Human Health Risk Assessment

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EXECUTIVE SUMMARY

A human health risk assessment (HRA) was conducted to evaluate the chemical concentrations detected in the soil, sediments, and groundwater at the southeast portion [redacted]

Groundwater beneath the Site is not, and will not be, a source of potable or industrial [redacted]

[redacted]

Exposure Scenario	Estimated Carcinogenic Risks	Estimated Hazard Index
[redacted]	[redacted]	[redacted]
Sediment	1E-06	--
Recreational User		
Sediment	1E-06	0.007
Surface Water	8.E-08	0.002
[redacted]		

[redacted]

cis-1,2-dichloroethene (cis-1,2-DCE), vinyl chloride, and dissolved cadmium. Risk-based levels (RBLs) were developed for these constituents under the assumption that these constituents will ultimately reach the surface water in Frog Mortar Creek. The [redacted] Frog Mortar Creek, and were based on a target risk of 1 E-06 and a target hazard index of 0.1 for each chemical of concern.

The calculated RBLs for surface water in the creek are presented in the table below.

Analyte	**Risk-based Levels in Surface Water**
TCE	0.01 mg/L
cis-1,2-DCE	1.1 mg/L
Vinyl chloride	0.004 mg/L

The corresponding target cleanup goals for groundwater are the chemical concentrations that will not exceed the surface water RBLs when, and if, the chemical plumes in groundwater will ultimately reach Frog Mortar Creek. To calculate the target groundwater cleanup goals that would be protective of the recreational user, a dilution

Section 1
INTRODUCTION

On behalf of Lockheed Martin Corporation, Tetra Tech has prepared this human health risk assessment (HRA) that was conducted for the southeast portion of Martin State [redacted]

The risk assessment was conducted in accordance with the following guidance documents:

Risk Assessment Guidance for Superfund (RAGS); Part A, Vol. 1: Human Health Evaluation Manual, USEPA, 1989;

[redacted]

Updated Dermal Exposure Assessment Guidance, Region 3 Technical Guidance Manual, 2003,

Guidance for Data Usability in Risk Assessment, USEPA, 1992;

Superfund Exposure Assessment Manual (USEPA 1988) and .

93-001, January 2003.

State of Maryland Department of the Environment, Cleanup Standards for Soil accomplished by identifying the complete and significant pathways by which humans could potentially contact the COPCs in the areas of concern. Dose assessment predicts the amount of chemical intake (i.e., dose) of a potential receptor at a particular exposure point or location. Dose-receptor functions are used to correlate exposure doses to [redacted]

1.4 Organization of the HRA

Section 2 presents the background information on the Site. The physical and environmental setting, as well as a summary of the previous investigations, are [redacted]

human receptors that could be potentially exposed, and how the human receptors could [redacted]

Section 2
SITE BACKGROUND

2.1 Site Location and Description

[redacted]

The uppermost 10 to 20 feet of soil consists of fill materials that were placed during

[redacted]

poorly graded fine sands) were dominant from approximately 15 to 45 feet below mean

[redacted]

2.3 Site Hydrogeology

Groundwater elevations in the wells have ranged from 1.10 to 7.55 feet above msl from 2002 through 2004. The groundwater flow direction is to the east toward Frog Mortar Creek (Tetra Tech, 2003). Due to the Site's proximity to Frog Mortar Creek, a 12-hour

[redacted]

[redacted]

[redacted]

Administration (MAA) and by Lockheed Martin Corporation.

2.4.1 MAA's Investigations

[redacted]

(Correspondence from MDE, 1/6/92 and 1/14/97)

[redacted]

are four areas of concern (AOCs), namely:

- *Taxiway Tango Median Anomaly Area* – several anomalous zones [redacted]

[redacted]

- *Two Existing Ponds* – historical records suggest that acids may have been [redacted]

- *Petroleum Hydrocarbon Area* – a petroleum hydrocarbon area was encountered at the Site in 1996. The petroleum hydrocarbon area is located approximately 200 feet west of the ponds.

[redacted]

2.4.2 Lockheed Martin Corporation's Investigations

[redacted]

In March 1999, Lockheed Martin collected groundwater monitoring well data to obtain [redacted]

trichloroethane (TCA), trichloroethene (TCE), and vinyl chloride] and two dissolved metals (*beryllium* and *cadmium)* were present above the Maximum Contaminant Levels (MCLs) for drinking water.

Source Identification and Assessment Program - 2000

Additional investigations (*Source Identification and Assessment Program, Tetra Tech, 2000*) were conducted from March through June 2000 to identify the potential source/sources of the chemicals in groundwater. Each of the four AOCs listed in Section 2.4.1 was investigated through a combination of excavations, localized trenching, soil borings, and sampling and analyses of soil, sediments, and groundwater samples (Tetra Tech, 9/2000). VOCs, petroleum hydrocarbons, and metals were [redacted]

Data Gap and Hydrogeologic Investigation - 2003

groundwater investigation, and further evaluation of the vertical extent of groundwater

[illegible]

plumes, (3) to characterize the geology of the surficial aquifer, and (4) to conduct

[illegible]

chemical concentrations in groundwater indicate that three potential source areas (drum area, petroleum hydrocarbon and Pond #1 area, and Taxiway Tango median area) are present at the site contributing to three primary groundwater plumes. Based on the concentration and frequency of detection, three chlorinated VOCs (cis-1,2-DCE, TCE, and vinyl chloride) and one metal (dissolved cadmium) are considered the primary chemicals of concern.

