FINAL

TECHNICAL MEMORANDUM
HUMAN HEALTH RISK ASSESSMENT
MARTIN STATE AIRPORT
Middle River, Maryland

LOCKHEED MARTIN

Tetra Tech
Environmental Engineers & Scientists
TC#13741-01/July 2004

Final Technical Memorandum
Human Health Risk Assessment
Martin State Airport
Middle River, Maryland

July 2004

Prepared for:

Lockheed Martin Corporation

Prepared by:

Tetra Tech, Inc.

Nisha Bansal
Project Manager

Loveriza Sarmiento, Ph.D.
Senior Toxicologist

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Section 1
INTRODUCTION

On behalf of Lockheed Martin Corporation (LMC), Tetra Tech has prepared this Technical Memorandum describing the technical approach for conducting the baseline human health risk assessment (BHRA) at Martin State Airport, Middle River, Maryland ("Site"). This memorandum was finalized based on comments received from Maryland Department of the Environment (MDE) dated June 18, 2004. The purpose of this document is to facilitate concurrence between LMC MDE on the methodologies for evaluating the potential health risks associated with the chemicals of potential concern (COPCs) at the Site. The concept of developing technical memoranda, such as this document, for risk assessment was originally defined in OSWER Directive 9835.1a entitled *Supplemental Guidance on Performing Risk Assessments in Remedial Investigation, Feasibility Studies (RI/FS) Conducted by Potential Responsible Parties (PRPs), July 2, 1991.* This Technical Memorandum is being submitted in lieu of a risk assessment work plan.

1.1 GUIDANCE DOCUMENTS

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

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

Risk Assessment Guidance for Superfund, Part A, Vol. 1: Human Health Evaluation Manual, Supplemental Guidance Manual, "Standard Default Exposure Factors", USEPA, 1996;

Dermal Exposure Assessment: Principles and Applications, USEPA, 1992;

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

Superfund Exposure Assessment Manual (USEPA, 1988).

Risk Assessment Guidance for Superfund (RAGS).Vol. I - Human Health Evaluation Manual (USEPA, 1989).

1.2 PURPOSE AND OBJECTIVES OF THE BHRA

One objective of the BHRA is to evaluate the likelihood of potential health risks to individuals who could come into contact with the chemicals of potential concern (COPCs) in the soil and groundwater at the Site. Another objective is to propose the cleanup goals for each chemical of concern (COC) in the soil and groundwater in order to reduce or mitigate any unacceptable levels of health risks.

1.3 SCOPE OF THE BASELINE HEALTH RISK ASSESSMENT

The data from soil and groundwater investigations will be collectively used to perform the site-specific human health risk assessment. This includes, (a) the soil data collected during the subsurface investigations conducted from 2000 through 2002, and (b) the groundwater data collected within the past two years. The BHRA will use groundwater data collected within the past two years from approximately 45 wells at the Site, providing the most current understanding of Site conditions.

The BHRA will include the following elements:

- Identification of Chemicals of Potential Concern (COPCs),
- Exposure Assessment,
- Toxicity Assessment, and
- Risk Characterization.

This Technical Memorandum discusses the methodology for each of the above-mentioned elements, with the ultimate goal of obtaining approval from the MDE on the proposed approach and assumptions. Through this process, the BHRA can be conducted with minimum iterations and can be completed in a timely manner.

1.4 ORGANIZATION OF THE TECHNICAL MEMORANDUM

- Section 2.0 presents the background information on the Site. The physical, geological, and hydrogeological setting are described in subsections 2.1 through 2.3, A summary of the previous investigations is presented in Section 2.4..
- Section 3.0 describes how the collected data will be evaluated. The BHRA will be based solely on data that meet the requirements for conducting a human health risk assessment.

This section also discusses the screening evaluation that will be conducted in order to focus the BHRA on the COPCs that fail the screening evaluation.

