0E-14	1.9E-09	1.9E-09
Lead-214	Ra-226 Daughter1										
Pu-241+D	44	6.7E-07	1.9E-11	NC	3.0E-13	9.3E-14	2.5E-13	2.3E-14	5.8E-16	2.9E-13	2.0E-11
Radium-223	U-235 Daughter1										
Radium-226+D	0.00083	6.7E-07	1.4E-15		4.6E-16	8.6E-14	8.1E-15	2.2E-15	9.8E-16	6.7E-13	7.7E-13
Strontium-90+D	0.023	6.7E-07	5.9E-16	NC	8.9E-16	7.1E-15	2.2E-13	3.8E-13	5.3E-14	1.0E-16	6.7E-13
Thorium-228+D	0.0063	6.7E-07	2.3E-13	4.7E-14	1.0E-15	6.2E-13	8.4E-16	1.5E-16	5.0E-18	3.1E-12	4.0E-12
Thorium-232	0.0040	6.7E-07	1.8E-13	3.0E-14	1.4E-15	6.0E-13	2.4E-14	6.0E-15	3.3E-15	9.5E-13	1.8E-12
Thorium-234 (U-238+D)	0.56	6.7E-07	2.5E-12	0.0E+00	2.4E-14	5.6E-13	5.1E-14	1.4E-14	1.6E-14	5.8E-12	8.9E-12
Tritium	1.7	6.7E-07	9.2E-17	NC	8.5E-17	0.0E+00	2.5E-13	3.0E-13	1.2E-13	1.4E-19	6.7E-13
Uranium-235+D	0.19	6.7E-07	8.1E-13	0.0E+00	6.5E-15	6.3E-13	1.6E-14	8.9E-15	3.0E-15	4.5E-12	6.0E-12

notes:

X/Q = Ratio of radionuclide concentration in soil or ground water at the receptor location to the concentration in soil in the Doe OUs.

D = Daughter products.

NC = Exposure pathway not complete for radionuclide.

(1) These radionuclides are daughter products of others; no separate action level is calculated for daughter products.

These are interim calculations showing adjusted risks and including calculated risks from surface water pathways.

Table J-6. **Scenario 3**, Summary of Soil Action Standards and Pathway Specific Risk Contributions at 10^{-6} Risk.

			Pathway-Specific Risk at LEHR Site Action Standard								
Contaminant	**Site Action Standard (pCi/g)**	**Annual Dose at Action Standard (mrem/yr)**	**Inhalation (excluding Radon)**	**Radon Inhalation**	**Direct Soil Ingestion**	**External Radiation**	**Plant Ingestion**	**Meat Ingestion**	**Milk Ingestion**	**Surface Water/ Aquatic Foods**	**Total Risk at Action Standard**
Americium-241	16,329	3.6E-01	2.4E-07	NC	3.8E-09	1.2E-09	3.1E-09	2.8E-10	7.4E-12	7.5E-07	1.0E-06
Bismuth-212	Th-228 Daughter[1]										
Bismuth-214	Ra-226 Daughter[1]										
Carbon-14	7,033	7.0E-02	7.0E-07	NC	4.9E-12	1.2E-12	6.3E-08	1.9E-07	3.8E-08	3.5E-09	1.0E-06
Cesium-137+D	24,734	5.4E-02	1.8E-10	NC	5.5E-10	8.1E-07	1.8E-08	1.4E-07	2.1E-08	8.2E-09	1.0E-06
Cobalt-60	5,838	5.5E-02	1.5E-10	NC	7.8E-11	9.0E-07	5.2E-09	2.3E-08	1.3E-09	7.0E-08	1.0E-06
Lead-210+D	40	2.4E-01	6.0E-11	NC	2.8E-11	9.9E-14	2.4E-10	6.9E-11	1.6E-11	1.0E-06	1.0E-06
Lead-214	Ra-226 Daughter[1]										
Pu-241+D	2,224,245	3.6E-01	9.5E-07	NC	1.5E-08	4.7E-09	1.3E-08	1.2E-09	2.9E-11	1.5E-08	1.0E-06
Radium-223	U-235 Daughter[1]										
Radium-226+D	1,068	6.6E-02	1.9E-09	0.0E+00	5.9E-10	1.1E-07	1.0E-08	2.8E-09	1.3E-09	8.7E-07	1.0E-06
Strontium-90+D	33,864	9.1E-02	8.9E-10	NC	1.3E-09	1.1E-08	3.3E-07	5.7E-07	8.0E-08	1.5E-10	1.0E-06
Thorium-228+D	1,594	5.4E-02	5.9E-08	1.2E-08	2.6E-10	1.6E-07	2.1E-10	3.7E-11	1.3E-12	7.7E-07	1.0E-06
Thorium-232	2,247	6.4E-02	1.0E-07	1.7E-08	8.1E-10	3.4E-07	1.4E-08	3.4E-09	1.9E-09	5.3E-07	1.0E-06
Thorium-234 (U-238+D)	62,548	8.1E-02	2.8E-07	0.0E+00	2.7E-09	6.3E-08	5.7E-09	1.6E-09	1.8E-09	6.5E-07	1.0E-06
Tritium	2,520,075	3.0E-02	1.4E-10	NC	1.3E-10	0.0E+00	3.7E-07	4.5E-07	1.9E-07	2.1E-13	1.0E-06
Uranium-235+D	31,742	1.3E-01	1.3E-07	0.0E+00	1.1E-09	1.1E-07	2.7E-09	1.5E-09	5.0E-10	7.5E-07	1.0E-06