Groundwater Modeling – 2003 -2004

Fate and transport modeling was conducted to evaluate dynamic changes of the

[illegible]

(Reactive Transport in 3-Dimensions) model code was used to model sequential decay

[illegible]

2.4.3 Sediment and Surface Water Investigations

In May 2000, sediment samples were collected from Ponds #1 and #2 and analyzed for

[illegible]

sediment and surface water samples from Frog Mortar Creek and surface water samples

[illegible]

Section 3
IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

3.1 Data Evaluation

As discussed in Section 1, the HRA was based on data from (a) soil and sediment investigations conducted from 2000 through 2002, (b) groundwater sampling conducted within the past two years, and (c) sediment and surface water sampling conducted in [redacted]

The data from the previous investigations were reviewed to ensure that the quantity and quality of the analytical data were suitable for risk assessment purposes. The quality of the data was evaluated based on the quality control samples that were collected and analyzed. Field quality control samples included field duplicates and trip blanks. Laboratory control samples included surrogate spikes. The quantity of quality control [redacted]

Assessment, Martin State Airport (Tetra Tech, 2004), it was stated that the HRA will [redacted]

of each AOC, thus, an AOC-specific risk evaluation does not have a defensible rationale. [redacted]

Information on the historical operations at the Site indicated that the potential sources of [redacted] site investigations focused on collecting soil samples from a depth of one foot bgs to a

were used to evaluate subsurface soil exposures.

This section describes the methodology of the screening evaluation that was intended to generate a reduced set of chemicals that will be evaluated quantitatively in the risk assessment. The methodology was consistent with the recommended methodology in the *Risk Assessment: Technical Guidance Manual* (USEPA Region 3, 2003).

2.3.1 Soil COPCs

subsurface soil, respectively. Each Table also shows the number of samples collected, the number of samples with detectable concentrations, the practical quantitation limit (PQL), the frequency of detection, the range of detected concentrations, the maximum

by EPA Region 3. The initial step was to compare the practical quantitation limit (PQL)

samples, and its PQL was at or lower than the EPA Region III industrial RBC, then the chemical was excluded from the ... However, if the PQL is

The next step in the screening evaluation was to compare the maximum concentration to the USEPA Region III industrial RBC. The identification of COPCs was based on the following:

- A chemical with a maximum detected concentration in soil that was higher than the industrial RBC was identified as a COPC.

- A chemical that was reported as a non-detect in all of the soil samples but had a [illegible] limit that was higher than the industrial RBC, was also identified as a [illegible]

[illegible]

- A chemical with a maximum concentration that was lower than the industrial RBC [illegible]

[illegible]

- A chemical that was not detected in all of the soil samples [illegible] limit [illegible] RBC was also eliminated from further [illegible]

[illegible]

COPC.

The soil COPCs are listed in the Table below.

Surface Soil COPCs	Subsurface Soil COPCs
Arsenic	Antimony
Lead	Arsenic
[illegible]	[illegible]
Benzo(a)pyrene	Lead
Benzo(b)fluoranthene	Mercury
[illegible]	[illegible]
	PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene].

PAHs – polycyclic aromatic hydrocarbons

It should be noted that lead, mercury, and carbazole were identified as COPCs because there are no published RBCs.

3.2.2 Groundwater COPCs

Table 2 in Appendix B [illegible] evaluation of the groundwater. The [illegible] of comparison was the tap water RBC established by USEPA Region III. Based on

[illegible]

3.2.3 Sediment COPCs

[illegible]

3.2.4 Surface Water COPCs

The surface water samples from the ponds and Frog Mortar Creek were analyzed for inorganic constituents, VOC, semi-VOCs, and PAHs. Table 4 in Appendix B also lists the detected constituents in the surface water samples. The highest surface water

[illegible]

If any one of the four elements is missing, the exposure pathway is considered incomplete.

[illegible]

Current potential exposure pathways are those that exist as a result of the current extent [illegible]

likely means of future pathway completion is chemical migration from one medium to another or changes in land use.

The proposed future land use of the Site will be similar to the current land use, as stipulated in a deed restriction that will be recorded for the Site. In addition to the fact [illegible]

industrial development. Therefore, potential exposures do not include potential exposures through inhalation of indoor air emissions from volatile COPCs that could [illegible]

Another Site-specific condition in this HRA is the absence of groundwater use at the Site. The groundwater beneath the Site is not, and will not be, a source of potable or industrial water supply. This Site-specific condition eliminates one of the components of a complete exposure pathway, i.e., a point of contact between a potential human receptor and the transport medium, namely, groundwater. Therefore, the exposure [illegible]

considered incomplete.