- Section 4.0 presents the conceptual site model (CSM) that provides the framework of the exposure assessment. Section 4 also describes the different factors that will be considered in evaluating how, and to what extent, potential exposures could occur. These factors include land use, the human receptors that could be potentially exposed, and how the human receptors could be exposed. Applicable chemical-specific properties will be incorporated in estimating the chemical dose to each exposed individual.
- Section 5.0 presents the sources of the toxicity values that will be used to estimate the potential risk associated with exposures to each identified COPC. If interim values will be used, the appropriate references will be cited in the BHRA report.
- Section 6.0 discusses the methodology for estimating potential risks and hazard indices.
- Section 7 is a list of the references that will be used in the risk assessment.

Section 2
SITE BACKGROUND

2.1 SITE LOCATION AND DESCRIPTION

The Site is located at 701 Wilson Point Road in Middle River, Maryland on the southeast portion of Martin State Airport. The Site is bounded by Frog Mortar Creek to the east, and the main airport runway to the west (Figure 2-1).

2.2 SITE GEOLOGY

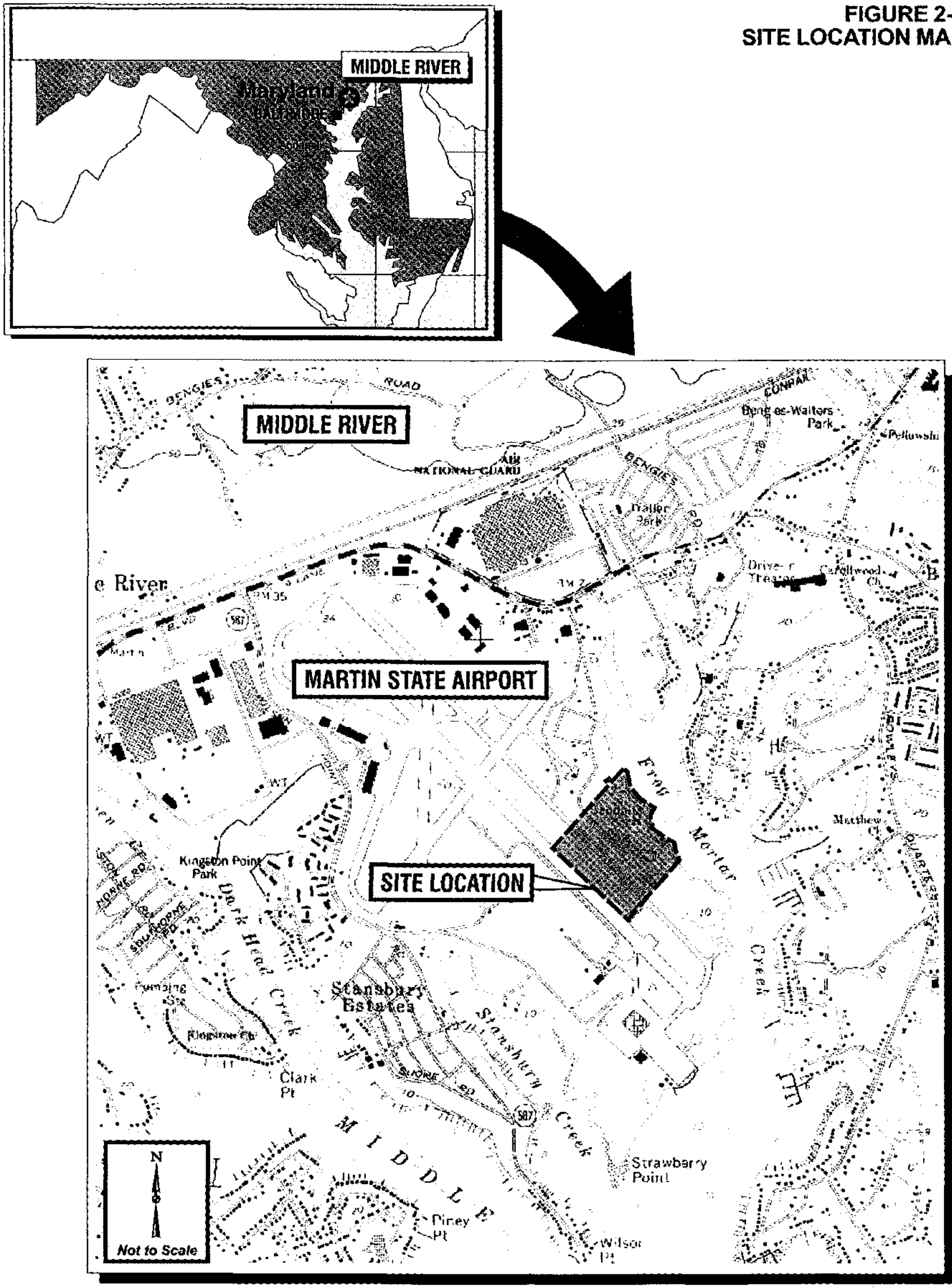
The uppermost 10 to 20 feet of soil consists of fill materials that were placed during construction of the airport in the 1950s (Army Corps of Engineers Soil Profile Map, 1956). The fill materials are composed of heterogeneous layers of sands, silts and clays, with debris that includes concrete, scrap metal, brick, glass, and wood.