D = Daughter products.

NC = Exposure pathway not complete for radionuclide.

(1) These radionuclides are daughter products of others; no separate action level is calculated for daughter products.

Table J-7. Table of Site Specific Vadose Zone and RESRAD Modeling Input Parameters

Parameter	Units	OU-1 SW Trenches	Source of Data
OU1 - Surface Area of Entire OU	m^2	1915	(Weiss Associates, 1997a)
OU1-Surface Area of contaminated zone	m^2	970	(Weiss Associates, 1997a)
OU2 - Surface Area of Entire OU	m^2	1980	
OU2- Surface Area of contaminated zone	m^2	510	
OU3 - Surface Area of Entire OU	m^2	14720	
OU3- Surface Area of contaminated zone	m^2	11550	
OU4 - SurfaceArea of Entire OU	m^2	0	
OU4-Area of contaminated zone	m^2	0	
Total all OUs - surface area	m^2	18615	
Total all OUs - contaminated surface area	m^2	13030	
Area used for RESRAD modeling (1)	m^2	16200	
Thickness of contaminated zone	m	4.57	(Weiss Associates, 1997a)
Length parallel to aquifer flow	m	28	(Weiss Associates, 1997a)
Cover depth	m	0	
Density of contaminated zone	g/cm3	1.7	Dry Bulk Dens. (DBS, 1996)
Contaminated zone total porosity	v/v	0.39	Calculated Porosity (DBS, 1996)
Contaminated zone effective porosity	v/v	0.19	(DBS, 1996)
Contaminated zone hydraulic conductivity	m/yr	1.8E-02	(DBS, 1996)
Precipitation (1993-1996 Average)	m/yr	0.46	(Weiss Associates, 1997a)
Precipitation (1908-1990 Mean)	m/yr	0.418 (used in RESRAD)	(Dames & Moore, 1993)
Irrigation	m/yr	none	
Runoff coefficient	none	0.76	
Density of saturated zone	g/cm3	1.7	(Dames & Moore, 1993)
Saturated zone total porosity	v/v	0.35	(Dames & Moore, 1993)
Saturated zone effective porosity	v/v	0.2	Default RESRAD
Sat. zone hydraulic conductivity (horiz)	m/yr	400	HSU-1 (Modeling from Dames & Moore, 1997)
Sat. zone hydraulic conductivity (vert)	m/yr	10	HSU-1 (Modeling from Dames & Moore, 1997)
Sat. zone hydraulic conductivity (vert)	m/yr	2,480-17,520	HSU-2 (Modeling from Dames & Moore, 1997)
Saturated zone hydraulic gradient	m/m	0.0001 to 0.0015	(Weiss Associates, 1997a)
Number of unsaturated zone strata		1	(Weiss Associates, 1997b)
Unsaturated zone thickness	m	9.14	(Weiss Associates, 1997b)
Unsaturated zone soil density	g/cm3	1.7	(DBS, 1996)
Unsaturated zone total porosity	v/v	0.38	Calculated Porosity (DBS, 1996)
Unsaturated zone effective porosity	v/v	0.08	(DBS, 1996)
Unsaturated zone hydraulic conductivity	m/yr	1.8E-02	(DBS, 1996)

