Health Risk Assessment
of the
B.K.K. Landfill, West Covina, California

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INTERIM REPORT

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GLOSSARY OF TERMS

ANALYSIS OF VARIANCE - A statistical technique that isolates and assesses the contribution of one or more factors to the variation in an outcome of interest. In analysis of variance (ANOVA), independent categorical variables (factors) are investigated for their influence on the dependent continuous random variable (outcome). Assumptions underlying ANOVA are: independence of the values, normality of the errors in the values, and equal variance for all observations.

AMBIENT AIR - Outdoor air.

AMBIENT AIR QUALITY STANDARD - A standard adopted by CARB in consideration of public health, safety, and welfare, including, but not limited to, health, illness, irritation to the senses, aesthetic value, interference with visibility, and effects on the economy; standards may vary from one air basin to another; standards relating to health effects are based on the recommendations of DHS (California Health and Safety Code Section 39606). An ambient air quality standard applies at the boundary of a facility. In 1978, CARB adopted an ambient air quality standard for vinyl chloride of 10 parts per billion (ppb) for a 24-hour average. The standard represented the limit of detection for vinyl chloride at that time.

CARB - California Air Resources Board

CAPCOA - California Air Pollution Control Officers Association

CERCLA - In 1980, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) which established broad federal authority to deal with releases or threats of releases of hazard us substances. CERCLA, also known as Federal Superfund, was amended in 1986.

CH2MHILL - A consulting engineering firm contracted by EPA in October 1985 to conduct an exposure assessment of the B.K.K. Landfill.

CHRONIC REFERENCE DOSE - An estimate of the daily exposure to humans, including sensitive populations, that is likely to be without an appreciable risk of adverse health effects during the lifetime (70-years). Developed by EPA, the chronic reference dose is specifically designed to be protective for long-term exposures; the subchronic reference dose is used with short-term exposures.

CLASS I LANDFILL - A classification system for landfills in California developed by state agencies. All landfills require a permit to operate. Class I landfills may accept hazardous waste, subject to federal and state regulations for hazardous waste management units.

CLASS III LANDFILL - A landfill that accepts only non-hazardous waste (municipal refuse and dewatered sludge). Class III landfills are regulated by state and local agencies.

DHS - California Department of Health Services

DHS-EETB - California Department of Health Services, Environmental Epidemiology and Toxicology Branch

DHS-TSCP - California Department of Health Services, Toxic Substances Control Program

EPA - United States Environmental Protection Agency

HEALTH RISK ASSESSMENT - An analysis of the potential adverse health effects associated with exposure to hazardous substances based upon four systematic components: hazard identification, exposure assessment, dose-response assessment, and risk characterization.

INDIVIDUAL EXCESS LIFETIME CANCER RISK - An upper-bound estimate of the probability of an individual developing cancer due to a lifetime (70-year) exposure to the level in question of a carcinogen.

LANDFILL GAS - Methane, carbon dioxide, and trace gases generated by the anaerobic decomposition of buried organic wastes (both municipal and hazardous wastes). These gases serve as a transport medium for volatile organic compounds deposited or generated onsite. Landfill gas that is not collected by a gas collection system is released to ambient air, or migrates laterally through the soil before being released to the air or groundwater.

LEACHATE - Any liquid, including suspended components in the liquid, that p rcolates through or drains from buried wastes.

LINEARIZED MULTISTAGE MODEL - A mathematical model used to estimate the probability of incidence of disease by extrapolating from high dose animal studies to low level human exposures. This model is commonly used in quantitative carcinogenic risk assessments where the chemical agent is assumed to be a complete carcinogen and the risk is assumed to be proportional to the dose in the low region. This model yields estimates of risk that are conservative, representing a plausible upper limit for the risk.

MAXIMUM CONTAMINANT LEVEL - The enforceable drinking water standard, based on health and technical feasibility.

MAXIMUM LIKELIHOOD ESTIMATE - The best fit dose-response line from a set of data.

POPULATION EXCESS CANCER BURDEN - An upper-bound estimate of the increase in cancer cases in a population as a result of a defined exposure to a carcinogen.

RCRA - In 1976, Congress passed the Resource Conservation and Recovery Act (RCRA) which controls the generation, treatment, storage, and disposal of solid and hazardous waste. The Act, referred to as "cradle-to-grave" regulation of solid and hazardous waste, was amended in 1980 and 1984.

RCRA PART B PERMIT APPLICATION - Requires owners and operators of hazardous waste facilities to submit detailed information about a facility, such as: a description of the procedures, structures or equipment used to prevent runoff and contamination of water supplies; a topographic map showing surface waters, surrounding land uses (residential, commercial, agricultural, recreational); a wind rose; and injection and withdrawal wells onsite and offsite. Contents of Part A and Part B of the Application are specified in the California Code of Regulations, Title 22, Division 4, Chapter 30, Sections 66390 and 66391.

SAM WORK PLAN - The Site Assessment and Mitigation (SAM) Work Plan for the Class I Hazardous Waste Management Unit, developed by consultants to the B.K.K. Landfill in coordination with regulatory agencies. Provisions of the SAM Work Plan address ongoing monitoring requirements of the B.K.K. Landfill.

SCAQMD - South Coast Air Quality Management District

SLOPE FACTOR - An upper-bound estimate of the probability of developing cancer per unit intake of a chemical over a lifetime (70-year). The slope factor is usually, but not always, the upper 95th percent confidence limit of the slope of the dose-response curve and is expressed as $(mg/kg\text{-}day)^{-1}$.

THRESHOLD - A dose level below which a response attributable to a particular substance will not occur.

TOXIC AIR CONTAMINANT - An air pollutant which may cause or contribute to an increase in mortality or an increase in serious illness, or which may pose a present or potential hazard to human health. As established by legislation in 1983, and in consultation with DHS, CARB is implementing a program which first identifies and then controls toxic air contaminants (California Health and Safety Code Section 39650 *et seq*, Food and Agriculture Code Section 14021 *et seq*).

UNIT RISK - A measure of the carcinogenic potential of a substance, expressed in terms of risk per unit concentration of the substance in the medium where human contact occurs. The inhalation unit risk is an estimate of the probability of developing cancer as a result of constant exposure over 70 years to 1 $\mu g/m^3$ of a substance in air.

UPPER 95 PERCENT CONFIDENCE LIMIT - The statistical upper bound of the excess cancer risk derived from low dose extrapolation models.

VOC - Volatile organic compound

EXECUTIVE SUMMARY

In October 1985, the United States Environmental Protection Agency (EPA) contracted CH2MHill to conduct an exposure assessment of the B.K.K. Landfill, West Covina, California with the understanding that the California Department of Health Services (DHS) would perform a quantitative health risk assessment based on the data collected and evaluated. In August 1988, CH2MHill completed its seven-volume report, entitled "B.K.K. Landfill Environmental Exposure Characterization Report, West Covina, California." The report was reviewed by EPA, DHS, a technical peer review subcommittee, and a citizens advisory committee.

This health risk assessment of the B.K.K. Landfill was prepared by the Hazardous Waste Toxicology Section of the California Department of Health Services, Health Hazard Assessment Division. The health risk assessment is concerned primarily with the risk of developing cancer from a 70-year exposure to the concentrations of carcinogens detected in air around the B.K.K. Landfill between 1982 through 1987. Air monitoring data from this period met retrospective quality assurance review for use in a quantitative risk characterization. The health risk assessment is divided into five parts:

- INTRODUCTION, which introduces the health risk assessment and summarizes the history of the B.K.K. Landfill;

- HAZARD IDENTIFICATION, which gives information about the indicator chemicals (carcinogens and noncarcinogens) detected in groundwater, surface water, and air in and around the B.K.K. Landfill;

- EXPOSURE ASSESSMENT, which describes the population in the vicinity of the B.K.K. Landfill, evaluates the pathways of exposure to neighboring residents, and describes the air monitoring programs used in the risk characterization;

- DOSE-RESPONSE ASSESSMENT, which identifies the chronic reference doses for noncarcinogens and the inhalation unit risk values for carcinogens used in the risk characterization;

- RISK CHARACTERIZATION, which estimates the individual excess lifetime cancer risk and the population excess cancer burden from a 70-year exposure to the concentrations of carcinogens detected in air around the B.K.K. Landfill between 1982 through 1987. A summary of the three previous health risk assessments of the B.K.K. Landfill is provided in the Appendix for informational purposes.

The B.K.K. Landfill in West Covina, California, operated a Class I landfill (that is, a landfill permitted for disposal of hazardous waste) from approximately 1972 to December 1984. During that time, the B.K.K. Landfill was the largest Class I hazardous waste land disposal facility in California and the primary hazardous waste disposal facility for the Los Angeles area. The Class I landfill began as 40 acres in 1972, expanded to 140 acres in 1975,

and by 1984 encompassed approximately 170 acres of the 583-acre facility. Acreage in excess of the 140 acres includes a buffer zone of the adjoining non-hazardous waste disposal area. Approximately 3.4 million tons of hazardous waste were deposited at the facility. Seventy-two percent of the waste was liquid hazardous waste such as acid solutions, alkaline solutions, solvents, and wastes containing vinyl chloride. Hazardous wastes were buried in drums, injected into wells, co-mingled with non-hazardous waste, or solidified (mixed) with onsite soil.

The surrounding land was relatively undeveloped when the B.K.K. Landfill opened as a municipal waste disposal facility in 1963. Since that time, residential neighborhoods were developed to the north, west, south, and southeast. By 1985, EPA estimated the population within a one-mile radius from the center of the landfill to be approximately 40,000 persons (EPA, 1985). Beginning in 1969, neighboring residents complained about odors, surface water runoffs, spills, and dust releases from the facility.

Since 1979, studies, investigations, and hearings have been conducted in response to complaints from residents and concerns of regulatory agencies. Environmental monitoring at the B.K.K. Landfill detected volatile organic compounds in air, groundwater, and surface water in and around the facility. Vinyl chloride, a human carcinogen, was detected in ambient air at concentrations above California's ambient air quality standard of 10 parts per billion (ppb). EPA issued orders in 1984 and 1986 to the B.K.K. Corporation citing hazardous waste violations. On November 30, 1984, the B.K.K. Landfill stopped accepting hazardous waste. Under the direction of EPA and State

agencies, the B.K.K. Landfill completed closure of the Class I landfill in March 1989, and is conducting a Site Assessment and Mitigation (SAM) Work Plan. A Class III (non-hazardous waste) land disposal facility continues to operate on approximately 150 acres of the remaining 413 acres.

EPA contracted the engineering firm of CH2MHill to conduct an exposure assessment to evaluate whether contaminants released from the B.K.K. Landfill presented a health risk to neighboring residents in comparison to background exposure concentrations. CH2MHill's report evaluated groundwater, surface water, and air monitoring data for 1975 to March 1986. The CH2MHill report had several important conclusions about plausible past routes of exposure: 1) although groundwater below the B.K.K. Landfill is contaminated, groundwater is not used for drinking water or irrigation; 2) human exposure could have potentially occurred through ingestion or dermal contact with contaminated surface water released from the B.K.K. Landfill, but exposure would have been limited and infrequent; and 3) air monitoring data indicated an exposure pathway for neighboring residents.

The hazard identification section and the exposure assessment section of this health risk assessment summarize information presented and evaluated by CH2MHill in its 1988 report. The dose-response section identifies the toxicity values (reference doses and unit risk values current through June 1989) used in the quantitative risk characterization. The risk characterization section estimates the risk of adverse health effects associated with exposure to the concentrations of contaminants (carcinogens

and noncarcinogens) detected in offsite surface water and air for residents living near the B.K.K. Landfill.

Because it is assumed that no threshold exists for substances that induce cancer, the risk characterization is concerned primarily with the risk of developing cancer from a 70-year exposure to the concentrations of carcinogens detected in air around the B.K.K. Landfill between 1982 through 1987. Individual excess lifetime (70-year) cancer risks are estimated using data from three site-specific air monitoring programs and one Los Angeles basin air monitoring program evaluated by CH2MHill, and one air modeling program of site data used by the California Air Resources Board (CARB). The population excess cancer burden is estimated for residents within a one-mile radius of the landfill.

Ambient vinyl chloride monitoring data represent the most appropriate data to assess the excess cancer risk associated with the B.K.K. Landfill because vinyl chloride is a human carcinogen and is not commonly detected in the Los Angeles air basin. Carcinogens such as benzene, perchloroethylene, and trichloroethylene are detected in ambient air both at the B.K.K. Landfill and in the Los Angeles basin (SCAQMD, 1987). These compounds may present an additional cancer risk to people living around the B.K.K. Landfill, but it is not possible with the present data to distinguish between exposure due to ambient levels and exposure due to the B.K.K. Landfill. Vinyl chloride is rarely detected in ambient air and therefore more clearly represents exposure associated with the B.K.K. Landfill.

Based on the 1987 ambient vinyl chl ride concentrations and the methods and assumptions used in this health risk assessment, the individual exc ss lifetime cancer risk associated with exposure to the carcinogen detected in air around the B.K.K. Landfill is estimated to be approximately 1 to 2 individuals in 100,000 persons. This assumes everyone is exposed to vinyl chloride at the 1987 concentrations for an entire 70-year lifetime. In the population of 40,000 persons living within a one-mile radius of the B.K.K. Landfill, less than one additional case of cancer would be expected to occur from this exposure.

Currently, DHS and CARB are reevaluating the data on the carcinogenicity of vinyl chloride, in recent and past literature, for the purpose of identifying vinyl chloride as a toxic air contaminant. When this process is completed, a new unit risk value for vinyl chloride will be established. The new value is likely to be about 29 times greater than the value used in this health risk assessment. When this new value is adopted, DHS will prepare an addendum t this health risk assessment, reflecting the changed unit risk value for vinyl chloride, updating toxicity values, and adding air monitoring data collected since 1987.

INTRODUCTION

Nature of Health Risk Assessments

Health risk assessments estimate potential adverse health effects associated with exposure to toxic and hazardous compounds based upon four systematic components: hazard identification, exposure assessment, dose-response assessment, and risk characterization. Each component refines the analysis and all four together are the assessment. Results of a health risk assessment are conditional on the methods and assumptions used, and the limitations and uncertainties identified. Health risk assessments are derived from the kn wledge and technology available at a particular time, and consequently need to be continually reviewed to ensure consistency with scientific advances.

Purpose and Scope of this Health Risk Assessment

The purpose of this health risk assessment is to estimate, for residents living near the B.K.K. Landfill, the risk associated with exposure to the concentrations of contaminants detected in environmental monitoring of the facility through 1987. This 1990 health risk assessment updates a 1982 joint agency assessment (DHS-TSCP/CARB/SCAQMD, 1983) and is expected to be updated when reevaluation of the cancer potency of vinyl chloride is completed.

Information on the history of the B.K.K. Landfill, the choice of indicator chemicals, and the exposure assessment was taken primarily from Volume I of CH2MHill's seven-volume report to EPA. For a more detailed discussion of the

history, indicator chemicals, or exposure assessment, the reader is referred t that report (CH2MHill, Volume I, 1988). The CH2MHill report was reviewed by EPA, DHS, a technical peer review subcommittee, and a citizens advisory subcommittee.

Figures and tables taken from CH2MHill's report and other reports are individually referenced.

History of the B.K.K. Landfill, West Covina, California

The B.K.K. Landfill, operated by B.K.K. (Kenneth B. Kazarian) Corporation, is located within the corporate boundary of the City of West Covina, California, 18 miles east of downtown Los Angeles in Los Angeles County (Figure 1). In 1963, the B.K.K. Landfill opened on 130 acres in the San Jose Hills as a municipal waste landfill for the disposal of household and commercial refuse and inert solids such as construction debris. A land use permit was obtained from the City of West Covina, and waste discharge requirements were prescribed by the Los Angeles Regional Water Quality Control Board.

In 1971, the City of West Covina approved an expansion of the facility from 130 acres to the present 583 acres, and permitted the disposal of hazardous waste onsite. In 1972, the B.K.K. Landfill opened a 40-acre Hazardous Waste Management Unit (that is, a Class I landfill) and began accepting hazardous waste. In 1975, the Class I Hazardous Waste Management Unit expanded by an additional 100 acres (Figure 2).

The B.K.K. Landfill was the largest Class I hazardous waste land disposal facility in California and the primary commercial hazardous waste disposal facility for the Los Angeles area. Annual summaries of hazardous wastes deposited at the facility are available for the years 1975 through 1984. These summaries record that approximately 3.4 million tons of hazardous waste were deposited at the B.K.K. Landfill. Seventy-two percent of the waste was liquid hazardous waste. Wastes accepted in the greatest quantities were: acid solutions, alkaline solutions, contaminated soils, drilling muds, oil and oil sludges, tank bottom sediments, and other (unspecified) hazardous waste (Table 1). Hazardous wastes were deposited onsite by four methods: buried in drums, injected into wells, co-mingled with solid non-hazardous waste, and "solidified" (mixed) with onsite soil.

In 1963, the B.K.K. Landfill was located in a relatively undeveloped area of the San Gabriel Valley. In 1971, a residential neighborhood was sited approximately 2,000 feet from the northern border. By 1975, residential zoning and land use permits in West Covina allowed the construction of homes up to the property line on the southern and southeastern borders (Figure 3).

Migration of hazardous waste constituents from the landfill occurred. Anaerobic decomposition of the waste generated landfill gas which served as a transport medium for volatile organic compounds (VOCs) deposited onsite to migrate to ambient air. Hydrogeologic investigations found contamination in groundwater under the facility.

TABLE 1
(Environmental Solutions, Inc.)

TABLE 1.4
HAZARDOUS WASTE TYPES DEPOSITED IN BKK LANDFILL(1)(2)
(1975-1984)

(TONS)

WASTE TYPE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	TOTAL
Acid Sludge							299	1,817			2,116
* Acid Solution	19,300	33,497	41,756	71,615	83,440	112,755	66,526	31,483	22,649	312	483,333
Acid Solution w/Metals									13,942	24	13,966
Acid Solution w/o Metals									2,984	146	3,130
Acid Solution - Neutralized							5,395	21,063			26,458
Adhesive							210	378	481	406	1,475
Alkaline Sludge							1,361	3,064			4,425
* Alkaline Solution	49,598	62,761	70,747	69,782	69,396	79,487	45,899	40,732	18,219	6,177	512,798
Alkaline Solution w/Metals									18021	9,149	27,170
Alkaline Solution w/o Metals									12,595	3,176	15,771
Alkaline Solution - Neutralized							281				281
Alkali Solids								1,025			1,025
Alum Sludge							269	3,713	6,312	7,090	17,384
A. P. I. Generator Sludge							919	21,254			22,173
Aqueous Solution w/Metals									30,292	19,863	50,155
Aqueous Soluiton w/>10% Organics									4,729	6,664	11,393
Asbestos-Containing Wastes								1,783	2,506	2,659	6,948
Ashes								150	1,692	286	2,128
Baghouse Waste								2,511	2,868	1,890	7,269
Bilge Water							721	1,073			1,794
Bio. Waste Other Than Sewage									404	278	682
Blasting Sand								3,881			3,881
Brine	685	172	329	1,121	648	673					3,628
Cannery Waste	9,046	22,998	17,380	3,895	1,641	367					55,327
Catalyst							5,393	8,974	5,870	3,623	23,860
Chemical Toilet Waste	220	45	34	34	31	213	69	11			657
Chemicals, Unused							91	485	834	894	2,304
Containers, Empty								1,073	966	1,111	3,150
Contaminated Equipment								6,523			6,523
* Contaminated Soil and Sand	708	289	585				185	79,927	299,417	76,929	458,540
Cyanide Waste				1,421	3,978	4,488	4,256	1,257			15,400
Degreasing Sludge									1,285	1,157	2,442
Detergent and Soap							2,645	1,332	2,065	1,733	7,775
Distillation Bottoms							564	1,235	2,243	237	4,279
* Drilling Mud	17,288	12,316	13,773	41,650	27,319	19,153	25,388	7,394	10,210	1,392	175,883
FCC Waste							59	4,323	8,411	5,678	18,471
Filter Cake							206	2,238			2,444
Filters, spent								304			304
Flux								14			14
Fly Ash								30			30
Gasoline and Water							2,084	1,590			3,674
Glaze Sludge							11	542			553
Glue							55	63			118
Hair Pulp								131			131
Heavy Metal Solution							2,263	7,221			9,484
Heavy Metal Sludge							240	6,342			6,582
Ink and Solvent							716	971			1,687

(1)Source: BKK annual waste summaries, 1975 through 1984.
(2)Blanks in the table result from change in waste classification.