To summarize, the current and future exposure pathways for on-Site workers include the [illegible]

- Dermal contact with surface soil and sediments,
- Inhalation of air-borne particulates

[illegible] intermittent construction/excavation activities to a maximum depth of five feet bgs, the current and future construction worker was assumed to come into contact with the surface and subsurface soil. Since the shallowest groundwater table is deeper than five feet bgs, the current and future construction worker is not anticipated to have potential exposures to groundwater. Therefore, the current and future construction worker is assumed to have potential exposures through:

- Inhalation of air-borne particulates, and
- Dermal contact with surface and subsurface soil, and sediments.

Human receptors have restricted access to the existing ponds where benzo (a) pyrene was detected in one out of six sediment samples. Despite the restricted access, however, the HRA proceeded to evaluate potential exposures of the on-site worker to benzo (a) pyrene [illegible]

Potential exposures of the current and future recreational user to arsenic, the only sediment COPC in Frog Mortar Creek, were evaluated in the HRA. However, since there were no surface water COPCs in the pond areas, exposure pathways to surface water in the ponds [illegible]

4.1.2 Current and Future Receptors

The current and future land use are anticipated to be similar, thus, the current and future receptors are the on-Site workers, the construction worker involved with excavation or

This section describes the quantification of the chemical intake or exposure doses. These

provide an estimate of the maximum exposure that might occur (EPA, 1989). Under the RME scenario, the intent is to conservatively quantify an exposure that is still within the range of possible exposures.

4.2.1 Estimation of Concentration at the Point of Exposure

The 95 percent upper confidence limit (95% UCL) of the mean concentration of each COPC was used to estimate the concentration at the point of exposure (i.e., exposure point concentration or EPC). The 95% UCL provides reasonable confidence that the true site

Environmental Sciences, was used to calculate the 95% UCL. Since the calculation of the

Chebyshev UCL was typically applied. If the data was normally distributed, then the Student's t UCL was used as the exposure point concentration (EPC). If the 95% UCL was

concentration than the maximum detected concentration was

[redacted]

The highest chemical concentrations that were detected in sediments and surface water [redacted]

4.2.2 Exposure Parameters

The exposure parameters for this HRA are presented in the following Table. Default exposure frequency of an industrial worker (EPA, 1989; EPA ,1997) are not applicable at this Site because the on-site worker would not be present within the boundaries of the Site [redacted]

The exposure duration of one year for a construction worker was based on a more conservative estimate of the extent of most redevelopment activities. Activities associated [redacted]

Since the likely recreational activities at Frog Mortar Creek would be fishing, boating, or wading, it was assumed that the recreational user could be along the shoreline and would come into contact with the sediments. Recreational usage was based on spending time at the Creek for a total of two days a week for eight months or 35 weeks a year. This is based on the assumption that weather conditions would not make it feasible to engage in outdoor activities at the Creek for four months a year.

[redacted]

Summary of Exposure Parameters
Martin State Airport

Exposure Assumptions	On-Site Worker	Construction Worker	Recreational User
[illegible]	[illegible]	[illegible]	[illegible]
Exposure Duration (years)	25	1	25
Inhalation Rate (m^3/day)	20	20	20
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

4.2.3 Ingestion Algorithm

The equation for calculating the soil intake through ingestion is as follows:

$$IngestionDose = \frac{(Cs\ or\ Csw)\ x\ IR\ x\ EF\ x\ ED\ x\ CF}{BW\ x\ AT}$$

where:

Ingestion Dose	=	ingestion dose (mg/kg-day)
Cs	=	EPC in soil or sediment (mg/kg) or
Csw	=	EPC in surface water
IR	=	ingestion rate (mg/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days)
CF	=	unit conversion factor

4.2.4 Inhalation Algorithm

[illegible]

[illegible]

where:

Inhalation Dose	=	inhalation dose (mg/kg-day)
InhR	=	inhalation rate (m^3/day or m^3/hr)

ED = exposure duration (years)

4.2.5 Dermal Algorithm

The equation for calculating intake through dermal contact with soil is as follows:

[illegible]

Dermal Dose	=	dermal dose (mg/kg-day)
C	=	EPC in soil or sediment (mg/kg) or
SSA	=	exposed skin surface area (cm^2/day)
ABS	=	absorption fraction of chemical from soil or sediment
EF	=	exposure frequency (days/year)
CF	=	unit conversion
BW	=	body weight (kg)
AT	=	averaging time (days)

Section 5

TOXICITY ASSESSMENT

Toxicity assessment is based on the ability of a compound, at an administered dose, to elicit an adverse human health response. For risk assessment purposes, toxic chemical effects were separated into two categories of toxicity: carcinogenic effects and non-carcinogenic effects. This division relates to the currently held scientific opinion that the

at any level, result in an increased probability of developing cancer. For a chemical exhibiting non-carcinogenic effects, it is believed that humans have protective mechanisms

range of exposures up to some defined threshold can be tolerated by humans without

For carcinogens, it is assumed that any level of exposure has a finite possibility of causing cancer; therefore, there is no threshold dose for carcinogenic effects. That is, a single exposure to a carcinogenic chemical may, at any level, result in an increased probability of developing cancer. The USEPA evaluates chemicals that have carcinogenic effects in a two-step process. In the first part of the evaluation, both human and experimental animal studies are reviewed to determine the weight of evidence that a chemical is carcinogenic. Then a weight-of-evidence classification is assigned to the compound.