Weiss Associates, 1997a, Draft Final Site Characterization Report

Weiss Associates, 1997b, Draft Vadose Zone Modeling Report

Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples

Dames & Moore, 1993, Phase II Characterization

Dames & Moore, 1997, Engineering Evaluation/Cost Analysis, Groundwater Interim Remedial Action

(1) Includes contaminated areas for OU1 +OU2 + total area of OU3, to account for eastern and western dog pens.
Eastern dogpens are actually under UC Davis OU5, but might contribute to ground water contamination.
RESRAD can accept only one area, not a surface area and a subsurface area, therefore value conservatively calculated.

ATTACHMENT J

RESRAD INPUT PARAMETER REPORT

— IT CALCULATIONS

— RESRAD OUTPUT FILE INPUT PARAMETER SUMMARY

INTERNATIONAL TECHNOLOGY CORPORATION

GFE Date 4/23/97 Subject LEHR NEW RESRAD Sheet No. 1 of 10
Chkd. By ____ Date ____ SOIL ACTION LEVELS Proj. No. 770529

CALCULATION of RESRAD INPUT PARAMETERS CORRESPONDING TO

Contaminated Zone Parameters (R011)

Area of Contaminated Zone:
Sum of OU-1, OU-2, OU-3, OU-4 areas

OU-4 = 0 m^2 (Septic Tanks)

$A = 970 m^2 + 510 m^2 + \cancel{1300} 14720 m^2 = \cancel{2780} 16,200 m^2$ (Ref 2)

GP 4/97

Thickness of Contaminated Zone = 4.57 m (Ref. 1)

Length Parallel to Aquifer Flow = 28 m (Ref. 2)

Basic Radiation Dose Limit = calculated during individual runs

Time Since Material Emplacement = 0 (RESRAD Default)

Times for Calculation: 1, 2, 10, 30, 100, 1000. (Ref. 3)

Initial Concentration of Principal Radionuclides (R012)

Calculated during individual runs.

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INTERNATIONAL TECHNOLOGY CORPORATION

By GTZ Date 4/23/97 Subject LEHR NEW RESRAD Sheet No. 2 of 10
Chkd. By ___ Date ___ SOIL ACTION LEVELS Proj. No. 777529

Cover and Contaminated Zone Hydrogeological Data (RDI3)

Cover Depth = 0 m (Ref 3)

Density of Contaminated Zone = 1.7 g/cm³ (Ref 2)

Contaminated Zone Erosion Rate = 0.001 m/yr (RESRAD default)

Contaminated Zone Total Porosity = 0.39 (Ref 2)

Contaminated Zone Effective Porosity = 0.19 (Ref 2)

Contaminated Zone Hydraulic Conductivity = 0.018 m/y (Ref 2)

Contaminated Zone b Parameter = 7.12 (Ref 4)

Evapotranspiration Coeff. = 0 (Ref 1)

Precipitation = 0.418 m/yr (Refs 1, 2)

Irrigation = 0 m/y + Irrigation Mode = not applicable (Ref 2)

Runoff coefficient = 0.93 (calculated as described in Ref 1)

Watershed area for nearby stream/pond = determined (as described in Ref 5)

Accuracy for water/soil computation = 0.001 (RESRAD default)

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INTERNATIONAL TECHNOLOGY CORPORATION

By BZE Date 4/23/97 Subject LEHR NEW RESRAD Sheet No. 3 of 10
Chkd. By ___ Date ___ SOIL ACTION LEVELS Proj. No. 22829

Saturated Zone Hydrological Data (R014)

Density of Saturated Zone = 1.7 g/cm³ (Ref. 2)

Saturated Zone Total Porosity = 0.35 (Ref 2)