*Deposited in the greatest quantity during this period.
Reference: Modified from CH$_2$M Hill (March 6, 1986).

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TABLE 1.4
HAZARDOUS WASTE TYPES DEPOSITED IN BKK LANDFILL (1)(2)
(1975-1984)
(Continued)

(TONS)

WASTE TYPE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	TOTAL
Ink Sludge							76	541			617
Ink Wastewater							423	1,215			1,638
Laboratory Chemicals							186	253			439
Latex Waste	714	3,107	446	6,482	5,433	1,586			658	606	19,032
Lime Sludge							3,055	10,304	10,679	2,737	26,775
Machine Tool Coolant							3,528	3,582			7,110
Metal Sludge									22,857	15,393	38,250
Metal Dust and Machining Waste							1,376	529	406	293	2,604
Mud and Water	17,754	51,486	29,259	65,816	44,457	38,426	1,177				248,375
* Oil	24,630	11,229	9,467	27,405	22,276	14,137	1,204	471	3,650	1,369	115,838
* Oil Sludge							2,568	9,516	70,711	26,345	109,140
Oil and Water							35,201	35,631			70,832
Oil-Containing Waste, Unspecified									24,703	18,462	43,165
Organic Liquids									1,690	303	1,993
Organic Monomer Waste									131	281	412
Organic Solids									534	927	1,461
* Paint Waste	3,377	5,401	6,372	7,414	6,952	5,092	3,628	17,604	15,256	11,643	82,739
Paper Sludge/Pulp									53	59	112
Pesticides	904	534	130	189	290	358	353	238	245	169	3,410
Pesticide Containers								24	79	42	145
Pesticide Rinsewater							263	26	301	124	714
Pharmaceuticals							35	578	53	61	727
Phenolic Waste							82	32			114
Phosphate Sludge									528	877	1,405
Photoprocessing Waste							823	1,445	1,099	1,680	5,047
Plating Sludge							1,870	5,949			7,819
Plating Solution, Acid							5,848	3,583			9,431
Plating Solution, Alkaline							879	2,480			3,359
Polychlorinated Biphenyls								7	49	65	121
Resin Waste							1,158	11,320	3,377	1,142	16,997
Scrubber Waste							550	1,103	982	79	2,714
Solvent, Halogenated							1,046	9,498	1,392	585	12,521
* Solvent, Hydrocarbon							813	853	652	122	2,440
* Solvent, Oxygenated							188	171	1,281	224	1,864
* Solvent, Mixed							19,418	14,662	17,612	960	52,652
Solvent, Unspecified	3,447	6,424	9,211	16,649	17,139	27,340					80,210
Spill Cleanup							856	3,925			4,781
Stretford Solution							1,583	4,640			6,223
Sulfide Sludge							211	625	2,589	3,054	6,479
Sump Sediment							12,734	25,920			38,654
* Tank Bottom Sediment	24,205	52,742	57,661	100,434	124,448	146,152	13,088	39,964	44,471	11,733	614,898
Tanning Sludge							155	1,097			1,252
Tetraethyl Lead Sludge	88	91	35	25	60	24		32	150	8	513
Wastewater Treatment Sludge				3,250	15,863	290	6,344	16,674	5,170	2,221	49,809
Other Liquids							989	3,143	26,248	13,191	43,571
Misc. Sludge Waste									12,522	1,970	14,492
Other Hazardous Waste	6,769	5,805	2,302	1,501	4,890	8,966			20,037	74,451	124,721
TOTALS	178,733	268,897	259,487	418,683	428,261	459,507	287,813	493,539	759,660	342,050	3,896,630

(1)Source: BKK annual waste summaries, 1975 through 1984.
(2)Blanks in the table result from change in waste classification.

*Deposited in the greatest quantity during this period.

Reference: Modified from CH2M Hill (March 6, 1986).

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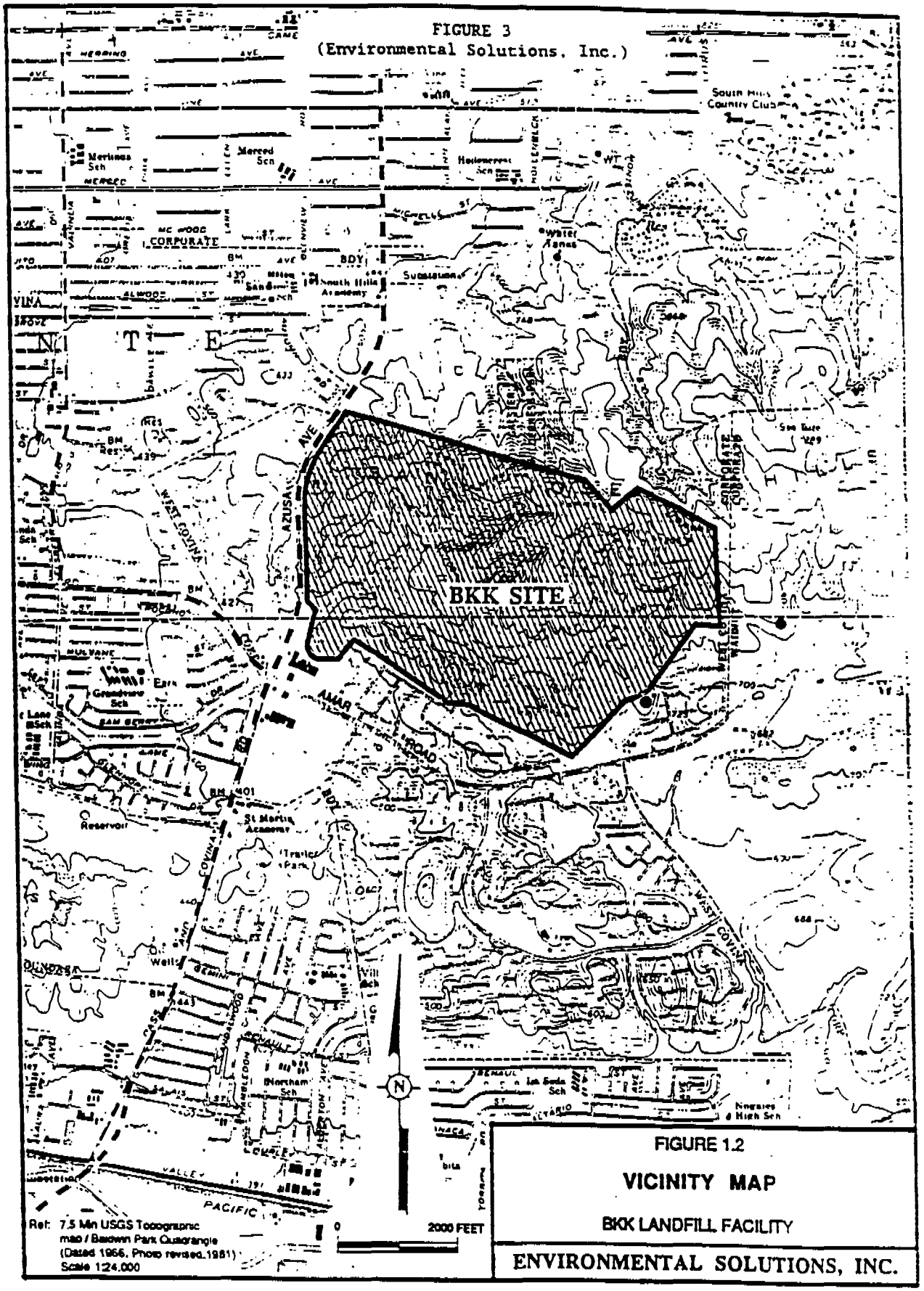
Source: Environmental Solutions, Inc., Table 1.4, "BKK Landfill Site Assessment and Mitigation Work Plan, Book I, Subsurface: Site Characterization," March 15, 1988, pgs. 1-22 and 1-23.

FIGURE 3
(Environmental Solutions, Inc.)



Source: Environmental Solutions, Inc., Figure 1.2, "BKK Landfill Site Assessment and Mitigation Work Plan, Book I. Subsurface: Site Characterization," March 15, 1988, p. 1-3.

The first odor complaint against the B.K.K. Landfill was reported to the South Coast Air Quality Management District (SCAQMD) in 1969. The number of odor c mplaints reported to SCAQMD increased to 278 in 1979, 537 in 1980 and 936 in 1981. Neighboring residents have been concerned for many years about odors and hazardous waste releases in surface water runoff, spills, and dust from the B.K.K. Landfill, and have voiced general health concerns about living near a hazardous waste facility. Since 1979 various studies, investigations, and hearings have been conducted in response to complaints from residents and concerns of regulatory agencies.

In 1980, SCAQMD began monitoring ambient air in the vicinity of the B.K.K. Landfill for odorous organic compounds. In 1981 vinyl chloride, an odorless gas and a human carcinogen, was detected in concentrations above California's ambient air quality standard of 10 ppb. In June 1981, the California Department of Health Services-Toxic Substances Control Program (DHS-TSCP) banned further disposal of waste containing vinyl chloride from the B.K.K. Landfill, and SCAQMD established a program to monitor ambient air around the B.K.K. Landfill for vinyl chloride.

The following nine agencies formed an interagency task force in 1981 to coordinate activities associated with the B.K.K. Landfill:

- California Department of Health Services (the Toxic Substances Control Program and Public Health)
- Los Angeles Regional Water Quality Control Board
- United States Environmental Protection Agency

- California Waste Management Board
- South Coast Air Quality Management District
- City of West Covina
- County of Los Angeles Department of Public Works
- County of Los Angeles Department of Health Services
- County of Los Angeles Sanitation Districts.

In 1983, EPA requested a Resource Conservation and Recovery Act (RCRA) Part B Permit Application from the B.K.K. Landfill. During a facility inspection and permit application review later that year, EPA found several violations regarding groundwater monitoring, bulk liquid disposal, and ignitable/reactive waste disposal.

In April 1984, EPA issued B.K.K. Corporation a RCRA Section 3013 Order of Consent, requiring a comprehensive investigation of onsite and offsite contamination. In July 1984, 19 homes along the southern perimeter were evacuated as a result of lateral subsurface migration of landfill gas. EPA issued B.K.K. Corporation a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 106 Order, requiring mitigation of landfill gas emissions and leachate migration. EPA and DHS monitored indoor air in homes, and reoccupancy criteria were developed by DHS Epidemiologic Studies and Surveillance Section (DHS, 1984). All evacuated homes were allowed to be reoccupied by December 1984.

On November 30, 1984, the B.K.K. Landfill withdrew its RCRA permit application, stopped accepting hazardous waste, and began closure of the Hazardous Waste Management Unit. At that time, the size of the Class I unit was defined as 170 acres, which includes a buffer zone from the adjoining non-hazardous waste disposal area.

In 1986, EPA again issued orders to B.K.K. Corporation: a RCRA Section 7003 Order finding that an imminent and substantial endangerment to human health may have been present from handling and disposal practices at th B.K.K. Landfill; and a RCRA Section 3013 Order finding that a substantial hazard to human health or the environment may have been present from air and groundwater contamination and the proximity of drinking water sources in th area. The B.K.K. Corporation retained Environmental Solutions, Inc. to pr pare a SAM Work Plan in response to the EPA orders and in conjunction with federal, state, and local regulatory agencies.

In March 1989, closure of the Class I Hazardous Waste Management Unit was completed with the placement of the final cover and collection systems as stipulated in federal and state regulations. As part of the post-closur permit, monitoring will continue at B.K.K. Landfill, and may continue for 30 years from the date of closure. A Class III (non-hazardous waste) land disposal facility continues in operation on approximately 150 acres of the remaining 413 acres.

SAM Work Plan activities completed in 1989 included: a "phase I" sit hydrogeologic characterization, a landfill gas analysis, flare source testing, a soil and sediments sampling program, an ambient air gas and particulate monitoring program, and an air tracer test. An odor study, an elevated subsurface temperature and carbon monoxide sampling program, and a surface emissions program were in progress. Final SAM Work Plan reports are due in December 1990.

HAZARD IDENTIFICATION

The hazard identification component of a health risk assessment determines whether or not chemicals present at a site may pose a hazard to human health, and whether the health hazard is carcinogenic or noncarcinogenic. Noncarcinogenic effects may result from acute or chronic exposures, and threshold levels are established below which no adverse health effect is expected. It is assumed that no threshold exists for carcinogens. This section identifies the indicator chemicals (carcinogens and noncarcinogens) detected in groundwater, surface water, and air in and around the B.K.K. Landfill.

Indicator Chemicals Detected at the B.K.K. Landfill

CH2MHill prepared a list of all chemicals detected in groundwater, surface water, and air around the B.K.K. Landfill (CH2MHill, 1988). To focus on the contaminants of primary concern, CH2MHill applied the indicator chemical selection process, outlined by EPA in the "Superfund Public Health Evaluation Manual (1986)", and identified carcinogen and noncarcinogen indicator chemicals (Table 2).

The indicator chemical selection process directs attention to the contaminants of primary concern to human health and the environment, while not excluding any chemical that may cause harm to human health or the environment. Criteria used in the selection process are: the measured concentration of the

TABLE 2 (CH2MHill)
LISTING OF CHEMICALS DETECTED AND INDICATOR CHEMICALS
FOR GROUNDWATER, SURFACE WATER, AND AIR*
BKK LANDFILL, WEST COVINA, CALIFORNIA
A: GROUNDWATER

CHEMICALS DETECTED

VOLATILE ORGANICS
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethylene
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2-Butanone
Acetone
Benzene
Bromomethane
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
cis-1,2-Dichloroethylene
trans-1,2-Dichloroethylene
Ethylbenzene
Methylene Chloride
Xylenes
o-Chlorotoluene
Perchloroethylene
Propylbenzene
Styrene
Toluene
Trichloroethylene
Trichloromonofluoromethane
Vinyl Chloride

SEMI-VOLATILES
1,2,4-Trichlorobenzene
1,3,5-Trimethylbenzene
2 Hexanone
2,4-Dimethylphenol
bis(2-Chloroethyl)ether
bis(2-Chloroisopropyl)ether
bis(2-Ethylhexyl)phthalate
Dibutylphthalate
Diethylphthalate
Dimehtylnitrosamine
di-Octylphthalate
Isophorone
Napthalene
n-Nitrosodimethylamine
Phenol
Phenols (total)
Tetrahydrofuran

INORGANICS
Arsenic
Barium
Boron
Cadmium
Chromium(total)
Cobalt
Copper
Cyanide
Fluoride
Iron
Lead
Manganese
Mercury
Nickel
Nitrates
Selenium
Silver
Zinc

INDICATOR CHEMICALS

NON-CARCINOGENS
VOLATILE ORGANICS
1,1,1-Trichloroethane
1,1-Dichloroethane
1,2-Dichlorobenzene
2-Butanone
Chlorobenzene
cis-1,2-Dichloroethylene
trans-1,2-Dichloroethylene
Ethylbenzene
o,p-Xylene
Toluene

SEMI-VOLATILES
Phenols, (total)
Phenol

INORGANICS
Barium
Cadmium
Copper
Fluoride
Lead
Manganese
Mercury
Silver
Zinc

CARCINOGENS
VOLATILE ORGANICS
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethylene
1,2-Dichloroethane
Benzene
Carbontetrachloride
Chloroform
Methylene Chloride
Perchloroethylene
Trichloroethylene
Vinyl Chloride

SEMI-VOLATILES
bis(2-Chloroethyl)ether
n-Nitrosodimethylamine

INORGANICS
Arsenic

*Chemicals detected represent those found in the landfill gas;
the indicator chemicals represent those analyzed in the monitoring programs

SYNONYMS
2-Butanone = Methylethylketone
2-Hexanone = Methylbutylketone
n-Nitrosodimethylamine = Dimethylnitsosamine
Methylene Chloride = Dichloromethane
Perchloroethylene = Tetrachloroethylene

TABLE 2 (Continued)
LISTING OF CHEMICALS DETECTED AND INDICATOR CHEMICALS
B: SURFACE WATER

CHEMICALS DETECTED	INDICATOR CHEMICALS
	NON-CARCINOGENS
VOLATILE ORGANICS	VOLATILE ORGANICS
1,2-Dichlorobenzene	1,1,1-Trichloroethane
1,1,1-Trichloroethane	1,1-Dichloroethane
1,1,2-Trichloroethane	1,2-Dichlorobenzene
1,1-Dichloroethane	Chlorobenzene
1,1-Dichloroethylene	Ethyl Benzene
1,2-Dichloroethane	Xylenes
Acetone	Toluene
Benzene	
Bromodichloromethane	SEMI-VOLATILES
Chlorobenzene	Phenol (total)
Chlorodibromomethane	
Chloroform	INORGANICS
cis-1,2-Dichloroethylene	Cadmium
trans-1,2-Dichloroethylene	Chromium (total)
Dichloromethane	Copper
Ethylbenzene	Cyanide
Xylenes	Lead
o-Chlorotoluene	Nickel
Perchloroethylene	Selenium
Styrene	Zinc
Propylbenzene	
Toluene	
Trichloroethylene	CARCINOGENS
Vinyl chloride	VOLATILE ORGANICS
	1,1,2-Trichloroethane
SEMI-VOLATILES	1,2-Dichloroethane
1,3,5-Trimethylbenzene	Benzene
1,4-Dichlorobenzene	Chloroform
Acenaphthene	Methylene Chloride
bis(2-Ethylhexyl)phthalate	Perchloroethylene
Dibutyl phthalate	Trichloroethylene
di-Octylphthalate	Vinyl Chloride
Nitrosodiphenylamine	
Phenols (total)	INORGANICS
	Arsenic
INORGANICS	
Arsenic	
Cadmium	
Chromium (total)	
Copper	
Cyanide	
Lead	
Nickel	
Selenium	
Silver	
Zinc	

The indicator chemicals represent those analyzed in the monitoring programs

SYNONYMS

2-Butanone = Methylethylketone
2-Hexanone = Methylbutylketone
n-Nitrosodimethylamine = Dimethylnitrosamine
Methylene Chloride = Dichloroethane
Perchloroethylene = Tetrachloroethylene

TABLE 2 (Continued)
LISTING OF CHEMICALS DETECTED AND INDICATOR CHEMICALS
C: AIR*

CHEMICALS DETECTED	INDICATOR CHEMICALS
	NON-CARCINOGENS
VOLATILE ORGANICS	VOLATILE ORGANICS
1,1-Dichloroethane	1,1,1-Trichloroethane
1,1-Dichloroethylene	Chlorobenzene
1,2-Dichloroethane	trans-1,2-Dichloroethylene
1,3-Dichloropropene	
1,1,1-Trichloroethane	
1,1,2-Trichloroethane	CARCINOGENS
2,3-Dimethylbutane	VOLATILE ORGANICS
Benzene	1,1-Dichloroethylene
Carbon Tetrachloride	1,2-Dichloroethane
Chlorobenzene	Benzene
Chloroethane	Carbon Tetrachloride
Chloroform	Chloroform
Cyclohexane	Perchloroethylene
cis-1,2-Dichloroethylene	Trichloroethylene
trans-1,2-Dichloroethylene	Vinyl Chloride
Hexane	
Isopropylbenzene	
Iso-octane	
Methane	
Methylcyclohexane	
Methycyclopentane	
Methylene Chloride	
Nonane	
n-Propylbenzene	
Perchloroethylene	
Toluene	
Trichloroethylene	
Vinyl Chloride	
Xylene (total)	
BASE/NEUTRALS	
1,4-Dichlorobenzene	
Dichlorobenzene	
ACID EXTRACTABLES	
2-Butanol	

*Chemicals detected represent those found in the landfill gas;
the indicator chemicals represent those analyzed in the monitoring programs

SYNONYMS
2-Butanone = Methylethylketone
2-Hexanone = Methylbutylketone
n-Nitrosodimethylamine = Dimethylintrosamine
Methylene Chloride = Dichloromethane
Perchloroethylene = Tetrachloroethylene

R&S145950

Source: CH2MHill, Table 5-4, "BKK Landfill Environmental Exposure Characterization Report, West Covina, California," August 15, 1988, Volume I, p. 5-22.

chemical; the toxicity of the chemical; and the physical/chemical properties of the chemical, which determine fate and transport in environmental media. Consequently, indicator chemicals represent the most toxic, mobile, and persistent chemicals at a site as well as those in the greatest concentrations.