In the second part of the evaluation, a slope factor (SF) is calculated, which is an estimate actual slope factors estimating carcinogenic potency could be lower, but are not likely to be

5.2 Noncarcinogenic Toxicity

The threshold dose for noncarcinogenic effects can be related to a reference dose (RfD). A chronic RfD is an estimate of a daily exposure level to which people, including sensitive individuals, do not have an appreciable risk of suffering significant adverse

[illegible]

protective mechanisms that must be overcome before the adverse effect results; therefore, there is a threshold dose for these effects. This threshold concept view of non-carcinogenic

[illegible]

The noncarcinogenic, or threshold, health effects of a chemical are evaluated using a

[illegible]

threshold health effects in humans, including sensitive subpopulations (women of child-

[illegible]

1997b). The slope factors and reference doses used in estimating the risks and hazard

[illegible]

Adverse health effects associated with exposure to lead have been correlated with concentrations of lead in whole blood and not with intake of lead by an individual.

[illegible]

Section 6

RISK CHARACTERIZATION

This section of the PHHRA describes how calculated exposure doses were integrated [illegible]

[illegible] involves the integration of health effects information, developed as part of the dose-response assessment, with exposure estimates developed as part of the exposure [illegible]

[illegible]

[illegible] Department of Environment, August 2001) also states that a contaminant is considered [illegible]

6.1 Carcinogenic Risk Estimates

The theoretical excess lifetime cancer risk is an estimate of the increased risk of an individual developing cancer as a result of exposure to the COPCs at specified daily dosages averaged over a lifetime of 70 years. The excess lifetime cancer risk will be estimated for each known, probable, or possible carcinogenic constituent, by using the following equation:

$$Excess\ Cancer\ Risk = Exposure\ Dose \times Slope\ Factor$$

[illegible]

[illegible]

6.2 Noncarcinogenic Effects

The hazard quotient (HQ) is the ratio of the estimated exposure dose to the RfD. This [illegible] The sum of the HQs is termed the hazard index (HI).

Since some individuals are exposed by more than one pathway, HQs are summed for each pathway that contributes to the exposure to the same individual in a given population. If the total hazard index is equal to or less than 1.0, it is believed that no threshold health effects will occur. An HI of slightly greater than 1, however, is not [illegible] effects are additive. Since this assumption is known not to be accurate, when a total population hazard index exceeds 1.0, it is appropriate to re-examine the health effects, and to segregate the individual hazard quotients on the basis of target organ or mechanism of action.

[illegible]

[illegible] Table [illegible]). Detailed calculations are presented in Tables 5 through [illegible] in Appendix B. [illegible]

worker, the cumulative cancer risk estimate due to potential soil exposures is 3×10^{-5} (Table 5 in Appendix B). The primary contributors to the estimated risks are ingestion [illegible] and skin contact with benzo(a)pyrene in soils within one foot of soil. The chemical-specific risk attributed to benzo(a)pyrene is 2×10^{-5}.

[illegible]

The HRA also evaluated the unlikely scenario that an on-site worker's exposure to the [illegible]

to the benzo (a) pyrene in the pond sediments would lead to an estimated risk of 3×10^{-6} (Table 6 in Appendix B). There are no available toxicity factors for noncarcinogenic effects of benzo(a)pyrene, hence, there is no estimated hazard index.

6.3.2 Risks Associated with Exposures of a Future Construction Worker

The construction worker is assumed to be a 70-kilogram male working at the site for 8 hours per day, 5 days per week for a total of one year. Combined ingestion of soil particles at a rate of 480 milligrams a day (EPA, 1997a), inhalation of dust, and adherence of soil particles to the skin provide the basis for exposure dose calculations. Under these conditions, the estimated cancer risk is 4×10^{-6} (Table 7 in Appendix B), and the hazard index is 5. The major contributor to the hazard index is antimony (HI=2).

If a construction worker is assumed to come into contact with the benzo (a) pyrene in the [illegible]

hence, there is no estimated hazard index.

6.3.3 Risks Associated with Exposures of a Recreational User to Sediment

[illegible]

cancer risk estimate due to levels of detected carcinogens is in the acceptable range. [illegible] adverse health effects associated with the construction worker scenario.

The results of the health risk assessment also indicated that there are no potential health concerns associated with coming into contact with the sediments and surface water at Frog Mortar Creek.

Section 7
UNCERTAINTY

7.1 Uncertainties in the Risk Assessment

[illegible] uncertainties involved in the process of quantifying risk for human receptors. Because risk estimates are based on a combination of measurements and assumptions, it is important to provide information on sources of uncertainty in risk characterization. [illegible]

7.1.1 Uncertainties in the Exposure Assessment

A prevailing uncertainty in the exposure assessment lies in the estimation of chemical intake or dose. The concentration at the point of exposure is a significant factor in the uncertainty of the risk estimates. It is evident from the data that the distribution of the chemical concentrations throughout the Site does not follow a normal distribution. In most cases, the exposure point concentration is biased high due to high concentrations present [illegible]

and hazard indices are likely.

