PUBLIC HEALTH EVALUATION

MARSH RUN PARK

NEW CUMBERLAND ARMY DEPOT
FAIRVIEW TOWNSHIP, PENNSYLVANIA

Prepared by:

U.S. Army Corps of Engineers, Omaha District

Omaha, Nebraska

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EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers - Omaha District- has prepared a report addressing the contaminants present in the surface soils at the former landfill adjacent to the existing New Cumberland Army Depot, Fairview Township, Pennsylvania.

The objective of this study is to present a public health evaluation of the landfill area, analyzing the potential health risks from exposure to the soils, groundwater, surface water and air around the landfill potentially contaminated with hazardous substances.

The landfill site is approximately 14 acres in size and is currently used as a soccer field for children. Reportedly 600 children a year have played on the site since the township purchased the site in 1976. The landfill was originally designated as a disposal site for damaged canned goods, and domestic items from the period of 1917 to 1950. All landfill activities ceased in 1950 until 1976 when the area was purchased by the township.

Chemical results for soil studies were assessed to determine the presence or absence of contamination. Based on the sampling results the arithmetic representation or public health evaluation shows no health hazard to the children playing at the Marsh Run Park.

ANALYTICAL RESULTS:

The Corps of Engineers performed sampling of the surface soils at the Marsh Run Park at the New Cumberland Army Depot on May 25, 1988 to determine if contamination is present and whether any possible human health hazards exist. Seven representative sampling locations on-site and one off-site (SS-7) were selected. Samples were analyzed for the presence of volatile organics, semi-volatile organics, PCBs, metals, and cyanide. Environmental Health Research and Testing, Inc. of Cincinnati, Ohio., performed the analysis.

Table 1 summarizes the results of the chemicals detected in the surface soils at the locations shown in Figure 1.

In four of the eight locations, low levels of polycyclic aromatic hydrocarbons (PAHs) were found at accumulative total concentrations ranging from 0.5 mg/kg in SS-4 to 49.4 mg/kg in SS-8. Phthalate ester concentrations ranged from non-detected (ND) to 1.89 mg/kg. Phthalate esters are typically prevalent as common laboratory contaminants. The only other semi-volatile organic compound found was dibenzofuran found in one sample (SS-8) at 0.58 mg/kg.