Carcinogens Detected at the B.K.K. Landfill

EPA evaluates available data on the carcinogenic effects of chemicals from two sources: human epidemiologic investigations and long-term animal tests. EPA applies to the data a "weight of evidence" judgment on the likelihood that the chemical is a human carcinogen (EPA, 1986; EPA, 1989). The evidence is characterized separately for human studies and animal studies as sufficient, limited, inadequate, no data or no evidence. For example, the weight-of-evidence for human studies is as follows:

- sufficient evidence of carcinogenicity, which indicates that there is a causal relationship between the chemical and human cancer;
- limited evidence of carcinogenicity, which indicates that a causal interpretation is credible, but that alternative explanations, such as chance, bias, or confounding, could not adequately be excluded;
- inadequate evidence, which indicates that either there were few pertinent data, or that available studies, while showing evidence of association, did not exclude chance, bias, or confounding and therefore a causal interpretation is not credible;

- no data, which indicates that data are not available;

- no evidence, which indicates that no association between an exposure and an increased risk of cancer was found in well-designed and well-documented epidemiologic studies.

Based on the "weight of evidence", EPA classifies carcinogens as follows:

- A: Human carcinogen, i.e., sufficient evidence of carcinogenicity in humans;
- B1: Probable human carcinogen, i.e., sufficient evidence of carcinogenicity in animals with limited evidence in humans;
- B2: Probable human carcinogen, i.e., sufficient evidence of carcinogenicity in animals with inadequate evidence in humans;
- C: Possible human carcinogen, i.e., limited evidence of carcinogenicity in animals with inadequate evidence in humans;
- D: Not classifiable as to human carcinogenicity, i.e., inadequate evidence of carcinogenicity in animals with no evidence in humans;
- E: Evidence of noncarcinogenicity for humans.

The "weight of evidence" classifications for the carcinogens detected in groundwater, surface water, and air around the B.K.K. Landfill are A, B2, and C. The sites of carcinogenic effects for these chemicals include the liver, lung, skin, kidney, breast, and stomach. Table 3 presents this information for the carcinogens detected around the B.K.K. Landfill, based on toxicological data current through June 1989.

TABLE 3

CARCINOGENS DETECTED IN GROUNDWATER, SURFACE WATER, AND AIR

BKK LANDFILL WEST COVINA, CALIFORNIA

Carcinogen	CAS#[a]	EPA[b] Class	Cancer Site
Arsenic (inorganic)	-	A	lung, skin
Cadmium	-	B1	lung, prostate, mammary
Chromium(VI)	-	A	lung
Lead	-	B2	kidney, lung, nervous system
Nickel	-	A	lung, nasal
Benzene	71-43-2	A	hematopoietic system (leukemia)
Bis-2-chloroethyl ether	111-44-4	B2	liver
Carbon Tetrachloride	56-23-5	B2	liver
Chloroform	67-66-3	B2	kidney, liver
1,2-Dichloroethane	107-06-2	B2	stomach, breast, uterus circulatory system, lung, liver
1,1-Dichloroethylene	75-35-4	C	kidney, breast, lung
Methylene chloride	75-09-26	B2	liver, breast lung, hematopoietic system (leukemia)
N-nitrosodimethylamine	62-75-9	B2	liver, lung, kidney, circulatory system
Perchloroethylene	127-18-4	C	liver
1,1,2,2-Tetrachloroethane	79-34-5	C	liver
1,1,2-Trichloroethane	79-00-5	C	liver, kidney, adrenal, spelen, circulatory system
Trichloroethylene	79-01-6	B2	lymph, liver
Vinyl chloride	75-01-4	A	liver

a= Chemical abstract service number

b= EPA weight of evidence classification: A, sufficient evidence in humans; B1, sufficient evidence in animals, limited in humans; B2, sufficient evidence in animals, inadequate in humans; C, limited evidence in animals, inadequate in humans. Taken from EPA's Integrated Risk Information System (IRIS), June 1989. With the exception of 1,1-dichloroethylene and certain lead compounds, the above carcinogens are listed as known to the State of California to cause cancer for purposes of the Health and Safety Code Section 25249.5 et seq.

R&S145953

EXPOSURE ASSESSMENT

The exposure assessment component of a health risk assessment identifies and describes the population at risk, and the types, frequency, magnitude, and duration of exposures. This section describes the population in the vicinity of the B.K.K. Landfill, evaluates the pathways of exposure to neighboring residents, and tabulates the air monitoring programs which will be used in the risk characterization. For a more detailed analysis of the exposure assessment, the reader is referred to Volume I of CH2MHill's report (CH2MHill, 1988).

In October 1985, EPA contracted CH2MHill to conduct an exposure assessment as a technical enforcement support activity. The regulatory basis for the assessment was RCRA Section 3019, Subsection (b) and the procedural basis was the Superfund Public Health Evaluation Manual (EPA, 1986). The report, completed in 1988, included data available through March 1986 and consisted of the following volumes: Volume I - Text; Volume II - Plates; Appendices Volume 1 (groundwater data), Volume 2 (groundwater data), Volume 3 (groundwater data), Volume 4 (groundwater and surface water data), Volume 5 (surface water, air, and soils data).

Limited environmental monitoring data for the B.K.K. Landfill and the surrounding area have been collected since 1975, specifically: groundwater data are available from 1975 to the present; surface waters have been sampled since 1980; landfill gas, ambient air, and odor studies have been conducted

onsite and offsite since 1979. In 1984, ten onsite soil samples were analyzed for particle size only; one offsite residential soil sample was analyzed for volatile organic compounds and none were detected.

CH2MHill's objectives for the exposure characterization were:

1. to compile and evaluate existing environmental monitoring data collected onsite and near the B.K.K. Landfill;

2. to provide detailed analyses of the data to assess whether exposure to contaminants released from the B.K.K. Landfill posed either an immediate or a long-term risk to human health or the environment, in comparison to background exposure concentrations.

Data analyses included both:

- retrospective quality assurance review of the environmental monitoring data, and
- fate and transport evaluation of the contaminants in groundwater, surface water, and air.

Population in the Vicinity of the B.K.K. Landfill

In 1963, when the B.K.K. Corporation received its permit, the landfill was located in a relatively undeveloped area of the San Gabriel Valley. In 1967, the California Department of Finance estimated a population of approximately

67,000 in West Covina to the north and west of the facility, and a population of approximately 4,500 in Walnut to the east. In 1988, the Department of Finance estimated a population of 94,000 in West Covina and 25,000 in Walnut.

CH2MHill identified the age and sex distribution of the population in whole census tracts around the B.K.K. Landfill (Figure 4, Tables 4 and 5). Ethnicity, occupation, and socioeconomic status were not characteriz d. Demographics, prepared by CH2MHill from the 1980 U. S. population census, indicated that the residential communities in and around the B.K.K. Landfill consisted primarily of young adults, families with children, and women of childbearing age. CH2MHill examined sensitive population groups within a one-mile radius of the landfill boundary and identified 12 elementary schools, 2 child care centers, and 1 nursing home (Figure 5).

The population within a one-mile radius around the landfill was estimated for use in previous risk assessments and in the exposure assessment. In 1982, three agencies jointly conducted the first health risk assessment (DHS-TSCP/CARB/SCAQMD, 1983) and identified a population of 7,700 people at a distance of one mile from the B.K.K. Landfill property line. This population was derived by dividing the assessor's plot maps into quadrants corresponding to four monitoring stations (A, B, D, and F), and estimating the population within each quadrant using 1980 census data. In 1985, EPA identified a population of 40,000 people within a one-mile radius from the center of the landfill (EPA 1985). The difference in population numbers reflect different estimation methods rather than real population increase. This 1990 health

FIGURE 4
(CH2MH111)

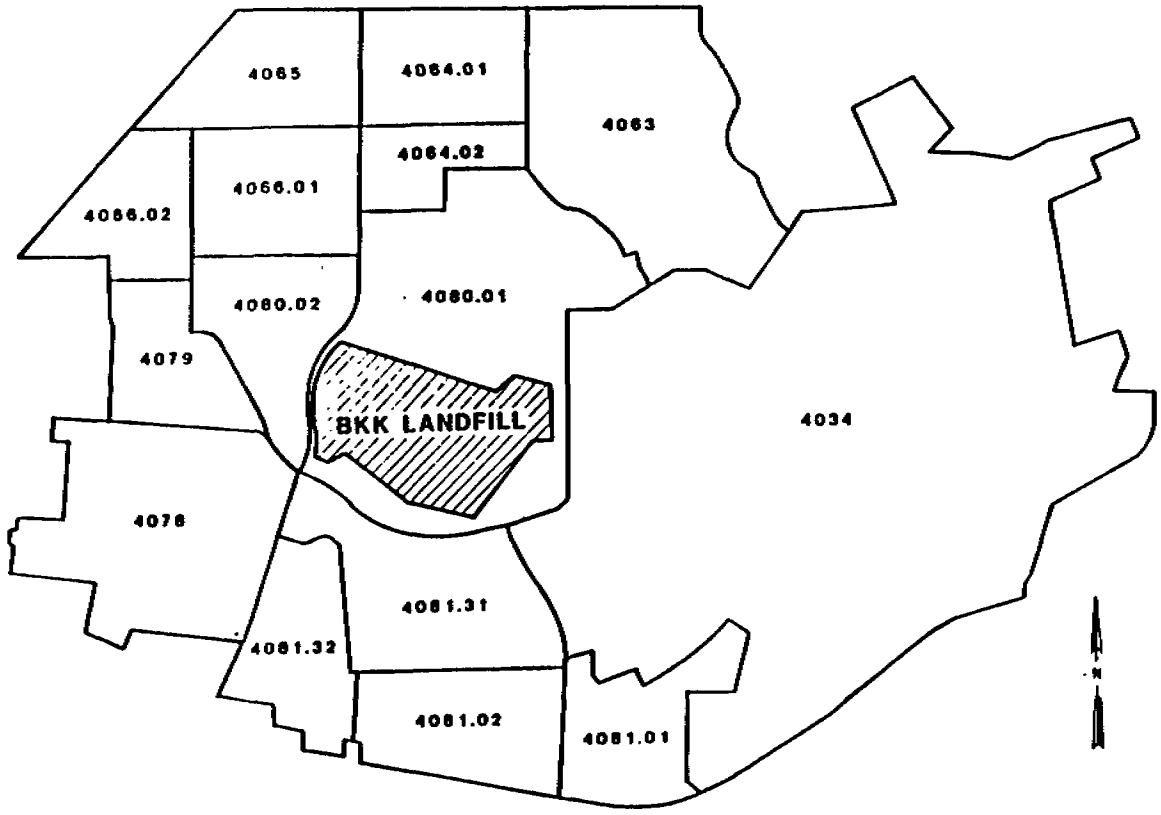


FIGURE 6-3
POPULATION CENSUS TRACTS IN
THE VICINITY OF THE BKK LANDFILL
BKK LANDFILL ENVIRONMENTAL EXPOSURE
CHARACTERIZATION

Source: CH2MHill, Figure 6-3, "BKK Landfill Environmental Exposure Characterization Report, West Covina, California," August 15, 1988, Volume I, p. 6-22.

R8S145957

TABLE 4
(CH2MHill)

Table 4-4
SUMMARY OF POPULATION CENSUS TRACT DATA FOR THE VICINITY OF THE BKK LANDFILL

Population Group	Location Relative to BKK Landfill (Census Tract No. Below)														
	Contains BKK	South			East-Southeast		West-Southwest			Northwest			North		Northeast
	4080.01	4081.31	4081.32	4081.02	4034	4081.01	4078	4079	4080.02	4066.01	4066.02	4065	4064.01	4064.02	4063
I. All Groups															
Total	5,324	10,535	8,101	7,201	12,478	6,025	7,107	5,015	4,885	4,759	3,998	5,444	4,424	1,898	3,826
Children (0-4)	564	1,254	844	725	1,168	534	589	484	388	255	324	364	277	92	110
Children (5-9)	377	1,057	940	821	1,262	568	711	468	365	292	280	367	311	93	188
Children (10-14)	300	756	1,061	897	1,483	676	873	535	405	394	343	380	413	176	301
Children (15-19)	389	628	1,057	840	1,398	622	964	547	505	574	460	509	559	225	503
Adults (20-24)	671	1,043	666	661	714	507	613	375	596	389	366	604	340	108	508
Adults (25-64)	2,875	5,533	3,323	2,986	6,185	2,948	3,160	2,423	2,438	2,552	1,969	2,833	2,257	1,081	1,971
Adults (65+)	148	228	330	271	272	172	197	183	158	303	256	387	267	123	245
Median Age	27.7[a]	27.1	21.0	22.1[a]	26.6	26.2[a]	23.3[a]	26.3[a]	26.0[a]	33.1[a]	29.8[a]	29.3	30.8	36.8	33.1[a]
II. Females															
Total	2,693	5,287	4,097	3,619	6,246	3,997	3,576	2,537	2,469	2,406	2,000	2,815	2,226	970	1,893
Females (0-19)	822	1,861	1,917	1,595	2,588	1,176	1,547	1,032	814	733	668	796	768	297	568
Females (20-34)	1,003	2,151	893	960	1,691	867	895	668	860	501	464	828	450	149	414
Females (35-64)	791	1,145	1,115	913	1,816	860	1,028	757	757	1,003	714	953	892	457	775
Females (65+)	76	130	172	151	155	94	106	100	100	169	154	238	140	67	136

[a]Represents the average median age for the census tract, because medians are calculated separately for populations within each city boundary within each census tract.

Source: Based on 1980 Census (U.S. Dept. of Commerce, 1983).

LASUPER8/036

Source: CH2MHill, Table 6-4, "BKK Landfill Environmental Exposure Characterization Report, West Covina, California," August 15, 1988, Volume I, p. 6-21.

TABLE 5
(CH2MHill)

Table 6-5

POTENTIALLY SENSITIVE POPULATION SUBGROUPS FROM CENSUS TRACTS IN THE VICINITY OF THE BKK LANDFILL

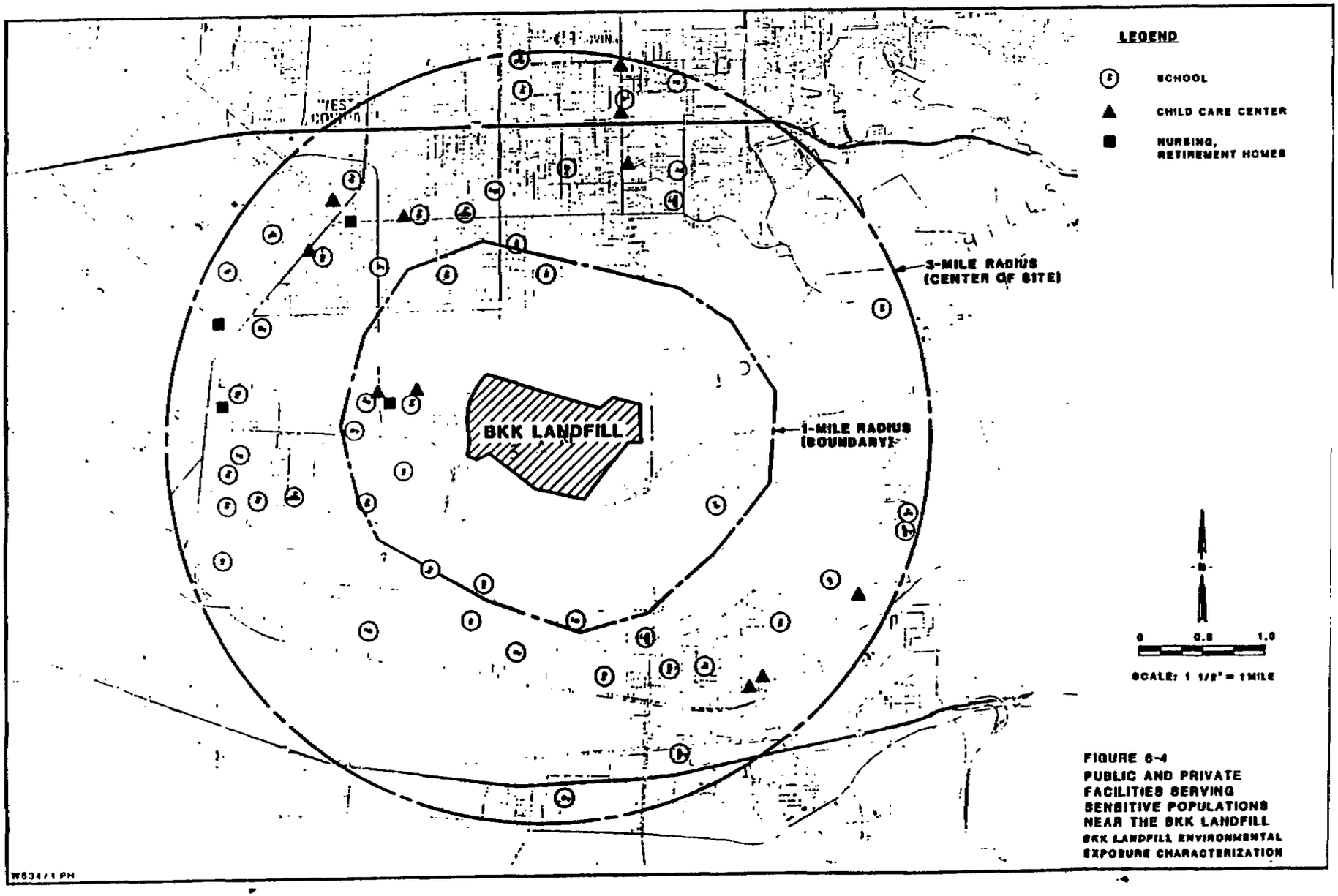
Regions (Located Relative to BKK)	Census Tract No.	Percent of Census Tract Populations by Subgroups: Infants (0-4 yrs)	Children (5-14 yrs)	Females of Child-Bearing Age (15-44 yrs)	Senior Adults (65+ yrs)	Total No. of Females of Child-Bearing Age (15-44 yrs)	Census Tract Total No.	Region Total No.
Contains BKK	4080.01	10.6	12.7	28.4	2.8	1,511	5,324	5,324
South	4081.31	11.9	17.2	29.5	2.2	3,109	10,535	
	4081.32	10.4	24.7	24.0	3.8	1,943	8,101	
	4081.02	10.0	23.8	24.7	3.8	1,781	7,201	25,837
East-Southeast	4081.01	8.9	20.6	23.9	2.8	1,443	6,025	
	4034	9.3	22.0	27.8	2.2	3,465	12,478	18,503
Northeast	4063	7.9	12.8	24.8	6.4	950	3,826	3,826
North	4064.01	6.3	16.4	23.3	6.0	1,031	4,424	
	4064.02	4.8	14.2	20.6	6.5	391	1,898	6,322
Northwest	4065	6.7	13.7	25.5	7.1	1,391	5,444	
	4066.01	5.4	14.4	23.6	6.4	1,124	4,759	
	4066.02	8.1	15.6	22.3	6.4	891	3,998	14,201
West	4080.02	7.9	15.7	29.2	3.2	1,418	4,855	
	4079	9.7	20.0	25.7	3.6	1,287	5,015	9,900
Southwest	4078	8.3	22.3	25.4	2.8	1,804	7,107	7.107

Source of Data: 1980 Census (U.S. Dept. of Commerce, 1983)

LASUPER8/031

Source: CH2MHill, Table 6-5, "BKK Landfill Environmental Exposure Characterization Report, West Covina, California," August 15, 1988, Volume I, p. 6-29.