Beneath the surficial layer of fill materials, the uppermost native soils are heterogeneous sands, silts, and clays. In general, coarser-grained materials (well graded sands to poorly graded fine sands) were dominant from approximately 15 to 45 feet below mean sea level (msl). Finer-grained materials, primarily of low to medium plastic clay, occur from approximately 65 to 75 feet below msl (Tetra Tech, 2004).

2.3 SITE HYDROGEOLOGY

Groundwater elevations in the wells have historically ranged from 0.46 to 5.19 feet above msl. 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 tidal influence study was conducted on June 7, 2002, as described in the "Chemical Delineation and Groundwater Modeling Report", dated December 27, 2002. During the study, groundwater elevations fluctuated up to 0.31 feet due to tidal influence.

FIGURE 2-1
SITE LOCATION MAP



2.4 PREVIOUS INVESTIGATIONS

This section summarizes the Site investigations conducted by the Maryland Aviation Administration (MAA) and by Lockheed Martin Corporation.

2.4.1 MAA's Investigations

The MAA identified the investigation area in July 1991 when four drums were encountered adjacent to Taxiway Tango during trenching activities for the installation of an electrical cable. Based on the discovery of these buried drums, the MDE required the MAA to investigate the surrounding area for potential impacts to soil and groundwater (Correspondence from MDE, 1/6/92 and 1/14/97).

The MAA conducted several investigations at the southeast portion of Martin State Airport from 1992 through 1996. The results of the investigations indicated that there are four areas of concern (AOCs), namely:

- *Taxiway Tango Median Anomaly Area* – several anomalous zones potentially containing buried metal.

- *Drum Area* – previous site investigations conducted in 1996 uncovered several drums during surface vegetation clearing.

- *Two Existing Ponds* – historical records suggest that acids may have been discharged during the 1950s and 1960s at the locations where two ponds currently exist.

- *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.

2.4.2 Lockheed Martin Corporation's Investigations

In March 1999, Lockheed Martin collected groundwater monitoring well data to obtain updated chemical data on groundwater quality, groundwater elevation, and flow direction at the Site. Samples were collected from six monitoring wells and one piezometer, and the results showed that four volatile organic compounds (VOCs) [*cis-1, 2-dichloroethene (DCE), toluene, 1, 1, 1-trichloroethane (TCA), and trichloroethylene (TCE)*] and two dissolved metals (*beryllium* and *cadmium)* were present above the Maximum Contaminant Levels (MCLs)for drinking water..

Additional investigations (Source Identification and Assessment Program, Tetra Tech, 2000) were conducted from March through May 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 detected in the soil and groundwater during this investigation. VOCs and metals were detected in the soil, and VOCs were detected in the groundwater above MCLs in the pond and petroleum hydrocarbon areas.

Based on the results of the source identification and assessment, further investigations were conducted from December 2001 through December 2002. The objective was to delineate the lateral extent of chemical occurrence in the near-surface groundwater at the Site. A limited number of deep wells were installed to evaluate the vertical extent of VOCs and metals in the groundwater. The results of the lateral investigations indicated that the potential source areas are the Taxiway Tango median area, the drum area, and the petroleum hydrocarbon area -- see Section 2.4.1. The primary contaminants were identified to be TCE, vinyl chloride, and cis-1, 2-DCE. The groundwater modeling suggested that VOCs in groundwater appear to be migrating from west to east toward Frog Mortar Creek (Tetra Tech, 2002). The general extent of VOCs in groundwater was delineated to the north and south, but not to the east and west.

Additional multi-level monitoring wells were subsequently installed to characterize the lateral and vertical extent of groundwater contamination. Data gaps in the shallow groundwater investigation, and further evaluation of the vertical extent of groundwater contamination were addressed in the data gap investigations conducted in 2003. The objectives of the data gap investigations were, (1) to delineate the eastern and western extent of chemicals in groundwater, (2) to characterize the chemicals within the existing plumes, (3) to characterize the geology of the surficial aquifer, and (4) to conduct quarterly monitoring to track and evaluate chemical trends in the groundwater. To attain these objectives, a total of 32 wells consisting of shallow, intermediate, and deep monitoring wells were installed at the site. The lateral and vertical distribution of 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.

Fate and transport modeling was conducted to evaluate dynamic changes of the chemical plumes, in particular with respect to plume migration toward Frog Mortar Creek. The distribution of VOCs in groundwater suggests that dechlorination of TCE to its daughter products cis-1,2-DCE and vinyl chloride is occurring. Therefore, the RT3D (Reactive Transport in 3-Dimensions) model code was used to model sequential decay reactions associated with VOC fate and transport. Numerical modeling of chemical fate and transport has predicted chemical concentrations of the plumes in the next 15 years.

Section 3
DATA EVALUATION

The data from the previous investigations will be reviewed to ensure that the number and quality of the analytical data are suitable for risk assessment purposes. A detailed discussion of the data validation process will be included in the BHRA report.

Since the investigation areas or AOCs are based on the suspected sources of chemical release, the collected data was used to characterize the lateral and vertical distribution of the chemicals. For risk assessments, however, the useable data will be based on the potential exposure areas of Site-specific receptors. Therefore, the data set for the BHRA may vary from the data set used for site characterization. The potential human health risks will be evaluated by assuming two exposure areas, namely (1) an individual's activities will be confined within each AOC, and (2) an individual will be engaged in Site-wide activities. Under the first assumption, the potential risk associated with each AOC will be calculated based on the data collected from each of the four AOCs. In contrast, the second assumption will use the data from the entire Site to estimate the potential risk to human receptors.

Information on the historical operations at the Site indicated that the potential sources of release consist of buried drums and debris (MES, 1994). Since it is unlikely that there would be surface releases, the site investigations focused on collecting subsurface soil samples starting at a depth of one foot below ground surface (bgs). Therefore, the BHRA will evaluate surface soil exposures based on data collected from one foot bgs, and subsurface soil exposures will be based on data from below one foot bgs to a maximum depth of 15 feet bgs..

3.1 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

Any constituent that is detected at least once will be included in the screening risk evaluation. A constituent that is reported as a non-detect in all of the analyzed samples will not be identified as a COPC, and will be excluded from the BHRA. If a chemical is reported as a non-detect, but its practical quantitation limit (PQL) is higher than the most conservative risk-based concentration, i.e., the cleanup standard for an industrial site (EPA Region III), then the chemical will be identified as a COPC that will be evaluated further in the risk assessment.

3.2 SCREENING EVALUATION

In the screening evaluation, the highest concentration* of each detected chemical will be compared to its corresponding industrial cleanup standard. A chemical that exceeds its corresponding Industrial cleanup standard will be identified as a COPC that will be evaluated in the BHRA. Alternatively, a chemical that does not exceed its industrial cleanup standard will not be identified as a COPC.

* Note: Using the highest detected concentration, rather than the average or 95% upper confidence limit (UCL) of the average site concentration, is also consistent with the conservative nature of the screening evaluation.

