HEALTH CONSULTATION

SOUTH INDIAN BEND WASH LANDFILL AREA

SCOTTSDALE, MARICOPA COUNTY, ARIZONA

EPA FACILITY ID: AZD980695969

Prepared by:

Arizona Department of Health Services
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Health Consultation

South Indian Bend Wash Landfill Area

TEMPE, MARICOPA COUNTY, ARIZONA

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Agency for Toxic Substances and Disease Registry
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Purpose

This consult is in response to a petition request by the City of Tempe to de-list the area from the South Indian end Wash Superfund site, to allow the redevelopment into a multi-use retail marketplace.

Introduction

The South Indian Bend Wash (SIBW) Superfund site is an area of approximately 3 square miles in Tempe, Maricopa County, Arizona. The site is bounded by the Salt River on the north, Apache Boulevard on the south, Rural Road on the west, and the Price Freeway (Loop 101) on the east. The area consists of various land uses, from single family residential to heavy industy, including manufacturing facilities, retail outlets, houses, apartments, parks, open spaces, golf courses, and waterways.

The primary contaminants of the area are volatile organic compounds (VOCs) such as trichloroethylene (TCE), 1,1,1 trichloroethane (TCA), and perchloroethylene (PCE). These chemicals were disposed in dry wells or directly onto the ground at various facilities in the area beginning in the 1960's. Methane is also present from the degradation of organic materials in the landfills. Groundwater contamination was discovered in 1981. The area was placed on the National Priorities List (NPL), or Superfund list, in 1983.

This consultation focuses on the potential for human exposures to the contaminants from soil vapors in the section of SIBW known as the Landfill Area, or the McClintock/Rio Salado Brownfield Redevelopment Area (Redevelopment Area). The attached maps (Appendix 2) show the Landfill Area in relation to the remaining SIBW site boundaries.

Background

The landfill area consists of approximately 200 acres of the northeast corner of the defined SIBW area south of the Salt River. It comprises five former landfills, which contain 50 separate land parcels; the First Street, Maricopa County, Old Tempe, Bennett Family Trust, and Resources Reclamation Corporation of America. Allstate Mine Supply is a separate parcel within the Landfill Area. When operating these landfills were used primarily for municipal and construction waste disposal. In July 2002, the City of Tempe submitted a petition to the EPA for a Partial Deletion of this portion of the SIBW from the NPL.

Although the most recent soil gas data on the Landfill Area was collected in 1994, the site has been surveyed thoroughly for the past 23 years. The groundwater monitoring and vapor extraction wells at the site have consistently shown very low levels of chemicals being released. In July 2002, the City of Tempe submitted a petition to the United States Environmental Protection Agency (EPA) for a Partial Deletion of this portion of the SIBW from the NPL.

The SIBW Landfill Area lies outside the 5 micrograms per liter (µg/l) TCE gradient that was used to define the extent of the groundwater contamination. It is this delineation of the groundwater contamination that originally defined the SIBW boundaries, including the Landfill Area.

Discussion

Data used

Comprehensive soil characterization has been conducted in the area to determine the extent of any contamination. Soil vapor samples, as well as water samples from monitoring wells, were taken several times during the past 20 years. The latest samples were taken in the late 1990's as part of the EPA remediation plan for the area. Although the most recent sampling of the soil gases was taken in 1994, several monitoring wells around the site are sampled regularly. None of these wells have shown any increase in the amount of the contaminants being released from the soil matrix into the groundwater or the air. Vapor monitoring wells area also in place to detect the methane gas generated by the municipal waste.

Contaminants of Concern

This section identifies the contaminants of concern for the Landfill Area of the SIBW site. The discussion addresses available data, the methodology used in the identification process, the criteria for selection, and the extent and levels of contamination. The contaminants associated with this site have been documented at low levels. The intended use of the area as an open-air marketplace could result in completed exposure pathways. We selected the contaminants of concern for this reason.

Shallow Soil Vapor Data

The contaminants (methane, PCE, TCA, and TCE) are present in varying frequencies and ranges in the landfill sites (Table 1). These compounds were identified because they were pervasive and persistent in the three shallow soil vapor studies (CH2MHill).

Table 1. Volatile Organic Compounds in Soil Gas and Methane concentrations (micrograms per liter, µg/L) in South Indian Bend Wash Landfills

	TCA			**PCE**			**TCE**			**Methane**		
	Min	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**
Landfill Sites	0.0002	210	3.58	0.001	28	.095	0.01	16.7	1.36	11.7	273,040	29,821**
Allstate Site	0.68	210	56.6*	0.66	28	7.45*	ND	ND	ND	NA	NA	NA

Abbreviations: NA-Not Available; ND-No Detection; PCE-perchloroethylene; TCA-1,1,1 trichloroethane; TCE- trichloroethylene.