FIGURE 5
(CH2MHill)



Source: CH2MHill, Figure 6.4, "BKK Landfill Environmental Exposure Characterization Report, West Covina, California," August 15, 1988, Volume I, p. 6-27.

risk assessment uses EPA's population estimate of 40,000 people within a one-mile radius of the landfill.

Pathways of Exposure to Neighboring Residents

Pathways of exposure to humans include environmental media (air, water, soil, and food) and routes of exposure (ingestion, dermal contact, and inhalation). CH2MHill prepared a schematic (Figure 6) to illustrate existing and potential pathways of exposure to contaminants from the B.K.K. Landfill. All the pathways together represent the total exposure from the site. Analysis of each individual pathway represents the exposure to different populations, such as onsite workers or neighboring residents.

Groundwater Although groundwater below the B.K.K. Landfill has been contaminated, contaminants from the landfill have not been detected in the municipal drinking water supply wells, located one to three miles from the facility. Mitigation measures and monitoring schedules stipulated in the SAM Work Plan are designed to detect if contaminants migrate to municipal drinking water supply wells, at which time EPA and/or the State would issue a corrective action order. Groundwater in the vicinity is not used for irrigation. Seeps near the B.K.K. Landfill may have provided a potential source of exposure to contaminated groundwater in the past during rainy seasons. Seeps were dewatered by extraction wells, and have been dry since 1984.

FIGURE 6
(CH2MHill)

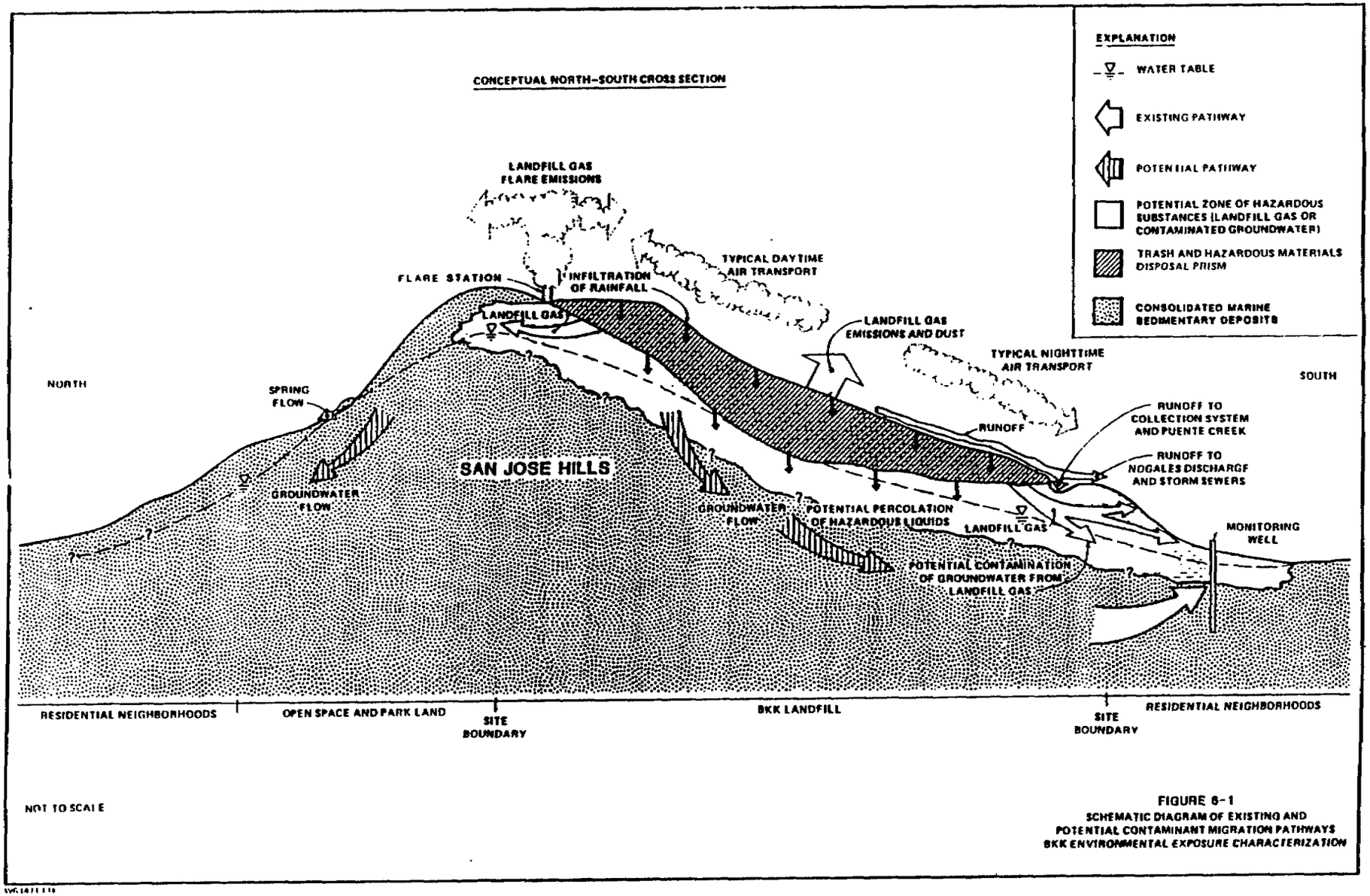


FIGURE 6-1
SCHEMATIC DIAGRAM OF EXISTING AND POTENTIAL CONTAMINANT MIGRATION PATHWAYS
BKK ENVIRONMENTAL EXPOSURE CHARACTERIZATION

Source: CH2MHill, Figure 6.1, "BKK Landfill Environmental Exposure Characterization Report, West Covina, California," August 15, 1988, Volume I, p. 6-3.

Surface Water Three surface water drainage areas exist around the B.K.K. Landfill: Vine Creek Drainage to the north, Nogales Street Storm Drain/Giano Channel Drainage to the southeast, and Puente Creek Drainage to the southwest. Measured and estimated concentrations of contaminants in surface water originating from the landfill were less than the Clean Water Act criteria for acute toxicity in freshwater organisms; drainages are ephemeral and do not support permanent populations of aquatic organisms (CH2MHill, 1988). Human exposure could have potentially occurred through ingestion or dermal contact with contaminated surface water released from the B.K.K. Landfill. Unfortunately, no quantitative estimate of exposure can be made based on the available information. Median values of indicator chemicals detected in offsite surface water are given in Table 6. The volume of runoff discharge from the Nogales Street Storm Drain/Giano Channel Drainage was reduced 95 percent in November 1986, at which time drains and containment measures were constructed on the landfill.

Soil Soil from only one residential yard located on Miranda Street was analyzed in July, 1984 for VOC's and none were detected.

Air Fifteen separate air sampling programs were conducted between 1979 to 1986. These programs included odor studies, landfill gas emissions monitoring, flare gas testing, periodic and continuous ambient air monitoring, and indoor air monitoring. CH2MHill tabulated the 15 programs, dates, and methods (Table 7). Sampling stations located in residential neighborhoods

TABLE 6

INDICATOR CHEMICALS DETECTED IN OFFSITE SURFACE WATER, 1981-1985

BKK LANDFILL, WEST COVINA, CALIFORNIA

Indicator Chemical	Median Value[a] (ppb)	Location
Non-Carcinogens		
Trans-1,2-Dichloroethylene	2.4	storm drain, Azusa Avenue
1,1,1-Trichloroethane	3.4	storm drain, Azusa Avenue
1,1-Dichloroethane	56	runoff discharge, Nogales Street
1,2-Dichlorobenzene	ND[b]	Galster Park Spring
Chlorobenzene	1.08	storm drain, Azusa Avenue
Ethyl benzene	ND[b]	Galster Park Spring
Xylenes	0.2	storm drain, north of entrance gate
Toluene	0.2	storm drain, north of entrance gate
Phenol	3,900	Hidden Valley Spring
Copper	40	south fork, Puente Creek
Cyanide	3	GTE manhole, Amar and Woodgate
Selenium	41	Galster Park spring
Zinc	17,000	Carmen's Pond discharge
Carcinogens		
Arsenic	89[b]	runoff discharge, Nogales Street
Cadmium	2	Hidden Valley Spring
Chromium	5	storm drain, Azusa Avenue
Lead	12	storm drain, Nogales and Shakespeare
Nickel	100	seep above Miranda Street
1,1,2-Trichloroethane	14	runoff discharge, Nogales Street
1,2-Dichloroethane	230	runoff discharge, Nogales Street
1,1-Dichloroethylene	3.2	seep above Miranda Street
Benzene	ND[b]	Galster Park Spring
Chloroform	1.7	storm drain, north of entrance gate
Methylene Chloride	71	runoff discharge, Nogales Street
Perchloroethylene	3.3	runoff discharge, Nogales Street
Trichloroethylene	2.1	runoff discharge, Nogales Street
Vinyl Chloride	40	seep above Miranda Street

a: Median values taken from Table 3-18 BKK Landfill Comparison of Contaminants Detected In Offsite Surface Water With State And Federal Standards, "BKK Landfill Environmental Exposure Characterization Report West Covina, California," CH2MHill, 1988, Volume I, pgs. 3-90 to 3-94.

b: Taken from Table 5-21 Maximum Values of Indicator Chemicals In Surface Water Samples Collected From the Vincinity of the BKK Landfill, CH2MHill, 1988, Volume I, pgs. 5-125 to 5-127.
ND = Not Detected.

TABLE 7
(CH2MHill)

Table 3-19
SUMMARY OF AIR QUALITY RELATED DATA COLLECTIONS
FOR THE BKK LANDFILL AND VICINITY

Sampling Program	Sampling Period	Sampled By	Sampling Activities	Sample Analyses
Investigation of Odorous and Volatile Compounds for BKK Landfill	Nov. 1979 - June 1980	Univ. of So. Cal, Environ. Engineering Dept.	Onsite: o Suction pump sampling using a Tenax-GC trap for Volatile Organics o Suction pump sampling for H_2S	o GC/MS speciation of organics (limited)
BKK Odor Study	Dec. 1980	Euteck Inc.	Onsite: o Landfill gas sampling	o GC analysis of gas samples
BKK Flare Station No. 1 Source Testing	April, May, and June 1980	SCAQMD	Onsite: o 2 liter bulb sampling of gas collection system inlet and gas outlet (at the flare); and ambient samples onsite and offsite	o GC/MS analysis for Vinyl Chloride
Ambient Air Monitoring Program	June 1981 - present	SCAQMD	Offsite: o 24-hour Tedlar bag samplings at various locations around the site o Two long-term stations and 12 mid- or short-term stations used to evaluate station sitings	o GC analysis for Vinyl Chloride only o 10 ppm detection limit for 6/81 through 12/82 o 2 ppm detection limit for 1/83 through present

Table 3-19
(Continued)

Sampling Program	Sampling Period	Sampled By	Sampling Activities	Sample Analyses
BKK Expanded Monitoring Program	July 19, - Oct. 15, 1982	SCAQMD, ARB, and DOHS-TSCD	Offsite: o 24-hour Tedlar bag samplings at 5 stations near the site and one control site	o GC/MS analysis for eight volatile organic compounds
Directional Ambient Air Sampling and Micrometeorological Survey	July-Aug. 1982	SCAQMD	Onsite: o Nine directionally controlled portable bag samplers, and eight portable wind recorders	o GC analysis for Vinyl Chloride only
BKK Flare Station No. 1 Source Testing	Oct. 1982	ARB	Onsite: o Grab samples in Tedlar bags from the inlet line and from four burners o Four composite samples of ambient air (2-to 3-hour composites) upwind and downwind of disposal areas	o GC/MS analysis for six volatile organic compounds
BKK Flare Station No. 1 Source Testing	Oct. 1983	Science Applications Inc. for BKK	Onsite o Samples collected at the main header to the flare station (inlet); sample collection method unknown (to be determined	o GC/MS analysis, 23 volatile organic compounds detected
Ambient Air Monitoring During Drilling at Barrier 2	May and June 1984	BKK	Onsite: o Eight-hour composite and grab samples in Tedlar bags; from one upwind and two downwind stations to the drill site	o GC analysis for Vinyl Chloride only

Table 3-19
(Continued)

Sampling Program	Sampling Period	Sampled By	Sampling Activities	Sample Analyses
Emergency Response Sampling	July 17-24, 1984	SCAQMD	**Offsite:**	
			o HNU/OVA and flask samples indoor and at subsurface areas around selected evacuated homes	o Flask samples analyzed for Vinyl Chloride and Methane
Indoor Air Sampling	July, Aug., and Sept. 1984	DOHS-TSCD	**Offsite:**	
			o Bulb and flask samples from under the sinks of 21 homes taken periodically	o Bulb and flask samples analyzed for 14 volatile organics, 3 inert gases, and CO_2 (Analyses by ARB and SCAQMD)
Extended Monitoring Program	Aug. Sept., Oct. 1984	SCS Eng. for DOHS and EPA	**Offsite:**	
			1- Collected 24-hour composite air samples (Tedlar bags) from indoors at 10 Priority I homes and 1 control	o Analysis for 10 volatile organic compounds using GC/MS
			2- Collected 24-hour charcoal tube samples from indoors at 51 Priority II homes and 10 control	o Analysis for Vinyl Chloride
			3- Continuous OVA monitoring in homes to parallel the composite sample collections	o For total hydrocarbons
			4- Periodic flask samples collected when OVA readings exceeded 100 ppm indoors	o Analysis for 10 volatile organics
			5- Subsurface probes (deep and shallow) monitoring with OVA meter, and flask collections when readings exceeded 1000 ppm	o Flask samples analyzed for 10 volatile compounds

Table 3-19
(Continued)

Sampling Program	Sampling Period	Sampled By	Sampling Activities	Sample Analyses
Ambient Air Collections During Excavation of the Ephemeral Pond	March 1985	BKK	Onsite: o Tedlar bag samples collected both during days of excavation and days without excavation	o GC analysis for Vinyl Chloride and Methane (analysis by Truesdail Labs)
Surface Emissions Monitoring Program	April 1985 (1st Sampling)	BKK	Onsite: o Integrated gas samples, each collected over a 100'x500' area using a flow metering pump into a Tedlar bag; with a total of approximately 150 acres sampled onsite	o Analysis for methane by BKK; and quantitative speciation of approximately 10 percent of samples by Truesdail Labs for 30 volatile organic (14 detected)
	Oct.-Nov. 1985	BKK	o Repeat of the 1st sampling, with approximately 150 acres sampled onsite	o Analysis for methane by BKK; and quantitative speciation of approximately 10 percent f samples by West Coast Analytical Lab for 49 compounds (21 detected)
BKK Flare Station No. 1	Oct. 1985	Certified Testing Laboratories for BKK	Onsite o Grab samples (3) into Tedlar bags from the inlet line and from one outlet (burner)	o GH/MS analysis for 13 volatile organic compounds and polychlorinated biphenyls and related dioxin derivatives (data under review at this time

LASUPER4/049

Source: CH2MHill, Table 3-19, "BKK Landfill Environmental Exposure Characterization Report, West Covina, California," August 15, 1988, Volume I, pgs. 3-97 to 3-100.

detected VOC's and indicated air as an exposure pathway for neighboring residents.

Air Monitoring/Modeling Programs Used in the Quantitative Risk Characterization

CH2MHill's retrospective quality assurance review identified 4 of the 15 air monitoring programs as relevant to quantitative analysis. Three of the four programs monitored ambient air around the B.K.K. Landfill; the fourth program monitored ambient air in the Los Angeles basin, in which the B.K.K. Landfill is located. Data from these four programs are used in the risk characterization and described in that section.

CARB used the 1987 ambient vinyl chloride monitoring data from the landfill in an air dispersion model to estimate population exposure to vinyl chloride for the purpose of proposing to identify vinyl chloride as a toxic air contaminant. The risk characterization uses CARB's modeled data and describes the program in that section.

Table 8 summarizes the programs and data used in the quantitative risk characterization.

LE 8

AIR MONITORING/MODELING PROGRAMS USED IN THE QUANTITATIVE RISK CHARACTERIZATION OF THE B.K.K. LANDFILL, WEST COVINA, CA

Program	Data Station(s)	Chemical(s) Monitored	Methods	Summary Statistic(s)
SCAQMD 1983-1987 Ambient Vinyl Chloride Monitoring Program	A, B, MY; located in residential neighborhoods south, southeast of the landfill	Vinyl chloride (detection limit 2 ppb)	24-hour continuous; Tedlar bags; GC analysis; daily 6/81-1990	Monthly and annual geometric means, calculated by DHS from SCAQMD's daily measurements
DHS-TSCP/CARB/SCAQMD 1982 Expanded Monitoring Program	A; considered in 1982 as the location for "worst-case" meteorologic conditions	9: vinyl chloride, perchloroethylene, trichloroethylene, 1,2-dichloroethane, chloroform, benzene, chlorobenzene, trans-1,2-dichloroethene, 1,1-dichloroethene	24-hour continuous; Tedlar bags; Sunday through Thursday, July 19-October 15; GC analysis, split samples analyzed by CARB lab and SCAQMD lab	Arithmetic means, taken from Table II, DHS-TSCP/CARB/SCAQMD 1983 report (a)
EPA-DHS 1984 Extended Monitoring Program	Indoor air 10 Priority I evacuated homes	9: vinyl chloride, perchloroethylene, trichloroethylene, 1,1-dichloroethene, 1,2-dichloroethane, chloroform, benzene, carbon tetrachloride, 1,1,1-trichloroethane	24-hour composite; Tedlar bags; GC-MS analysis	Median values, taken from Table 6-13 and Volume 5 Appendix H-2 CH2MHill 1988 report (b)
SCAQMD - CARB 1985 Los Angeles Basin Air Toxics Monitoring Program	El Monte, CARB	11: benzene, carbon tetrachloride, chloroform, ethylene dibromide, ethylene dichloride, methylene chloride, perchloroethylene, toluene, 1,1,1-trichloroethane, trichloroethylene, vinyl chloride	not described in SCAQMD 1987 report	Annual average taken from Table V-1 SCAQMD 1987 report (c)
CARB Modeling of 1987 Ambient Vinyl Chloride Monitoring Data	A, B, MY	vinyl chloride (detection limit 2 ppb)	SCAQMD's data: 24-hour continuous; Tedlar bags; GC analysis	Range of modeled concentrations, taken from Table II-5, CARB 1990 report (d)

TABLE 8
(continued)

Abbreviations:

SCAQMD = South Coast Air Quality Management District
DHS-TSCP = Department of Health Services-Toxic Substances Control Program
CARB = California Air Resources Board
EPA = U. S. Environmental Protection Agency
GC = gas chromatography
GC-MS = gas chromatography-mass spectrometry

a: DHS-TSCP/CARB/SCAQMD, "Ambient Air Monitoring and Health Risk Assessment for Suspect Human Carcinogens Around the BKK Landfill in West Covina," March 1983.

b: CH2MHill, "BKK Landfill Environmental Exposure Characterization Report West Covina, California," Volume I Text and Volume 5 Appendix H-2, August 15, 1988.

c: SCAQMD, "The Magnitude of Ambient Air Toxics Impacts From Existing Sources in the South Coast Air Basin," 1987 Air Quality Management Plan Revision, Working Paper No. 3, June 1987.

d: CARB, "Technical Support Document, Proposed Identification of Vinyl Chloride as a Toxic Air Contaminant," Draft Report Executive Summary and Part A, May 1990.

DOSE-RESPONSE ASSESSMENT

The dose-response assessment defines the relationship between the "dose" (intake) of a chemical and the probability of a response, such as induction of a carcinogenic effect. EPA uses the term intake instead of dose because the information required to estimate "dose" (that is, the amount of a chemical absorbed and subsequently distributed to target organs) is usually not known. Numerical expressions of a chemical's dose-response relationship are called toxicity values: reference doses are values for noncarcinogenic effects; slope factors and unit risks are values for carcinogenic effects. This section identifies the chronic reference doses and inhalation unit risk values, current through June 1989, used in the risk characterization.