Saturated Zone Effective Porosity = 0.2 (RESRAD default)

Saturated Zone Hydraulic Conductivity = 400 m/y (Ref 2)
Saturated Zone Hydraulic Gradient = 0.0015 (Ref 10)
Saturated Zone b Parameter = 7.75 (Refs 3, 4)

Water Table Drop Rate = 0.001 m/y (RESRAD default)

Well Pump Intake Depth = 10 m below water table (RESRAD default)

Model for Water Transport Parameter
Nondispersion or Mass Balance = Nondispersion (Ref 3).
Well Pumping Rate = 250 m³/yr (RESRAD default)

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By GFE Date 4/23/97 Subject LEHR NEW RESRAD Sheet No. 4 of 10
Chkd. By ____ Date ____ SOIL ACTION LEVELS Proj. No. 770529

Uncontaminated and Unsaturated Strata
Hydrological Data (R015)

Number of Unsaturated Strata = 1 (Ref 2)

Thickness = 9.14 m (Ref 1)
Soil Density = 1.7 g/cm³ (Ref 2)
Total Porosity = 0.38 (Ref 2)
Effective Porosity = 0.08 (Ref 2)
Soil Specific b Parameter = 7.12 (Ref 3, 4)
Hydraulic Conductivity = 0.018 m/y (Ref 2)

Distribution Coefficients (R011e)

RESRAD default values for each radionuclide and daughter.

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INTERNATIONAL TECHNOLOGY CORPORATION

By GTL Date 4/25/97 Subject LEHR NEW RESRH Sheet No. 6 of 10
Chkd. By ___ Date ___ SOIL ACTION LEVELS Proj. No. 770529

Time Fractions: Scenarios 1, 2, 3 Fraction of time at site spent out doors = 0.33 (Ref 6)
at site spent indoors = 0.67

Scenario 1

Fraction of time at site: EF = 250 d/y (Ref 6).

$$F_t = \frac{EF\ d/y}{365\ d/y} = \frac{250\ d/y}{365\ d/y} = 0.685$$

Fraction of time spent in gamma field = Te = 0.33

$$\text{Assume } Te = \frac{8\ hr/day \text{ in gamma field}}{24\ hr/day} = 0.33$$

Fraction of time spent at site in gamma field:

$$F_\gamma = F_t \times Te = 0.685 \times 0.33 = 0.226$$

$$F_{indoors} + F_{outdoors} = 0.226$$

$$\frac{F_{indoors}}{F_{outdoors}} = \frac{0.67}{0.33} = 2$$

$$3F_{outdoors} = 0.226$$

$$F_{outdoors} = 0.075$$
$$F_{indoors} = 0.151.$$

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INTERNATIONAL TECHNOLOGY CORPORATION

By RFE Date 4/23/97 Subject LEHR NEW RESRAD Sheet No. 2 of 10
Chkd. By ___ Date ___ SOIL ACTION LEVELS Proj. No. 770529

Time Fractions:

Scenarios 2, 3 EF = 350 d/y (Ref 6)

$F_t = \frac{350\ d/y}{365\ d/y} = 0.959$ $F_{out} = 0.33$ (Ref 6)

Fraction of day spent in gamma field = $T_e = 1.0$ Ref (6)

$F_{in} + F_{out} = F_t \times T_e$

$F_{out} = 0.33 \times 0.959 = 0.317$ (rounded)

$F_{in} = 0.67 \times 0.959 = 0.642$ (rounded)

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INTERNATIONAL TECHNOLOGY CORPORATION

By GFC Date 4/23/97 Subject LEHR NEW RESRAD Sheet No. 8 of 10
Chkd. By ___ Date ___ SOIL ACTION LEVELS Proj. No. 220529

Ingestion Pathway, Dietary Parameters (ROIR)

Fruits, non leafy veg. + grain consumption

$= 40\ g/day \times 10^{-3}\ kg/g \times 365\ day/yr = 14.6\ kg/yr$

Leafy vegetable consumption

$= 40\ g/day = 14.6\ kg/yr$

The total plant food intake = 80 g/day = 29.2 kg/yr (Ref 6)
It was assumed that this intake was equally divided between leafy and non-leafy plants. (Ref 9)