A similar uncertainty exists in the evaluation of the construction worker scenario. Although the evaluation assumed a construction period of one year, actual construction or excavation activities may be considerably shorter. As a result, the risk and health hazard estimates associated with these assumptions could be overestimated.

Another uncertainty in the risk assessment is the use of generic exposure factors, in some cases, in lieu of chemical-specific factors. The ability to have chemical-specific factors for [illegible] process that relies on scientific [illegible] effects are additive. It is recognized in the scientific community that chemical mixtures could have antagonistic or synergistic effects. Until more scientific evidence is made available, risk assessments err on the conservative side by assuming additive effects. This would lead to an overestimation of risk. On the other hand, if there are synergistic rather

Section 8
CONCLUSIONS

The results of the risk characterization demonstrate that potential exposures to the soil and sediments at the Site resulted in theoretical risk and hazard index estimates that are either within an acceptable range or that are below the *di minimis* level of risk. The evaluation of potential exposures to the surface water and sediments in Frog Mortar Creek while engaged in recreational activities also demonstrated that there are no unacceptable levels of risk and health hazard. Since the conservative evaluation of [illegible] exposures, it is unlikely that the much shorter exposures of a trespasser, if any, would pose a health problem.

In conclusion, this health risk assessment demonstrates that the current use and the future land use stipulated for the site do not pose unacceptable cancer risks and health [illegible]

Section 9

DEVELOPMENT OF CLEANUP GOALS

Although exposures to the surface water and sediments in Frog Mortar Creek resulted in [redacted]

[redacted] 2004) predicted that the chemical plumes on-Site could ultimately reach the Creek. Risk-based cleanup goals will be developed for specific constituents in groundwater that could be transported to the Creek. These constituents included TCE, cis-1,2-DCE, vinyl [redacted]

The development of risk-based levels (RBLs) in surface water that would be health-protective of the recreational users at Frog Mortar Creek is based on a target risk of 1 E- [redacted]

[redacted] are presented in the table below, and the spreadsheet calculations are presented in [redacted]

[redacted]	Surface Water
[redacted]	[redacted]
Vinyl chloride	0.004 mg/L
[redacted]	[redacted]

[redacted]

Section 10
REFERENCES

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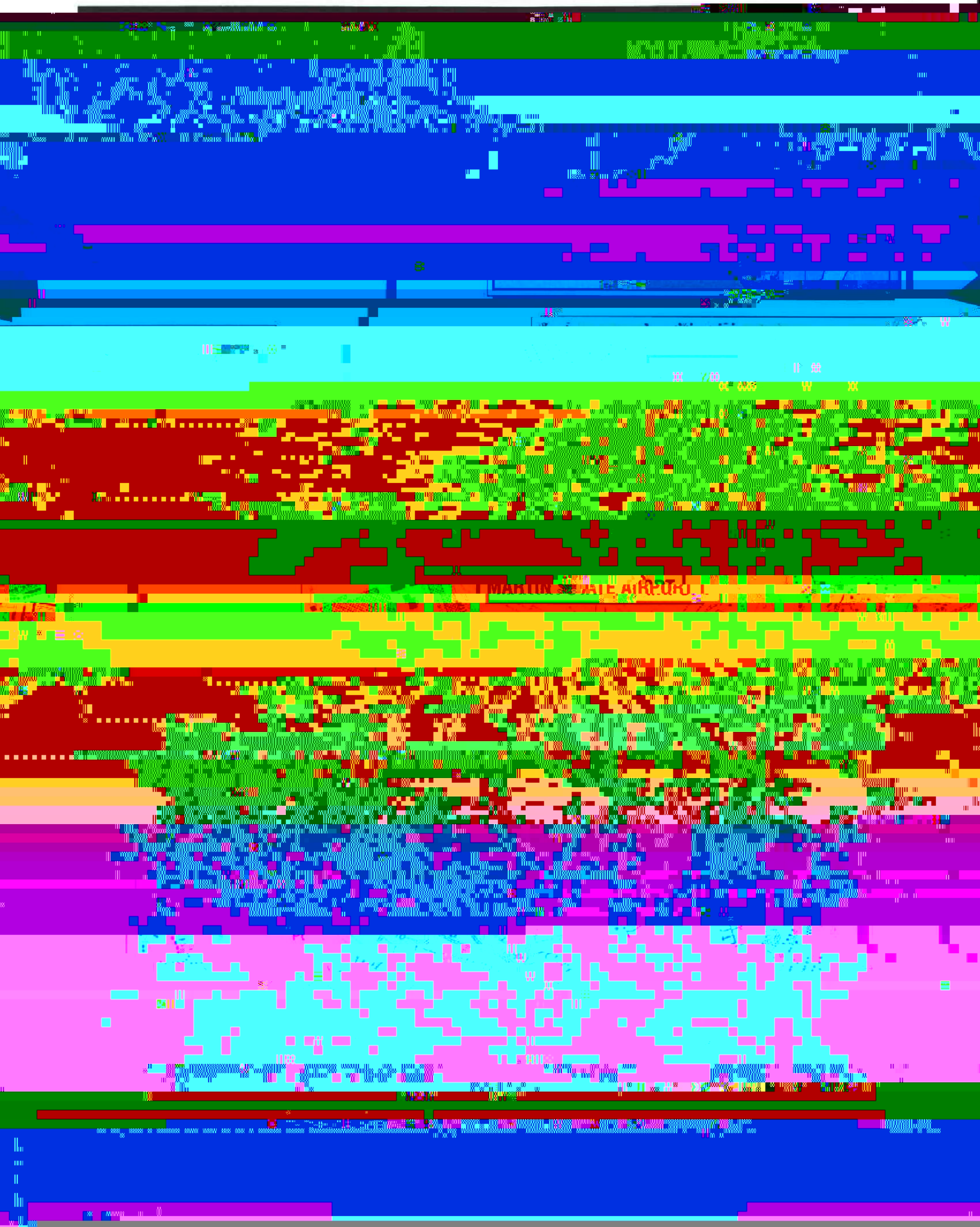
APPENDIX A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APPENDIX B
TABLES

Table 1. Identification of Surface Soil Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
VOCs										
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Bromobenzene	15	0.005	0	0%	--	--	--	No		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

Table 1. Identification of Surface Soil Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

1,1,2-Trichloroethane	15	0.005	0	0%	--	--	50	No	
Xylenes	15	0.015	0	0%	--	--	200000	No	

Table 1. Identification of Surface Soil Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

[illegible]	[illegible]	[illegible]	4	44%	[illegible]	[illegible]	[illegible]	Yes	13
Phenanthrene	9	0.4	5	56%	0.56 - 25	25	310,000	No	
PCBs	9	0.0005	0	0%	--	--		No	
alpha-BHC	9	0.00006	0	0%	--	--		No	

Table 2. Identification of Subsurface Soil Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

[illegible]									
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Lead	102	2.5	43	42%	1 - 66,000	66,000	NA	Yes	4361
Mercury	100	0.04	54	54%	0.02 - 3	3	NA	Yes	0.39
Nickel	100	2.5	82	82%	4.2 - 42,000	42,000	20000	Yes	2308
Selenium	100	2.5	11	11%	2.8 - 701	701	5100	No	
VOCs									
Acetone	88	0.05	7	8%	.025 - 2.55	2.55	920000	No	
Acrolein	74	0.2	0	0%	--	0		No	
Acetophenone	12	0.33-4.95	0	0%	--	--		No	
Acrylonitrile	74	0.18	0	0%	--	--		No	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				No	
Bromomethane	86	0.005	0	0%	--	--		No	
1,2-Dichloroethane	105	0.005	3	3%	.008 - .048	0.048	31	No	
1,2-dichlorobenzene	184	0.0025	12	7%	.008 - .44	0.44	92000	No	
cis-1,2-dichloroethene	105	0.005	39	37%	.025 - 20	20	10000	No	
t-1,2-DCE	105	0.005	22	21%	0.002 - 0.25	0.25	20000	No	
1,1,1-trichloroethane	103	0.005	0	0%	--		290000	No	
1,2,3-trichloropropane	103	0.005	1	1%	0.014	0.014	1.4	No	

Table 2. Identification of Subsurface Soil Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

Compound Name	Count	PQL (mg/kg)	Number Of Detects	Frequency of Detection	Range (mg/kg)	Maximum Reported	Industrial Region III RBC	COPC vs Indl [illegible]	UCL
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Benzo (k) Fluoranthene	56	0.33	5	9%	0.15 - 7.4	7.4	39	No	2.2
Benzo (g,h,i) Perylenea	56	0.33	6	11%	0.6 - 5.8	5.8	31000	No	
Chrysene	65	0.33	15	23%	0.165 - 31	31	390	No	3.8
Dibenz(a,h) anthracene	65	0.33	3	5%	0.1 - 2.5	4.1	0.39	Yes	0.435
Indeno(1,2,3-c,d)pyrene	65	0.33	9	14%	0.165 - 13	13	3.9	Yes	
Naphthalene	65	0.33	28	43%	0.029 - 230	230	20000	No	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

NA - not available
a - based on structural homology
b - no available toxicity value

[redacted]

Bromodichloromethane	120	0.4 - 5,000	0	0%	--	--	0.17	No	
Bromoform	120	0.405	0	0%	--	--	8.5	No	

[redacted]

4-Chlorotoluene	120	0.498 - 5000	0	0%	--	--	--	No	

[redacted]

Table 3. Identification of Groundwater Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

1,2-Dichloroethane	120	0.273	29	24%	2 - 310	310	0	Yes	207
1,2-Dibromoethane	120	0.384	0	0%	--	--	0.00075	No	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	120	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Nitrobenzene	63	10	0	0%	--	--	3.5	No	
p/m-Xylene	102	3	23	23%	3 - 33,000	33,000	210	Yes	

Table 3. Identification of Groundwater Chemicals of Potential Concern
Martin State Airport

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Chrysene	61	10.0 - 50	0	0%	0.5 - 20	20	9.2	No	
Dibenzo (a,h) anthracene	61	10.0 - 50	0	0%	0.87 - 4.1	4.1	0.009	No	
Fluoranthene	61	10	0	0%	0.53 - 64	64	1500	No	
2-Methylnaphthalene	61	10	0	0%	0.045 - 68	68	24	No	
[illegible]	42	0.2	0	0%	--	--	[illegible]	No	
alpha-Chlordane	42	0.2	0	0%	--	--	0.19	No	
gamma-Chlordane	42	0.2	0	0%	--	--	0.19	No	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Dieldrin	42	0.2	0	0%	--	--	0.0042	No	
Toxaphene	42	5	0	0%	--	--	0.061	No	

NA - not available

Table 4. Identification of Sediment and Surface Water Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

[redacted]

Arsenic	6	0.5	2	33%	1.9 - 6	6	1.90	Yes
Beryllium	6	2.5	0	0%	--	--	2000.00	No
Chromium (Total)	6	2.7	6	100%	7.4 - 12000	12000	1500000	No

[redacted]

Benzene	6	0.015	1	17%	0.044	0.044	52	No

[redacted]

Trichloroethene	6	0.006	2	33%	0.32 - 69	69	7	No

[redacted]

Benzo(g,h,i)perylene	6	0.8	1	17%	1.3	1.3	31000.00	No
Indeno(1,2,3-cd)pyrene	6	0.8	1	17%	1.4	1.4	3.90	No
Chrysene	6	0.8	1	17%	1.7	1.7	390.00	No

BEHP	6	0.8	1	17%	5	5	200	No
PCBs/Pesticides								

[redacted]

Table 4. Identification of Sediment and Surface Water Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

				Frequency				
Zinc	8	50	1		95	95	11000	No
VOCs								
c-1,2-Dichloroethene	8	1	2		3.0 - 3.0	3	61	No
Trichloroethene	8	1	2		3.0 - 4.0	**4**	0.026	**Yes**
Methyl-t-butyl ether	8	1	2		7.0 - 7.0	7	2.6	**Yes**

NA - not available

TABLE 5
Estimated Risks due to Potential Soil Exposures
On-Site Worker Scenario

Martin State Airport

PARAMETERS	UNITS	VALUES
[illegible]	[illegible]	[illegible]
BW = Body Weight, adult	kg	70
CF = Conversion Factor	kg/mg	1.00E-06
SFing = Ingestion Cancer Slope Factor	kg-day/mg	see table

CARCINOGENS	Cs	ABS	VF	EPCa	DOSE			Toxicity Factors		RISK			
Chemical	(mg/kg)	unitless	m^3/kg	(mg/m^3)	Inhalation	Ingestion	Dermal	SFing	SFinh	Inhalation	Ingestion	Dermal	Total
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Carbazole	4.6	0.10		3.38E-09	3.8E-11	3.2E-07	2.9E-07	2.00E-02	2.00E-02	7.6E-13	6.4E-09	5.8E-09	1.E-08
											HAZARD INDEX =		[illegible]

TABLE 6
Estimated Risks due to Potential Exposures to Sediments
On-Site Worker Scenario

Martin State Airport

BW = Body Weight, adult	kg	70
ATnc = Averaging Time - noncarcinogen	days	9125
ATc = Averaging Time - carcinogen	days	25550
Kp = Permeability Coefficient	cm/hour	see table
IngRad[a] = Ingestion Rate, adult	mg/day	100
InhRad = Adult Inhalation Rate(EPA, 1996a, p.5-20)	m^3/hour	1
ET = Exposure Time	hrs/day	8
SSA = [illegible] skin surface area, adult [illegible]	cm^2/day	5670
[illegible]		

CARCINOGENS	Cs	ABS	VF	EPCa	DOSE			Toxicity Factors		RISK			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Inhalation	Ingestion	Dermal	Total

TABLE 7
Estimated Risks due to Potential Soil Exposures
Construction Worker Scenario

Martin State Airport

[redacted]

BW = Body Weight, adult	kg	70
ATnc = Averaging Time - noncarcinogen	days	365

[redacted]

SFing = Ingestion Cancer Slope Factor	kg-day/mg	see table
SFinh = Inhalation Cancer Slope Factor	kg-day/mg	see table

[redacted]

CARCINOGENS	Cs	ABS	VF	EPCa	DOSE	Toxicity Factors	RISK

[redacted]

na - not available

TABLE 8
Estimated Risks due to Potential Sediment Exposures
Construction Worker Scenario

Martin State Airport

PARAMETERS	UNITS	VALUES
BW = Body Weight, adult	kg	70
ATnc = Averaging Time - noncarcinogen	days	365
ATc = Averaging Time - carcinogen	days	25550
Kp = Permeability Coefficient	cm/hour	see table
IngRad[a] = Ingestion Rate, adult	mg/day	480
InhRad = Adult Inhalation Rate(EPA, 1996a, p.5-20)	m^3/day	20
ET = Exposure Time	hrs/day	8
CSA = skin surface area, adult	cm2/day	5670
CF = Conversion Factor	kg/mg	1.00E-06

CARCINOGENS	Cs	ABS	VF	EPCs	DOSE	Toxicity Factors	RISK

TABLE 9
Estimated Risks due to Potential Sediment Exposures
Recreational Scenario

Martin State Airport

PARAMETERS	UNITS	VALUES
EPCs = Concentration in soil	mg/kg	see table
EF = Exposure Frequency	days/year	70
ED = Exposure Duration (EPA,1996a)	years	25
BW = Body Weight, adult	kg	70
[illegible]	[illegible]	[illegible]

TABLE 10
Risk Estimates due to Potential Surface Water Exposures
Recreational Scenario
Martin State Airport
Middle River, Maryland

Dose	Dose of chemical	mg/kg-day	See below
HI	Target hazard index	unitless	See below
EF	Exposure frequency	days/year	70
RfDo	Oral reference dose	mg/kg-day	See below

TABLE 10
Risk Estimates due to Potential Surface Water Exposures
Recreational Scenario
Martin State Airport
Middle River, Maryland

Dose	Dose of chemical	mg/kg-day	See below
HI	Target hazard index	unitless	See below
Risk	Risk	unitless	See below
Cw	Chemical concentration in groundwater	mg/L	See below
Ca	Chemical concentration in air	mg/m3	See below
IRw	Groundwater ingestion rate	L/day	0.05
InhR	Inhalation rate	m3/hour	1
ET	Exposure Time	hrs/day	8
EF	Exposure frequency	days/year	70
ED	Exposure duration	years	25
BW	Body weight	kg	70
AP	Averaging period	days	See below
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
RfDo	Oral reference dose	mg/kg-day	See below
CSFo	Oral cancer slope factor	$(mg/kg\text{-}day)^{-1}$	See below

Noncarcinogens	9,125 days												Total
Compound	Cw	VF	Ca	RfDo	RfDi	Kp	$Dose_{ing}$	$Dose_{der}$	$Dose_{inh}$	HI_{ing}	HI_{der}	HI_{inh}	HI
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 11
Summary of Estimated Risks and Hazard Indices
Martin State Airport
[illegible]

Exposure Scenario	Estimated Carcinogenic Risks	Estimated Hazard Index
On-Site Worker		
Soil	3.E-05	0.02
Sediment	3.E-06	--
Recreational User		
Sediment	1.E-06	0.007
Surface Water	8.E-08	0.002

Table 12. Evaluation of Lead in Surface Soil

Soil adherence	ug/cm²	70	200	Water ingestion		0.84	66%		0.84	69%
Dermal uptake constant	(ug/dl)/(ug/da	0.0001		Food ingestion, bkgrnd		0.23	18%		0.23	19%
Bioavailability	unitless	0.44			Pathway contribution			Pathway contribution		
Breathing rate	m³/day	20	6.8	Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent

MEDIUM	LEVEL		Percentile Estimate of Blood Pb (ug/dl)						PRG-99	PRG-95
[illegible]			[illegible]							
Respirable Dust (ug/m³)	1.5		BLOOD Pb, OCCUPATIONA	3.9	7.2	**8.5**	10.3	11.7	3465	5448

[illegible]

Soil adherence	ug/cm²	70	200	Water ingestion		0.84	16%		0.84	21%

[illegible]

					Pathway contribution			Pathway contribution		
Bioavailability	unitless	0.44								
Breathing rate	m³/day	20	6.8	Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Inhalation constant	(ug/dl)/(ug/d	0.08	0.19	Soil Contact	5.6E-5	0.24	1%		0.24	0%
Water ingestion	l/day	1.4	0.4	Soil Ingestion	7.0E-3	30.70	94%	1.4E-2	61.40	97%
Food ingestion	kg/day	1.9	1.1	Inhalation	2.0E-6	0.01	0%		0.01	0%

TABLE14
Calculation of Surface Water Risk-Based Levels
Martin State Airport
Middle River, Maryland

Parameter	Description	Units	Value	Reference
HI	Target hazard index	unitless	See below	Calculated
ET	Exposure time	hours/day	8	USEPA, 1996a
BW	Body weight	kg	70	USEPA, 1996a
AP	Averaging period	days	See below	USEPA, 1989
SSA	Skin surface area	cm^2	5670	USEPA, 1996a
Kp	Permeability constant	cm/hr	See below	USEPA, 1992
CF1	Conversion factor, ug to mg	mg/ug	1.00E-03	Constant
CF2	Conversion factor, cm^3 to L	L/cm^3	1.00E-03	Constant
CSFo	Oral cancer slope factor	$(mg/kg\text{-}day)^{-1}$	See below	USEPA, 1998, 1996

TABLE14

Calculation of Surface Water Risk-Based Levels

[redacted]

HI	Target hazard index	unitless	See below	Calculated
Risk	Risk	unitless	See below	Calculated

[redacted]

ET	Exposure time	hours/day	8	USEPA, 1996a
BW	Body weight	kg	70	USEPA, 1996a
AP	Averaging period	days	See below	USEPA, 1989
SSA	Skin surface area	cm^2	5670	USEPA, 1996a

[redacted]

CSFo	Oral cancer slope factor	$(mg/kg\text{-}day)^{-1}$	See below	USEPA, 1998, 1996

[redacted]

Total hazard index [illegible]