Chronic Reference Doses

Information about the amount of a chemical that produces a toxic response and the type of toxic response produced at a given dose level is obtained quantitatively from studies in experimental animals or observations in human epidemiologic investigations. Noncarcinogenic effects may result from acute or chronic exposures, and threshold levels are established below which no adverse health effect is expected. EPA has derived reference doses for chemicals based on different routes of exposure. The chronic reference dose (RfDc) is an estimate of the daily exposure to humans, including sensitive p pulations, that is likely to be without appreciable risk of adverse effects during a lifetime. Reference doses for carcinogens refer to effects other than the risk of cancer. Table 9 lists the ref rence doses for indicator

TABLE 9

REFERENCE DOSES[a] FOR INDICATOR CHEMICALS DETECTED IN OFFSITE SURFACE WATER AND AIR
BKK LANDFILL, WEST COVINA, CA

Indicator Chemical	RfDc-O mg/kg-day	RfDc-O ppb	RfDc-I mg/kg-day	RfDc-I $\mu g/m^3$
Non-Carcinogens				
Trans-1,2-Dichloroethylene[c]	2E-2	700	-	70
1,1,1-Trichloroethane	9E-2	3,150	3E-1	1,050
1,1-Dichloroethane	1E-1	3,500	1E-1	350
1,2-Dichlorobenzene	9E-2	3,150	4E-2	140
Chlorobenzene	2E-2	700	5E-3	17.5
Ethyl Benzene	1E-1	3,500	-	350
Xylenes	2E+0	70,000	3E-1 mg/m^3	300
Toluene	3E-1	10,500	2E+0 mg/m^3	2,000
Phenol	6E-1	21,000	-	2,100
Copper	1E-0	1,300	-	130
Cyanide	2E-2	700	-	70
Selenium	2E-3	105	1E-3	3.5
Zinc	2E-1	7,000	-	700
Carcinogens				
Arsenic	1E-3	35	-	3.5
Cadmium	5E-4	17.5	-	1.75
Chromium	-	MCL-50[b]	-	-
Lead	-	MCL-50[b]	-	-
Nickel	2E-2	700	-	70
Benzene	-	MCL-1[b]	-	-
Carbon Tetrachloride	7E-4	24.5	-	2.45
Chloroform	1E-2	350	-	35
1,2-Dichloroethane	-	MCL-0.5[b]	-	-
1,1-Dichloroethylene	9E-3	315	-	31.5
Methylene Chloride	6E-2	2,100	-	210
Perchloroethylene	1E-2	350	-	35
1,1,2-Trichloroethane	4E-3	140	-	14
Trichloroethylene	-	MCL-5[b]	-	-
Vinyl Chloride	-	MCL-0.5[b]	-	d

a: Oral and Inhalation Chronic Reference Doses (RfDc-O, RfDc-I) in mg/kg-day are taken from Table A, "Health Effects Assessment Summary Tables, Third Quarter FY 1989," EPA July 1989, OERR 9200.6-303-(89-3). Chronic Reference Doses in ppb and $\mu g/m^3$ are calculated using conversion factors of 70 kg, 2 liters/day, and 20 m^3/day.

b: MCL = Maximum Contaminant Level in Drinking Water, California Code of Regulations, Title 22, Division 4, Chapter 15, Sections 64435 and 64444.5.

c: Trans-1,2-Dichloroethylene was reportedly not detected in ambient air in the 1982 Expanded Monitoring Program (DHS-TSCP/CARB/SCAQMD, 1983); CH2MHill included data for the chemical in its 1988 report (Volume 5, Appendix H-2, CH2MHill, 1988).

d: Noncarcinogenic effects of vinyl chloride occur at concentrations in air near or above 10,000 ppb which is muc greater than ambient levels detected near the BKK Landfill, West Covina ("Technical Support Document, Proposed Identification of Vinyl Chloride as a Toxic Air Contaminant, Draft Report Part B," CARB May 1990, pg. 1-2).

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chemicals detected in offsite surface water and/or air around the B.K.K. Landfill. For those chemicals detected around the landfill that do not have a reference dose, the maximum contaminant level in drinking water is listed.

Inhalation Unit Risk Values

Cancer is considered a multistage process, and it is assumed that no threshold exists for substances that induce cancer. For carcinogens, risks are estimated as probabilities. Mathematical models used to derive estimates of risk associated with carcinogens are generally based on theories of carcinogenesis. EPA normally uses the linearized multistage model to extrapolate from observed high dose animal studies to expected low level environmental exposures. Values obtained from this extrapolation ar expressed as slope factors or unit risks for a lifetime (70 years) exposur . Generally, after the data are fit to the appropriate mathematical model, the upper 95 percent confidence limit of the slope of the resulting dose-response curve is calculated. This value is known as the slope factor and represents an upper 95 percent confidence limit on the probability of a response per unit intake of a chemical over a lifetime. In some cases, slope factors based on human dose-response data use a "best" estimate (that is, the best fit dose-response line from a set of data) instead of the upper 95 percent confidence limit. The slope factor, expressed as $(mg/kg\text{-}day)^{-1}$, is used when calculating the risk from actual daily dose in mg/kg to an individual.

The unit risk is the risk per unit concentration of a chemical in the medium where human contact occurs. The unit risk, expressed as ppm^{-1}, ppb^{-1}, or

$(ug/m^3)^{-1}$, is used when calculating the risk from ambient air concentrations to which an individual is exposed.

EPA recommends that numerical estimations of risk be coupled with the "weight-of-evidence" classification of a carcinogen.

Risk assessors may arrive at different values for a carcinogen because they select different data sets or different extrapolation models. This health risk assessment uses the unit risk values derived by either EPA's Carcinogen Assessment Group or DHS's Air Toxics Section, and contained in California's "Air Toxics Assessment Manual, Table 3.15" (CAPCOA, 1987). Table 10 presents the unit risk values and the corresponding "weight-of-evidence" classification for the carcinogens detected at the B.K.K. Landfill.

TABLE 10

INHALATION UNIT RISK (IUR) VALUES FOR CARCINOGENS DETECTED AT BKK LANDFILL, WEST COVINA, CALIFORNIA

Carcinogen	AGENCY[a]	IUR[a] $(\mu g/m^3)^{-1}$	EPA[b] Class
Arsenic (inorganic)	EPA	4.3E-3	A
Cadmium	DHS	1.2E-2	B1
Chromium(VI)	DHS	1.5E-1	A
Lead	-	-	B2
Nickel	EPA	4.8E-4	A
Benzene	DHS	5.3E-5	A
Bis-2-chloroethylether	EPA	3.3E-4	B2
Carbon Tetrachloride	DHS	4.2E-5	B2
Chloroform	EPA	2.3E-5	B2
1,2-Dichloroethane	DHS	2.2E-5	B2
1,1-Dichloroethylene	EPA	5.0E-5	C
Methylene Chloride	DHS	1.0E-6	B2
N-Nitrosodimethylamine	EPA	1.4E-2	B2
Perchloroethylene	EPA	5.8E-7	C
1,1,2,2-Tetrachloroethane	EPA	5.8E-5	C
1,1,2-Trichloroethane	EPA	1.6E-5	C
Trichloroethylene	EPA	1.3E-6	B2
Vinyl Chloride	EPA	2.7E-6	A

a: Reference documents for the values listed were derived by the Environmental Protection Agency (EPA) or the Department of Health Services, Health Hazard Assessment Division, Air Toxics Section (DHS), and are given with Table 3.15, "Air Toxics Assessment Manual," California Air Pollution Control Officers Association, October 1987 pgs. 3.5-24 to 3.5-28. Values are current through June 1989.

b: EPA weight of evidence classification: A, sufficient evidence in humans; B1, sufficient evidence in animals, limited in humans; B2, sufficient evidence in animals, inadequate in humans; C, limited evidence in animals, inadequate in humans. Taken from EPA's Integrated Risk Information System (IRIS), June 1989.

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RISK CHARACTERIZATION

Risk characterization integrates the three previous components of a health risk assessment (hazard identification, exposure assessment, and dose-response assessment), to provide a numerical estimation of risk and a framework to relate the significance of the risk. This section estimates, for residents living near the B.K.K. Landfill, the risks associated with exposure to the concentrations of contaminants detected in offsite surface water and air. Individual excess lifetime cancer risks are calculated for carcinogens detected in three site-specific air monitoring programs, one Los Angeles basin air monitoring program, and one air modeling program. The population excess cancer burden is also estimated. Limitations and uncertainties of the estimated risk are discussed, and the significance of the risk estimate is explained.

Risk Characterization of Exposure to Contaminants Detected in Offsite Surface Water Near the B.K.K. Landfill

Most indicator chemicals detected in offsite surface water near the B.K.K. Landfill were detected in concentrations below their thresholds for noncarcinogenic effects (Table 11). Four indicator chemicals were detected in concentrations above their reference dose or maximum contaminant level: zinc was detected at 17,000 ppb; arsenic, at 89 ppb; 1,2-dichloroethane, at 230 ppb; and vinyl chloride, at 40 ppb. Surface waters near the B.K.K. Landfill are not used for drinking water. Any exposure to contaminated

TABLE 11

COMPARISON OF INDICATOR CHEMICALS DETECTED IN OFFSITE SURFACE WATER, 1981-1985
TO ORAL CHRONIC REFERENCE DOSES
BKK LANDFILL, WEST COVINA, CA

Indicator Chemical	Median Value[a] ppb	RfDc-Oral[b] ppb
Non-Carcinogens		
Trans-1,2-Dichloroethylene	2.4	700
1,1,1-Trichloroethane	3.4	3,150
1,1-Dichloroethane	56	3,500
Chlorobenzene	1.08	700
Xylenes	0.2	70,000
Toluene	0.2	10,500
Phenol	3,900	21,000
Copper	40	1,300
Cyanide	3	700
Lead	12	MCL-50[c]
Selenium	41	105
Zinc	17,000	7,000
Carcinogens		
Arsenic	89[d]	35
Cadmium	2	17.5
Chromium	5	MCL-50[c]
Lead	12	MCL-50[c]
Nickel	100	700
1,1,2-Trichloroethane	14	140
1,2-Dichloroethane	230	MCL-0.5[c]
1,1-Dichloroethylene	3.2	315
Chloroform	1.7	350
Methylene Chloride	71	2,100
Perchloroethylene	3.3	350
Trichloroethylene	2.1	MCL-5[c]
Vinyl Chloride	40	MCL-0.5[c]

a: Median Values are taken from Table 3-18, "BKK Landfill Environmental Exposure Characterization Report, West Covina, California," CH2MHill, 1988, Volume I, pgs. 3-90 to 3-94. (Table 6 of this report).

b: Chronic Reference Doses (RfDc-Oral) were calculated from chronic reference doses listed in Table A, "Health Effects Assessment Summary Tables Third Quarter FY 1989." EPA July 1989 (Table 9 of this report).

c: MCL = Maximum Contaminant Level in Drinking Water, California Code of Regulations, Title 22, Division 4, Chapter 15, Sections 64435 and 64444.5.

d: Maximum value taken from Table 5-21, CH2MHill, 1988, Volume I, pgs. 5-125 to 5-127.

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surface water would have been infrequent, much less than two liters a day, and of limited duration. The risk associated with exposure to the concentrations of these contaminants in offsite surface water near the B.K.K. Landfill is not considered significant. No numerical estimate of risk is made because no quantitative estimate of exposure can be made from the available information.

Risk Characterization of Noncarcinogens Detected in Air Near the B.K.K. Landfill

From the limited sampling in air monitoring programs around the B.K.K. Landfill, only two noncarcinogen indicator chemicals were detected in air, both below their reference dose. 1,1,1-Trichloroethane was detected in 10 Priority I homes during the 1984 Extended Monitoring Program at a median value of 4 ppb; the inhalation chronic reference dose is approximately 192 ppb. Trans-1,2-dichloroethylene, originally reported not detected in the 1982 Expanded Monitoring Program (DHS-TSCP/CARB/SCAQMD, 1983), was reported by CH2MHill (Volume 5, Appendix H-2, CH2MHill, 1988); the median value was 1 ppb and the inhalation chronic reference dose is approximately 18 ppb.

Noncarcinogenic effects of vinyl chloride occur at concentrations in air near or above 10,000 ppb, which is much greater than ambient levels detected around the B.K.K. Landfill (CARB, Part B, 1990).

Because the concentrations of contaminants detected in ambient air around the landfill do not exceed their thresholds for chronic reference doses, impacts from noncarcinogenic adverse health effects are not anticipated.

Risk Characterization of Carcinogens

No threshold is assumed for carcinogens, therefore, this risk characterization estimates the risk of developing cancer from exposure to the carcinogens detected in air around the B.K.K. Landfill between 1982 through 1987. Data is taken from the following programs, which are summarized in Table 8 of the exposure assessment section:

Site-specific programs (see Figure 7)

- SCAQMD's 1983-1987 Ambient Vinyl Chloride Monitoring Program
- DHS-TSCP/CARB/SCAQMD's 1982 Expanded Monitoring Program
- EPA and DHS's 1984 Extended Monitoring Program

Los Angeles air basin program

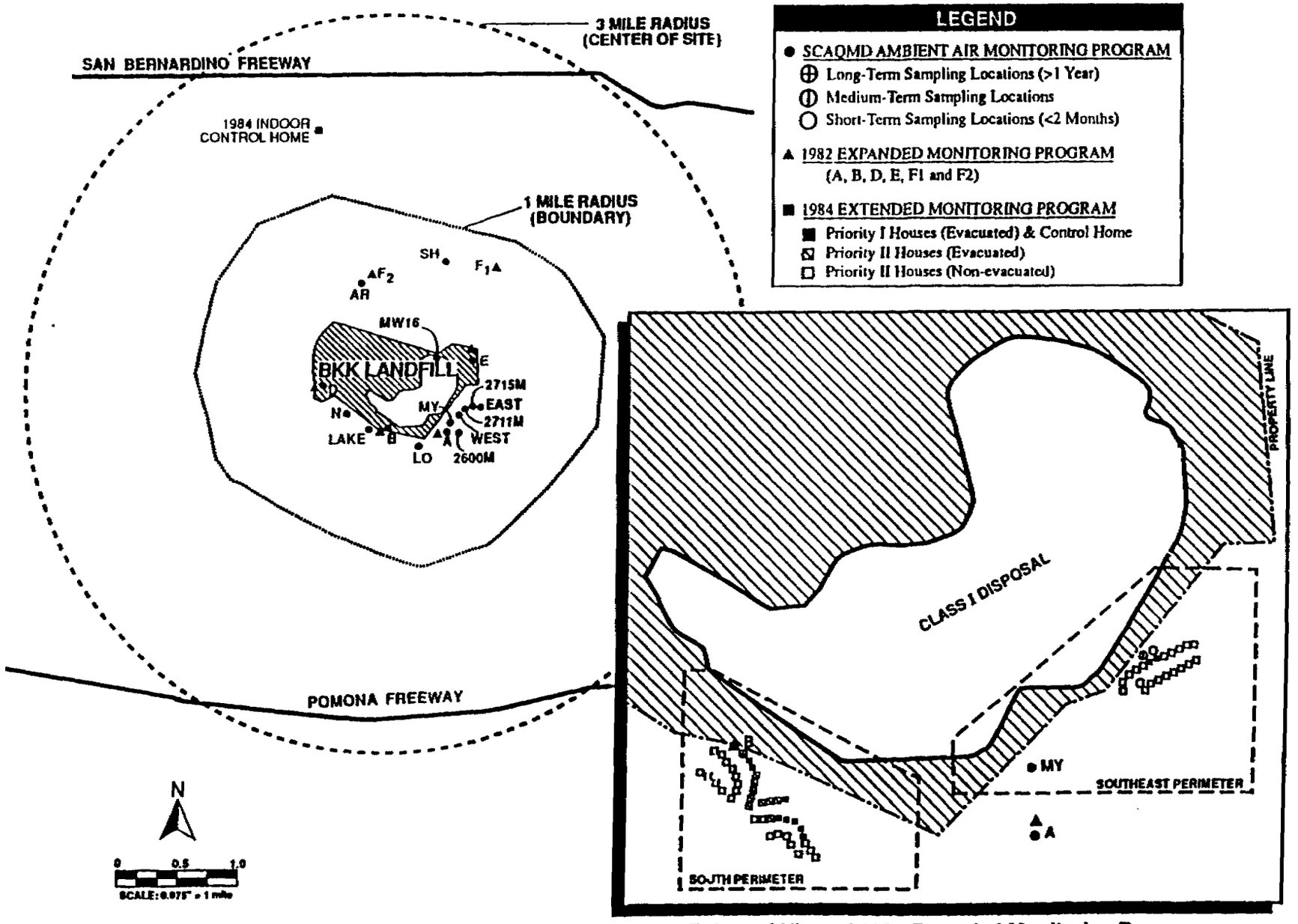
- CARB and SCAQMD's 1985 Los Angeles Basin Air Toxics Monitoring Program

Modeling program

- CARB's Modeling of 1987 Ambient Vinyl Chloride Concentrations Around the B.K.K. Landfill.

Two measures are used to estimate the risk: the "individual excess lifetime cancer risk" and the "population excess cancer burden". These risk estimates are statistical concepts which represent plausible upper bound estimates of the probability of developing cancer due to lifetime (70-year) exposure. The individual excess lifetime cancer risk implies that an individual remains in the same location for an entire lifetime, and that the concentrations of carcinogens remain unchanged. The population excess cancer burden represents the plausible upper limit on the number of excess cases of cancer which could occur in a population after exposure for a specific period of time.

FIGURE 7: Air M nitoring Programs, BKK Landfill, West Covina, CA (Based on CH2MHill Fig. 5-21 and Plate 15)



Enlarged View of 1984 Extended Monitoring Program

Source: CH2MHill, "BKK Landfill Exposure Characterization Report, West Covina, California," August 15, 1988, Volume I, p. 5-165 (Figure 5.21) and Volume II, Plate 15.

Numerical Estimations of Risk

1. Numerical Estimation - Individual Excess Lifetime Cancer Risk

The risk calculation is expressed as:

$$ECR = C \times YR \times EF \times RF \times UR \times 1/LT$$

Where

ECR - Excess lifetime cancer risk

C - Concentration in $\mu g/m^3$ of the carcinogen; parts per billion were converted to micrograms per cubic meter ($\mu g/m^3$) as follows (assuming 25°C and 760 mm Hg pressure):

$$\mu g/m^3 = \frac{ppb \times \text{molecular weight}}{24.45\ m^3/\mu mole}$$

YR - Years of residence associated with exposure

EF - Exposure factor, i.e., percent of time spent at home

RF - Retention factor, i.e., percent of measured concentration absorbed in the lungs

UR - Unit risk value

LT - Human individual lifetime in years.

Assumptions for this calculation are the following:

- persons have an average adult body weight of 70 kg and breathe 20 m^3 of air per day;
- persons are at home 80 percent of the time (that is, the residential scenario assumes an annual exposure fraction of 292/365 days);
- persons retain 100 percent of the measured concentration;
- persons have an average 70 years lifetime.

a. Risk Characterization Using SCAQMD's 1983-1987 Ambient Vinyl Chloride Monitoring Program Data

In 1977, SCAQMD measured ambient air at four plants which manufactured or used vinyl chloride in the Los Angeles Basin: Keysor-Century in Saugus; Union Carbide in Torrance; and B.F. Goodrich and Stauffer Chemical in Carson (SCAQMD, 1982). The B.K.K. Landfill received wastes containing vinyl chloride from these plants. In 1981, SCAQMD conducted limited sampling of landfill gas emissions at the B.K.K. Landfill and detected vinyl chloride at concentrations above the California ambient air quality standard of 10 ppb. Because vinyl chloride is a human carcinogen, it became the landfill gas contaminant of primary concern. Vinyl chloride is the only contaminant for which there are continuous monitoring data from 1981 to the present.

SCAQMD began monitoring in residential neighborhoods around the B.K.K. Landfill: Station A, established in 1981, was located at the intersection of Marlena and Nogales Streets, 450 feet southeast of the property line; Station B, established in 1981, was located on Lynn Court, immediately adjacent to the southern property line; Station MY, established in June 1984, was located on Myra Court, 150 feet southeast of the property line. Because the detection limit for vinyl chloride was lowered from 10 ppb to 2 ppb in 1983, comparison with data prior to 1983 is limited.