Section 4
EXPOSURE ASSESSMENT

The exposure assessment identifies and describes potentially exposed human receptors, develops exposure pathways, and estimates the chemical concentration at the point where a human receptor could come into contact with the soil, surface water and groundwater at the Site (i.e., exposure point concentration).

4.1 CONCEPTUAL SITE MODEL

Figure 4-1 presents the conceptual site model (CSM) that will be used as the framework for evaluating the potential exposures. Based on the current and future land use, the exposure assessment identifies the populations who could be potentially exposed, the means by which exposure could occur, and the amount of chemical intake into the body from each exposure medium. The CSM also indicates whether specific exposure pathways are complete or incomplete, and incomplete pathways are excluded from the BHRA.

4.1.1 Potential Exposure Pathways

An exposure pathway is the mechanism by which a human receptor is exposed to chemicals from a source. The four elements of a complete exposure pathway are:

- a source of chemical release,
- a mechanism of release through a transport medium, i.e., release of chemicals in the soil through indoor air or through dust particles,
- a point of contact between the potential receptor and the transport medium, i.e., ingestion of soil, and
- a potential receptor, i.e., an on-site worker.

If any one of the four elements is missing, the exposure pathway is considered incomplete. Only complete exposure pathways would result in exposures.

Current potential exposure pathways are those that exist as a result of the current extent of contamination, combined with existing land use and human activity patterns. Future exposure pathways include pathways that have a reasonable probability of completion based on projected future land use and predicted human activity for the Site.

The current exposure pathways include the following:

- Incidental ingestion of surface soil,
- Dermal contact with surface soil,
- Incidental ingestion of surface water,
- Incidental contact with surface water,
- Inhalation of air-borne soil particulates

Future potential exposure pathways include those that are not currently complete, but which could become complete in the future under certain conditions. The most likely means of future pathway completion is chemical migration from one medium to another or changes in land use. The proposed future land use is likely to be similar to the current land use. In addition to the fact that the area is within the taxiway of the airport, there are no known future plans of having buildings or structures at the Site. Therefore, potential exposures through inhalation of vapor emissions from volatile COPCs will not be evaluated.

Another conservative assumption in the evaluation of future exposure pathways pertains to the groundwater. Although the identification of groundwater COPCs will be based on a comparison to the MCLs for potable water, the current and future land use of the MSA does not include the use of the aquifer beneath the site as a source of potable water. However, the BHRA will assume that the groundwater could be used for industrial operations at the Site.

In summary, the current and future Site worker is assumed to have potential exposures through:

- Incidental ingestion of surface soil,
- Inhalation of dust particulates,
- Dermal contact with surface soil, and
- Dermal contact with groundwater.

To allow for the possibility that operations at the Site might require occasional or intermittent construction/excavation activities, the BHRA will also evaluate potential exposures of an on-Site construction worker. The construction worker is assumed to have potential exposures through:

- Incidental ingestion of surface and subsurface soil,
- Inhalation of dust particulates,
- Dermal contact with surface and subsurface soil, and
- Dermal contact with groundwater.

Human receptors have no access to the existing ponds, thus, there are no potential exposures to sediment and surface water in these ponds. Therefore, sediment and surface water data from the existing ponds will not be evaluated in the BHRA. This is not the case for Frog Mortar Creek. Since there is a possibility that there could be recreational users at Frog Mortar Creek, the BHRA will evaluate potential exposures of recreational users to surface water and sediment from the Creek.

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. Since a potential Site visitor would have more limited exposures than the on-Site worker, the visitor scenario will be evaluated if the potential risk to the on-Site worker has been demonstrated to be unacceptable.

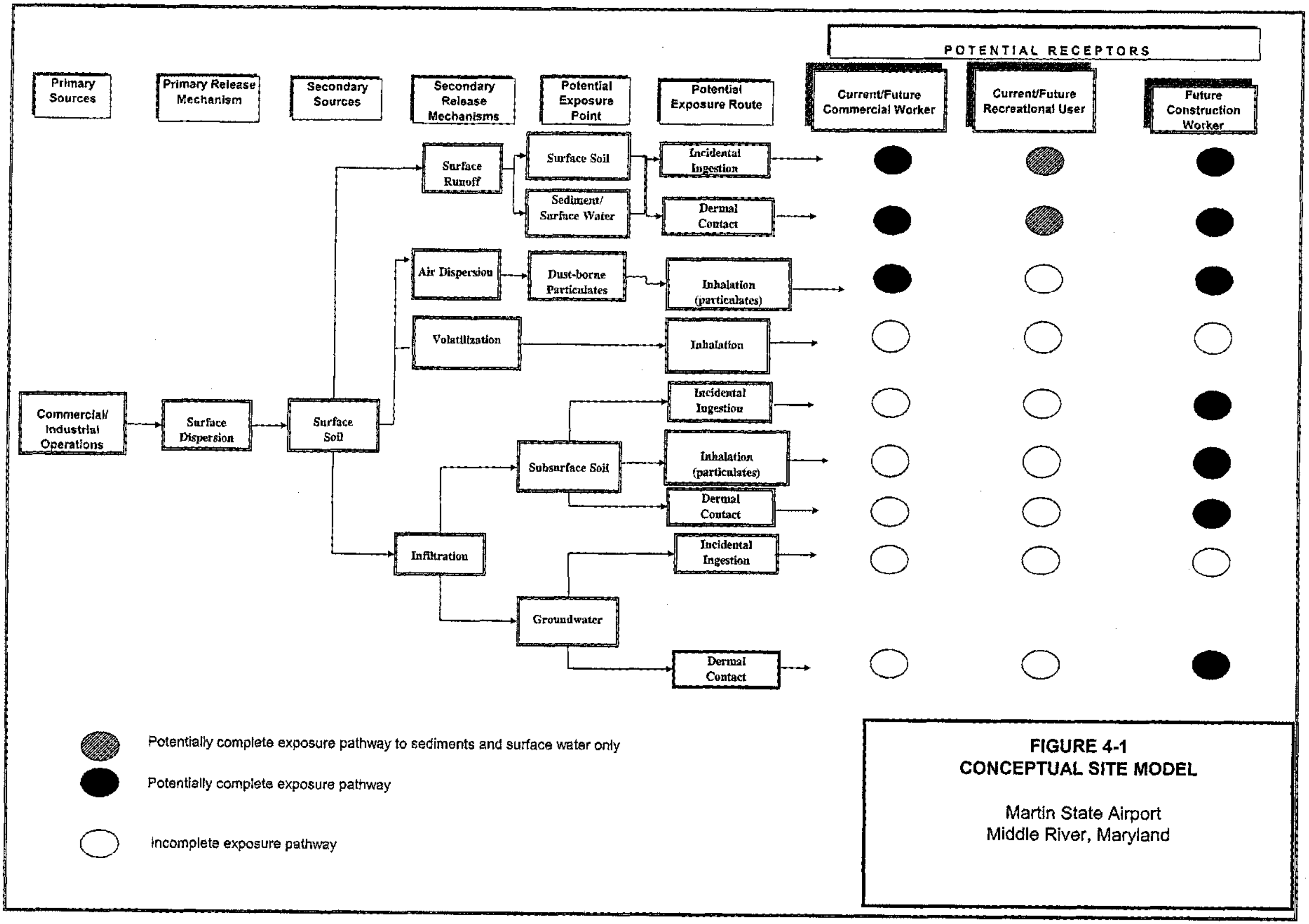


FIGURE 4-1
CONCEPTUAL SITE MODEL

Martin State Airport
Middle River, Maryland

001\jobs\6240\talcsm

4.2 QUANTIFICATION OF EXPOSURE

This section describes the quantification of the chemical intake or exposure doses. These exposure doses provide the basis for subsequent risk calculations based on dose-response relationships. The reasonable maximum exposure (RME) approach will be used to 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 is generally used as the estimated concentration at the point of exposure (i.e., exposure point concentration). The 95% UCL provides reasonable confidence that the true site average will not be underestimated (EPA, 1992c).