* These sample averages are not representative of the overall soil gas concentrations on the site because of the small sample size. The highest concentrations of both TCA and PCE were detected at the same sample location.

** The methane concentrations varied widely over all of the landfill area, with some parcels having low concentrations and others having concentrations in the hundreds of thousands.

The only significant concentrations of TCA or PCE within the Landfill Area were associated with the Allstate Site. NoVOCs were found at levels high enough to indicate that a layer of dense non-aqueous phase liquids is present in the soil beneath the landfills.

Methane is also present in quantities at the landfill sites in concentrations well below the lower explosive limit, but may still cause a potential explosion risk if the gases build up inside a structure and exceed the lower explosive limit concentration of 5% (Sittig). The methane generation in higher concentrations is generally confined to only a few small parcels in the western part of the Landfill Area. Table 2 depicts the range of methane detection on the various properties.

Table 2. Methane concentrations at the South Indian Bend Wash Landfills

Parcel	Minimum	Maximum
Maricopa Landfill	17.2 micrograms/liter	273,040 micrograms/liter
Bennett Family Trust, Old Tempe, RRCA, First Street Landfills	127 micrograms/liter	74,790 micrograms/liter

Exposure Pathways

Inhalation exposures to VOCs and methane may have occurred and may continue when the properties are redeveloped into shopping areas and other commercial uses.

The Arizona Department of Health Services (ADHS) evaluated the environmental and human components that lead to human exposure to determine whether people are exposed to contaminants from the site.

An exposure pathway consists of five elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of exposure, and a receptor population.

ADHS categorizes an exposure pathway as completed or potential exposure pathway if the exposure pathway cannot be eliminated. In completed exposure pathways, all five elements exist, and exposure to a contaminant has occurred in the past, is occurring, or will occur in the future. In potential pathways, at least one of the five elements is missing but could exist. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring, or could occur in the future. This exposure assessment focuses on persons who are on the site. It estimates the types and magnitudes of exposures to chemicals of potential concern and possible exposure pathways associated with contamination detected at the site.

Complete Exposure Pathways

People could be exposed through inhalation of vapors released from the surface soils (Table 3). The number of exposures points to the contaminants is unknown.

Table 3. Complete Exposure Pathways

	EXPOSURE PATHWAY ELEMENTS				
Source	**Media**	**Point of Exposure**	**Route of Exposure**	**Estimated Population**	**COC***
SIBW landfill gases	Soil vapors	Ambient air	Inhalation	200	PCE TCA Methane TCE

*COC = contaminants of concern

Soil gas exposures were evaluated using the previously collected samples; the latest area-wide data is from 1994. Selected sites within the Landfill Area, such as the Allstate sub-site were sampled in 1999, with deep soil vapor samples taken from monitoring wells.

The EPA recommended upper bound for inhalation rates vary from 15 cubic meters per day (m^3/day) to 20 m^3/day. We used the more conservative estimate (20 m^3/day) for all scenarios in this health consultation.
We assumed that people spent 33% of their time at their place of work and 90% of their time indoors. We used EPA exposure assessment criteria for our calculations (Appendix 1).

Estimated child doses did not exceed the minimum risk level (MRL) for the respective contaminants (Tables 4 through 7).

Health Concerns

The potential for exposure to the volatile organic compounds(VOCs) found in the soils of the South Indian Bend Wash Landfill Area is very limited. Soil concentrations of the VOCs are so low that the EPA has not designated any of the SIBW Landfill sites for remediation activities. These low levels of VOCs indicate that there are little or no exposures to persons on the properties.

Because of the transient nature of the population that may be exposed to the soil gas vapors and the methane, cancer related exposures were not calculated.

For non-cancer effects, only child exposure doses are shown. Because of their smaller body weight and greater inhalation rate, child doses would be higher than adults under the same exposure conditions. Exposure dose estimates for adults did not exceed health-based comparison values.

Physical hazards

Methane generation on some of the parcels may allow concentrations to exceed the 5% lower explosive limit inside a building, resulting in possible fires and explosions.
The redevelopment of the area and the subsequent placement of structures over the methane-generating portion of the landfills are being evaluated by the developer. Placement of structures on the site will be done so to avoid the higher gas generating areas. This will prevent interior buildup of any methane that is not captured by the on-site systems proposed for the area.