Samples were collected as 24-hour continuous daily samples in Tedlar bags and analyzed at SCAQMD's laboratory by gas chromatography.

Table 12 presents the monthly and annual geometric means of vinyl chloride at Stations A, B, and MY for the years 1983 through 1987. DHS staff calculated the geometric means from SCAQMD's daily measurements. Measurements of vinyl chloride below the detection limit of 2 ppb were assumed to be at the detection limit. Figure 8 was generated from this data, and shows that both the maximum value of vinyl chloride detected and the frequency of detection have declined since 1985.

Applying the present risk calculation to the 1987 annual geometric mean of vinyl chloride from Station MY (the highest value), and assuming a 70-year exposure to this level of vinyl chloride, the individual excess lifetime cancer risk is estimated to be 1.5×10^{-5}, or approximately 1 to 2 in 100,000.

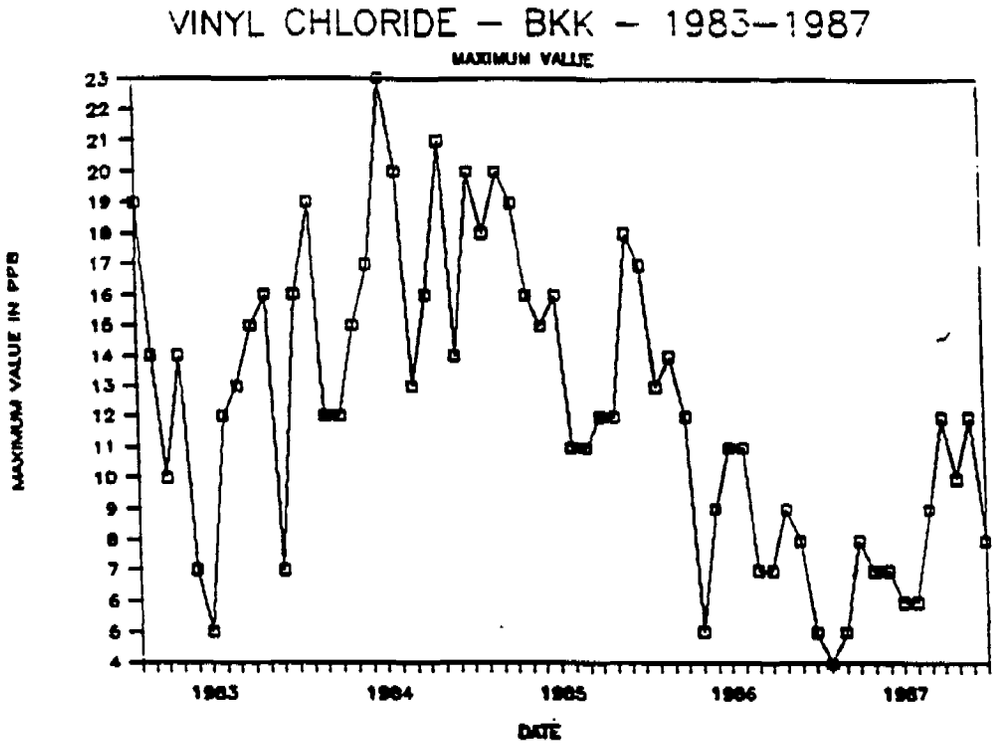
TABLE 12

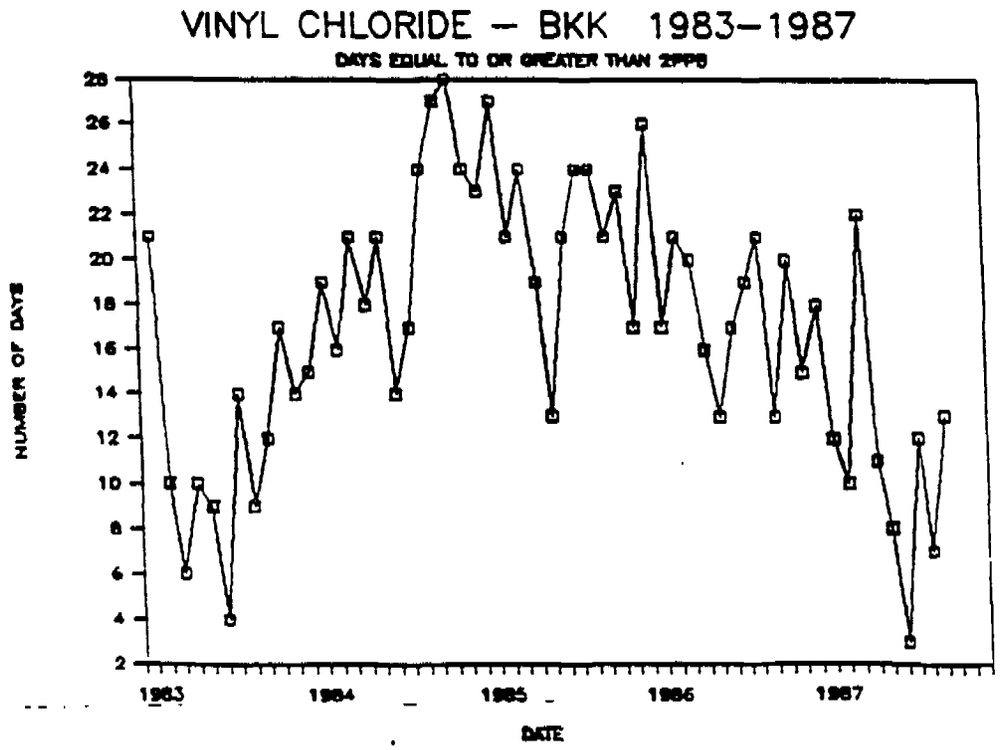
VINYL CHLORIDE IN AMBIENT AIR (ppb) - 1983-1987
MONTHLY AND ANNUAL GEOMETRIC MEANS
SCAQMD MONITORING STATIONS AROUND BKK LANDFILL, WEST COVINA, CA

MONTH	STATION	1983	1984	1985	1986	1987
JAN	A	3.8	3.1	3.9	2.7	2
FEB		3.6	2.8	3.4	2.6	2.1
MAR		2.3	3	4.7	2.6	2.3
APR		2.1	2.5	3	2.3	2.6
MAY		2.6	3.2	2.6	2.3	2.1
JUNE		2.3	2.8	2.9	2.5	2.1
JULY		3.4	ND	2.9	2.6	2.3
AUG		2.5	3.7	4	2.3	2.2
SEPT		3.5	4.7	3.2	2.2	2.6
OCT		2.9	4.4	3.2	2.2	2.4
NOV		2.2	3.7	2.6	2.1	2.1
DEC		2.7	3.6	3.7	2	2.4
ANNUAL		2.8	3.3	3.3	2.4	2.3
JAN	B	3.4	7	3	2.1	2.1
FEB		2.8	3.7	3.1	2.5	2
MAR		2.5	3.9	2.5	2.2	2
APR		2.4	3.5	2.5	2	2.1
MAY		2.1	4.6	2.3	2.1	2
JUNE		2.1	3.5	2.3	2.1	2
JULY		3.7	ND	2.3	2.2	2
AUG		3.1	2.3	2.7	2.1	2.2
SEPT		2.5	2.7	2.5	2.2	2
OCT		3.4	3.6	2.8	2.1	2
NOV		3.4	5.1	2.3	2	2
DEC		4.2	3.8	2.8	2	2
ANNUAL		2.9	3.8	2.6	2.1	2.0
	MY					
JAN			ND	6.6	3.1	2.3
FEB			ND	4.4	3.8	2.4
MAR			ND	4.5	3.2	2.9
APR			ND	3.8	2.3	3
MAY			ND	3	2.7	2.6
JUNE			ND	3.9	3.2	2.3
JULY			ND	4.1	3.2	2
AUG			4.1	4.8	3.2	2.8
SEPT			4.5	4	2.6	3.2
OCT			5.3	3.9	2.6	2.6
NOV			5.1	3.9	3.3	3.1
DEC			3.8	6.3	2.8	3.1
ANNUAL			4.5	4.3	3.0	2.7
ANNUAL TOTALS		2.8	3.9	3.3	2.5	2.3

NOTE: DHS staff calculated monthly and annual geometric means from SCAQMD's daily measurements of vinyl chloride. ND = No data was received. Measurements below the detection limit of 2 ppb were assumed to be at the detection limit. Station A = Marlena & Nogales Streets; Station B = Lynn Court; and Station MY = Myra Court, established June 1984.

FIGURE 8
VINYL CHLORIDE IN AMBIENT AIR
1983-1987 STATION A MONTHLY MONITORING DATA
BKK LANDFILL, WEST COVINA, CA





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NOTE: DHS staff generated these figures from daily measurements of vinyl chloride by SCAQMD at Station A.

If a value of 1 ppb (that is, half the detection limit) is substituted for values of vinyl chloride below the detection limit, the 1987 geometric means by station would be: A, 1.4 ppb; B, 1.1 ppb; and MY, 1.4 ppb. The annual geometric mean of all three stations would be 1.3 ppb. Using the value from Station MY, 1.4 ppb or 3.6 $\mu g/m^3$, the individual excess lifetime cancer risk would be 7.8×10^{-6}, or approximately 8 in 1,000,000.

Vinyl chloride emissions from the B.K.K. Landfill appear to have changed over time. Years used to compare the changes in vinyl chloride emissions are:

- 1982, at which time the first health risk assessment was conducted;
- 1983, at which time the detection limit for vinyl chloride was lowered to 2 ppb;
- 1984, at which time homes were evacuated due to subsurface migration of landfill gas, leading to an improved landfill gas collection system;
- 1987, at which time mitigation measures were further lowering vinyl chloride emissions from the facility.

Table 13 evaluates the 70-year risk over these changing exposure periods. A one-year exposure period is defined for data from 1983 through 1986. The 1982 data represent the following: the initial seven-year period for which waste disposal records are available (1975-1982); the landfill expansion from 40 acres to 140 acres; and

TABLE 13

INDIVIDUAL EXCESS LIFETIME CANCER RISK[a]

SCAQMD AMBIENT VINYL CHLORIDE MONITORING PROGRAM

BKK LANDFILL, WEST COVINA, CALIFORNIA

	1982[b] $\mu g/m^3$ (ppb)	1983[c] $\mu g/m^3$ (ppb)	1984[d] $\mu g/m^3$ (ppb)	1985[d] $\mu g/m^3$ (ppb)	1986[d] $\mu g/m^3$ (ppb)	1987[d] $\mu g/m^3$ (ppb)	Total
C_{VC}	18.6 (7.3)	7.2 (2.8)	11.5 (4.5)	11.0 (4.3)	7.7 (3.0)	6.9 (2.7)	
YR	7	1	1	1	1	59	70
ECR	4.0×10^{-6}	2.2×10^{-7}	3.5×10^{-7}	3.4×10^{-7}	2.4×10^{-7}	1.3×10^{-5}	1.8×10^{-5}

a: Calculated by ECR = C_{VC} x YR x EF x RF x UR x 1/LT where
- ECR = Excess lifetime cancer risk
- C_{VC} = Concentration in $\mu g/m^3$ of vinyl chloride
- YR = Years of residence associated with exposure
- EF = Exposure factor, i.e. percent of time at home (80%)
- RF = Retention factor, i.e. percent of measured concentration absorbed in the lungs (100%)
- UR = Unit risk value for vinyl chloride: 2.7×10^{-6} $(\mu g/m^3)^{-1}$, taken from Table 3.15, "Air Toxics Assessment Manual," California Air Pollution Control Officer's Association, October 1987, p. 3.5-28. Value current through June 1989.
- LT = Human individual lifetime in years (70)

b: Mean value, Station A, Table II, "Ambient Air Monitoring and Health Risk Assessment for Suspect Human Carcinogens Around the BKK Landfill in West Covina," DHS-TSCP/CARB/SCAQMD, March 1983, p. 16 (Appendix B of this report).

c: DHS staff calculated the annual geometric mean from daily measurements of vinyl chloride by SCAQMD at Stations A and B (Table 12 of this report).

d: DHS staff calculated the annual geometric mean from daily measurements of vinyl chloride by SCAQMD at Station MY (Table 12 of this report).

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the increased residential construction along the southern border. The 1987 measurements are projected for the remaining 59-year period, although mitigation measures may be expected to lower vinyl chloride emissions. Applying the present risk calculation to the data specified in Table 13, the individual excess lifetime cancer risk over the changing exposure periods is estimated to be 1.8×10^{-5}, or approximately 2 in 100,000.

b. Risk Characterization Using DHS-TSCP/CARB/SCAQMD's 1982 Expanded Monitoring Program Data

During July to October 1982, DHS-TSCP, CARB and SCAQMD conducted a 90-day study to monitor ambient air around the B.K.K. Landfill for nine VOCs. The study was the first health risk assessment of the landfill. A summary of the report as well as a copy of the report are provided in the Appendix.

Three monitoring stations were located in residential neighborhoods around the landfill (A and B to the south; F to the north); two monitoring stations were located on the landfill (D at the entrance, E at the highest elevation); and SCAQMD's monitoring station in Pico Rivera, nine miles to the southwest, was selected as the control station C. The selection of Pico Rivera as a residential control site has since been questioned because of the influence from industrial emission sources in Pico Rivera. In 1982 it was considered to be the closest established monitoring station for which routine data had been

collected over a period of years, and an upwind location. Stations A, B, D, E, and F are shown in Figure 7. The study defined the exposure period as the previous seven years (1975-1982) reflecting the seven year period for which waste disposal records were available, the landfill expansion from 40 acres to 140 acres, and the increased residential construction along the southern border.

Continuous 24-hour samples were collected in Tedlar bags Sunday through Thursday. Split samples were taken and analyzed by two laboratories, SCAQMD's laboratory and CARB's southern laboratory branch (Haagen-Smit). Of the nine compounds monitored, seven were detected. Mean values from each laboratory were reported.

CH2MHill's 1988 report has conflicting information about the program's data for benzene. DHS-TSCP/CARB/SCAQMD reported that benzene was detected by one laboratory which had a detection limit of 2 ppb, but not by the second laboratory which had a detection limit of 20 ppb. Benzene was included in their health risk assessment. CH2MHill listed the detection limits for benzene from the two laboratories as 10 ppb and 20 ppb, and excluded benzene from its exposure assessment. CH2MHill did not document the discrepancy between the 2 ppb and 10 ppb detection limit for the one laboratory.

For this risk characterization, data from Station A are used. Topographic and meteorologic data suggested that the location of

Station A received higher contaminant levels than the other stations (B, D, E, and F), and represented a "worst-case" scenario.

Applying the present risk calculation to the 1982 Station A measured data, assuming the seven-year exposure period defined in the program (1975-1982) and an additive effect of the carcinogens, the individual excess lifetime cancer risk is estimated to be 1 in 10,000. This estimate includes the benzene data reported by one laboratory. Deleting the benzene data because of the discrepancies in detection limits reduces the estimated risk to approximately 5 in 100,000 (Table 14).

c. Risk Characterization Using EPA and DHS' 1984 Extended Monitoring Program Data (Indoor Air Monitoring, Priority I Evacuated Homes)

In July 1984, 19 homes along the southern and southeastern perimeter of the B.K.K. Landfill were evacuated when methane, from lateral subsurface migration of landfill gas, was detected at concentrations above the lower explosive limit (50,000 ppm). The Southern California Gas Company detected and identified the methane gas from the landfill during a routine survey (every four years for residential distribution piping systems). The landfill gas served as a transport medium for VOC's deposited at the facility. EPA and DHS developed the "Extended Monitoring Program" to investigate the hazards: 10 homes and 1 control home were designated Priority I, requiring indoor air monitoring for 9 VOC's and total hydrocarbons; 51 occupied homes and

TABLE 14

INDIVIDUAL EXCESS LIFETIME CANCER RISK[a]

DHS-TSCP/CARB/SCAQMD 1982 EXPANDED MONITORING PROGRAM

BKK LANDFILL, WEST COVINA, CA

Carcinogen	Molecular Weight	C-Station A[b] ppb	C-Station A[b] µg/m3	Unit Risk[c] $(\mu g/m^3)^{-1}$	Cancer Risk	EPA[d] Class
Chloroethane (Vinyl Chloride)	62.5	7.3	18.6	2.7E-6	4.0E-6	A
Perchloroethylene (PCE)	165.85	3.7	25.0	5.8E-7	1.2E-6	C
Trichloroethene (TCE)	131.4	1	5.37	1.3E-6	5.8E-7	B2
1,1-Dichloroethene (Vinylidene Chloride)	96.95	1.3	5.15	5.0E-5	2.1E-5	C
1,2-Dichloroethane (Ethylene Dichloride)	98.96	3	12.1	2.2E-5	2.1E-5	B2
Trichloromethane (Chloroform)	119.39	0.5	2.44	2.3E-5	4.5E-6	B2
Benzene	78.11	4.8	15.3	5.3E-5	6.5E-5	A
Total Excess Lifetime Cancer Risk Including Benzene						1.2E-4
Total Excess Lifetime Cancer Risk Excluding Benzene						5.2E-5

a: Calculated by ECR = C x YR x EF x RF x UR x 1/LT where

- ECR = Excess lifetime cancer risk
- C = Concentration in $\mu g/m^3$
- YR = Years of residence associated with exposure (7)
- EF = Exposure factor, i.e. percent of time at home (80%)
- RF = Retention factor, i.e. percent of measured concentration absorbed in the lungs (100%)
- UR = Unit risk value
- LT = Human individual lifetime in years (70)

b: Mean values, Station A, Table II, "Ambient Air Monitoring and Health Risk Assessment for Suspect Human Carcinogens Around the BKK Landfill in West Covina," DHS-TSCP/CARB/SCAQMD, March 1983, pg. 16. (Appendix B of this report).

c: Values taken from Table 3.15 of the "Air Toxics Assessment Manual," California Air Pollution Control Officers Association, October 1987, pgs. 3.5-24 to 3.5-28. Values current through June 1989.

d: EPA weight of evidence classification: A, sufficient evidence in humans; B1, sufficient evidence in animals, limited in humans; B2, sufficient evidence in animals, inadequate in humans; C, limited evidence in animals, inadequate in humans. Taken from EPA's Integrated Risk Information System (IRIS), June 1989.

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10 control homes were designated Priority II, requiring monitoring for vinyl chloride; and 90 subsurface landfill gas probes were installed onsite and offsite to monitor for total hydrocarbon levels.

Field technical support and data quality assurance support for the program were provided by the EPA FIT contractor (Ecology and Environment, Inc.). Laboratory analyses were done by West Coast Analytical Laboratories. Data management support was provided by an EPA contractor, Tech Law.

Priority I homes were monitored in October 1984 for the following nine VOC's: chloroform, 1,1-dichloroethylene, benzene, carbon tetrachloride, 1,2-dichloroethane, 1,1,1-trichloroethane, perchloroethylene, trichloroethylene, and vinyl chloride. Composite 24-hour samples were collected in Tedlar bags and analyzed by gas chromatography-mass spectrometry.

Data for Priority II homes were not available and not discussed by CH2MHill. CH2MHill prepared Table 15 as a summary of the data for the Priority I homes and the control home, and recorded the data for the program in Volume 5 Appendix H-2. CH2MHill did not list benzene, as seen in Table 15, because detections were attributed to laboratory contamination. No documentation or explanation of the laboratory contamination was provided. Data for benzene is added as a footnote to Table 15. Carbon tetrachloride and chloroform were not detected in any of the ten Priority I homes, and are not included in the risk

TABLE 15 (CH2MHILL)

Table 6-13
SUMMARY OF 1984 INDOOR MONITORING IN PRIORITY I HOMES AND A CONTROL HOME

Chemicals	Priority I Homes (10) (ppb v/v)			Control Home (ppb v/v)		
	No.[a]	Median	Maximum	No.	Median	Maximum
1,1-Dichloroethylene	75	<1	2	4	<1	<1
1,2-Dichloroethane	75	3	14	4	<1	<1
1,1,1-Trichloroethane	75	4	14	4	3	4
Carbon Tetrachloride	75	<1	<1	4	<1	<1
Chloroform	75	<1	<1	4	<1	<1
Perchloroethylene	75	2.5	21	4	1.5	2
Trichloroethylene	75	1.5	6	4	<1	<1
Vinyl Chloride	75	<4	7	4	<4	<4

Notes:
Data source is the 1984 Extended Monitoring Program.
Values presented with < symbol are detection limits.
[a]Number of samples.