Initially, summary statistics including number of samples, minimum value, maximum value, the minimum variance, and the standard deviation will be calculated for each data set. If a COPC was reported as non-detect in a sample, but was detected once in the sample analyses, its concentration will be assumed to be present in the sample at one-half the detection limit.

The distribution of the data will be tested for normality or lognormality. This statistical test is described by Gilbert (1987). The procedure used for estimation of the 95% UCL will be based on the results of the distribution tests. If the data set is not consistent with a normal distribution, but was consistent with a lognormal distribution, then the data set will be transformed using the natural logarithm function before determining the 95% UCL. In the event that the highest concentration is lower than the 95% UCL, then the highest concentration would be used as the EPC [EPA, 1992].

Air exposure pathways to the non-volatile COPCs could occur through inhalation of chemicals bound to dust-borne particulates. Potential transport of chemicals in the soil through dust particulates will be based on a particulate emission factor (PEF).

4.2.2 Exposure Parameters

The default exposure assumptions of an industrial worker (EPA, 1989) will be used in the BHRA, as shown in Table 4-1.

Table 4-1
Summary of Exposure Parameters
Martin State Airport

Exposure Assumptions	Future On-Site Worker		On-Site Construction Worker
Body Weight (kg)	70	(1)	70
Averaging Time Non-Carcinogens (yrs)	25	(2)	1
Averaging Time Carcinogens (days)	25,550	(1)	25,550
Ingestion Rate (mg/day)	50	(1)	480
Exposure Frequency (day/yr)	250	(1)	250
Exposure Duration (years)	25	(1)	1
Inhalation Rate (m^3/day)	20	(1)	20
Skin Surface Area (cm^2)	5,800	(1)	5800
Adherence Factor (mg/ cm^2)	Chemical-specific	(1)	Chemical-specific
Target Risk	1.00E-06	(1)	1.00E-06
Target Hazard Index	1	(1)	1

Notes:
(1) EPA 1989 Risk Assessment Guidance for Superfund - Volume 1 Human Health Evaluation Manual.
(2) Averaging time for non-carcinogenic effects, based on the duration of exposure in years x 365 days/year.

4.2.3 Ingestion Algorithm

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

$$IngestionDose = \frac{Cs \times IR \times EF \times ED \times CF}{BW \times AT}$$

where:

Ingestion Dose	=	ingestion dose (mg/kg-day)
Cs	=	exposure point concentration in soil (mg/kg)
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 (10^{-6} kg/mg)

4.2.4 Inhalation Algorithm

The equation for calculating intake through inhalation of dust from Site soil is as follows:

$$Inhalation\ Dose = \frac{EPCa \times InhR \times ET \times EF \times ED}{BW \times AT}$$

where:

Inhalation Dose	=	inhalation dose (mg/kg-day)
InhR	=	inhalation rate (m^3/day or m^3/hr)
EPCa	=	exposure point concentration in air (mg/m^3) particulates
	=	concentration in soil x (1/PEF)
where:		PEF = particulate emission factor (m^3/kg),
ED	=	exposure duration (years)
EF	=	exposure frequency (days/year)
	=	(2 hours/day) x (1 day/8 hours) x (350 days/year)
BW	=	body weight (kg)
AT	=	averaging time (days)

4.2.5 Dermal Algorithms

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

$$Dermal\ Dose = \frac{Cs \times SSA \times ABS \times AF \times EF \times ED \times CF}{BW \times AT}$$

where:

Dermal Dose	=	dermal dose (mg/kg-day)
C_s	=	exposure point concentration in soil (mg/kg)
AF	=	soil to skin adherence factor (mg/cm^2),
SSA	=	exposed skin surface area (cm^2/day)
ABS	=	absorption fraction of chemical from soil
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
CF	=	unit conversion (10^{-6} kg/mg)
BW	=	body weight (kg)
AT	=	averaging time (days)

Section 5
TOXICITY ASSESSMENT

The primary sources of toxicity values will be the United States Environmental Protection Agency's (USEPA) Integrated Risk Information Service (IRIS) and HEAST (USEPA 1997b). The carcinogenic slope factors and noncarcinogenic reference doses of the COPCs will be presented in the BHRA report.