Table 4. Perchloroethylene Dose Estimates and Minimum Risk Levels

Sample Location	Range PCE soil gas concentration (µg/L)	Child's Estimated Daily Dose (mg/kg-day)	MRL (mg/kg-day)	Child Dose Exceeds MRL?
Maricopa Landfill (Allstate Site)	Trace-28.0	0.00012	0.0036	No
All Other Landfills	ND-38.7	0.00016	0.0036	No

Table 5. Trichloroethane Dose Estimates and Minimum Risk Levels

Sample Location	Range TCA Concentration (µg/L)	Child's Estimated Daily Dose (mg/kg-day)	MRL (mg/kg-day)	Child Dose Exceeds MRL?
Maricopa Landfill (Allstate Site)	0.68-210	.00002	0.4	No
All Other Landfills	0.02-75.2	.000007	0.4	No

Table 6. Methane Dose Estimates and Minimum Risk Levels

Sample Location	Range Methane Concentration (µg/L)	Child's Estimated Daily Dose (mg/kg-day)	MRL (mg/kg-day)	Child Dose Exceeds MRL?
Maricopa Landfill (Allstate Site)	ND	NA	NA	NA
All Other Landfills*	103-273,040	NA	NA	NA

* Includes the main portion of the Maricopa Landfill

Table 7. Trichloroethylene (TCE) Dose Estimates and Minimum Risk Levels

Sample Location	Range TCE Concentration (µg/L)	Child's Estimated Daily Dose (mg/kg-day)	MRL (mg/kg-day)	Child Dose Exceeds MRL?
Maricopa Landfill (Allstate Site)	0.55*	0.000002	0.575	No
All Other Landfills	0.02-16.7	0.00007	0.575	No

*Single sample

Abbreviations: kg kilogram; L liter; mg milligram; MRL minimum risk level; ND no detect; NA not applicable

Child Health Issues

Because only limited exposures from any of the VOCs on the SIBW Landfill properties exists, only a few, if any, would be expected to impact children's health. All of our exposure doses for children were well below their respective MRLs (Tables 4 through 7).

Conclusions

Under the current conditions at the site, the SIBW Landfill Area poses **no public health hazard.**

Recommendations

The Arizona Department of Health Services has the following recommendations:

- To reduce the likelihood of methane buildup inside a structure, placement of buildings on the site within the known area of higher methane emissions should be avoided.
- Continued monitoring of the soil vapors and groundwater to determine if future actions are required to avoid exposures to the VOC's.

Public Health Action Plan

- ADHS will continue to review and evaluate data provided for this site

- The Arizona Department of Health Services will notify property owners in the area of the findings of this health consultation.

References

CH2MHILL. Technical Memorandum. Prepared for the U.S. Environmental Protection Agency. South Indian Bend Wash Landfill Sites, July 2002.

Roy F. Weston, Inc. Review of previous site characterization work at former landfills, South Indian Bend Wash. Prepared for the Arizona Department of Environmental Quality, June 1999.

Sittig, M. Handbook of toxic and hazardous chemicals and carcinogens, 3rd edition. 1991.

CERTIFICATION

The Arizona Department of Health Services, under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), prepared this South Indian Bend Wash (SIBW) Superfund site health consultation. It was prepared in accordance with approved methodology and procedures existing at the time.

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The Division of Health Assessment and Consultation has reviewed this health consultation and concurs with its findings.