Milk Consumption = 0.17 L/day × 365 day/yr = 62 L/yr (Ref 6,9)

Meat + Poultry Consumption = 0.25 kg/day × 365 d/y = 91 kg/yr (Ref 6)

Fish Consumption = 54 g/day × 365 day/yr × 10^{-3} kg/g = 19.7 kg/yr (Ref 6)

Other Seafood Consumption = 0 (Ref 9)

Soil Ingestion (Adult) = 100 mg/day × 10^{-3} g/mg × 365 day/yr = 36.5 g/yr
(Ref 6,9)

For Scenario 1: Soil Ingestion (Adult) = 50 mg/day × 10^{-3} g/mg × 365 day/yr = 18.25 g/yr

Drinking Water Intake (Adult) = 2 L/day × 365 day/yr = 730 L/y (Ref 6,9)

Contamination Fraction (Ref 6)

Drinking Water	= 1
Livestock Water	= 1
Irrigation Water	= Not Used
Aquatic Food	= 0.5
Plant Food	= 1
Meat	= 1
Milk	= 1

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INTERNATIONAL TECHNOLOGY CORPORATION

By GTE Date 4/23/97 Subject LEHR NEW RESRAD Sheet No. 9 of 10
Chkd. By ___ Date ___ SOIL ACTION LEVELS Proj. No. 220529

Ingestion Pathway Data, Nondietary Parameters (Ref 19)

Livestock ingestion rate parameters = RESRAD Default

Mass Loading for Foliar Deposition (Ref 7)

Scenario 1 = 5.28E-06 g/m³
Scenario 2 = 1.40E-09 g/m³
Scenario 3 = 9.70E-09 g/m³

Depth of Soil Mixing Layer = 0.15 m RESRAD default

Depth of Roots = 0.9 m RESRAD default

Storage Times before use of foodstuffs = RESRAD default

Groundwater Fractional Use RESRAD default
Drinking Water = 1
Livestock Water = 1
Irrigation = Not Applicable

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INTERNATIONAL TECHNOLOGY CORPORATION

By GTE Date 4/23/97 Subject LEHR NEW RESRAD Sheet No. 10 of 10
Chkd. By ___ Date ___ SOIL ACTION LEVELS Proj. No. 270529

References:

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2. Weiss fax from John Pekala 4/23/97 11:14 AM
3. IT Document, December, 1996
4. T.E. Chapman, Pacific Northwest Laboratory PNL-8873, UC-900, 1993.
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7. Weiss fax from Carolyn Atwood 4/18/97 12:34 PM
8. Weiss e-mail from Carolyn Atwood 4/3/97 1:43 PM
9. Telephone conversation with Carolyn Atwood 4/25/97 5:15 PM
10. Telephone conversation with Carolyn Atwood 9/28/97 12:16 PM

FINAL
7/97

RESRAD, Version 5.62 T½ Limit = 0.5 year 05/19/97 15:26 Page 1
Summary : LEHR NEW RESRAD SCENARIO 2 EAST RESIDENT Am-241 10-6 RISK
File : AM206.DAT

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary 3
Summary of Pathway Selections 7
Contaminated Zone and Total Dose Summary 8
Total Dose Components
Time = 0.000E+00 9
Time = 1.000E+00 10
Time = 2.000E+00 11
Time = 1.000E+01 12
Time = 3.000E+01 13
Time = 1.000E+02 14
Time = 6.697E+02 15
Time = 1.000E+03 16
Dose/Source Ratios Summed Over All Pathways 17
Single Radionuclide Soil Guidelines 17
Dose Per Nuclide Summed Over All Pathways 18
Soil Concentration Per Nuclide 18

RESRAD, Version 5.62 T½ Limit = 0.5 year 05/19/97 15:26 Page 2
Summary : LEHR NEW RESRAD SCENARIO 2 EAST RESIDENT Am-241 10-6 RISK
File : AM206.DAT