Source: CH2MHill, Table 6-13, "BKK Landfill Environmental Exposure Characterization Report, West Covina, California," August 15, 1988, Volume I, P. 6-45.

Benzene data in CH2MHill Volume 5, Appendix H-2, 1988, are the following: Priority I homes - 70 samples, median value 7 ppb, maximum value 29 ppb; Control home - 2 samples, 4 and 6 ppb.

Carbon tetrachloride and chloroform were not detected in any of the 10 Priority I homes.

A detection limit of 4 ppb for vinyl chloride is not substantiated by recorded values in Volume 5, Appendix H-2.

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characterization; the values in Table 15 for carbon tetrachloride and chloroform are the detection limits for the compounds. A detection limit of 4 ppb for vinyl chloride in Table 15 is not substantiated by recorded values in Volume 5, Appendix H-2: a value of 1 ppb is recorded for one home and a value of 2 ppb is recorded for three homes.

Because the concentrations detected in the Priority I homes appear somewhat similar to the concentrations detected in the control home, analysis of variance (ANOVA) was performed to determine if there was a difference. ANOVA is a statistical technique that investigates the contribution of one or more factors to the variation in an outcome of interest. For the seven compounds detected in the Priority I homes (vinyl chloride, 1,1-dichloroethylene, 1,2-dichloroethane, 1,1,1-trichloroethane, perchloroethylene, trichloroethylene, and benzene), 3-way ANOVA shows that concentrations detected in the Priority I homes were significantly higher than concentrations detected in the control home ($p < 0.039$). Excluding benzene, 2-way ANOVA of the six compounds shows a significant difference in the concentrations detected in the Priority I homes ($p < 0.006$). Both analysis controlled for sample date/calendar period, indicating that the difference was not due to the day the sample was taken. (Appendix E contains a more detailed description of the analyses.) Whether or not there were additional sources of the compounds within the homes cannot be determined from the available data.

Table 16 applies the present risk calculation to the six carcinogens detected in the Priority I homes. (1,1,1-Trichloroethane, a Class D carcinogen, is not included in the risk calculation; the inhalation reference dose is 192 ppb.) A one-year exposure period of January to December 1984 is assumed since all evacuated homes were allowed to be reoccupied by December, and elevated levels of methane and landfill gas may have been present for a short time prior to being detected by the routine survey. Assuming an additive effect of the carcinogens, the individual excess lifetime cancer risk is estimated to be 2 in 100,000 including benzene, and approximately 6 in 1,000,000 excluding benzene.

d. Risk Characterization Using CARB and SCAQMD's 1985 Los Angeles Basin Air Toxics Monitoring Program Data

Pursuant to California's toxic air contaminant program (Health and Safety Code, Section 39650 *et seq*), CARB and SCAQMD initiated programs in 1985 to monitor selected VOC's at specific locations within the Los Angeles basin. Results were reported in "The Magnitude of Ambient Air Toxics Impacts From Existing Sources in the South Coast Air Basin" (SCAQMD, 1987). Air monitoring stations for SCAQMD were located in Anaheim, Azusa, Burbank, and Lennox; monitoring stations for CARB were located in El Monte, Long Beach, Los Angeles, Rubiodoux and Upland (Figure 9). Compounds selected for monitoring were: benzene, carbon tetrachloride, 1,2-dibromomethane, 1,2-dichloroethane, methylene chloride, perchloroethylene, toluene, 1,1,1-trichloroethane,

TABLE 16

INDIVIDUAL EXCESS LIFETIME CANCER RISK[a]

EPA and DHS 1984 EXTENDED MONITORING PROGRAM

BKK LANDFILL, WEST COVINA, CA

Carcinogen	Molecular Weight	Median[b] ppb	Median[b] µg/m3	Unit Risk[c] $(\mu g/m^3)^{-1}$	Cancer Risk	EPA[d] Class
Vinyl Chloride	62.5	4	10.2	2.7 E-6	3.1 E-7	A
Perchloroethylene	165.85	2.5	17.0	5.8 E-7	1.1 E-7	C
Trichloroethene	131.4	1.5	8.1	1.3 E-6	1.2 E-7	B2
1,1-Dichloroethene	96.95	1	4.0	5.0 E-5	2.3 E-6	C
1,2-Dichloroethane	98.96	3	12.1	2.2 E-5	3.0 E-6	B2
Benzene	78.11	7	22.4	5.3 E-5	1.4 E-5	A
Total Excess Lifetime Cancer Risk Including Benzene						2.0 E-5
Total Excess Lifetime Cancer Risk Excluding Benzene						5.8 E-6

a: Calculated by ECR = C x YR x EF x RF x UR x 1/LT where

- ECR = Excess lifetime cancer risk
- C = Concentration in $\mu g/m^3$
- YR = Years of residence associated with exposure (1)
- EF = Exposure factor, i.e. percent of time at home (80%)
- RF = Retention factor, i.e. percent of measured concentration absorbed in the lungs (100%)
- UR = Unit risk value
- LT = Human individual lifetime in years (70)

b: Median values taken from Table 6-13, "BKK Landfill Environmental Exposure Characterization Report, West Covina, California," CH2MHill. 1988, Volume I, p. 6-45.

c: Values taken from Table 3.15, of the "Air Toxics Assessment Manual," California Air Pollution Control Officers Association, October 1987, pgs. 3.5-24 to 3.5-28. Values current through June 1989.

d: EPA weight of evidence classification: A, sufficient evidence in humans; B1, sufficient evidence in animals, limited in humans; B2, sufficient evidence in animals, inadequate in humans; C, limited evidence in animals, inadequate in humans. Taken from EPA's Integrated Risk Information System (IRIS), June 1989.

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FIGURE 9
(SCAQMD)

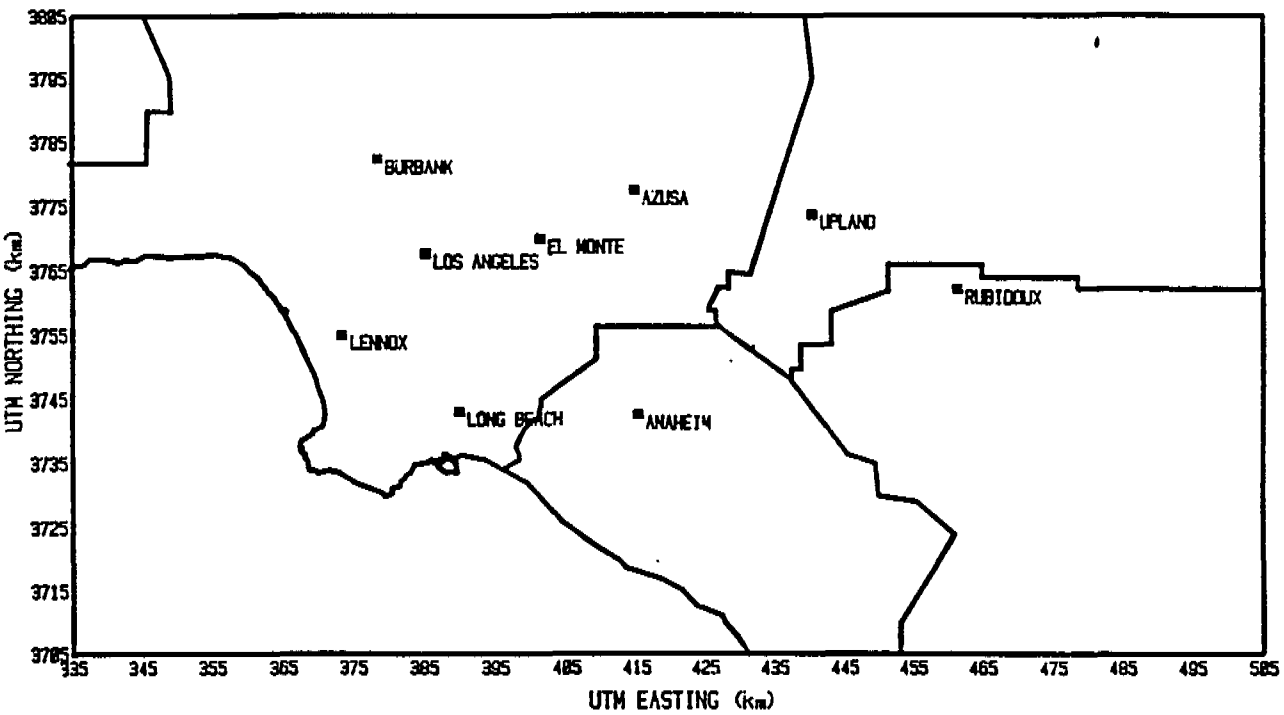

FIGURE V-1

AMBIENT AIR TOXIC MONITORING SITES IN THE SOUTH COAST AIR BASIN

Source: South Coast Air Quality Management District, Figure V-1, "The Magnitude of Ambient Air Toxics Impacts From Existing Sources in the South Coast Air Basin," June 1987, p. V-2.

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trichloroethylene, chloroform, and vinyl chloride, (Table 17). Values obtained from these programs provide "background" levels in the Los Angeles air basin. Sampling methods and analysis were not described in the report.

CH2MHill used data from the four SCAQMD monitoring stations in its 1988 report. This risk characterization uses data from CARB's El Monte station. Of all nine locations shown in Figure 9, El Monte appeared to be more representative of ambient air conditions which might exist around the B.K.K. Landfill. The Azusa station was not considered representative because of its proximity to mountains.

With the exception of vinyl chloride, the carcinogens detected in ambient air near the B.K.K. Landfill have also been detected in ambient air in the Los Angeles basin. For the carcinogens detected near the B.K.K. Landfill, Table 18 applies the present risk calculation to the annual average ambient concentrations of those carcinogens also detected at El Monte Station in the Los Angeles basin. Assuming a 70-year exposure and an additive effect of the carcinogens, the individual excess lifetime cancer risk for the area near the El Monte Station is estimated to be approximately 7 in 10,000.

Benzene emissions have the greatest cancer risk impact in the Los Angeles basin, corresponding to an upper-bound risk of 1 in 10,000 to 1 in 1,000 (SCAQMD, 1987). Benzene emissions are attributed almost

TABLE 17
(SCAQMD)

TABLE V-1

1985 ANNUAL AVERAGE AMBIENT AIR CONCENTRATIONS OF VARIOUS TOXIC ORGANIC GASES IN THE SOUTH COAST AIR BASIN[a]

(concentration in ppbv)

Pollutant	SCAQMD				ARB				
	Anaheim	Azusa	Burbank	Lennox	El Monte	Long Beach	LA	Rubidoux	Upland
BENZENE									
Ave. Conc.	1.7-2.8	1.0-2.6	2.0-3.0	1.7-2.8	4.9	4.1	4.2	2.5	3.4
Std. Dev.	1.6	.92	1.3	1.5	2.6	1.9	2.2	1.3	1.4
Detection Limit[b]	2.0-4.0	1.0-4.0	1.0-3.0	2.0-3.0	.5	.5	.5	.5	.5
Sample Size/# < DL[c]	24/10	21/13	23/9	23/10	39/0	25/0	23/0	24/0	22/0
Data Category[d]	B	B	B	B	A	A	A	A	A
CARBON TETRACHLORIDE									
Ave. Conc.	.12	.12	.10	.11	.095	.10	.11	.099	.12
Std. Dev.	.038	.036	.023	.033	.024	.014	.016	.015	.073
Detection Limit	.016	.016	.016	.016	.004	.004	.004	.004	.004
Sample Size/# < DL	22/0	19/0	20/0	20/0	36/0	22/0	21/0	20/0	20/0
Data Category	A	A	A	A	A	A	A	A	A
CHLOROFORM									
Ave. Conc.	.045-.30	.053-.29	.018-.24	.063-.27	.063	.082	.11	.053	.071
Std. Dev.	*[e]	*	*	*	.023	.025	.090	.028	.045
Detection Limit	.02-1.0	.02-1.0	.077-.5	.077-.89	.02	.02	.02	.02	.02
Sample Size/# < DL	22/21	19/18	20/20	20/18	36/0	22/0	21/0	20/0	20/0
Data Category	C	C	C	C	A	A	A	A	A
ETHYLENE DIBROMIDE									
Ave. Conc. (ppt)	5-100	0-100	0-100	0-100	3-6	4-8	2-6	2-6	3-5
Std. Dev. (ppt)	*	*	*	*	4	9.0	2.0	1.4	1.0
Detection Limit (ppt)	100	100	100	100	5	5	5	5	5
Sample Size/# < DL	22/21	19/19	20/20	20/20	36/26	22/15	21/14	20/16	20/9
Data Category	C	C	C	C	B	B	B	B	B
ETHYLENE DICHLORIDE									
Ave. Conc.	0-17	0-14	0-18	1.0-18					
Std. Dev.	*	*	*	*					
Detection Limit	2.1-28	4.0-28	4.0-28	4.0-28					
Sample Size/# < DL	22/22	19/19	20/20	20/19					
Data Category	C	C	C	C					

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TABLE V-1 (continued)

Pollutant	SCAQMD				ARB				
	Anaheim	Azusa	Burbank	Lennox	El Monte	Long Beach	LA	Rubidoux	Upland
METHYLENE CHLORIDE									
Ave. Conc.					5.1	4.6-4.7	3.5	2.2-2.3	2.7-2.8
Std. Dev.					2.6	2.9	2.0	1.9	1.7
Detection Limit					.006	.006	.006	.006	.006
Sample Size/# < DL					36/0	22/1	21/0	20/4	20/3
Data Category					A	A	A	B	B
PERCHLOROETHYLENE									
Ave. Conc.	3.1	2.0	2.7	2.3	1.6	1.0	1.2	.45	.70
Std. Dev.	2.4	1.8	1.6	2.5	.86	.56	.91	.32	.45
Detection Limit	.2	.2	.2	.2	.01	.01	.01	.01	.01
Sample Size/# < DL	22/0	19/0	20/0	20/0	36/0	22/0	21/0	20/0	20/0
Data Category	A	A	A	A	A	A	A	A	A
TOLUENE									
Ave. Conc.	4.0-5.6	2.5-4.9	5.6-6.7	3.5-5.3					
Std. Dev.	2.9	2.3	3.0	4.2					
Detection Limit	3.0-6.0	3.0-7.0	5.0	.40-5.0					
Sample Size/# < DL	24/8	21/11	23/5	23/11					
Data Category	B	B	B	B					
1,1,1-TRICHLOROETHANE									
Ave. Conc.	2.3	2.6	3.3	2.5	7.1	3.0	2.4	1.1	1.6
Std. Dev.	1.4	1.7	1.7	1.5	4.7	2.1	2.6	.73	1.1
Detection Limit	.23	.23	.23	.23	.02	.02	.02	.02	.02
Sample Size/# < DL	22/0	19/0	20/0	20/0	36/0	22/0	21/0	20/0	20/0
Data Category	A	A	A	A	A	A	A	A	A
TRICHLOROETHYLENE									
Ave. Conc.	.23-.35	16-.33	.39-.45	.20-.23	.40	.29	.34	.10	.37
Std. Dev.	.23	.26	.72	.22	.25	.20	.22	.06	.17
Detection Limit	.20-.90	.11-.90	.12-.22	.12-.15	.02	.02	.02	.02	.02
Sample Size/# < DL	22/7	19/8	20/7	20/15	36/0	22/0	21/0	20/0	20/0
Data Category	B	B	B	B	A	A	A	A	A
VINYL CHLORIDE									
Ave. Conc.	0-2.0	0-2.0	0-2.0	0-2.0					
Std. Dev.	*	*	*	*					
Detection Limit	2.0	2.0	2.0	2.0					
Sample Size/# < DL	24/24	21/21	24/24	24/23					
Data Category	C	C	C	C					

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TABLE V-1 (continued)

Pollutant	SCAQMD				ARB				
	Ana-heim	Azusa	Burbank	Lennox	El Monte	Long Beach	LA	Rubi-doux	Upland
BENZO(A)PYRENE (from EPA monitoring network)									
Ave. Conc. (ng/m^3)	.75						.75		
Std. Dev.	.17						.0079		
Det. Lim. (ng/m^3)	.33						.33		
Sample Size/# < DL	21/0						18/0		
Data Category	A						A		

[a] Blanks indicate no data available. Ranges of arithmetic annual averages defined as follows: first estimate is the average assuming all sub-detection limit observations equal zero; second estimate is the average assuming all sub-detection limit observations are equal to the detection limit concentration.

Standard deviations were calculated using only the observations above detection limits; if more than 90 percent of the observations were below detection limits, standard deviations were not calculated.

[b] Detection limits for some SCAQMD-measured pollutants reported as range because limits changed from sample to sample depending on analytical conditions. See text for further explanation.

[c] "Sample Size/# < DL" = (the total number of samples taken over the year) / (total number of these samples with concentrations below minimum detectable limits).

[d] Data Category codes for SCAQMD and ARB data are defined as: A - Most of the data above detection limits (>90%), C - Very few of the data points are above detection limits (<10%), and B - Several data points fall above and below detection limits.

[e] * standard deviation not calculated for Data Category C.

Source: South Coast Air Quality Management District, Table V-1, "The Magnitude of Ambient Air Toxics Impacts From Existing Sources in the South Coast Air Basin," 1987 Air Quality Management Plan Revision Working Paper No. 3, June 1987, Pgs. V-4 to V-6.

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TABLE 18

INDIVIDUAL EXCESS LIFETIME CANCER RISK[a]

CARCINOGENS DETECTED AT EL MONTE STATION, 1985 LOS ANGELES BASIN AIR TOXICS MONITORING PROGRAM AND ALSO DETECTED NEAR THE BKK LANDFILL, WEST COVINA, CA

Carcinogen	Molecular Weight	El Monte[b] ppb	El Monte[b] $\mu g/m^3$	Unit Risk[c] $(\mu g/m^3)^{-1}$	Cancer Risk	EPA[d] Class
Benzene	78.11	4.9	15.7	5.3 E-5	6.7 E-4	A
Vinyl Chloride	62.5	-	-	2.7 E-6	-	A
Perchloroethylene	165.85	1.6	10.9	5.8 E-7	5.1 E-6	C
Trichloroethylene	131.4	0.40	2.1	1.3 E-6	2.2 E-6	B2
1,2-Dichloroethane	98.96	-	-	2.2 E-5	-	B2
Chloroform	119.39	0.06	.3	2.3 E-5	5.5 E-6	B2
Total Excess Lifetime Cancer Risk					6.8 E-4	

a: Calculated by ECR = C x YR x EF x RF x UR x 1/LT where

ECR = Excess lifetime cancer risk

C = Concentration in $\mu g/m^3$

YR = Years of residence associated with exposure (70)

EF = Exposure factor, i.e. percent of time at home (80%)

RF = Retention factor, i.e. percent of measured concentration absorbed in the lungs (100%)

UR = Unit risk value

LT = Human individual lifetime in years (70)

b: Values taken from El Monte Station, Table V-1, "1985 Annual Average Ambient Air Concentrations of Various Toxic Organic Gases in the South Coast Air Basin," SCAQMD, 1987, pgs. V-4 to V-6.

c: Values taken from Table 3.15 "Air Toxics Assessment Manual," California Air Pollution Control Officers Association, October 1987, pgs. 3.5-24 to 3.5-28. Values current through June 1989.

d: EPA weight of evidence classification: A, sufficient evidence in humans; B1, sufficient evidence in animals, limited in humans; B2, sufficient evidence in animals, inadequate in humans; C, limited evidence in animals, inadequate in humans. Taken from EPA's Integrated Risk Information System (IRIS), June 1989.

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equally to mobile sources (motor vehicles) and area sources (gasoline marketing, stationary gasoline engines, crude oil production, and agricultural burning). In two earlier characterizations, (the 1982 Expanded Monitoring Program and the 1984 Extended Monitoring Program) benzene could be excluded from the risk calculation because of discrepancies with the data. The data in this characterization suggest that risks presented by exposure to benzene are more significant from ambient sources than from the B.K.K. Landfill.

e. Risk Characterization Using CARB's Modeling of 1987 Ambient Vinyl Chloride Concentrations Around the B.K.K. Landfill

CARB used monitoring data from the B.K.K. Landfill in an air dispersion model to estimate population exposure to vinyl chloride for the purpose of proposing to identify vinyl chloride as a toxic air contaminant (CARB, 1990, Draft Document). CARB is the state agency responsible for identification of toxic air contaminants. A toxic air contaminant is subject to a different regulatory process than an ambient air quality standard. A toxic air contaminant is an air pollutant which may cause or contribute to increased morbidity or mortality, or which may pose a present or potential human health hazard (California Health and Safety Code Section 39655). Identification of vinyl chloride as a toxic air contaminant allows CARB to develop control strategies that reduce vinyl chloride air levels far below 10 ppb.

CARB used the Industrial Source Complex Short Term (ISCST) Gaussian model to estimate vinyl chloride concentrations and exposed population. This model does not allow direct inference of distance. In this model, the B.K.K. Landfill was represented as an area source in the center of a grid of 41 one-square-kilometer cells (that is, a grid of approximately 25 square-miles). For each square-kilometer cell, annual average vinyl chloride concentrations were estimated using SCAQMD's 1981 meteorological data from Walnut Station, and SCAQMD's 1987 ambient vinyl chloride monitoring data from Station A, B, and MY (Table 19). Population estimates for each square-kilometer cell were determined from 1985 population census estimates. The 1,681 grid cells and associated population estimates were sorted from high to low by modeled vinyl chloride concentrations. Grid cell populations were then summed to determine the cumulative population exposed to a certain level of modeled vinyl chloride concentration. Table 20 shows the results of CARB's modeling.

Using CARB's modeled vinyl chloride concentrations, and applying the present risk calculation, the individual excess lifetime cancer risk ranges from 7 in 100,000,000 for exposure to 0.01 ppb of vinyl chloride to 4 in 100,000 for exposure to 7 ppb of vinyl chloride (Table 21).

TABLE 19
(CARB)

TABLE II-1

SUMMARY STATISTICS FOR THE JANUARY 1987 THROUGH DECEMBER 1987 MONITORING DATA FOR VINYL CHLORIDE NEAR BKK LANDFILL
(Concentrations reported in parts per billion (ppb))

	Station 1	Station 2	Station 3
Number of samples	337	337	345
Percent of Samples Below the LOD[a]	73	90	55
Estimated Concentration for[b] Samples Below the LOD	1.0	1.0	1.1
Estimated Mean[b] Concentration	1.7	1.2	2.6
Maximum 24-Hour Concentration[c]	7	8	15

a - The SCAQMD's limit of detection (LOD) for vinyl chloride is 2 ppb.
b - Gleit's method was used to estimate the concentration of samples below the LOD.
c - California's Ambient Air Quality Standard for vinyl chloride is 10 ppb for a 24-hour averaging period.

Source: California Air Resources Board, Table II-1, "Technical Support Document, Proposed Identification of Vinyl Chloride as a Toxic Air Contaminant, Draft Report, Executive Summary and Part A," Stationary Source Division, May 1990, p. A-7.

Stations 1, 2, and 3 are Stations A, B, and MY respectively.

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TABLE 20
(CARB)

TABLE II-5

RANGE OF CUMULATIVE POPULATION EXPOSED TO VINYL CHLORIDE NEAR BKK

Vinyl Chloride Concentration (ppb)	Range of Cumulative Population Exposed		
	Lower-Bound Estimate[a]		Upper-Bound Estimate[b]
0.01	2,026,000	-	2,154,000
0.05	732,000	-	1,970,000
0.1	374,000	-	1,431,000
1.0	17,000	-	131,000
2.0	0	-	54,000
3.0	0	-	28,000
4.0	0	-	20,000
5.0	0	-	14,000
6.0	0	-	7,000
7.0	0	-	2,500

a - The exposure estimate is based on a vinyl chloride emission rate of 0.75 micrograms meter^{-2} sec.$^{-1}$

b - The exposure estimate is based on a vinyl chloride emission rate of 3.32 micrograms meter^{-2} sec.$^{-1}$

Source: California Air Resources Board, Table II-5, "Technical Support Document, Proposed Identification of Vinyl Chloride as a Toxic Air Contaminant, Draft Report, Executive Summary and Part A", Stationary Source Division, May 1990, p. A-14.

Modeled data is for an area approximately 25 miles-by-25 miles around the B.K.K. Landfill, West Covina, California.

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TABLE 21

INDIVIDUAL EXCESS LIFETIME CANCER RISK[a]

CARB MODELING OF 1987 AMBIENT VINYL CHLORIDE CONCENTRATIONS

NEAR BKK LANDFILL, WEST COVINA, CA

Modeled Vinyl Chloride Concentration[b] ppb	$\mu g/m^3$	Cancer Risk
.01	.03	6.5E-8
0.1	0.3	6.5E-7
1.0	2.6	5.6E-6
2.0	5.1	1.1E-5
7.0	17.9	3.9E-5

a: Calculated by ECR = C_{VC} x YR x EF x RF x UR x 1/LT where

- ECR = Excess lifetime cancer risk
- C_{VC} = Concentration in $\mu g/m^3$ of vinyl chloride
- YR = Years of residence associated with exposure (70)
- EF = Exposure factor, i.e. percent of time at home (80%)
- RF = Retention factor, i.e. percent of measured concentration absorbed in the lungs (100%)
- UR = Unit risk value for vinyl chloride: 2.7×10^{-6} $(\mu g/m^3)^{-1}$, taken from Table 3.15, "Air Toxics Assessment Manual", California Air Pollution Control Officer's Association, October 1987, p. 3.5-28. Value current through June 1989.
- LT = Human individual lifetime in years (70)

b: Modeled vinyl chloride concentrations in ppb are taken from Table II-5, "Technical Support Document, Proposed Identification of Vinyl Chloride As A Toxic Contaminant, Draft Report, Executive Summary and Part A," CARB Stationary Source Division, May 1990, pg. A-14.

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2. Numerical Estimation - Population Excess Cancer Burden

The population excess cancer burden is calculated by multiplying the individual excess lifetime cancer risk in an exposed area by the population in the exposed area.

The individual excess lifetime cancer risks estimated in the risk characterization scenarios of the B.K.K. Landfill are:

- 1987 Ambient Vinyl Chloride Monitoring, Station MY 1.5×10^{-5}
- 1982-1987 Ambient Vinyl Chloride Monitoring 1.8×10^{-5}
- 1982 Expanded Monitoring Program, excluding benzene 5.2×10^{-5}
- 1984 Extended Monitoring Program, excluding benzene 5.8×10^{-6}
- Modeling of 1987 Ambient Vinyl Chloride 6.5×10^{-8} to 3.9×10^{-5}

In 1985, EPA estimated the population within a one-mile radius of the center of the B.K.K. Landfill to be approximately 40,000 persons (EPA, 1985). In actual fact, not all 40,000 persons are exposed to the levels of vinyl chloride suggested in these scenarios. Most residents are exposed to lower levels. CARB's Table 19 shows that in 1987 the proportions of samples below the detection limit of 2 ppb was 73 percent, 90 percent, and 55 percent for Stations A, B, and MY respectively.

Based on the risk characterization scenarios, the most appropriate individual excess lifetime cancer risk to estimate population excess cancer burden is derived from monitored data at Station MY. Using the individual excess lifetime cancer risk of 1.5×10^{-5} associated with 1987 ambient vinyl chloride monitoring at Station MY, and the estimated

population within a one-mile radius of the B.K.K. Landfill, the estimated population excess cancer burden is 0.6. That is, in a population of 40,000 persons less than one additional case of cancer would be associated with exposure to vinyl chloride at 2.7 ppb for an entire 70-year period.

Limitations and Uncertainties

A risk number is an estimate of the risk of adverse health effects conditional on the methods and assumptions of the risk characterization, and the limitations and uncertainties of the data collection.

CH2MHill addressed the limitations and uncertainties of the data collection in its exposure characterization (CH2MHill, 1988). These included the following:

- only a few air monitoring data sets were judged to be appropriate for quantitative risk assessment based on a retrospective quality assurance review;
- 24-hour air samples were collected, providing data on average air emissions only;
- air monitoring data are primarily from residential stations in the south and southeast which represent nighttime ("worst-case"), air flow.
- detection limits for vinyl chloride and benzene have changed, limiting direct comparison of data over time;

- not all analytes were measured in all media, and some media (soil, particulates) were rarely sampled;
- demographics are based on the 1980 U. S. population census data and projections, although there has been considerable development around the B.K.K. Landfill.

Limitations of this health risk assessment include the following:

- use of data from 1982 through 1987 only;
- use of different summary statistics (that is, geometric means, arithmetic means, medians, and annual averages);
- use of June 1989 toxicity values.

Uncertainties inherent in this health risk assessment include:

- the assumptions stated at the beginning of the risk characterization;
- the choice of unit risk values.

The Class I Hazardous Waste Management Unit stopped accepting hazardous waste by December 1984, and was capped and closed in March 1989. Mitigation measures stipulated in the SAM Work Plan may be expected to reduce vinyl chloride emissions to levels and frequences below those detected in 1987.

Significance of the Risk

Excess lifetime cancer risk is estimated in order to assess the potential impact of a particular exposure in addition to the relatively constant background level of cancer risk. An individual has approximately a one in three (3×10^{-1}) risk of developing cancer during his or her lifetime.

The ambient vinyl chloride monitoring data represent the most appropriate data t assess the excess cancer risk associated with the B.K.K. Landfill because vinyl chloride is not commonly detected in the Los Angeles air basin. Carcinogens such as benzene, perchloroethylene, and trichloroethylene are detected in ambient air both at the B.K.K. Landfill and in the Los Angeles basin. These compounds may present an additional cancer risk to people living near the B.K.K. Landfill but it is not possible with the present data to distinguish between exposure due to ambient levels and exposure due to the B.K.K. Landfill. Vinyl chloride is rarely detected in the ambient air, and therefore vinyl chloride more clearly represents the increased exposure associated with the B.K.K. Landfill.

Based on the 1987 ambient vinyl chloride concentrations, and the methods and assumptions used in this health risk assessment, the individual excess lifetime cancer risk associated with exposure to the carcinogen detected in air around the B.K.K. Landfill is estimated to be approximately 1 to 2 individuals in 100,000 persons. This assumes everyone is exposed to vinyl chloride at the 1987 concentrations for an entire 70-year lifetime. Most residents are exposed to lower levels of vinyl chloride and most

residents are not likely to stay at one place an entire lifetime. Mitigation measures stipulated in the SAM Work Plan may be expected to reduce vinyl chloride emissions from the B.K.K. Landfill.

Currently, DHS and CARB are reevaluating the data on the carcinogenicity of vinyl chloride, in recent and past literature, for the purpose of identifying vinyl chloride as a toxic air contaminant, pursuant to the Health and Safety Code Section 39650 *et seq*. When this process is completed, a new unit risk value for vinyl chloride will be established. The new value is likely to b about 29 times greater than the value used in this health risk assessment. When this new value is adopted, DHS will prepare an addendum to this risk assessment, reflecting the changed unit risk value for vinyl chloride, updating toxicity values, and adding air monitoring data collected since 1987.

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APPENDIX A

SUMMARY OF THE THREE PREVIOUS HEALTH RISK ASSESSMENTS OF THE B.K.K. LANDFILL, WEST COVINA, CALIFORNIA

Three previous health risk assessments have been performed evaluating residential exposure to seven carcinogens detected in ambient air around the B.K.K. Landfill. Risk estimates varied due to different assumptions and methods of risk calculation, as described in the following paragraphs. Copies of the three risk assessments are provided as Appendices A, B, and C. The seven carcinogens evaluated were: vinyl chloride, benzene, trichloroethylene (TCE), 1,1-dichloroethylene (vinylidene chloride), perchloroethylene (PCE), 1,2-dichloroethane (ethylene dichloride), and trichloromethane (chloroform).

1. "Ambient Air Monitoring and Health Risk Assessment for Suspect Human Carcinogens Around the BKK Landfill in West Covina", Department of Health Services-Toxic Substances Control Program/California Air Resources Board/South Coast Air Quality Management District (DHS-TSCP/CARB/SCAQMD), March 1983. (Appendix B)

   During July to October 1982, DHS-TSCP, CARB, and SCAQMD conducted a 90-day study to monitor ambient air around the B.K.K. Landfill for nine volatile organic compounds in response to continued concerns from neighboring residents. Twenty-four hour ambient air samples were collected in Tedlar bags on Sunday through Thursday at six sample stations. Figure 7 of this report (and Figure I of Appendix A) shows the locations of the stations: Stations A and B were located in residential areas south of the landfill, reflecting nighttime air drainage patterns; Station D was located at the entrance to th landfill; Station E was located at the highest elevation within the landfill, reflecting daytime transport; Station F was initially located in a residential area on the northeast side and on August 26, 1982, it was moved to the northwest in response to odor complaints from that area. Station C was located in Pico Rivera, nine miles southwest (upwind) of the facility, to estimate background levels. Stations A, B, D, and E were within 400 to 1,000 feet of the waste disposal area while Station F was 2,500 and 6,000 feet from the facility. The data given for Station F are an equally weighted average of the two locations. Split samples were taken and analyzed by two laboratories, SCAQMD's laboratory and CARB's southern laboratory branch, (Haagen-Smit).

   DHS considered the nine volatile organic compounds to be known or potential human carcinogens: vinyl chloride, benzene, perchloroethylene, trichloroethylene, 1,1-dichloroethylene, chloroform, 1,2-dichloroethane, chlorobenzene, and trans-1,2-dichloroethene. The report stated that chlorobenzene and trans-1,2-dichloroethene were not detected. The remaining seven chemicals were detected in concentrations near the analytical limit of detection. Elevated levels of the seven were found around the B.K.K. Landfill compared to the control community of Pico Rivera. Stations A, B, and D had consistently more elevated levels than Stations E and F.

The risk assessment focused solely on the risk of cancer because the chemicals were detected in concentrations considered below their threshold for non-carcinogenic, toxic effects -- even at the highest concentrations detected. Excess cancer risks were derived by subtracting the average concentration of each substance at Station C from the average concentration of that substance at the B.K.K. Landfill monitoring site. The exposure period was defined as the previous seven years, 1975 to 1982, since that time reflected the beginning of recorded waste deposits, the landfill expansion from 40 acres to 140 acres, and the increased residential construction along the southern border. The report did not identify slope factors or unit risk values used in the risk calculation. Individual excess lifetime (70-year) cancer risk was based on the following assumptions:

- no dilution in the measured concentrations at Stations A-F;
- exposure for 24 hrs/day, 365 days/year, for 7 years (1975-1982);
- 100 percent absorption in the lungs.

The maximum individual excess lifetime cancer risk attributable to emissions from the B.K.K. Landfill for the previous 7 years was estimated to be approximately 5 per 100,000 (5×10^{-5}).

The population living within a one-mile radius of the B.K.K. Landfill property line was estimated to be approximately 7,700 persons. This number was derived by dividing the county assessor's plot maps into quadrants corresponding to monitoring Stations A, B, D, and F, and estimating the population within each quadrant from the 1980 census data. The population excess cancer burden was calculated for the population within each quadrant using the mean concentration difference for the respective station, then summing the derived excess number of cancers. No additional cases of cancer were suggested.

2. "Estimates of Carcinogenic Risk in the Vicinity of the BKK Landfill", K. S. Crump and Co., Inc., March 1986. (Appendix C)

In March 1986, K. S. Crump, as a consultant to attorneys for the B.K.K. Landfill, performed a risk assessment on the seven carcinog ns detected in the DHS-TSCP/CARB/SCAQMD 1983 report. Crump identified epidemiologic data that he used to derive a human potency estimate for benzene, and the animal toxicologic data that he used in the linearized multistage extrapolation model to derive human potency estimates for the six other compounds. Exposure concentrations were taken from two air monitoring programs: the SCAQMD 1981-1985 ambient vinyl chloride monitoring program of the B.K.K. Landfill, supplemented by a University of Southern California 1980 residential monitoring program around the B.K.K. Landfill. The following assumptions were used:

- average air concentrations, from 12 SCAQMD stations and 4 USC stations;
- exposure for 24 hours per day, 365 days per year, for 8 years (1978-1985).

According to Crump's methods, the lowest maximum likelihood estimate of total risk from all seven carcinogens was 2.5 x 10^{-6} and the highest upper 95 percent confidence limit estimate of total risk was 11 x 10^{-6} (Table 11 of Appendix B). If typical year-round occupancy of a home were no more than 12 hours/day, Crump estimated the risk to range between 1.25 to 6 per million people exposed.

3. "Risk Assessment for Exposure to Ambient Air in the Vicinity of the BKK Landfill in West Covina, 1978-1985", K. T. Bogen and M. T. Smith, April 1986. (Appendix D)

In April 1986, Bogen and Smith, as consultants to attorneys for the B.K.K. Landfill, performed a risk assessment on the seven carcinogens detected in the DHS-TSCP/CARB/SCAQMD 1983 report. Bogen and Smith identified relevant animal bioassay data and used a Monte Carlo Potency Analysis (MCPA) method to derive potency distributions for the seven carcinogens. The MCPA method uses the multistage model of cancer, but rather than a single upper-bound confidence value for potency, Monte Carlo simulation produced complete distributions for potency estimation error. The following assumptions were applied by Bogen and Smith to the data in the 1983 DHS-TSCP/CARB/SCAQMD report:

- 50 percent dilution in the measured concentrations at Stations A, B, D, and F due to dispersion in ambient air;
- exposure for 15 hours/day, 365 days/year, for 7 years (1978-1985);
- 50 percent absorption in the lungs, based on a study cited by Bogen and Smith.

Potency distributions were generated for each compound and each monitoring station and, again using a Monte Carlo procedure, the corresponding potencies were added to obtain a distribution of total increased risk from all seven compounds. From the latter distribution, Bogen and Smith selected the 50th percentile value of 2.2 x 10^{-6} as a "best" estimate of increased lifetime cancer risk for the average individual living near the B.K.K. Landfill for the seven-year period. The "best" estimate value is a risk value as likely as not to overestimate the true level of average increased individual risk. Assuming the population of 7,700 exposed individuals from the DHS-TSCP/CARB/SCAQMD 1983 report, Bogen and Smith calculated a population excess cancer burden of 0.01 cases.

TABLE 22

SUMMARY OF THE THREE PREVIOUS HEALTH RISK ASSESSMENTS
OF THE BKK LANDFILL, WEST COVINA, CA

Report	Assumptions[a]	Methods	Excess Cancer Risk
"Ambient Air Monitoring and Health Risk Assessment for Suspect Human Carcinogens Around the BKK Landfill in West Covina." DHS-TSCP/CARB/SCAQMD 1983	- no dilution in 1982 measured concentrations at Stations A B C D E F - exposure for 24 hrs/day 365 days/yr, 7 yrs (1975-82) - 100% absorption in the lungs	individual excess lifetime cancer risk and population excess cancer burden	5×10^{-5}
"Estimates of Carcinogenic Risk in the Vicinity of the BKK Landfill." K.S. Crump & Co. 1986	- average air concentrations from 12 SCAQMD Stations and 4 USC Stations - exposure for 24 hrs/day 365 days/yr, 8 yrs (1978-85)	maximum likelihood and upper 95% confidence limit estimate	$2.5\text{-}11 \times 10^{-6}$
"Risk Assessment for Exposure to Ambient Air in the Vicinity of the BKK Landfill in West Covina, 1978-1985." Bogen & Smith 1986	- 50% dilution in 1982 measured concentrations at Stations A B D & F - exposure for 15 hrs/day 365 days/yr, 7 yrs (1978-85) - 50% absorption in the lungs	Monte Carlo potency analysis method and Monte Carlo procedure; "best" estimate	2.2×10^{-6}

a: All three health risk assessments evaluated residential exposure to concentrations of the following seven carcinogens: vinyl chloride, benzene, trichloroethylene, perchloroethylene, 1,1-dichloroethylene, 1,2-dichloroethane, and chloroform.

APPENDIX B