Section 6
RISK CHARACTERIZATION

This section describes how the calculated exposure doses will be integrated with the toxicity criteria to yield estimated health risks.

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:

$$\text{Excess Cancer Risk} = \text{Exposure Dose} \times \text{Slope Factor}$$

Lifetime daily intakes, using an averaging time of 70 years, effectively prorate the total cumulative dose over a lifetime. This approach is based on the assumption that a high dose of carcinogens received over a short period of time, at any age, is equivalent to a correspondingly low dose received over a lifetime.

6.2 Noncarcinogenic Effects

The potential for adverse effects on human health other than cancer will be evaluated by comparing an intake over a specific time period with a reference dose derived from a subchronic (less than 7 years of exposure) and chronic (greater than 7 years of exposure) exposure period, if both are available. Otherwise, the reference dose based on chronic exposures will be applied. This comparison is performed by calculating the hazard quotient (HQ) in the following equation:

$$HQ = CDI/RfD$$

Where:	HQ	=	Hazard Quotient (unitless)
	CDI	=	Chronic Daily Intake (mg/kg/day) for chronic study
	RfD	=	Reference Dose (mg/kg/day) for subchronic/chronic, no-effect dose

A HQ of slightly greater than 1 is not necessarily an indication that adverse effects will occur. The hazard index is the sum of the HQs for each of the chemicals considered in the different pathways. Since the individuals are assumed to be exposed by more than one pathway, HQs will be summed to account for exposures via all the possible pathways. 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 necessarily an indication that health effects will occur. Summing HQs across all chemicals and across all pathways assumes that all acute and chronic human health 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.

6.3 Results of the Risk Characterization

The estimated cancer and noncancer risks will be presented in the BHRA report. The uncertainties associated with each component of the risk assessment will be discussed.

Section 7
REFERENCES

Cowherd, C., Muleski, G., Engelhart, P., and Gillett, D., 1985. *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination.* Prepared for EPA Office of Health and Environmental Assessment. 1985.

Gilbert, Richard O., 1987. Statistical Methods for Environmental Pollution Monitoring.

Maryland Environmental Service, 1994. Martin State Airport Preliminary Site Investigation of the Taxiway Tango. May 1994.

Tetra Tech, 1999. Final Groundwater Monitoring Well Surveying and Sampling Report, Martin State Airport, Middle River Maryland. May 18, 1999.

Tetra Tech, 2000. Final Source Identification and Assessment Report, Martin State Airport, Middle River Maryland. September 29, 2000.

Tetra Tech, 2002. Final Chemical Delineation and Modeling Report, Martin State Airport, Middle River Maryland. December 27, 2002.

Tetra Tech, 2003. Final Data Gap and Hydrogeologic Investigation Work Plan, Martin State Airport, Middle River Maryland. May 23, 2003.

Tetra Tech, 2004. Final Data Gap Investigation and Modeling Report, Martin State Airport, Middle River Maryland. May 2004.

U.S. Environmental Protection Agency (US EPA), 1989. *Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual (Part A)*, US EPA 540/1-89-002: Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency (U.S.EPA), 1991a. *Risk Assessment Guidance for Superfund, Vol. 1, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factor.* March 25.

U.S. Environmental Protection Agency (U.S.EPA), 1992a. *Dermal Exposure Assessment, Principles and Applications*: Office of Health and Environmental Assessment, EPA/600/8-91/011B.

U.S. Environmental Protection Agency (U.S.EPA), 1992b. *Guidance for Data Useability in Risk Assessment*: 9285.7 09A. April.

U.S. Environmental Protection Agency (U.S.EPA), 1992c. *Supplemental Guidance to RAGS: Calculating the Concentration Term,* PB92-963373. May.

U.S. Environmental Protection Agency (U.S.EPA), 2002. *Exposure Factors Handbook,* National Center for Environmental Assessment, Office of Research and Development, EPA/600/P-95-002F(a-c).

U.S. Environmental Protection Agency (USEPA), online. *Integrated Risk Information System:* Office of Research and Development, National Center for Environmental Assessment, Washington, and DC.