Dose Conversion Factor (and Related) Parameter Summary
File: DOSFAC.BIN

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Am-241	4.440E-01	4.440E-01	DCF2(1)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(2)
B-1	Th-229+D	2.160E+00	2.160E+00	DCF2(3)
B-1	U-233	1.350E-01	1.350E-01	DCF2(4)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Am-241	3.640E-03	3.640E-03	DCF3(1)
D-1	Np-237+D	4.440E-03	4.440E-03	DCF3(2)
D-1	Th-229+D	4.030E-03	4.030E-03	DCF3(3)
D-1	U-233	2.890E-04	2.890E-04	DCF3(4)
D-34	Food transfer factors:			
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(1,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(1,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(1,3)
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(2,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(3,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(3,3)
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(4,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(4,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(4,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Am-241 , fish	3.000E+01	3.000E+01	BIOFAC(1,1)
D-5	Am-241 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(2,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(2,2)
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(3,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(3,2)
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(4,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(4,2)

RESRAD, Version 5.62 T½ Limit = 0.5 year 05/19/97 15:26 Page 3
Summary : LEHR NEW RESRAD SCENARIO 2 EAST RESIDENT Am-241 10-6 RISK
File : AM206.DAT

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Used by RESRAD Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.620E+04	1.000E+04	—	AREA
R011	Thickness of contaminated zone (m)	4.570E+00	2.000E+00	—	THICK0
R011	Length parallel to aquifer flow (m)	2.800E+01	1.000E+02	—	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.676E-01	3.000E+01	—	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	—	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	—	T(2)
R011	Times for calculations (yr)	2.000E+00	3.000E+00	—	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	—	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	—	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	—	T(6)
R011	Times for calculations (yr)	6.697E+02	3.000E+02	—	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	—	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	—	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	—	T(10)
R012	Initial principal radionuclide (pCi/g): Am-241	1.751E-02	0.000E+00	—	S1(1)
R012	Concentration in groundwater (pCi/L): Am-241	not used	0.000E+00	—	W1(1)
R013	Cover depth (m)	0.000E+00	0.000E+00	—	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	—	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	—	VCV
R013	Density of contaminated zone (g/cm**3)	1.700E+00	1.500E+00	—	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	—	VCZ
R013	Contaminated zone total porosity	3.900E-01	4.000E-01	—	TPCZ
R013	Contaminated zone effective porosity	1.900E-01	2.000E-01	—	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.800E-02	1.000E+01	—	HCCZ
R013	Contaminated zone b parameter	7.120E+00	5.300E+00	—	BCZ
R013	Humidity in air (g/cm**3)	not used	8.000E+00	—	HUMID
R013	Evapotranspiration coefficient	0.000E+00	5.000E-01	—	EVAPTR
R013	Precipitation (m/yr)	4.180E-01	1.000E+00	—	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	—	RI
R013	Irrigation mode	overhead	overhead	—	IDITCH
R013	Runoff coefficient	7.600E-01	2.000E-01	—	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+21	1.000E+06	—	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	—	EPS
R014	Density of saturated zone (g/cm**3)	1.700E+00	1.500E+00	—	DENSAQ
R014	Saturated zone total porosity	3.500E-01	4.000E-01	—	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	—	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	4.000E+02	1.000E+02	—	HCSZ
R014	Saturated zone hydraulic gradient	1.500E-03	2.000E-02	—	HGWT
R014	Saturated zone b parameter	7.750E+00	5.300E+00	—	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	—	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	—	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	—	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	—	UW
R015	Number of unsaturated zone strata	1	1	—	NS