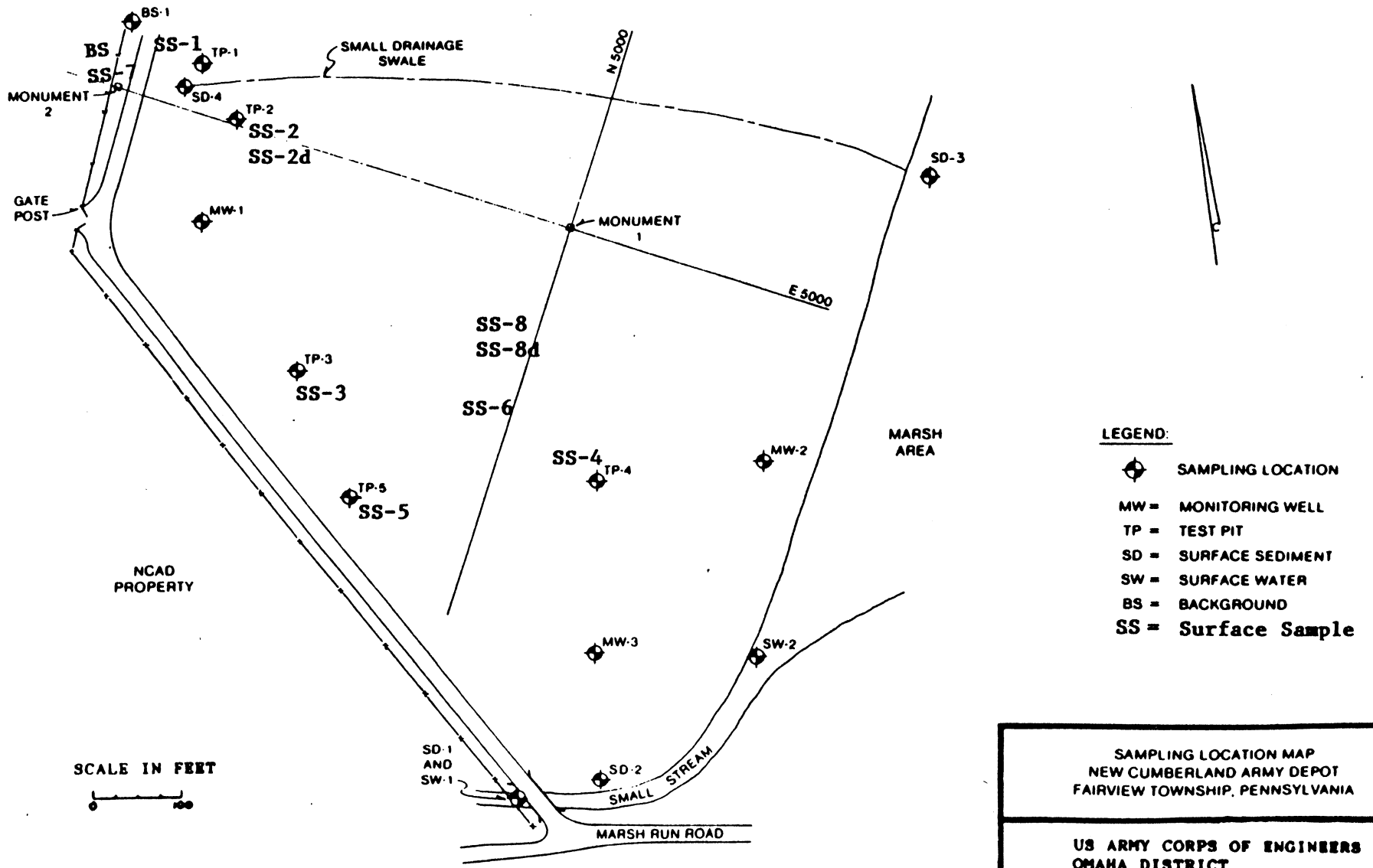
The analysis showed the presence of eight metals in concentration ranges from 3.33-16.6 mg/kg for chromium, 4.74-15.1 mg/kg for nickel, 2.77-6.93 mg/kg for arsenic, 5.29-39.9 mg/kg for copper, ND-0.36 mg/kg for mercury, ND-0.18 mg/kg for selenium, 36.7-80.1 mg/kg for zinc, and 10.8-130.0 mg/kg for lead. Lead was the only metal detected at significant levels above those found in the off-site sample (SS-7). at location SS-3.

No volatile organic compounds, cyanide, or PCBs were detected at

TABLE 1. RESULTS OF CHEMICAL ANALYSES OF SURFACE SOILS AT MARSH RUN FIELD, NEW CUMBERLAND, PENNSYLVANIA. ALL VALUES IN MG/KG (PPM).

ANALYTE	SS1	SS2	SS2D	SS3	SS4	SS5	SS6	SS7	SS8	SS8D
1.					0.16	0.85	0.78		8.10	4.84
2.					0.14	1.16	0.64		6.86	4.10
3.					0.16	0.51	0.45		7.15	3.63
4.						0.06			0.41	0.08
5.						0.08			0.26	0.06
6.					0.02	0.03			1.49	0.70
7.						0.52	0.39		3.97	1.93
8.						0.39	0.35		4.20	1.97
9.							0.16		1.93	0.75
10.							0.18		2.05	0.80
11.									0.96	0.38
12.									0.98	0.42
13.									2.04	0.90
14.									3.33	1.41
15.									1.77	0.89
16.									0.78	
17.									0.25	
18.									2.83	1.27
19.									0.58	0.22
20.	0.10	0.17	0.07	0.11	0.19	0.08			0.07	0.07
21.	0.56	0.84	0.38	0.63	1.12	0.47	0.91	0.99	0.62	0.57
22.				0.61	0.69	1.27	1.60	1.89		0.94
23.	4.23	6.93	6.79	6.36	2.77	6.81	3.93	4.19	6.22	5.63
24.	9.03	8.88	9.28	3.33	14.60	4.23	13.10	14.80	8.36	10.60
25.	10.90	18.70	19.70	16.60	12.80	13.40	5.29	9.38	39.90	26.60
26.	10.80	12.50	14.10	130.00	25.10	73.70	21.90	15.30	44.00	27.30
27.	0.34	0.08	0.15	0.13	0.14	0.36	0.19	0.13	0.40	
28.	10.30	14.00	15.10	4.82	12.40	4.74	10.60	10.80	8.87	11.70
29.				0.18	0.12	0.12	0.08	0.16	0.10	0.04
30.	36.70	48.20	50.20	77.90	56.60	80.10	45.70	39.90	57.70	64.90

1. FLUORANTHENE
2. PYRENE
3. PHENANTHRENE
4. NAPHTHALENE
5. 2-METHYLNAPHTHALENE
6. ANTHRACENE
7. CHRYSENE
8. BENZO(A)ANTHRACENE
9. INDENO(1,2,3-C-D)PYRENE
10. BENZO(G,H,I)PERYLENE
11. ACENAPHTHENE
12. FLUORENE
13. BENZO(B)FLUORANTHENE
14. BENZO(A)PYRENE
15. BENZO(K)FLUORANTHENE
16. DIBENZO(A,H)ANTHRACENE
17. 1-METHYLNAPHTHALENE
18. BENZ(E)ACEPHENANTHRYLENE
19. DIBENZOFURAN
20. DIETHYLPHTHALATE
21. DI-N-BUTYLPHTHALATE
22. BIS(2-ETHYL-HEXYL)-PHTHALATE
23. ARSENIC
24. CHROMIUM
25. COPPER
26. LEAD
27. MERCURY
28. NICKEL
29. SELENIUM
30. ZINC



SAMPLING LOCATION MAP
NEW CUMBERLAND ARMY DEPOT
FAIRVIEW TOWNSHIP, PENNSYLVANIA

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
MAY 28, 1988

FIGURE 2

the eight sampling locations.

PUBLIC HEALTH EVALUATION:

A public health evaluation or assessment of potential risk of human health hazards at the Marsh Run soccer field was performed according to current EPA guidelines found in the EPA Superfund Exposure Assessment Manual, the EPA Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites, and the EPA Superfund Public Health Assessment Manual. The public health assessment provided below was generated from the above data according to current EPA guidelines including the selection of indicator compounds, possible routes of exposure (dermal, inhalation, and ingestion), and evaluation of any potential health hazards. The chemical contaminants found in the former landfill area are evaluated in the following sections of the public health evaluation

A. Indicator Chemical Selection.

The concentration, toxicity, mobility, and persistence of the contaminants present, are factors to be considered in choosing the highest risk chemicals of concern. Table 2 list physical characteristics and toxicity values used to evaluate contaminants.

Table 2

Contaminant	Maximum Concentration mg/kg	Vapor Pressure mm Hg	Koc ml/g	Ranking PC¹	Ranking NC¹	Toxicity Constants (sTc)mg/kg
Diethylphthalate	0.19	3.5E-03	142		X	1.3E-08
Di-nButylphthalate	0.99	1.0E-05	170000		X	1.9E-06
B(2-Ethyl-Hexyl)phthalate	1.89	NA	NA	X		2.8E-08
Fluoranthene	8.10	5.0E-06	38000		X	[280mg/kgTDLo]*
Pyrene	6.86	2.5E-06	38000		X	[10mg/kgTDLo]*
Phenanthrene	7.15	6.8E-04	14000		X	[71mg/kgTDLo]*
Naphthalene	0.41	NA	NA		X	[3500mg/kgTDLo]*
2Methylnaphthalene	0.26	NA	NA		X	NA
Anthracene	1.49	1.9E-04	14000		X	[300mg/kgTDLo]*
Chrysene	3.97	6.3E-09	200000	X		[3600ug/kgTDLo]*
Benz(a)Anthracene	4.20	2.2E-08	1380000	X		2.9EE-05
Ideno(1,2,3cd)pyrene	1.97	1.0E-10	1600000	X		[72mg/kgTDLo]*
Benzo(g,h,i)perylene	2.05	1.0E-10	1600000		X	NA
Acenaphthene	0.96	1.5E-03	4600		X	NA
Fluorene	0.98	7.1E-04	7300		X	NA
Dibenzofuran	0.58	NA	NA		X	NA
Benzo(b)fluoranthene	2.04	5.0E-07	550000	X		[72mg/kgTDLo]*
Benzo(a)pyrene	3.33	5.6E-09	5500000	X		2.2E-04
Benzo(k)Fluoranthene	1.77	5.1E-07	550000	X		[2820mg/kgTDLo]*
Dibenzo(a,h)Anthracene	0.78	1.0E-10	3300000	X		5.4E-04
Benz(e)Acephenanthrylene	2.83	NA	NA	X		[72mg/kgTDLo]*
Arsenic	6.93			X		2.0E-05
Chromium	16.60			X		1.1E+02(aTc)
Copper	39.90				X	3.5E-05
Lead	130.00				X	4.5E-05
Mercury	15.10				X	9.1E-04
Selenium	0.17				X	5.2E-03
Zinc	80.10				X	5.3E-06

1-NC is noncarcinogen, PC is potential carcinogen
*-Toxicity constants not available for these substances, however values were available through RTECS, TDLo=Toxic Dose Low=lowest dose known to produce a toxic effect.
NA-Information not available

Benzo(a)pyrene and lead were chosen to represent health risks associated with children playing at the former landfill.

Benzo(a)pyrene was selected to represent the carcinogenic risk from the PAH's (polycyclic Aromatic Hydrocarbons) based on concentrations in the soil, the tendency to adhere to soil particles, and the carcinogenic potency. They are insoluble in water, and as seen in Table 2, adhere very strongly to soils, i.e., PAHs move very little in soil and groundwater. PAHs are lipid soluble which may be of concern with respect to their exposure to the skin.

Lead was selected due to the concentrations compared to the other metal concentrations in the soil, and for known toxicity data, especially with children.

B. Exposure Pathways

A mechanism for a release of a contaminant to the environment is the second step in determining the potential risk or hazard of exposure. Once a source is identified, the transport medium (e.g., air, ground, or water) for the released chemical contaminant is developed.
For a landfill, contamination transport can occur by gas generation, air entrainment of contaminated soil particles, groundwater or surface water.

Properties of benzo(a)pyrene and lead are such that gas generation from the landfill, and leaching to the groundwater would not be likely scenarios for contaminant migration. Benzo(a)pyrene has a high Koc value which indicates it would adhere strongly to soil particles, and a low vapor pressure which would preclude any volatilization from the soil. Lead like all metals, has little mobility in soil without a driving mechanism, and no volatilization from any medium.

The only likely exposure pathway for these two contaminants would be by fugitive dust emission .

C. Exposure Routes and Contact Points

There are three potential human exposure routes for the contaminated soil. Children playing soccer at the former landfill area were modeled assuming skin contact may occur, children will inhale dust particles, and will inadvertently ingest soil by hand to mouth contact. Other populations would be too distant to be affected.

D. Exposure Point Concentrations

1. Dust, Inhalation.

To determine the concentrations of contaminants in the dust generated by any activity on site, and any erosion/dispersion of dust particles, a simple model was devised.

Emission Factor = 0.036 (a/d)exp3 (f(x))

The following basic assumptions were applied:

a = Average wind velocity for the Harrisburg area = 3.4 m/sec
b = Soil particle size = 75 um
c = Threshold Friction Velocity = 50cm/sec
d = Threshold wind speed = 7.5 m/sec
e = Approximate area of the landfill = 56,000 m2
x = Estimate of unlimited erosion = 1.95 (unitless factor)
g = concentration of the contaminant in the soil
f(x) = Estimate of unlimited erosion = 0.5

Annual Average Emission Factor of the dust is equal to;

E = 0.036[(3.4/7.5)exp3] 0.5
E = 0.00167 g/hr/m2

The Annual Average Emission Rate of the Contaminant in the dust is:

R= Emission Rate = e (g) E

For Benzo(a)Pyrene
R = 56,000 m2 (3.3E-6) 0.00167 (1/60 x 1/60) = 8.57E-02 ug/sec

For Lead
R = 56,000 m2 (130E-6) 0.00167 (1/60 x 1/60) = 3.37 ug/sec

b. The Concentration of the Contaminant at the exposure point (breathing zone of the soccer player) is then:

C(x) = concentration at the exposure point
Oy = dispersion coefficient in the lateral (crosswind) direction = 0.5m
Oz = dispersion coefficient in the vertical direction = 2.5m
u = mean wind speed = 3.4 m/sec
pi = 3.14

C(x) = R / (pi (OyOz) u)

For Benzo(a)Pyrene
=(8.57E-02 ug/sec) / (3.14)(.5 x 2.5)(3.4)
= 6.42E-03 ug/m3

For Lead
= (3.37 ug/sec)/ (3.14) (.5 x 2.5) (3.4)
= 0.25 ug/m3

2. Dermal Contact
The concentration the soccer players skin would be exposed to would be the actual concentration in the surface soil; 3.33 mg/kg.

3. Ingestion of Soil
Ingestion concentrations would be the actual concentrations in the soil; 3.33 mg/kg. Incidental ingestion of the dust containing the contaminants from hand to mouth behavior would be 100 mg/day of dust.

E. Dose Calculations and Risk

In a public health evaluation the potential exposure time must be estimated in order to establish the possible human dose such as the users

of the Marsh Run field. The exposure time considered in the assessment was two hours per day, five days per week, four months of the year for ten years. Obviously, the actual exposure to individuals would vary greatly but for the purposes of this model this exposure was selected to provide information on a worst case exposure.

Inhalation of Dust

The Following assumptions were made for the Dose Calculation:

a. The players were exposed to the dust 2 hours a day, 5 days a week, 16 weeks a year, for a ten year period.
b. The average body weight of the children was 57 kg.
c. The inhalation rate for the children while playing was 7.1 m3/hour.

2. The Dose is calculated as follows:

Dose =[(Exposure)(Frequency of)(Concentration)(Inhalation)] / (Body)
Period Exposures in Dust Rate Weight

For Benzo(a)Pyrene
Dose = {[(2hr/d)(5d/wk)(16wk/yr)(10yr/lifetime)(1lifetime/2.54E04d)] x [(6.42E-03ug/m3)(7.1m3/hr)]} / (57kg)
= 7.09E-09 mg/kg-day

For Lead
Dose = {[(2hr/d)(5d/wk)(16wk/yr)(10yr/lifetime)(1lifetime/2.54E04)] x [(0.25ug/m3)(7.1m3/hr)]} / (57kg)
= 1.96E-06 mg/kg-day

3. The Cancer Risk for inhalation of dust contaminated with benzo(a)pyrene is therefore:

Risk = Potency Factor x Dose
= 6.1(mg/kg-day)-1 x 7.09E-09mg/kg-day
= 4.32E-08
= 4 in 100,000,000

4. The Calculation of the non-cancer health risk can be determined by the hazard Index. A hazard index of greater than one indicates an adverse health effect. For Lead then, the Hazard index is:

Hazard Index = Dose / Reference Dose
= (1.96E-06mg/kg-day) / (4.3E-04mg/kg-day)
= 4.5E-03

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Dermal Contact.

1. The following assumptions were made to determine the dose received from dermal contact:

a. The exposure period was 2 hrs a day, 5 day a week, 16 weeks a year and 10 years out of the total lifetime.
b. The surface area of skin exposed on each child was 800cm2.
c. Soil adherence to the skin is 1.45 mg/cm2

The dose calculation is as follows:

For Benzo(a)pyrene
Dose = {[(800 events/lifetime)(1lifetime/2.54E+04d)] x
[(800cm2)(1.45mg/cm2)(3.3E-06)]} / {(57kg)}
Dose = 2.11E-06 mg/kg-day

For Lead
Dose = {[(800 events/lifetime)(1lifetime/2.54E+04d)] x
[(800cm2)(1.45mg/cm2)(130E-06)]} / {(57kg)}
Dose = 8.33E-05 mg/kg-day

2. The cancer risk from dermal absorption of benzo(a)pyrene through the skin is calculated as follows:

Risk = Dose x Potency Factor

= 2.11E-06mg/kg-day x 11.5 (mg/kg-day)-1
= 2.4E-05

3. The Non-carcinogenic health hazard risk for lead is:

Health Hazard Index = Dose / Reference Dose

= 8.33E-05mg/kg-day / 1.4E-03 mg/kg-day
= 5.95E-02
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Ingestion of Soils

1. Ingestion of soil by the children would be inadvertent; hand to mouth behavior, incidental ingestion during inhalation. The following parameters were used to calculate the dose for ingestion:

a. Exposure event frequency is 2 hrs a day, 5 days a week, 16 weeks a year, and 10 years out of the total lifetime.
b. Inadvertent ingestion quantity of soil of 100mg/day
c. Absorption in the intestinal tract is 100%

For Benzo(a)Pyrene
Dose = {[(5 days/wk)(16wk/yr)(10yrs/lifetime)(1lifetime/2.54E+04days)]
x [(100mg/day)(3.3E-06)]} / [(57kg)]
= 1.82E-07 mg/kg-day

For Lead
Dose = {[(5days/wk)(16wk/yr)(10yrs/lifetime)(1lifetime/2.54E+04days)]
x [(100mg/day)(130E-06)]} / [57kg]
= 7.2E-06mg/kg-day

2. The cancer risk from ingesting the benzo(a)pyrene contaminated soils is as follows:

Risk = Dose x Potency Factor
= 1.82E-07 mg/kg-day x 11.5 (mg/kg-day)-1

= 2.09E-06

3. The health hazard effects for lead for soil ingestion is as follows:

Hazard Index = Dose / Reference Dose
= 7.2E-06mg/kg-day / 1.4E-03mg/kg-day
= 5.1E-03

F. Total Carcinogenic Risk and Health Hazard Effects

The total risk can be calculated by summing the risk values for exposure to PAH's for each contact point, the total risk is determined as:

Total Risk = (risk from inhalation) + (risk from ingestion) + (risk from dermal contact)
= 4.32E-08 + 2.06E-06 + 2.4E-05
= 2.06E-05 total cancer risk or 2 in 100,000 people will possibly contract cancer.

For lead the health hazard effects are determined by summing the health hazard indices for each exposure scenarios:

Hazard Index, total = 4.5E-03 + 4.95E-02 + 5.13E-03
= 5.9E-03
A Value less than 1.00 indicates no adverse health effects are expected based on the concentrations of lead found in the landfill area.

G. Evaluation of the Results.

The total cancer risk covering all exposure pathways falls with the acceptable limits proposed by the EPA in the EPA Superfund Public Health Evaluation Manual.

A total cancer risk of 2.06E-05 covers all exposure pathways; ingestion, inhalation of dust, and dermal contact with the soils. This number is comparable to 2 in 100,000. The acceptable range developed by EPA is 1.0E-04 to 1.0-07, or 1 in 10,000 to 1 in 10,000,000, with the value of 1.0E-06, or 1 in 1,000,000 being the preferred risk level. The value determined by the public health evaluation 2.06E-05 falls within the acceptable range.

In calculating the risk levels the conservative approach was applied, i.e., for dermal exposure the assumption was made that soil in contact with the skin, all the contaminant present in the soil would be absorbed in the body. In actuality only a very small percentage of benzo(a)pyrene would be absorbed through the skin. Therefore, risk from this scenario would be much lower.

For inhalation, the landfill was considered to be bare of vegetation, and the maximum possible erosion characteristics (potential for dust generation) were used. Actual dust levels due to amount of grassland present would be much less, and the corresponding risk level would be much smaller.

For all scenarios, since the maximum concentration of benzo(a)pyrene

found at the site was used in the calculation, the risk levels would be much lower if an average value from the sampling was employed. PAHs occur naturally in the environment in coal tars and are readily generated by incomplete combustion such as automobile exhaust and cigarette smoking, chimney soot are found in industrial activities such as coke ovens and coal refuse heaps and oil spills.
For lead, a non-carcinogen, cancer risk calculations are not applicable, but the health hazard indices are an indicator of possible adverse effects. Since all values fell below 1.00 , lead would not be considered to be a health risk. Lead occurs in metal ores which results in its prevalence naturally in soils. EPA Standard naturally occurring lead concentrations in soils in the United States is listed as 2-200 mg/kg, depending on the region of the country.

In conclusion the levels found in the surface soil at the Marsh Run Park, are in concentrations that would not present any unacceptable risks or health hazards to the children who have been exposed to the soils.