Bobbi Erlwein
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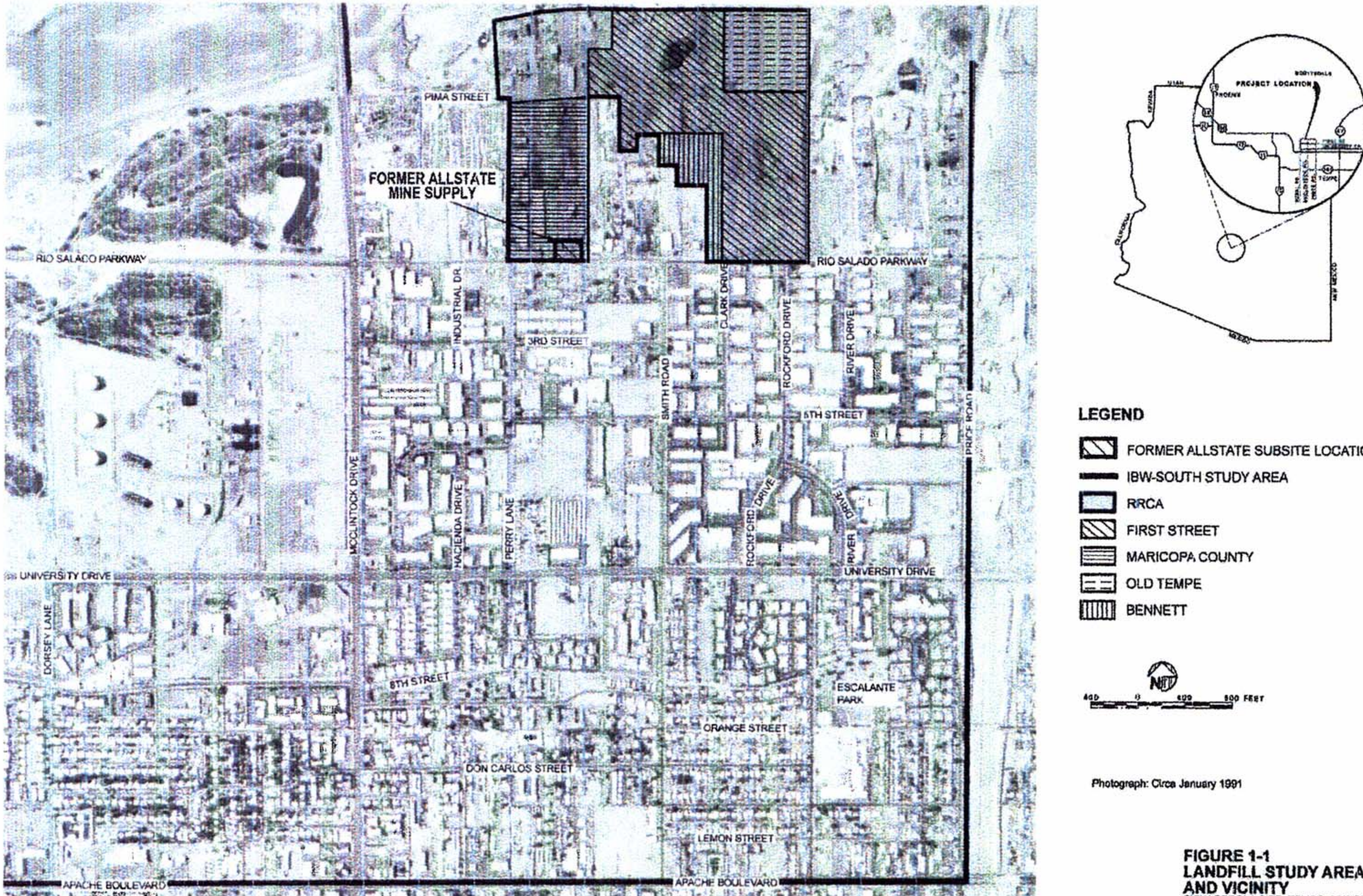

LEGEND

- FORMER ALLSTATE SUBSITE LOCATION
- IBW-SOUTH STUDY AREA
- RRCA
- FIRST STREET
- MARICOPA COUNTY
- OLD TEMPE
- BENNETT

400 0 400 800 FEET

Photograph: Circa January 1991

FIGURE 1-1
LANDFILL STUDY AREA AND VICINITY
S.BW CERCLA SITE, TEMPE, ARIZONA

CH2MHILL

APPENDIX 1

Details on Exposure Estimates

Modeling of inhalation exposures

CHRONIC DAILY INTAKE:

$$(CDI) = \frac{[(IAC)(IR)(ET_i)(EF)(ED)(CF) + (OAC)(IR)(ET_o)(EF)(ED)(CF)]}{(BW)(AT)}$$

where:

IAC	=	Indoor Concentration in Air (mg/m^3)
OAC	=	Outdoor Concentration in Air (mg/m^3)
IR	=	Inhalation Rate ($meters^3/day$)
ET_i	=	Exposure Time Indoors (hours/day)
ET_o	=	Exposure Time Outdoors (hours/day)
EF	=	Exposure Frequency (days/year)
CF	=	Conversion Factor (1 day/24 hours)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kilograms)
AT	=	Averaging Time (days)

Variable Values:

IAC	=	Site Specific (mg/m^3)
OAC	=	Site Specific (mg/m^3)
IR	=	Inhalation Rate (20 $meters^3/day$)
ET_i	=	Exposure Time Indoors (21.6 hours/day)
ET_o	=	Exposure Time Outdoors (2.4 hours/day)
EF	=	Exposure Frequency (350 days/year)
ED	=	Exposure Duration (30 years)
BW	=	Body Weight (70 kilograms for adult; 35 kilograms for child)
AT	=	Averaging Time Non-carcinogen = 10950 days

Soil Gas

Soil gas emissions were modeled using results obtained at each sampling point for soil vapor phase concentrations. The 1994 samplings covered a very large area and concentrations were very dependent on location, therefore, it was not considered practical to average results over the area. Data used for the soil gas exposure assessment included all results reported for the 1993 sampling event.

Assumptions for estimating exposure concentrations for three population groups in areas with soil gas sampling data from 1993, including on-site sampling locations, are shown in Table 3.3. Calculations using the data are shown in Appendix Table D. On-site sampling locations were also included in assessment of residential exposures for comparison. Figures used in calculations of outdoor and indoor concentrations are shown in Appendix Table D.

Chemicals in the vapor phase will diffuse through the soil at a rate dependant on the concentration gradient in the soil, the soil porosity, and tortuosity. Millington and Quirk[11] suggested an empirical model to calculate an effective diffusion coefficient:

$$D_s = \frac{D_o \times (P_a)^{10/3}}{(P_t)^2}$$

where:

D_s = effective vapor phase diffusion coefficient (m^2/sec);
D_o = vapor phase diffusion coefficient in air (m^2/sec);
P_a = air filled porosity (unitless); and
P_t = total porosity (unitless).

The flux rate was determined by the following equation, as simplified by Karimi et al.[12]:

$$J = \frac{-D_s \times (C_s - C_g)}{L}$$

where:

J = flux rate of the vapors through the soil (mg/m^2-sec);
D_s = effective vapor phase diffusion coefficient (m^2/sec);
C_s = vapor phase concentration at the soil surface (mg/m^3);
C_g = vapor phase concentration in the soil at depth L (mg/m^3); and
L = thickness of the clean soil layer (m).

Karimi et al.[12] suggested simplifying this equation by assuming C_s to be zero. C_s is very small compared to C_g and the assumption yields a liberal estimate of the flux rate, since values greater than zero will give a lower flux rate. This leads to a more conservative estimate of risk.

Equations and Assumptions for Calculation of Soil Gas Exposure Concentrations

(1) Karimi model for estimating flux rate from soil:

$$J = [(D_s)(C_s\text{-}C_g)]/L$$

where:

D_s	=	$[(D_o)(p_a^{10/3})]/(p_t^2)$
P_a	=	air filled porosity = 0.25
D_o	=	diffusion coefficient
P_t	=	total porosity = 0.45
C_s	=	vapor phase concentration at the soil surface (mg/m^3) = 0
C_g	=	vapor phase concentration at depth L (mg/m^3) (as measured)
L	=	thickness of clean soil layer (m) (as measured)

(2) Estimation of outdoor air concentrations (OAC):

$$OAC = E/[(w)(h)(u)]$$

assumptions : area of emission (A_e) = 100 m^2

where:

E	=	emission rate into box (E = (J)(Ae))	mg/day
w	=	square root area of box	10 m
h	=	height of box	1.5 m
U	=	wind velocity	2.8 m/sec

(3) Estimation of indoor air concentrations (IAC):

$$IAC = [(J)(A)(F)]/[(ACH/3600)(v)]$$

where:

J	=	flux rate of vapors through soil	
A	=	area of infiltration	140 m^2
F	=	fraction of gas flux entering building	0.001
ACH	=	air changes per hour	0.5
3600	=	Seconds per hour	3600 sec/hr
v	=	volume of air in building	350 m^3

The total soil porosity (P^t) was assumed to be 0.45. This is a reasonable figure for soils with high percentages of silt and sand. Assuming a soil bulk density of about 1.7 Mg/m^3 and a moisture content of 12 g/100g, the air filled porosity (Pa) is about to 0.25. The soil thickness used in the calculations is the sampling depth.

Outdoor Air Exposures

The Karimi model was used to estimate the flux rate, using the reported soil gas figures from the soil gas data. An emission can be calculated by introducing an area term. Outdoor exposure concentrations were estimated using a simple Box model:

$$OAC = (E)(W)^{-1}(H)^{-1}(U)^{-1}$$

where:

OAC	=	outdoor air concentration (mg/m^3);
E	=	emission rate ($E = J \times A_e$);
J	=	flux rate (mg/m^2-sec);
A_e	=	area of emission (m^2);
W	=	square root of box area (m);
H	=	height of box (m); and
U	=	wind velocity (m/sec).

The height of the box is taken to be 1.5 m, approximately the average human nose height. Wind velocity was estimated at 2.8 m/sec, a value considered to be normal for the Phoenix area by the National Weather Service. A reasonable, but low, value was chosen to maximize exposure concentrations.