RESRAD, Version 5.62 T½ Limit = 0.5 year 05/19/97 15:26 Page 4
Summary : LEHR NEW RESRAD SCENARIO 2 EAST RESIDENT Am-241 10-6 RISK
File : AM206.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	9.140E+00	4.000E+00	—	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.700E+00	1.500E+00	—	DENSUZ(1)
R015	Unsat. zone 1, total porosity	3.800E-01	4.000E-01	—	TPUZ(1)
R015	Unsat. zone 1, effective porosity	8.000E-02	2.000E-01	—	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	7.120E+00	5.300E+00	—	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.800E-02	1.000E+01	—	HCUZ(1)
R016	Distribution coefficients for Am-241				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	—	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	—	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	0.000E+00	2.000E+01	—	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.383E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.036E+02	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	2.036E+02	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	0.000E+00	-1.000E+00	2.036E+02	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.336E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	—	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	—	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	0.000E+00	6.000E+04	—	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.152E-07	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	—	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	—	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	0.000E+00	5.000E+01	—	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.571E-04	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	—	INHALR
R017	Mass loading for inhalation (g/m**3)	5.800E-10	2.000E-04	—	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	—	LM
R017	Exposure duration	3.000E+01	3.000E+01	—	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	—	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	—	SHF1
R017	Fraction of time spent indoors	6.420E-01	5.000E-01	—	FIND
R017	Fraction of time spent outdoors (on site)	3.170E-01	2.500E-01	—	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	1 shows circular AREA.	FS

RESRAD, Version 5.62 T½ Limit = 0.5 year 05/19/97 15:26 Page 5
Summary : LEHR NEW RESRAD SCENARIO 2 EAST RESIDENT Am-241 10-6 RISK
File : AM206.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	—	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	—	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	—	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	—	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	—	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	—	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	—	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	—	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	—	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	—	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	—	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	—	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	—	FRACA(1)
R017	Ring 2	not used	2.732E-01	—	FRACA(2)
R017	Ring 3	not used	0.000E+00	—	FRACA(3)
R017	Ring 4	not used	0.000E+00	—	FRACA(4)
R017	Ring 5	not used	0.000E+00	—	FRACA(5)
R017	Ring 6	not used	0.000E+00	—	FRACA(6)
R017	Ring 7	not used	0.000E+00	—	FRACA(7)
R017	Ring 8	not used	0.000E+00	—	FRACA(8)
R017	Ring 9	not used	0.000E+00	—	FRACA(9)
R017	Ring 10	not used	0.000E+00	—	FRACA(10)
R017	Ring 11	not used	0.000E+00	—	FRACA(11)
R017	Ring 12	not used	0.000E+00	—	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.460E+01	1.600E+02	—	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.460E+01	1.400E+01	—	DIET(2)
R018	Milk consumption (L/yr)	6.200E+01	9.200E+01	—	DIET(3)
R018	Meat and poultry consumption (kg/yr)	9.100E+01	6.300E+01	—	DIET(4)
R018	Fish consumption (kg/yr)	1.970E+01	5.400E+00	—	DIET(5)
R018	Other seafood consumption (kg/yr)	0.000E+00	9.000E-01	—	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	—	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	—	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	—	FDW
R018	Contamination fraction of household water	not used	1.000E+00	—	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	—	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	—	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	—	FR9
R018	Contamination fraction of plant food	1.000E+00	-1	—	FPLANT
R018	Contamination fraction of meat	1.000E+00	-1	—	FMEAT
R018	Contamination fraction of milk	1.000E+00	-1	—	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	—	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	—	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	—	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	—	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	—	LSI

RESRAD, Version 5.62 T½ Limit = 0.5 year 05/19/97 15:26 Page 6
Summary : LEHR NEW RESRAD SCENARIO 2 EAST RESIDENT Am-241 10-6 RISK
File : AM206.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	1.400E-09	1.000E-04	—	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	—	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	—	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	—	FGWDW
R019	Household water fraction from ground water	0.000E+00	1.000E+00	—	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	—	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	—	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	—	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	—	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	—	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	—	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	—	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	—	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	—	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	—	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	—	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	—	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	—	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	—	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	—	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	—	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	—	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	—	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	—	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	—	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	—	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	—	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	—	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	—	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	—	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	—	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	—	DIFCV
R021	in foundation material	not used	3.000E-07	—	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	—	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	—	HMIX
R021	Average annual wind speed (m/sec)	not used	2.000E+00	—	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	—	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	—	HRM
R021	Building interior area factor	not used	0.000E+00	—	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	—	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	—	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	—	EMANA(2)

RESRAD, Version 5.62 T½ Limit = 0.5 year 05/19/97 15:26 Page 7
Summary : LEHR NEW RESRAD SCENARIO 2 EAST RESIDENT Am-241 10-6 RISK
File : AM206.DAT

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed